MAX PLANCK INSTITUTE FOR HUMAN DEVELOPMENT
RESEARCH REPORT 2020-2022/23

Research Report 2020–2022/23

This PDF presents the scientific activities of the Max Planck Institut (MPI) for Human Development. The digital report is complemented by our novel magazine Spotlight, which gives readers a unique perspective into our institute's inner working and highlights our work's interdisciplinary nature.

Centers

Center for Adaptive Rationality (ARC)
Director: Ralph Hertwig

How do people make decisions in a complex and everchanging world? Classic theories of rationality often assume that there is a single best, typically computationally complex, strategy for decision making. The Center has a different view: that people can draw on an “adaptive toolbox” of simple strategies that have evolved or been learned in response to environmental demands and the mind’s limited cognitive resources. Whether or not a simple strategy will succeed depends on the fit between that strategy and the statistical structure of the environment—that is, on its ecological rationality. Understanding how cognitive and environmental structures fit together is the key to explaining and predicting human decision making.

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Center for the History of Emotions (HoE)
Director: Ute Frevert

The Center was established with the aim of exploring the various aspects of emotions within the context of time and space. In the beginning, HoE focused mainly on reconstructing the norms and standards of past emotions and on the widely differing perceptions former generations had of emotions. In a second phase, the attention shifted to concepts and knowledge of emotions, which were seen as being embedded in social, cultural, and political contexts and closely linked to practices. Finally, emotions were not conceived, as in an earlier tradition, as something that was passively felt. Instead, they were conceptualized as something actively done, involving the mind, the heart, and the body alike.

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Center for Humans and Machines (CHM)
Director: Iyad Rahwan

The Center conducts interdisciplinary science to understand, anticipate, and shape major disruptions from digital media and artificial intelligence (AI) to the way we think, learn, work, play, cooperate, and govern.
CHM’s goal is to understand how machines are shaping human society today and how they may continue to shape it in the future. The projects are organized in broad themes: Behavioral AI Safety & Ethics, Cooperative AI, AI-Mediated Communication, AI Governance, and AI-Driven Cultural Evolution.

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Center for Lifespan Psychology (LIP)
Director: Ulman Lindenberger

How do children steadily acquire knowledge about the world they live in, even though their memories of specific events are often quite vague? Which factors promote the preservation of cognitive abilities in old age? How does the brain change while we learn a new skill? These are some of the research questions currently investigated at the Center for Lifespan Psychology (LIP). LIP studies human development from infancy into old age. Using training studies, it explores hidden potentials by examining how brain plasticity is related to behavioral change. It participates in longitudinal studies to identify determinants and consequences of between-person differences in change.

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Adaptive Rationality

Director: Ralph Hertwig

Introduction

Classic theories of rationality often assume that there is a single best, typically computationally complex, strategy for decision making—and best is best irrespective of the choice environment in which agents find themselves. We at the Center for Adaptive Rationality (ARC) have a different view, inspired by Herbert Simon's concept of bounded rationality and our and others' work on ecological rationality. Rather than assuming that there is an ideal and a priori strategy for decision making, we explore the notion of an "adaptive toolbox" of simple strategies that evolved or have been learned in response to environmental demands and the mind's limited cognitive resources. We highlight the importance of considering the statistical structures of the decision environments and how they can influence the speed, accuracy, or frugality—to name just a few key performance dimensions—of different decision strategies. This notion of ecological rationality implies what is ideally a collaborative relationship between mind and environment: The environment can compensate for the mind's limited cognitive resources by facilitating the use of simpler decision strategies without sacrificing accuracy. In this view, understanding how cognitive and environmental structures fit together is the key to explaining and predicting human decision making.

We study three classes of cognitive strategies that belong in the adaptive toolbox: heuristics, exploration and learning strategies, and strategies for harnessing the knowledge of others. Across these three classes, we aim to advance three major research goals. The first goal is to describe these cognitive strategies and how they exploit structures of environments. This includes theoretically analyzing and predicting the occurrence of specific structures to understand when and where specific heuristics will work well or falter. The second goal is to unravel the developmental dynamics of the adaptive toolbox over the lifespan. Cognitive tools develop in response to changes inside the mind—for example, cognitive resources such as memory grow or decline—and to changes outside the mind, such as shifting environmental demands. Therefore, it is imperative to understand how the mind's adaptive toolbox is impacted in response to these internal and external dynamic changes. Our final goal is to help people make better decisions, particularly in modern and highly engineered environments such as social media, which present challenges to individual autonomy and sound decision making. Our objective is to analyze the specific challenges posed by these environments and to design interventions that empower people to counter those challenges and make informed decisions, while preserving agency and autonomy.

ARC in June 2023
Image: MPI for Human Development

Coming from a wide range of disciplines—including cognitive science, psychology, philosophy, economics, biology, anthropology, computational social science, and machine learning—we use a variety of methods, including behavioral experiments, computer simulations, mathematical and theoretical analyses, as well as systematic literature reviews and meta-analyses. In the following, we outline the theoretical tenets and major research areas and turn to some highlights of our work between 2020 and 2022.

The Heuristic Mind

Heuristics are simple cognitive strategies whose success depends on how well they fit the statistical structures of the environment. There is now a growing catalog of environmental structures found to be conducive to the success of heuristics. But this cataloging approach has a weakness, which is that one may end up with a different heuristic for each discernible environmental structure. To predict whether a given heuristic will succeed or fail, researchers need to develop theories of the mechanisms that give rise to structures in the environment. To demonstrate this approach and its benefits, we proposed a new theory that explains the ubiquitous coupling of risks and rewards as arising from competition over limited resources. We also approached the thorny problem of strategy selection and investigated how individuals select a strategy from the adaptive toolbox by exploring how the number of choice attributes influences strategy selection. Finally, we examined how one's social environment may provide a rich and informative sampling space for making inferences about social statistics. [more]

The Exploring Mind

Considering how people search for and learn from information goes a long way toward explaining their choices. This is well-illustrated by the description–experience gap, that is, the finding that choices vary depending on whether they are based on semantic or symbolic descriptions of stochastic payoff structures versus their direct experience. We have continued to unravel implications of this gap that go far beyond the small world of monetary gambles. For instance, we proposed a framework of the psychology of risk to investigate the influence of learning on people's responses to risk. We also investigated whether the mainstream but lopsided perspective of people as irrational beings has been shaped by an experimental tradition that emphasized descriptions over experience. We also examined the cognitive attentional mechanisms underlying decisions from experience and continued our investigations into deliberate ignorance, that is, the conscious individual or collective choice not to seek or use available information. [more]

The Collective Mind

People can benefit greatly from social information when making decisions. Yet the social environment can also pose a threat, for instance, when opinions polarize. We have continued to investigate the benefits and challenges of social influence and how it impacts decision making. To this end, we considered the dynamic nature of social networks and their ability to adapt to changing information environments in order to produce intelligent collective behavior. Delving into the dark side of social networks, we developed a model, based on Twitter data, of the emergence of echo chambers and opinion polarization. We also explored the cognitive mechanisms underlying the integration of personal and social information and investigated the possibility that people join groups to divert regret and responsibility away from themselves. Finally, we proposed a new computational theory of conflicts in groups. [more]

The Unfinished Mind

The human mind is a work in progress. We have made significant advancements in understanding the evolutionary origins and the lifelong development of human preferences and the ability to make adaptive judgments and decisions. We conducted pioneering experiments with chimpanzees to examine whether their risk preferences show similarities with human risk preferences, such as an inverted-U-shaped relation between risk taking and age. In other work, we showed how an ecological perspective on adolescent risk taking may help people shift from seeing it as a flaw to seeing it as adaptive. Finally, we untangled a puzzling inconsistency: the finding that whereas adults are often seen as incompetent and even irrational when dealing with probabilities, babies and chimpanzees seem to be surprisingly capable of statistical learning and inference. It turns out that a key factor in understanding this discrepancy is whether judgments are based on abstract descriptions or on the direct experience of probabilities. [more]

The Boosted Mind

We have investigated and promoted the use of boosts—behavioral interventions that aim to foster people's competences to make good choices while preserving individual agency and autonomy. Boosts differ greatly from nudges, which exploit people's cognitive biases without correcting them. We continued our conceptual work contrasting boosting and nudging and identified conditions where policy makers may choose to use nudges instead of boosts—even though empowering people to liberate themselves from biased judgments is an uncontroversial social good. We also analyzed the challenges of the online world for democracy and individual autonomy and started developing a tool kit of boosting tools that internet users can use to counter those challenges. Last but not least, we also made contributions to improving risk communication and fighting misinformation in the contexts of COVID-19 vaccination and opioid prescriptions and investigated the use of AI-based models to improve physicians' decision-making competence. [more]

Research Team 2020-2022/23

Last update: August 2023

Researchers

Ruben C. Arslan (as of 04/2021: Leipzig University, Germany), Stefanie Bug-Tönnies (until 03/2021), Mattea Dallacker (as of 09/2022: German Federal Foreign Office, Germany), Luka J. Debbeler (as of 10/2021: Charité Universitätsmedizin Berlin, Germany), Marwa El Zein, Nadine Fleischhut, **Ralph Hertwig**, Stefan M. Herzog, Juliane E. Kämmer (as of 04/2020: University of Bern, Switzerland), Anastasia Kozyreva, Ralf H. J. M. Kurvers, Philipp Lorenz-Spreen, Mehdi Moussaid, Thorsten Pachur (as of 04/2022: Technical University of Munich [TUM], Germany), David Pietraszewski, Zoe Rahwan, Christin Schulze (as of 07/2023: University of New South Wales, Australia), Bernhard Spitzer (as of 01/2022: AMD Group, MPI for Human Development, Berlin, Germany), Odette Wegwarth (as of 08/2021: Charité Universitätsmedizin Berlin, Germany), Jan K. Woike (as of 06/2020: Plymouth University, UK), Dirk U. Wulff

Postdoctoral Fellows

Jinan N. Allan (as of 08/2023: Clemson University, USA), Stefan Appelhoff (as of 01/2023: AMD Group, MPIB, Berlin, Germany), Florian Bolenz, Simon Ciranka (with the AMD Group, MPIB, Berlin, Germany), Maria A. Claassen, Dominik Deffner, Félicie Dhellemmes, Kamil Fulawka, Anton Gollwitzer (as of 04/2022: Norwegian Business School (BI), Osto, Norway), Sebastian Grüneisen (as of 04/2021: Leipzig University, Germany), Lou M. Haux, Bertrand Jayles (as of 03/2021: EDHEC Business School, Singapore Campus, Singapore), Marwa Kavelaars, Elizaveta Konovalova (as of 09/2020: Business School, University of Warwick, UK), Christina Leuker (as of 08/2020: Robert Koch Institute, Berlin, Germany), Ying Li (as of 10/2022: Chinese Academy of Sciences, Beijing, China), Juan Linde-Domingo (as of 06/2022: AMD Group, MPI for Human Development, Berlin, Germany), Lisa Oswald, Anna Thoma, Kevin E. Tiede, Alan N. Tump, Veronika Zilker (as of 08/2022: Technical University of Munich [TUM], Germany), Nikolas Zöller

Predoctoral Fellows

Samuel Aeschbach, Julian Berger, Verena Clarmann von Clarenau (until 11/2022), Michael Geers, Ksenija Gumenik (until 01/2021), Marlene Hecht, Shahar Hechtlinger, Ezequiel López López, Pietro L. Nickl, Konstantin Offer, Lisa Reiber (as of 01/2021: Citizens for Europe, Berlin, Germany), Alexander Schakowski, Caedyn Stinson, Friederike Stock, Mubashir Sultan, Sarah Swanke, Anna Thoma, Yujia Yang

Associate Research Scientists

Florian Artinger (Berlin International University of Applied Sciences, Germany), Daniel Barkoczi (University of Southern Denmark, Odense, Denmark), Thomas Christophel (Humboldt-Universität zu Berlin, Germany), Larissa Conradt (NHS Business Services, Newcastle, UK), Renato Frey (University of Basel, Switzerland), Mirjam Jenny (University of Erfurt, Germany), Tomás Lejarraga (University of the Balearic Islands, Palma, Spain), Stephan Lewandowsky (University of Bristol, UK), Aleksandra Litvinova (DKB Code Factory, Berlin, Germany), Shenghua Luan (Chinese Academy of Sciences, Beijing, China), Jutta Mata (University of Mannheim, Germany), Björn Meder (Health and Medical University, Potsdam, Germany), Dirk Ostwald (Otto von Guericke University Magdeburg, Germany), Timothy Pleskac (The University of Kansas, Lawrence, USA), Jaron Alena Porciello (Cornell University, Ithaca, USA), Michael Schulte-Mecklenbeck (University of Bern, Switzerland), Leonidas Spiliopoulos, Wouter van den Bos (University of Amsterdam, Netherlands), Charley Wu (University of Tübingen, Germany)

Visiting Researchers

Zeynep Akbal (University of Potsdam, Germany), Bahador Bahrami (Ludwig-Maximilians-Universität München [LMU Munich], Germany), Hassan Bassam (Humboldt-Universität zu Berlin, Germany), Hannah Billenstein (Humboldt-Universität zu Berlin, Germany), Max Bromberg (Freie Universität Berlin, Germany), Jason Burton (Copenhagen Business School (CBS), Denmark), Xiaohong Cai (University of Kansas, Lawrence, USA), Valerii Chirkow (Humboldt-Universität zu Berlin, Germany), Yvonne Daschowski (University of Potsdam, Germany), Moritz Dörfler (MPI for Human Cognitive and Brain Sciences, Leipzig Germany), Helen Fischer (Leibniz-Institut für Wissensmedien, Tübingen, Germany), Maud Grol (Ghent University, Belgium), John Gubernath (Robert Koch Institute, Berlin Germany), Lin Hanzhe (Wageningen University, Netherlands), Susanne Haridi (MPI for Biological Cybernetics, Tübingen, Germany), Josefine Hebisch (University of Münster, Germany), Zakir Hussain (University of Basel, Switzerland), Esther Ibanez (Sorbonne University, Paris, France), Zhiqi Kang (Humboldt-Universität zu Berlin, Germany), Monika Keller, Casper Kerren, Lothar Krappmann, Barbara Kreis (University of Mannheim, Germany), Kiri Kuroda (University of Tokyo, Japan), Tomás Lejarraga (University of the Balearic Islands, Palma, Spain), Stefan Lipman (Erasmus University Rotterdam, Netherlands), Shenghua Luan (Chinese Academy of Sciences, Beijing, China), Jutta Mata (University of Mannheim, Germany), Surabhi S. Nath (MPI for Biological Cybernetics, Tübingen, Germany), Matteo Ottaviani (Scuola Normale Superiore di Pisa, Italy), Quincy Zora Peters (University of

California, Los Angeles, USA), Ilse Pit (University of Oxford, UK),Timothy Pleskac (The University of Kansas, Lawrence, USA), Jaron Alena Porciello (Cornell University, Ithaca, USA), Kavitha Ranganathan (T.A. Pei Management Institute (TAPMI), Manipal, India), Oded Ritov (University of California, Berkeley, USA), Alina Schneider (Humboldt-Universität zu Berlin, Germany), Leonidas Spiliopoulos, Wouter van den Bos (University of Amsterdam, Netherlands), Charley Wu (University of Tübingen, Germany), Justin Yeung Wang Ngai (University of Amsterdam, Netherlands)

A current list of the Center's staff with links to their web profiles can be found on the Center's website.

Image: MPI for Human Development

The Heuristic Mind

Making good decisions is not a simple feat. Ubiquitous conditions, such as bounds on information, time, and computational resources, can render the reckoning with risk and uncertainty a challenge. We argue that people respond to this challenge by harnessing simple but often highly efficient decision-making rules—heuristics. Our aim is to identify and describe these heuristics, to understand how they exploit statistical properties of the environment and what can be learned about these properties, and how people adapt their use of different heuristics to the environment in question.

How to Tap Into the Information Trove That Is One’s Personal Environment

A person’s social network constitutes a rich sampling space for making inferences about the distribution of social statistics, including other people’s preferences, opinions, or behaviors. How do people search this personal sampling space and use it when making such inferences about social statistics?

We (Schulze et al., 2021) developed the social-circle model to explain how people make inferences about social statistics by using their personal environment as an information search space. The model assumes that a person's internal representation of their social network is structured as distinct social circles of self, family, friends, and acquaintances. Our model outperformed both simpler and more complex competitor models and revealed interesting differences in the process of social sampling between adults and children. For instance, children weighted their “self” circle more heavily than adults did. By understanding how people tap into the information trove that is their proximate social environment, we hope to better understand how people learn, without instruction, from their social world and how they rely on it to infer important social statistics.

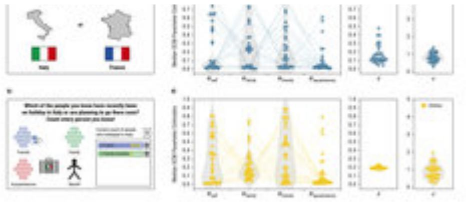

Figure 1. Illustration of the task screen used in the inference task (Panel a) and retrieval task (Panel b) in Schulze et al. (2021; Study 2). In the retrieval task, each participant indicated how many members of their social network had experienced the relevant events (e.g., whether they had spent a vacation in Italy) and to which social circle they belonged. These responses were used to derive the predictions of the social-circle model for participants' responses in the inference task. Panels c and d show the distributions of the medians of each individual's posterior distribution of social-circle model (SCM) parameter estimates in Study 2 of Schulze et al. (2021) for the adults and children, respectively. The lines link the estimated circle-weight parameters of each participant.

Figure: American Psychological Association
Adapted from Schulze et al. (2021)

Key Reference

Schulze, C., Hertwig, R., & Pachur, T. (2021). Who you know is what you know: Modeling boundedly rational social sampling. *Journal of Experimental Psychology: General*, *150*(2), 221–241. https://doi.org/10.1037/xge0000799
MPG.PuRe DOI

Heuristics in Decision Making With External Information Search

Many assume that in decision making based on information that is overtly presented in the environment—so-called *decisions from givens*—heuristics play only a modest role. In decisions from givens, the cost of information acquisition is relatively low, thus precluding any need for simplification.

However, we (Pachur, 2022) showed that the costs of gathering and integrating information in visual search can become quite high when the amount of information exceeds a certain threshold (around four units). In light of these mental costs, people may rely on heuristics even in decisions from givens because of one of their key strengths: the reduction of mental costs. To test this hypothesis, participants judged which of two diamonds was more valuable, with each diamond described in terms of either four or eight attributes. A novel Bayesian classification method that considers both a person's decision and their response-time patterns found that the proportion of participants using a simple heuristic was higher when eight attributes were presented, compared to four. Moreover, those participants who used a more complex compensatory strategy in the eight-attribute condition displayed high error rates, demonstrating the costs of search and integration (Figure 2b). Our findings highlight the role that heuristics play in decision making from givens.

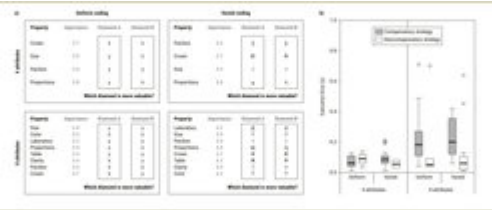

Figure 2. Panel a: The task screen of the different experimental conditions in Pachur (2022). Panel b: The estimated strategy execution error in the different conditions, separately for participants classified as using a compensatory or a noncompensatory strategy. Manipulating the type of coding of the attributes (uniform versus varied) had only a minor effect on strategy use.

Figure: Elsevier

Adapted from Pachur (2022)

Key Reference

Pachur, T. (2022). Strategy selection in decisions from givens: Deciding at a glance? *Cognitive Psychology*, *136*. https://doi.org/10.1016/j.cogpsych.2022.101483

MPG.PuRe DOI post-print

A Theory of Ecological Structure: How Risks and Rewards Get Coupled in the Environment

Many choice environments reveal a tight coupling of risks and rewards, or probabilities and payoffs. Specifically, they are coupled in such a way that high payoffs occur only with low probabilities. An adaptive mind can exploit this association by, for instance, using a potential reward size to infer the probability of obtaining it. This would offer people a simple way to reduce uncertainty. However, a mind can only adapt to and exploit such an environmental structure if it is frequent and recurrent.

We (Pleskac et al., 2021) developed the competitive risk–reward ecology theory (CET) that explains why the ecology of competition can make the association of high rewards with low probabilities ubiquitous. CET is based on the ideal free distribution principle. It states that competitors in a resource-rich environment will spread themselves out proportionally to, roughly speaking, the size of the resource patches. This principle implies that high rewards are associated with low probabilities because of others competing for the high rewards. Importantly, CET permits one to derive predictions about the boundaries of this relationship, such as how it degrades when the system is out of equilibrium. It also explains how various ecological factors can impact the relationship, for example, how computational and resource limitations lead to a shallower risk–reward relationship and how smaller rewards are associated with a larger range of probabilities.

Reanalyzing existing data and on the basis of new experiments, we found that people's mental representations and beliefs reveal the patterns that CET predicts. We further showed that people's estimates of probability changed with a variety of changing ecological conditions, as predicted by CET. Taken together, these results and insights highlight the necessity of not just describing those environmental structures that are relevant for human cognition but also developing theories for classes of environments. Only then can we predict when and how these environments support or hamper the mind's inferential machinery.

Key Reference

Pleskac, T. J., Conradt, L., Leuker, C., & Hertwig, R. (2021). The ecology of competition: A theory of risk-reward environments in adaptive decision making. *Psychological Review*, *128*(2), 315–335. https://doi.org/10.1037/rev0000261

MPG.PuRe DOI pre-print

The Hazards of Complexity in Modeling Cognition: Parameter Interdependencies

A key insight from ARC's research is that human decision-makers often rely on simple tools to address the challenges of a complex and uncertain world. More complex strategies, by contrast, can hamper good decision making. Trying to better understand the strengths and weaknesses of complex models commonly used in behavioral decision science, we (Krefeld-Schwalb et al., 2022) explored how fragile these complex models are. Specifically, we assumed that many adjustable parameters can compromise the usefulness of complex models of cognition. Models of recall and preferential choice commonly compute a subjective value for objects. They, in turn, are entered into a choice rule that determines the model's prediction of observable behavior. This rule is typically equipped with a free parameter that characterizes how deterministic versus noisy a behavior is. Our formal analyses and computer simulations of several prominent models of cognition (the general context model of categorization, the SIMPLE model of memory, and cumulative prospect theory for risky choice) revealed that this architecture gives rise to substantial interdependencies between the parameters involved in computing the subjective value and this noise parameter (as seen in Figure 3). These interdependencies, in turn, lead to considerable problems when recovering parameter values. Specifically, models suggest possibly distorted conclusions about the real values in human participants. We discussed and tested several approaches to simplifying the models to improve recoverability. Our analyses suggest that, as in the case of cognition itself, less complexity can be more when it comes to modeling cognition.

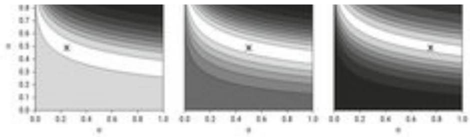

Figure 3. Likelihood surface showing the goodness of fit (negative log likelihood) of the model for different combinations of the value function parameter α and the noise parameter θ. Results are shown for three levels of noise in the generating model (θ = .25, .5, and .75, in the left, middle, and right panels, respectively). Darker shading indicates lower fit. The crosses indicate the parameter values that were used to generate the data.

Figure: American Psychological Association
Adapted from Krefeld-Schwalb et al. (2022)

Key Reference

Krefeld-Schwalb, A., Pachur, T., & Scheibehenne, B. (2022). Structural parameter interdependencies in computational models of cognition. *Psychological Review*, *129*(2), 313–339. https://doi.org/10.1037/rev0000285
MPG.PuRe DOI

The Exploring Mind

Many normative and descriptive theories of human choice are silent on how people search for and learn from novel information. This reticence seems to suggest that considering how people explore and update their knowledge of the world contributes little to comprehending how they cope with uncertainty when making decisions. We disagree. Facing the ocean of uncertainty, the human mind cannot help but explore: visually searching for targets of interest, searching its semantic memory, or looking up external information in the world's information ecology. These processes, of course, come with their own perils as, for instance, the COVID-19 infodemic has demonstrated, only highlighting how important understanding them is. Unless decision scientists understand cognition as processes of exploration and learning, they will fail to understand key aspects of the boundedly rational mind. This has become increasingly clear after the discovery of the description–experience gap, that is, the finding that choice can systematically diverge depending on whether people actively search for and experience information, thereby reducing uncertainty, or are being presented with a symbolic representation of all information in one go. We have been exploring some of the description–experience gap's far-reaching implications, as well as the deliberate refusal to update one's knowledge (i.e., deliberate ignorance), another fascinating facet of the exploring mind.

A Description—Experience Framework of the Psychology of Risk

The modern world holds countless risks for humanity, both large-scale and intimately personal—from cyberwarfare and climate change to sexually transmitted diseases. The success of countermeasures—so we argued (Hertwig & Wulff, 2022)—depends crucially on how individuals learn about those risks. There are at least two powerful but imperfect teachers of risk. First, people learn by consulting descriptive material, such as warnings, statistics, graphs, and images. More often than not, however, a risk's fluidity defies precise portrayals. Second, people may learn about risks through personal experience. For instance, at the start of the COVID-19 pandemic, personal experience with the virus was extremely rare, but it has since become common. This matters greatly. Responses to risk can differ systematically depending on whether people learn through one mode, both, or neither. One reason—but by no means the only one—for these differences is the distinct learning dynamics of rare events (typically the risk event) and common events (typically the risk's nonoccurrence) and their resulting impact on a person.

Building on the description–experience gap, we proposed a new framework of the psychology of risk. Its core is a fourfold pattern of epistemic states (Figure 1). When people face a risky decision, four states of knowledge arise, depending on whether one encounters risks through one learning mode, both, or neither. Drawing on extant behavioral evidence, one can now derive for each of these states predictions as to how they shape behaviors. For example, when only descriptive information, such as a fact box, is available (Figure 1, top left), one tends to overweight rare side effects of a vaccine and, ceteris paribus, be more inclined to decide against vaccination. Conversely, when information is gleaned from personal experience (bottom right), one tends to underweight rare harms because of lack of firsthand experience. Consequently, one is more inclined to choose vaccination. This fourfold pattern has numerous implications for understanding otherwise puzzling phenomena such as when and why experts and laypeople entertain very different perceptions of risks or when and why descriptive risk warnings frequently fail to deliver their intended effect. It also suggests new methods for risk communication (see the Boosted Mind section and simulated experience interventions).

Figure 1. A fourfold pattern of epistemic states in the context of the measles, mumps, and rubella (MMR) vaccine, depending on the presence versus absence of descriptive and experiential information.

Adapted from Hertwig and Wulff (2022)

Key Reference

Hertwig, R., & Wulff, D. U. (2022). A description-experience framework of the psychology of risk. *Perspectives on Psychological Science*, *17*(3), 631–651. https://doi.org/10.1177/17456916211026896
MPG.PuRe DOI publisher-version

How Experimental Methods Shape Views on Human Rationality and Competence

The heuristics-and-biases program advanced by Tversky and Kahneman in the 1970s has produced an extensive catalog of how people's judgments systematically deviate from norms of rational reasoning. Their findings have led to the conclusion that people are largely incapable of sound statistical reasoning and decision making. But previously the intuitive statistician program had reached a starkly different conclusion. This program found substantial correspondence between people's judgments and rules from probability theory and statistics. Indeed, a 1967 review concluded that people could be correctly understood as intuitive statisticians who can make reasonably accurate inferences about risks and uncertainties. How could psychology change its conclusions about people's mental competence so dramatically? After all, people's statistical intuitions did not suddenly go astray.

To tackle this question, we (Lejarraga & Hertwig, 2021) examined the methods of more than 600 experiments from both lines of research. We found that Tversky and Kahneman established a new experimental protocol to measure statistical intuitions. As Figure 2 shows, before their arrival, researchers used an *experiential* protocol that allowed people to learn probabilities from direct experience. Usually, people could practice, sample information sequentially, and adjust responses with feedback. Tversky and Kahneman's experiments replaced this with a *descriptive* protocol, commonly text-based scenarios that tended to ask for few or even one-off judgments. People had little opportunity to practice or learn from feedback.

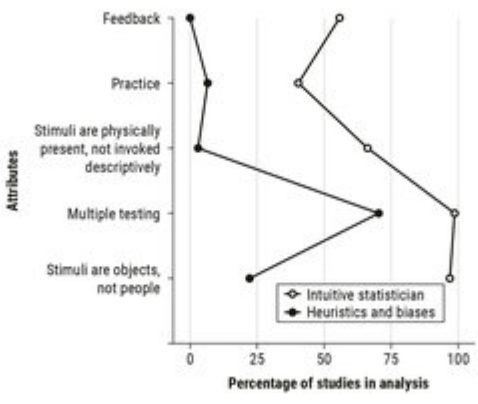

Figure 2. Classification of experimental protocols according to five attributes.

Here's the rub: The experimental methods researchers use are not neutral tools. They can shape people's judgments. People do not seem to be very good at solving word problems about probabilities—at least not without explicit instructions. But they do seem to be reasonably good intuitive statisticians when given the opportunity to learn through direct experience. Since the 1970s, decision researchers have relied mostly on descriptive protocols. This uniformity in the field's experimental culture has contributed, in our view, to the field's lopsided view of people as irrational beings.

Figure: American Psychological Association
Adapted from Lejarraga and Hertwig (2021)

Key Reference

Lejarraga, T., & Hertwig, R. (2021). How experimental methods shaped views on human competence and rationality. *Psychological Bulletin*, *147*(6), 535–564. https://doi.org/10.1037/bul0000324
MPG.PuRe DOI post-print

How Attentional Biases in Decisions From Experience Translate Into Nonlinear Probability Weighting

Only with a model of the underlying cognitive processes will researchers be able to understand how learning influences people's weighting of probabilities when making decisions under risk. For a long time, however, researchers have mainly used psychoeconomic functions, devoid of process assumptions, to account for deviations between choice behaviors and their normative benchmarks. Confronting this challenge, we (Zilker, 2022; Zilker & Pachur, 2022) investigated how deviations from normative predictions can result from imbalances in attention allocation. We did so by linking two influential frameworks: cumulative prospect theory (CPT) and the attentional drift diffusion model (aDDM). CPT describes the impact of risky outcomes on preferences in terms of nonlinear weighting of probabilities. The aDDM formalizes the finding that attentional biases toward an option can shape preferences within a sequential sampling process.

Using the aDDM, we simulated choices between two choice options while varying the strength of attentional biases toward either option and then modeled the resulting choices with CPT. Changes in preference due to attentional biases in the aDDM were reflected in the parameters of CPT's weighting function. A reanalysis of behavioral data on decisions from experience then found that people's attentional biases are also linked to patterns in probability weighting, as suggested by the simulation results (Figure 3).

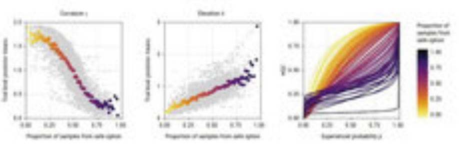

Figure 3. Modeling results for empirical choices between a safe and a risky option in the experiential sampling paradigm. The left and middle plots display parameter estimates for the probability-weighting functions for different levels of attentional bias toward the safe option. Colored dots represent the average estimates. The right plot displays the probability-weighting functions for the

respective level of attentional bias toward the safe option.

Figure: American Psychological Association
Adapted from Zilker and Pachur (2022)

By revealing that nonlinear probability weighting can arise from unequal attention allocation during a sequential sampling process, these analyses shed light on how cognitive processing can give rise to and shape psychoeconomic functions. Last but not least, let us emphasize that attentional biases need not be irrational. Zilker (2022) showed that attentional biases can increase the reward rate (the amount of reward obtained per unit of time invested in the choice)—even if they are detrimental to accuracy (the tendency to choose the highest value option).

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Deliberate Ignorance in Societal Transformations

When the government of reunified Germany opened up the Stasi files—highly sensitive information on millions of individuals gathered by the East German secret service—it expected that everyone would want to access theirs. Viewing their file would allow people, so the official logic went, to reclaim the life that had been stolen from them. Yet decades later, not even half of the 5.25 million people estimated to believe that the Stasi had kept a file on them have applied to read their file.

We (Hertwig & Ellerbrock, 2022; see also Hertwig & Engel, 2020) combined survey methods with life-history interviews to identify and describe the reasons people invoke for deliberately ignoring their Stasi file. By far the most prevalent reason people gave for not viewing their file was that the contents were not “relevant.” This lack of relevance, however, by no means suggests that the people no longer cared. In contrast, as revealed by the interviews, it means that they felt no amount of knowledge could undo actions in the past (e.g., a person spying on and betraying another person). Another frequent reason people gave was they worried that they would discover that their loved ones or friends had worked as informants; they wanted to avoid the anguish they would feel if their fears were confirmed. A number of respondents questioned the trustworthiness of the Stasi files. Finally, for some people, refusing to read the file was an act of "political opposition," either because they disapproved of Germany's reunification or because they remembered positive aspects of East German life and warned against conflating the Stasi with East Germany as a whole.

Taken together, these reasons paint a nuanced picture of individual choices not to know in political and social contexts that transform over time. Many of these reasons are rooted in a desire for harmony and cooperation, even while institutional and collective memory politics emphasize the importance of transparency and justice. The exploring mind is an adaptive one with different priorities and strategies, depending on historical contexts and individual circumstances (see more on this topic in the print magazine accompanying this report). It can also decide, for good reason, to deliberately not explore.

Key Reference

Hertwig, R., & Ellerbrock, D. (2022). Why people choose deliberate ignorance in times of societal transformation. *Cognition*, *229*. https://doi.org/10.1016/j.cognition.2022.105247
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Hertwig, R., & Engel, C. (Eds.). (2020). *Deliberate ignorance: Choosing not to know*. MIT Press.
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The Collective Mind

Our decisions are typically not Robinson Crusoe's decisions, and even he operated in a social world after Friday's arrival. Social worlds provide us with the chance to improve our judgments and make better decisions. Unfortunately, living in a social world also carries the risk of being influenced by the "madness of crowds," which may, for instance, foster the spread and amplification of misinformation. In this section, we report on our ongoing work aimed at better understanding how we can harness collective intelligence to provide a social good, for instance, better healthcare outcomes, and the cognitive strategies underlying the integration of social information. Then we move to the group level, providing a computational theory of what a group representation is in the context of conflict, and we investigate the reasons for joining a group in the first place. Finally, we present our work at the level of social networks, showing how the dynamics across adaptive networks can increase the quality of decisions but also lead to radicalization.

Reducing Antibiotic Overprescription by Harnessing the Wisdom of Crowds

The overprescription of drugs is a major global problem and costly in terms of financial and health consequences. The problem is especially pronounced with antibiotic prescriptions. Their overprescription contributes to rising levels of antibiotic resistance and patient mortality. To gain insight into this thorny issue, we (Krockow et al., 2020) investigated whether a "wisdom of crowds" perspective could promote an approach to prescribing antibiotics that is more compliant with medical guidelines (i.e., typically shorter durations). We used international survey data from 787 expert antibiotic prescribers from around the world. Across various clinical scenarios, they independently provided recommendations for treatment duration. We tested several aggregation algorithms to evaluate how pooling the independent decisions of the experts could improve antibiotic guideline compliance. We found that pooling the treatment recommendations improved guideline compliance across almost all clinical scenarios. This effect emerged in groups of just three expert prescribers and grew stronger in larger group sizes.

Most previous interventions to reduce unnecessary antibiotic prescription relied on either restrictive techniques to deter overprescribing of antibiotics or persuasive approaches to encourage a more deliberate decision process by providing more information about the therapeutic decision process and the societal risk of antimicrobial resistance. The effectiveness of these approaches, however, varied. Our results suggest that pooling independent judgments can play a role in global antibiotic stewardship specifically, and in better medical decisions in general.

Key Reference

Krockow, E. M., Kurvers, R. H. J. M., Herzog, S. M., Kämmer, J. E., Hamilton, R. A., Thilly, N., … Pulcini, C. (2020). Harnessing the wisdom of crowds can improve guideline compliance of antibiotic prescribers and support antimicrobial stewardship. *Scientific Reports*, *10*. https://doi.org/10.1038/s41598-020-75063-z

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Strategies for Integrating Disparate Social Information

The cosmos of social information around us typically consists of multiple opinions, which differ in the degree to which they conflict with each other and with our own personal information. How do we integrate such different pieces of social information? To test this, we (Molleman et al., 2020) investigated what strategies people use when weighting diverse social sources. In our experiment, participants were briefly shown an image and asked to estimate the number of animals in it. Afterward, they were presented with three different estimates from other participants, which also differed from the participant's own estimate. This simulated a wide distribution of social information. Finally, participants could revise their initial estimate.

By applying a cognitive model of the integration of social information, we discovered two main factors that influence how people integrate different opinions. People were more likely to incorporate social estimates that were (a) close to their own personal estimate or (b) close to the other social estimates. If participants observed even just one social estimate close to their own, they tended to ignore the other estimates. Our findings can help us better understand how people form an opinion in light of conflicting social information and offer insights into the causes of opinion polarization.

Key Reference

Molleman, L., Tump, A. N., Gradassi, A., Herzog, S., Jayles, B., Kurvers, R. H. J. M., & van den Bos, W. (2020). Strategies for integrating disparate social information. *Proceedings of the Royal Society of London: B, Biological Sciences*, *287*(1939). https://doi.org/10.1098/rspb.2020.2413

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Cognitive Mechanisms Underlying Information Cascades

The timing of decisions can have a major influence on how collective dynamics play out, from when pedestrians cross at a red light, to financial filter bubbles, to the spread of news online. To gain a better understanding of the cognitive mechanisms involved in the spread of information, we (Tump et al., 2020) posed a sequential decision-making task to groups of people. Participants first viewed a noisy stimulus and then indicated their own judgment and confidence. Afterward, they had the opportunity to reconsider their judgment while viewing the choices of their group members in real time. Participants could either make a decision quickly without social information or wait and observe the choices of others. Our findings show that the groups self-organized themselves, with confident and more accurate individuals deciding earlier, thereby providing high-quality information to their slower-moving peers.

We applied an evidence accumulation analysis to shed light on the cognitive mechanisms. We found (Figure 1) that in the social phase, more confident participants began with a more extreme starting point. The social influence was captured by a change in the drift rate. A participant’s willingness to wait for the choices of others was captured by the decision threshold. Our findings demonstrate how essential aspects of the cognitive underpinnings of social interactions influence information spread in social systems, paving the way for a more in-depth understanding of social systems.

Figure 1. Illustration of the evidence-accumulation process during the social phase with five individuals. The start point of each individual is influenced by their personal judgment and associated confidence. Highly confident individuals start closer to either of the thresholds (red lines) and decide earlier, providing social information for undecided (less confident) individuals by biasing

their evidence accumulation (as indicated by the arrows pointing upward).
Figure: Alan Novaes Tump / MPI for Human Development

Key Reference

Tump, A. N., Pleskac, T. J., & Kurvers, R. H. J. M. (2020). Wise or mad crowds? The cognitive mechanisms underlying information cascades. *Science Advances*, 6(29). https://doi.org/10.1126/sciadv.abb0266
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A Computational Theory of Conflicts in Groups

Understanding the psychology of intergroup conflict is one of social science's most pressing goals. Although the phenomenon of "groups" has been studied for over a century, with several recent computational modeling and game theoretic innovations, we still lack literal (as opposed to metaphorical) descriptions of what the mind is representing when it represents a social "group."

We (Pietraszewski, 2022) surveyed the history of scientific approaches to the study of groups. We argue that existing approaches fail to coalesce into a mechanistic description of how the mind represents and reasons about groups if we fail to generate explicit theories of what these representations may be (this is the "computational theory"). We present a viable candidate theory: that the purpose of a group representation at a mechanistic level (i.e., its "functional role", in philosophical terms) is to assign individual agents to a specific set of roles within a small number of triadic interaction types (Figure 2). These roles-within-triadic-interaction types can represent any conflict dynamics involving three or more agents. This resolves a long-standing problem of reconciling the infinite generativity of social dynamics with a finite set of cognitive representations. We discussed the empirical predictions of this theory and the new enterprises that need to commence within the study of groups if we are to have adequate, mechanistic theories.

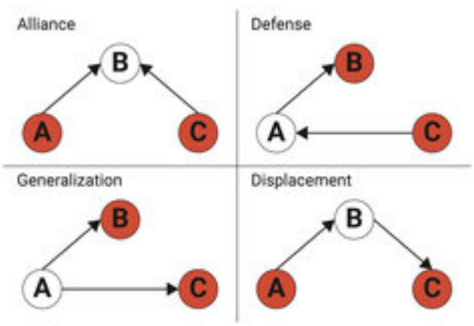

Figure 2. The four triadic interaction types that together form a representational vocabulary for describing all instances of multiagent conflict. Each letter represents an individual, and an arrow denotes a cost imposition or attack. In each cell, A first imposes a cost on B, and in response one more additional cost imposition occurs. The two red individuals belong to the same group in conflict

with the white individual.

Figure: Cambridge University Press
Adapted from Pietraszewski (2022)

Key Reference

Pietraszewski, D. (2022). Toward a computational theory of social groups: A finite set of cognitive primitives for representing any and all social groups in the context of conflict. *Behavioral and Brain Sciences*, *45*. https://doi.org/10.1017/S0140525X21000583
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Joining a Group Diverts Regret and Responsibility Away From the Individual

Much of the research on collective intelligence focuses on when and how groups make better (or worse) decisions than individuals. An equally important but less researched topic is why individuals join groups in the first place. Why would we make a decision with a group rather than on our own? We (El Zein et al., 2020) examined this question through the lens of regret and responsibility, testing whether shared responsibility is a motivation to join a group, as it may help minimize negative emotions such as regret.

In our experiment, participants had to repeatedly choose between two lotteries that could win or lose them money. To induce regret, they saw the outcomes of the lottery they chose and the one they did not. Seeing the counterfactual outcome exposed them to what could have been, leading to the feeling of regret if it was better than what they had received. At each round, participants could play the lottery alone or in a group of five, following a majority vote. We found that the experience of loss and regret motivated people to join groups. The bigger the loss, the more likely they were to switch from playing alone to with others. When playing in a group, the outcomes did not matter as much for subsequent decisions. Negative outcomes experienced alone led to worse choices than positive outcomes, but this effect was absent when playing in a group. This suggests that the collective can reduce the influence of negative emotions and help individuals reevaluate past choices.

Key Reference

El Zein, M., & Bahrami, B. (2020). Joining a group diverts regret and responsibility away from the individual. *Proceedings of the Royal Society of London: B, Biological Sciences*, *287*. https://doi.org/10.1098/rspb.2019.2251

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Adaptive Social Networks Promote Collective Intelligence

Our friends, relatives, and the people we follow on social media have a strong impact on what information we receive and how we form beliefs. Our social environment, however, is not static: It changes continuously as new ties are created and existing ones fade. But is this plasticity of social networks beneficial or detrimental to collective intelligence? Whereas most studies considered static social environments, we (Almaatouq et al., 2020) studied whether social networks can adapt to leverage the individual abilities and promote collective intelligence. For this, we conducted an experiment where groups of participants were placed in a communication network in which every group member had three neighbors. Participants undertook repeated estimation tasks with the possibility to see the answers of their neighbors. At the end of each round, the correct answer was shown and participants were able to replace some of their neighbors with other group members. That is, the structure of the network was malleable.

We found that social networks can quickly adapt and form collective intelligence. Across trials, the networks were more likely to centralize around the best-performing individuals. This resulted in better collective judgments than those of static networks and even surpassed the best-performing individual's performance. This demonstrates the “wisdom of the network,” with social-network plasticity as a key factor for refining collective judgments.

Key Reference

Almaatouq, A., Noriega-Campero, A., Alotaibi, A., Krafft, P. M., Moussaïd, M., & Pentland, A. (2020). Adaptive social networks promote the wisdom of crowds. *Proceedings of the National Academy of Sciences of the United States of America*, *117*(21), 11379–11386. https://doi.org/10.1073/pnas.1917687117
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Modeling Echo Chambers and Polarization Dynamics in Social Networks

There is an ongoing debate about the nature of “echo chambers” on social media. A core component of echo chambers is the formation of homogeneous social networks of people with the same opinions. An unresolved question is whether people with similar opinions select into such groups or whether they collectively homogenize their opinions after joining such groups. We (Baumann et al.,

2020) formalized a mechanism for the coevolution of these two processes, where opinions adapt to social contacts and social contacts adapt to opinions. In an agent-based simulation, microscopic rules specified that agents had a slight preference for like-minded people for their social interactions and that they adapted their opinions according to their social contacts. This enabled us to reproduce the macroscopic opinion distributions from real Twitter data on controversial topics (Figure 3).

Our model links the degree to which topics are controversial to the stability of these macroscopic states: When a topic allows for little "middle ground," polarized opinion distributions and highly homogeneous network structures develop simultaneously. Our results shed light on a possible mechanism behind the emergence of echo chambers and polarization on social media regarding controversial topics: Namely, both the social network and the opinions of the agents are constantly adapting and thus spiral each other into the extreme states of opinion and segregated networks that can also be empirically observed (see Figure 3).

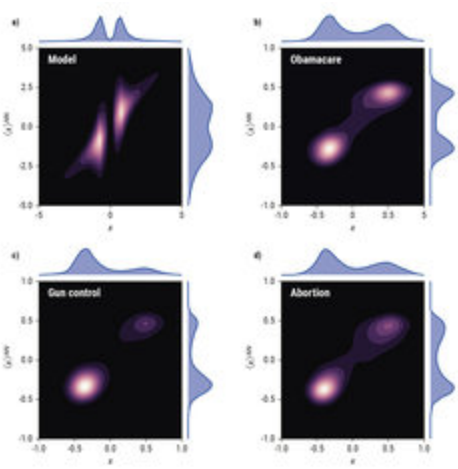

Figure 3. Contour maps show the average opinion of the closest neighbors to a user (⟨*x*⟩*NN*) versus the user's opinion (*x*) for simulations of the proposed model (Panel a) and three different data sets from real discussions on Twitter (Panels b–d). The colors indicate the density of users: The lighter the color, the more users there are. Additionally, the marginal distribution of opinions *P*(*x*) and the average opinion of the nearest neighbors *PNN*(*x*) are plotted on the *x* and *y* axis, respectively.

Figure: American Physical Society
Adapted from Baumann et al. (2020)

Key Reference

Baumann, F., Lorenz-Spreen, P., Sokolov, I. M., & Starnini, M. (2020). Modeling echo chambers and polarization dynamics in social networks. *Physical Review Letters*, *124*(4). https://doi.org/10.1103/PhysRevLett.124.048301
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The Unfinished Mind

People of all ages face uncertainty and risky situations throughout their lives. But what are the evolutionary and developmental origins of human decision making under uncertainty? How do children learn to manage an unpredictable world? And what role do social factors play in risk taking among adolescents? To answer these questions, we have used a variety of methods (such as behavioral and observational data and formalized computational models) to understand how our ability to make adaptive decisions in different situations develops over individual and evolutionary timescales. We have also explored possible implications of our findings for education.

Evolutionary Roots of Risk Preference, Reasoning, and Decision Making

Risk preferences influence many of the decisions people make in their lives—whether to explore new areas in search of food, shelter, or mates; compete for social status; or engage in financial investments. Indeed, as a key building block in decision processes that shape individuals' health, wealth, and well-being, an individual's risk preference has the potential to influence the entire course of their life. Yet the evolutionary roots of human risk preference remain poorly understood. Studying chimpanzees from infancy to adulthood, we (Haux et al., 2023) used a novel multimethod approach that combined observer ratings with behavioral choice experiments to determine whether the willingness to take risks in one of humans' closest living relatives is similar to that in humans. We found that chimpanzee and human risk preferences share key structural similarities: (a) chimpanzees' willingness to take risks manifests as a trait-like preference that is consistent across domains and measures; (b) chimpanzees are ambiguity averse; (c) male chimpanzees are more risk-prone than females; and (d) chimpanzees' appetite for risk shows an inverted-U-shaped relation to age that peaks during young adulthood (Figure 1). These evolutionary continuities are likely to reflect adaptations to similar dynamics in human and nonhuman primate life histories.

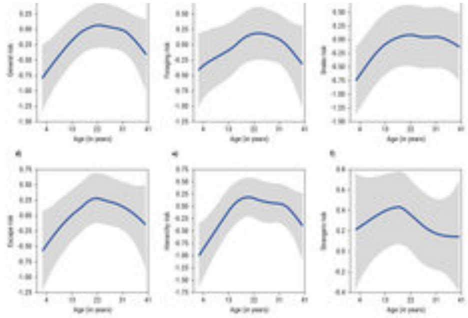

Figure 1. Age differences (aggregated across male and female chimpanzees) in mean levels of general and domain-specific willingness to take risks: regression splines with shaded 95% credible intervals. The domains represent major classes of risks in chimpanzees' ecology.

Adapted from Haux et al. (2023)

Uncertainty can arise in interactions with both social partners and nonliving objects. Previous research has shown that humans are more averse to uncertainty arising from social interactions than to uncertainty caused by interactions with objects such as gambling machines, and that this difference may be mediated by betrayal aversion. In other words, when compared to placing trust in other people, we may place too much trust in machines. Tracing the phylogenetic origins of this tendency, we (Haux et al., 2021) investigated whether chimpanzees differentiate between social and nonsocial forms of uncertainty. Chimpanzees participated in two experiments, each involving a social condition, in which the outcomes of some decisions depended on the behavior of another chimpanzee, and a nonsocial condition (i.e., playing against a machine). In both experiments, choosing the safe option resulted in immediate access to low-value food. Choosing the uncertain option could result in access to high-value food, but only if the partner (social condition) or a machine (nonsocial condition) proved trustworthy. In the first experiment, chimpanzees had no prior information on reciprocation rates (i.e., decided under uncertainty). Here chimpanzees were less likely to choose the uncertain option when they interacted with a partner than when they interacted with a machine. When they did choose the uncertain option, chimpanzees also hesitated longer in the social condition. In the second experiment, where chimpanzees had learned the statistical probabilities on reciprocation rates (i.e., decided under risk as opposed to uncertainty), they did not distinguish between social and nonsocial situations. They were generally risk averse. These results suggest that chimpanzees, like humans, are more averse to engaging in uncertain choices when the source of uncertainty is social.

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Haux, L. M., Engelmann, J. M., Arslan, R. C., Hertwig, R., & Herrmann, E. (2023). Chimpanzee and human risk preferences show key similarities. *Psychological Science*, *34*(3), 358–369. https://doi.org/10.1177/09567976221140326

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Haux, L. M., Engelmann, J. M., Herrmann, E., & Hertwig, R. (2021). How chimpanzees decide in the face of social and nonsocial uncertainty. *Animal Behaviour*, *173*, 177–189. https://doi.org/10.1016/j.anbehav.2021.01.015

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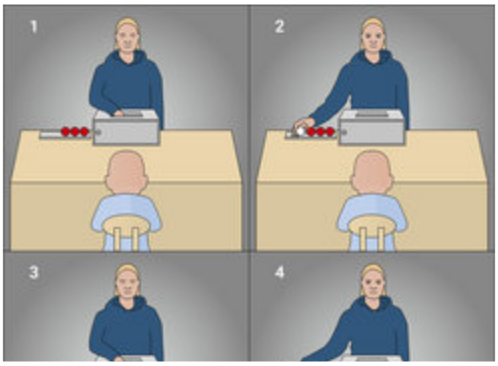
Experience as a Key Factor in Shaping Statistical Intuitions Across Ontogenetic Development

How do children and adults learn to deal with an uncertain world? The origins of the human ability to process uncertain and probabilistic information have recently been traced to infancy: Babies are already surprisingly sophisticated intuitive statisticians. But whereas infants have been found to be remarkably capable of statistical learning and inference, adults' statistical inferences are often argued to be inconsistent with the rules of probability theory and statistics. Similarly, whereas animals appear to be strikingly risk-savvy, humans often seem "irrational" when dealing with probabilistic information. Drawing on research on the description–experience gap in risky choice, we (Schulze & Hertwig, 2021) suggested that a key factor in understanding these ⊘ (and other) inconsistencies in statistical intuition research is whether probabilistic inferences are based on symbolic, abstract descriptions or on the direct experience of statistical information (see also the subsection **How Experimental Methods Shape Views on Human Rationality and Competence** in The Exploring Mind section). Because infants (and, similarly, animals) can neither produce nor process symbolic descriptions of the world, their statistical intuitions need to be studied in paradigms that involve experiencing probabilistic information (see Figure 2). Adults, by contrast—and this is one of the greatest cultural achievements of humankind—can communicate by means of written symbols. Consequently, since the 1970s, research on adults' statistical thinking has almost exclusively relied on described scenarios in which all information is packaged in summary descriptions. This difference in experimental protocols, however, is consequential—our work demonstrates that it is one key to understanding several puzzling inconsistencies in statistical intuition research.



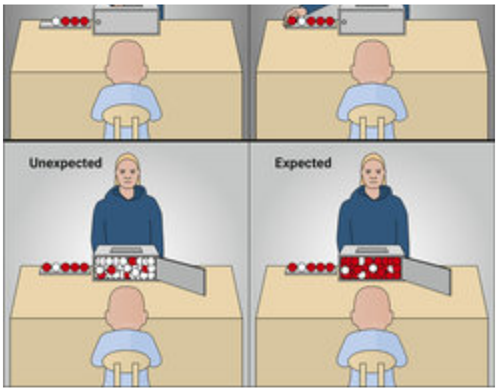


Figure 2. Illustration of an experimental paradigm used in research on infants' statistical intuitions. The experimenter draws several colored balls (e.g., red or white) from an opaque box without looking, the contents of the box are revealed, and the infant's looking time is recorded. If the sample drawn does not reflect the object distribution in the box (unexpected outcome, bottom left panel), infants tend to look at the contents of the box for longer than if the sample is consistent with the object distribution (expected outcome, bottom right panel).

Indeed, our research has also shown that experiencing statistical information is essential to improving adults' and children's ability to make decisions when dealing with uncertainty—a conclusion that has important implications for education policy. Collaborating with pedagogical researchers, we (Schulze et al., 2021) argued that the description–experience framework of statistical intuition can be harnessed to enrich formal education and, ultimately, help determine how early experience-based strategies for dealing with uncertain information can support more formal views of probability taught in school. For example, we have proposed that incorporating more experiential approaches such as experiments and case studies, alongside text analysis, into the teaching of social sciences in school may help students gain a more comprehensive understanding of complex topics.

Adapted from Schulze and Hertwig (2021)

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Social Influence in Adolescent Risk Taking and Decision Making

When observing them, one might think that adolescents are a different species altogether, typically being excessively risk taking and sensitive to peer influence. Various theories of adolescent behavior attribute this to their immature cognitive control, sensation seeking, or social motivation. At the same time, many agree that some adolescent risk-taking behavior is adaptive. Yet, what it means to be adaptive during development is largely undefined. We (Ciranka & van den Bos, 2021) argued that understanding the potential adaptivity of adolescent risk taking requires attending to adolescents' developmental goals and the environment they interact with to achieve them. Inspired by theories that conceptualize human development as optimization, we understand adolescents as learning agents in a complex and uncertain environment to which they increasingly adapt in the course of their development. We identified three unique properties of the adolescent landscape of opportunities and social environment: (1) greater opportunities to take risks, (2) novel opportunities with uncertain outcomes, and (3) peers becoming more influential. We used agent-based modeling to illustrate how adolescent risk taking may emerge from learning about an uncertain and unpredictable environment. We showed that a typical inverted-U-shaped age trajectory in risk taking may emerge without a specific adolescent motivational drive for sensation seeking or sensitivity to social information. Notably, and aligning with our experimental work, agents used social information the most when uncertainty was high. The simulations also showed how risky exploration may be necessary for adolescents to gain long-term benefits in later developmental stages and that social learning can help reduce losses. This work thus provides an ecological perspective on risk taking in adolescents by viewing them as learning and adapting agents.

Key Reference

Ciranka, S., & van den Bos, W. (2021). Adolescent risk-taking in the context of exploration and social influence. *Developmental Review*, *61*. https://doi.org/10.1016/j.dr.2021.100979

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The Boosted Mind

Today's citizens encounter highly engineered choice environments in almost all areas of life—in supermarkets and shopping centers, on social media and investment sites, and even at the ballot box. It would be overly optimistic to assume that the designers of these environments—the choice architects—typically act benevolently and with a focus on public welfare. More often, they pursue commercial or other self-serving interests. This systemic divergence between public welfare and commercial interests can lead to "toxic" choice environments—for example, ↗ food environments that are "obesogenic" and "diabetogenic"—and to online environments designed to hijack users' limited attention by means of distraction and manipulation. There is no silver bullet to address the threat that such engineered, non-benevolent choice environments pose to our political, economic, health, and social systems. Many current social and global problems require more than one kind of approach. We suggest, however, that the empowerment of citizens is a key ingredient of any attempt to redress the balance between toxic choice architectures and individual autonomy—and that the behavioral sciences, and especially psychology, have a pivotal role to play here.

Here we report on our work on ↗ boosting people's competences to deal with today's challenges, particularly in the online and health domains. Our contributions range from theoretical–analytical to empirical and translational work. The latter aims to inform the public and public policy experts about what behavioral science has to offer.

Why Policy Makers Are Tempted to Nudge

Two frameworks of behavior change informed by behavioral science are nudging and boosting. For the former, policy makers use citizens' cognitive and motivational frailties, in combination with a smartly designed choice architecture, to get ("nudge") citizens to act in their own best interests (e.g., redesigning a cafeteria in a way that leads "inert" people to consume less calorie-dense food). "Boosting," in contrast, aims to empower people to make better decisions that are in their own interest by fostering agency and existing competencies or building new ones.

The nudging approach has been criticized for ethical drawbacks including concerns about undermining individual autonomy and a potentially paternalistic premise (i.e., the policy maker makes unfounded assumptions about all or at least most individuals' preferences). Yet, nudging has gained the status of a much-promoted, adopted, and even hyped approach to behavioral public policy. Why? To find out, we (Hertwig & Ryall, 2020) assumed a model of dynamic policy making in which policy makers can choose to implement either a nudge or a boost intervention to address a public health problem. One novelty of the chosen setup is that the boost the policy maker can implement would equip the individual with the competence to overcome a nudge-enabling cognitive bias once and for all. This creates a strategic and, perhaps, ethical conflict for policy makers. With mathematical and game-theoretic analyses, we identified conditions under which the policy maker's preferences are not aligned with those of the individual. Specifically, policy makers have a strategic interest in choosing not to boost in order to preserve the option of using the nudge (and its associated bias or weakness) in the future—even though boosting is in the immediate best interests of both the policy maker and the individual. This analysis shows, first, that the dynamic of public policy can be analyzed analytically and, second, that policy makers, cognizant of the nudging intervention's long-term "option value," may be inclined to favor soft paternalism over empowerment of citizens.

Key Reference

Hertwig, R., & Ryall, M. D. (2020). Nudge versus boost: Agency dynamics under libertarian paternalism. *The Economic Journal*, *130*(629), 1384–1415. https://doi.org/10.1093/ej/uez054
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Boosting Digitalization and Democracy

The digital world is playing a larger and larger role in our daily lives. However, it brings with it a variety of challenges and risks, such as manipulative choice architectures, increased hostility online, and the spread of harmful misinformation. Inspired by the ecological and adaptive rationality perspective, we aim both to develop an evidence-based understanding of structures and challenges specific to these new digital environments and to present a roadmap for tackling these challenges. In our research, we took a multipronged approach to this topic, including a systematic review of evidence of the impact of digital media on democracy; surveys and experiments examining people's preferences and attitudes to, for instance, content moderation dilemmas; and conceptual reviews and experimental approaches to boosting people's digital competences.

Digital Media and Democracy: A Systematic Review of Evidence

One of the most contentious questions of our time is whether the rapid global uptake of digital media has contributed to a decline in democracy. We (Lorenz-Spreen et al., 2023) conducted a systematic review of studies investigating whether and how digital media impacts citizens' political behavior. To this end, we synthesized causal and correlational evidence from nearly 500 articles on the relationship between digital media and democracy worldwide. The findings show that social media has a significant impact around the world, but that the effects are intricate and depend on the political context (e.g., established versus emerging democracies). The results also highlight that digital media is a double-edged sword, with both beneficial and detrimental effects on democracy (Figure 1). The positive effects of digital media, such as increased political participation and knowledge, are more notable in countries with emerging democracies, such as those in South America, Africa, and Asia. In contrast, digital media has been linked to an increase in populism, polarization, and a decrease in trust in institutions and the political system, particularly in established democracies such as those in Europe and the United States.

Figure 1. Geographical distribution of associations showing beneficial and detrimental outcomes. Pie charts show the composition of directions for each country studied. Panel a) Geographical distribution of reported associations for the variables trust, knowledge, participation, exposure, and expression. Panel b) Geographic representation of reported associations for the variables hate, polarization, populism, homophily, and misinformation.

↗ Adapted from Lorenz-Spreen et al. (2023)

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Resolving Content Moderation Dilemmas Between Free Speech and Harmful Misinformation: A Conjoint Experiment

Content moderation of online speech is a moral minefield, especially when two key values come into conflict: upholding freedom of expression and preventing harm caused by misinformation. Currently, moderation decisions are made without any knowledge of how people trade off these two values. However, robust and transparent rules that take into account people's views and trade-offs are needed to handle this conflict in a principled and evidence-informed way, eventually fostering public support of such rules. We (Kozyreva et al., 2023) examined such moral dilemmas and trade-offs in a conjoint survey experiment where United States respondents were asked to decide whether to take action against various instances of misinformation. The results showed that despite notable differences between political parties, the majority of United States citizens preferred stopping harmful misinformation to protecting free speech (Figure 2). Furthermore, people seemed to agree on which features of the content to take into account when deciding whether to remove posts or suspend accounts. People's willingness to accept such interventionist measures depended on the type of content and increased with the severity of the consequences of misinformation and the sharer's past behavior (i.e., did the account previously post misinformation?) In contrast, features of the account itself, such as the person behind the account, their partisanship, and their number of followers, had little to no effect. These findings can inform transparent and legitimate rules for content moderation that meet public support.

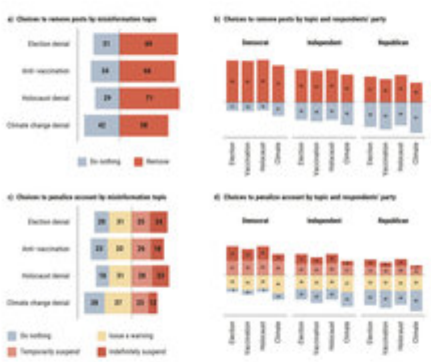

Figure 2. The proportion of choices to remove posts and to suspend accounts. All numeric values represent percentages. Panel a) Choices to remove posts or do nothing by misinformation topic (all cases). Panel b) Choices to remove posts or do nothing, by topic and respondents' party affiliation. Panel c) Choices to penalize accounts by misinformation topic (all cases). Panel d) Choices to penalize accounts by topic and respondents' party affiliation.

↗ Adapted from Kozyreva et al. (2023)

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Digital Challenges and Cognitive Tools for the Digital Age

One of ARC's long-term goals is to develop a tool kit of interventions that empower internet users to reclaim some control over their digital environments by boosting their digital literacy competency and their cognitive resistance to manipulation. To this end, we (Kozyreva et al., 2020) developed a conceptual map of behavioral and cognitive interventions that aim to counteract key digital challenges (Figure 3). After outlining the main challenges that digital environments pose to human autonomy and decision making, we identified two types of digital *boosting* tools: (1) those aimed at enhancing people's agency in their digital environments (e.g., self-nudging, deliberate ignorance) and (2) those aimed at boosting competencies of reasoning and resilience to manipulation (e.g., simple decision aids such as lateral reading, inoculation). Following up on this map, we (Kozyreva et al., 2022) further developed one particular class of boosting interventions. Specifically, we argued that digital information literacy must include the competency of *critical ignoring*—smartly choosing what to ignore and where to invest one's limited attentional capacities.

Aiming to address the challenge of highly personalized political advertisement, that is, the microtargeting of potential voters, we (Lorenz-Spreen et al., 2021) tested an intervention aimed at boosting people's ability to detect such microtargeting. Two online experiments demonstrated that a short, simple intervention markedly boosted participants' ability to accurately identify ads that were targeted at them by up to 26 percentage points. The intervention merely prompted participants to explicitly reflect on one of their major and microtargeted personality attributes by completing a short personality questionnaire. The ability to detect the personality-trait-based microtargeting increased even without personalized feedback. Yet, just providing a description of the targeted personality dimension failed to improve individuals' detection ability.

Finally, in cooperation with an international group of 26 misinformation researchers, we developed an expert-curated research resource of ten types of evidence-supported interventions as a guide to mitigating misinformation (visit the website ↗ Toolbox of Interventions Against Online Misinformation and Manipulation).

Figure 3. Map of challenges and boosts in the digital world.

Adapted from Kozyreva et al. (2020)

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Communicating Our Research to Policy Makers and the Public

Both citizens and policy makers need reliable knowledge to understand and successfully address key challenges that our societies are facing today. In our work on boosting, digitalization, and democracy, we are therefore also committed to building public-facing resources (e.g., the scienceofboosting.org website) and contributing to the interface between science and policy making. To this end, researchers from our group, together with other global experts and the Joint Research Center of the European Commission, co-authored the technology and democracy report (Lewandowsky et al., 2020) to further the understanding of the influence of online technologies on political behavior and decision making. We were also contributors to the statement "Digitalisierung und Demokratie" (2021) published by the Leopoldina, Germany's National Academy of Sciences, and to the report on Science Education in an Age of Misinformation (2022) by Stanford University.

Effective science communication is challenging when scientific messages need to take into account a dynamic and changing evidence base and when this communication is in competition with waves of misinformation (see the recent COVID-19 pandemic as a prime example). To help address this challenge, we (Holford et al., 2022) proposed that a new model of science communication is necessary—a collective intelligence and collaborative approach, supported by technology. This approach would promise multiple benefits compared to the traditional model of individual scientists communicating their findings (i.e., the "lone wolf" model of science communication). It would facilitate (a) aggregating knowledge from a wider scientific base, (b) contributions from diverse scientific communities, (c) incorporating stakeholder inputs, and (d) faster adaptation to changes in the knowledge base. Such a model could help combat misinformation and ensure that scientific communication remains informed by the latest evidence. We laid out what science communication as collective intelligence would look like: It should communicate the strength of the evidence, be forthcoming about uncertainty and error involved in the evidence, be diverse, be open to alternative perspectives, be transparent, build trust, be motivated by the common good, and be easy to understand. Showcasing recent examples of collective intelligence in the science communication domain, we demonstrated how some of those principles can be put into action.

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Boosting Health and Medicine

Today, the world is grappling with many urgent and costly public health issues. Examples abound—from the devastating number of fatalities resulting from medical misdiagnosis, to the long-term prescription of strong opioids, to skepticism of and hesitancy to accept potentially life-saving vaccinations. These issues must be addressed to ensure health and well-being around the globe. Here we report on research that again is committed to the goal of boosting citizens' and experts' competencies, thus empowering them to make good decisions.

Using Simple AI to Improve Diagnosticians' Performance

There is much hope, but also hype, for using artificial intelligence (AI) systems to improve medical diagnostics and thus reduce avoidable diagnostic errors. However, AI systems are usually not permitted to make automated decisions in high-stakes settings, such as those involving consequential decisions in medicine. Issues of concern range from transparency to accountability to bias. Instead, human decision-makers consult AI advice before making their own final decision (e.g., medical experts may consult a radiology AI system during their diagnostic process). However, since many such AI systems are black boxes that need to be "explained" after the fact, their designers face challenges in establishing trust with domain experts (e.g., medical diagnosticians) and other stakeholders (e.g., patients). We (Keller et al., 2020) argued that the research and practitioner communities should focus more on developing and implementing inherently interpretable, simple AI systems (e.g., simple decision trees). Such models front-load the computational effort to then arrive at a simple decision aid that can be very easily implemented (e.g., as a laminated pocket card for physicians). They augment experts' decision competence rather than replacing it. We (Keller et al., 2020) presented a case study in the context of the task of postoperative risk stratification in intensive care (i.e., deciding which patients need to be closely monitored after an elective surgery). Our results show that very simple, transparent, and understandable decision trees can achieve a level of performance almost as good as state-of-the-art, black-box machine learning models. Assuming that it is the joint performance of the physician and the AI system that matters (and not how well a system performs on its own), the question remains to what extent any advantage of a more complex, opaque model will be thwarted by possibly lower compliance of experts.

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New Avenues in Risk Communication: Simulated-Experience and Descriptive Formats

When educating people about risks, we usually resort to describing the risks and their likelihood of occurring (e.g., the side effects of drugs described in drug leaflets). However, in the absence of such described risks, people merely experience risks or their absence (e.g., a patient takes a drug and either experiences a side effect or does not, or a physician prescribes a drug and experiences a certain number of patients later complaining about a side effect or does not). As has frequently been found (see the section The Exploring Mind), people react very differently to described versus experienced risks. Intriguingly, this description–experience gap points to a new avenue for risk communication, namely, letting people experience (simulated) risks rather than just simple, static numbers.

We (Wegwarth et al., 2022) explored the potential of risk communication using simulated experience in the domain of strong opioids. Chronic pain affects about 20% of adults globally and is a major cause of decreased quality of life and disability. Evidence shows that even short-term use of strong opioids is associated with small improvements in pain and function relative to a placebo, no improvement relative to non-opioid medication, and increased risk of harm. Guidelines caution against long-term use. Notwithstanding these clinical recommendations, opioids have been increasingly used for the management of chronic pain in the United States and Germany. Currently 80% of long-term prescriptions of strong opioids are for chronic noncancer pain. This suggests a miscalibration of risk perceptions and behavior among those who prescribe, dispense, and take opioids. Can a profoundly different way of communicating risk change this? We ran a randomized clinical control trial to examine the effects of experience and description on risk perception and risk behavior in 300 German patients who took opioids to manage chronic noncancer pain. We investigated the effects of either simulated experience or description (Figure 4) on (a) objective risk perception, (b) subjective risk perception, and (c) risk behavior (i.e., continued intake of strong opioids). Patients' risk perception improved in both formats; even those who saw the description ("fact box") estimated some outcomes more accurately than with experience. A notable difference, however, emerged in behavior. Those who experienced the simulation were more likely to reduce and terminate their opioid intake and were more likely to adopt other therapies. These results suggest that simulated experience may suggest a qualitatively different way of communicating risks, one that may have a greater potential to change behavior. We are currently conducting more studies to explore this possibility.

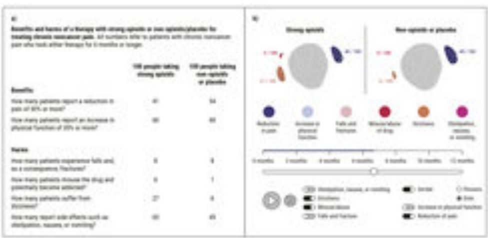

Figure 4. Descriptive and simulated experience risk education formats. Panel a) A descriptive risk education format ("fact box") was used online, where numerical values were concealed and participants had to move the mouse pointer over the respective boxes on the screen to access the information. Panel b) An interactive simulation was used, allowing participants to observe changes over time by moving a horizontal slider and explore specific risks by activating/deactivating the respective buttons.

Figure: Elsevier
Adapted from Wegwarth et al. (2022)

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Empowering Citizens to Effectively Communicate About COVID-19 Vaccines and Protect Themselves and Others Against Misinformation and Manipulation

The COVID-19 pandemic has highlighted a global health challenge: hesitancy to receive potentially life-saving vaccinations. Despite extensive research into how to communicate effectively and refute misinformation about vaccines and other controversial topics (e.g., climate change), knowledge and best practices have yet to be widely adopted. To bridge this gap, we (Lewandowsky et al., 2020) created a concise handbook outlining the current best practices for communicating about COVID-19 vaccines as well as how to effectively refute false information. The handbook is targeted at a broad audience—including journalists, policy makers, researchers, doctors, nurses, teachers, students, and parents—and was designed to boost their competence to communicate effectively on vaccines. It covers common misconceptions about vaccines and explores the psychological, social, and political factors that influence people's decisions about whether to get vaccinated. The handbook also provides concrete strategies for effective communication about the benefits of getting vaccinated and for challenging misinformation about the vaccines. For example, the reader learns how to counter false information by using the "debunking sandwich" (Figure 5) and how to inoculate people against common misinformation tactics ("prebunking"). By empowering citizens with the skills and knowledge to effectively communicate about COVID-19 vaccines and protect themselves and others against misinformation and manipulation, the handbook can help reduce the pervasive vaccine hesitancy that we see globally.

FACT	It is important to provide a factual alternative to the misinformation. If you have a clear, pithy, and sticky fact (e.g., "The vaccine is safe"), lead with it. It is also fine to lead with the warning/myth when the focus is on explaining why it is misleading. Avoid scientific jargon or complex, technical language. Well-designed graphs, videos, photos, and other semantic aids can be helpful to convey corrections involving complex or statistical information clearly and concisely.
WARN ABOUT THE MYTH	Repeat the misinformation, only once, directly prior to the correction. One repetition of the myth is beneficial to belief updating because then people know what memory they should revise.
EXPLAIN FALLACY	Rather than only stating that the misinformation is false, provide details as to why. This is crucial. Explain (a) why the mistaken information was thought to be correct in the first place and (b) why it is now clear it is wrong and (c) why the alternative is correct. It is important for people to see the inconsistency between misinformation and correct information in order to resolve it.
FACT	Finish by reinforcing the fact—multiple times if possible. Make sure it provides an alternative causal explanation whenever possible.

Figure 5. Structure of an effective debunking strategy ("fact sandwich"). From Lewandowsky et al. (2021). The COVID-19 Vaccine Communication Handbook & Wiki.

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History of Emotions

Director: Ute Frevert

Introductory Overview

When the Center for the History of Emotions was established at the MPI for Human Development in 2008, we started from two assumptions: Emotions make history, and emotions have a history.

Recent history has—unfortunately—proven the first assumption right. On 24 February 2022, Russia attacked Ukraine, and the war has not yet ended. Tensions had been building since at least 2014. Vladimir Putin felt threatened by Western powers who, he alleged, wanted to destroy the Russian state, and were using Ukraine as a deployment zone. Defining, in 2005, the collapse of the Soviet Union as the "biggest geopolitical catastrophe" of the 20th century, Putin flagged his concerns for Russia's security, stability, and power. Guided by a strong sense of nostalgia, he also made reference to acute experiences of humiliation, since the West, and the US in particular, no longer treated Russia the way she expected to be treated.

Whether Putin personally felt nostalgic and humiliated, and why, is less important than the fact that he used these emotions to carve out an aggressive politics against Ukraine and sell it to his people. His speeches and texts serve as a classic case of emotional politics: Emotions—especially love for home, family, and, above all, the motherland, "that deep-seated intimate feeling"—were enlisted as "the backbone of our country's sovereignty." This had been the lesson learned during the "Great Patriotic War" between 1941 and 1945, and the lesson would again be applied to the "special operation” starting in 2022. In the absence of counternarratives, Putin’s emotional politics find a successful echo among Russian citizens.

Needless to say, we, the researchers at the Center for the History of Emotions, would rather not have been given this case to study. Indeed, history has provided us with enough material to analyze how emotions have made history. Emotions have often been regarded as private, as the innermost core of an individual subject. But they are never only private. They are as much located between people as they are inside a person. As such, they motivate human behavior and foster the formation of social groups or movements. Emotions are also much more than affects. They are learned and cultivated in the life course; they can be manipulated, heightened, or channeled. What would modernity be without patriotism (see above) and national pride, without the addiction to honor and the fear of disgrace, without communities acting in unison driven by shared anger or hope? Can we imagine a political world or a world of consumption without continuous appeals to our emotions? The history of emotions raises new questions, but it also contributes a new entry point to questions about power and social change that historians have debated for a long time.

Image: MPI for Human Development

And what do we know about emotions’ historicity? Are emotions not an anthropological constant shaped through biological evolution? Although what psychologists call primary or secondary emotions—fear, joy, hate, envy, trust—were not unknown to earlier generations, the emotions have clearly changed. Once we read about emotions in earlier times or in more distant places, their love and hate feel increasingly unfamiliar. Historical subjects differ from us in regard to what they feared, whom they pitied, and what they were proud of. Emotional expression and resulting actions also followed different patterns. A person who was afraid of witches behaved differently from someone who worries about climate change or nuclear disaster centuries later—even the emotion of fear itself does not always feel the same. To return to Putin’s example: Nostalgia for the past is connected to a modern, i.e. progressive, sense of time and is less pronounced in societies that think of development in cyclical terms. Humiliation depends, as shown in Ute Frevert’s recent book, on the emergence of self-consciousness, which is tied to specific historical contexts.

Key Reference

Frevert, U. (2020). *The politics of humiliation: A modern history*. (A. Bresnahan, Trans.). Oxford: Oxford University Press. Retrieved from http://hdl.handle.net/21.11116/0000-0005-656E-F
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The Development of the Center for the History of Emotions

For the first couple of years after 2008, our work focused mainly on reconstructing the norms and standards of past emotions and on the widely differing perceptions former generations had of emotions, their concepts, and their knowledge—in medicine and psychology, but also in theology and moral philosophy, as well as in popular texts like encyclopedias and advice literature.

From the beginning, norms and knowledge were seen as being embedded in social and political contexts and closely linked to practices. Emotions were not conceived, as in an earlier tradition, as something that was passively felt. Instead, they were conceptualized as something actively done, involving the mind, the heart, and the body alike.

Neither mind nor heart nor body, though, are immune to historical change. The human body, in particular, has been subject to a growing number of social interventions, by medicine, sports, and fashion just as through work and leisure. While affect studies, as they proliferate in media and cultural studies, emphasize the significance of the body as a quasi-autonomous and non-representational site of feeling, we stress the historicity of the body and how it influences both the experience and the expression of emotions.

As an overview of theoretical approaches, methodologies, and topics that have featured in the Center's work so far, Ute Frevert is currently preparing a book on emotional economies in modern societies. It discusses the history of the field as well as its diversity, and introduces the reader to various emotions—from trust to empathy, from honor to shame—while connecting emotional practices to the modern development of capitalism and analyzing the politics of emotion as they have been conducted by a great number of actors during the 19th and 20th centuries.

Key Reference

Frevert, U. (in press). *Writing the history of emotions: Concepts and practices, economies and politics*. Bloomsbury.
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How Do We Work?

Historians of emotions analyze a wide multiplicity of texts written in the past: printed texts, but also manuscripts found in the archives. We have consulted encyclopedias and philosophical reflections, historical medical research, speeches, letters, autobiographies, and diaries, but also journals and magazines, and children's books in many different languages. In recent years, with a number of scholars from different disciplines joining the group—anthropologists, sociologists, art historians among others—we have further enlarged the source basis for our work. It now includes visual sources, prints and paintings, music, and films, which, along with interviews and fieldwork, help us find out more about emotions, past and present.

In general, each researcher works on their individual book project that relates to the overarching assumptions. They all focus on modern societies, i.e., the 18th to the 20th (and 21st) centuries, with some going back to the 17th. The geographical scope reaches from the USA to India, with Europe at the very center. This invites us to ask comparative questions or draw out relational aspects of transfer and translation.

Such questions are best asked and answered, as we have experienced, through close collaboration. Working in teams is still unusual in the humanities and demands a lot of time and other resources. We have used the splendid infrastructure of the MPI for Human Development to chart new territory and to promote common projects, which bring together the whole group or a cluster of researchers under a common topic and result in co-authored monographs, six of which have already been published. Two more are in the pipeline, as well as a number of special issues of renowned journals. Based on individual work, those multiauthored monographs go far beyond edited volumes, since they rely on intense collaboration during both the conceptualization and the writing process. This ensures that the chapters form an interwoven unit that is more than the sum of its parts.

Common Projects

Image: V&R unipress

Fluid Feelings

Researchers

Rukmini Barua

Stephanie Lämmert

Alexandra Oberländer

Margrit Pernau

Esra Sarioğlu

Fluid Feelings examines the interplay between gender and emotion and traces the dynamics of rigidity, instability, and fluidity within it. Fluidity, in these essays, comes in several forms and registers: as ambivalence, circulation, and divergence. Our essays explore the interface between the social and the individual as well as the points of tension or cohesion that appear in ways of feeling (out of) gender. In bringing fluidity to the center of our analysis, the special issue advances an understanding of gender, emotions, and their inter-actions as phenomena in motion and in the process of becoming, rather than fixed. With a geographical scope encompassing Zambia, Turkey, Soviet Russia, and India, and drawing on archival histories, individual biographies, ethnographies, and explorations of popular culture, we elaborate how gender categories are strengthened, disturbed, or made ambivalent by emotions.

Key Reference

Barua, R., Oberländer, A., Hämmerle, C., & Kraft, C. (Eds.). (2021). *Fluid feelings [Special issue]*. *L'Homme: Europäische Zeitschrift für Feministische Geschichtswissenschaft* (Vol. 32). https://doi.org/10.14220/lhom.2021.32.issue-2

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Feeling Political: Emotions and Institutions Since 1789

Image: Palgrave Macmillan

Researchers

Ute Frevert

Kerstin Maria Pahl

Agnes Arndt

Michael Amico

Juliane Brauer

Francesco Buscemi

Karsten Lichau

Hannah Malone

Caroline Moine

Philipp Nielsen

Julia Wambach

Feeling Political: Emotions and Institutions since 1789 deals with the highly topical question of whether and why feelings play a role in politics. Contrary to political theory's and the general public's conception of politics as the realm of "rational" decision making, emotions have been potent in political practice since at least the late 18th century. Rather than purely subjective and individual expressions of feeling, emotions in the political sphere are best understood through the institutional settings in which they occur. Whether these are official institutions, buildings, organizations, clubs, parties, or informal gatherings, they provide individuals with emotional templates: guidelines, rules, and models on how to feel and express this feeling. Through 11 case studies of various Western institutions, the book contributes to a dedicated public debate and shows how political participation depends on mobilizing, sharing, and communicating emotions.

Key Reference

Frevert, U., Pahl, K. M., Buscemi, F., Nielsen, P., Arndt, A., Amico, M., Lichau, K., Malone, H., Wambach, J., Brauer, J., & Moine, C. (2022). *Feeling political: Emotions and institutions since 1789*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-89858-8

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Currently, three new projects are being developed at the Center:

Changing the Feeling Rules: How Emotions Reshape Social Relations, c. 1700 to today

Figure 1. Character Heads numbers 19 and 20. Plaster cast after Franz Xaver Messerschmidt, before 1923.
Image: Sammlung Belvedere, Wien / Collection Belvedere Vienna

Researchers
Stephen Cummins
Kerstin Maria Pahl
Helen Ahner
Michael Amico
Max Jack
Karsten Lichau
Soňa Mikulová
Nagehan Tokdoğan
Mika Toyota
Julia Wambach

Most, if not all, human societies know "feeling rules": historically and culturally contingent norms and expectations that manage the expression of emotions, judge their appropriateness, and sanction divergences. The project Changing the Feeling Rules explores how existing social formations become unsettled when individuals or groups start contesting what is considered commendable emotional behavior. Foregrounding moments of conflict when social judgments clash and when values, through friction and rupture, become reoriented, the issue sheds new light on historical and social change by looking at shifts in emotions and sensibilities.

A collaboratively developed multidisciplinary work, this special issue currently under review with *Social Science History* brings together historians, sociologists, and ethnographers. Its case studies cover Europe, the USA, and Japan and range from the late 18th century to today. While drawing from a wide range of sources, including ego-documents, the press, ethnographic research, and sociological interviews, its unifying theme is the role of emotions in uncertain times. With social rupture being a preoccupation of the 21st-century world, this special issue offers a timely investigation into how people emotionally engage with each other in times of transformation.

Volatility and Vulnerability: Global Intersectional Perspectives From the 20th Century to the Present

Researchers

Agnes Arndt

Rukmini Barua

Stephanie Lämmert

Alexandra Oberländer

Esra Sarioğlu

How does our understanding of emotions change when we analyze them in times and places of the highest precarity? What kinds of emotions are experienced in these precarious contexts that bind humans and nonhumans in un-expected ways? Drawing on experiences from eastern Europe, western Europe, and the Global South, this project unpacks emotional dynamics associated with vulnerability and volatility and how they link humans with non-human beings in variegated ways. It is an interdisciplinary and collaborative project that brings together a group of historians and sociologists utilizing intersectional perspectives to study vulnerability and volatility from the 20th century to the present. The authors foreground emotion as an analytical lens to examine the myriad forms of vulnerability and volatility engendered by the dynamics of the capitalist economy and modern political structures, and to emphasize the entanglements of humans and non-human beings within these contexts. All the contributions to this project are united by the preliminary finding that vulnerability and a frequently experienced lack of emotional, physical, material, legal, and social well-being are among the basic constants of the emotional ecology of our globalized world that is not human-centric. However, we argue that despite being shared globally, vulnerability is not universal and that historically produced forms of vulnerability and precarity are unevenly distributed across the globe. Volatility and Vulnerability engages with a wide range of different historical junctures, geographies, and source materials, from Soviet Russian science fiction to Zambian Africanfuturism and various narratives of violence and vulnerability at the turn of the 21st century. It is global–historical in scope and includes case studies from India, South Africa, Zambia, Russia, Turkey, and Germany.

Public Mourning

Researchers

Karsten Lichau

Kerstin Maria Pahl

Parand Danesh

Ute Frevert

Pathetic or embarrassing? Touching or irritating? Should one join in or blaspheme? When emotions are shown publicly, the accusation they are being staged is not far away. The year 2022 once again pressed down on the emotional keyboard, as the death of the longest-serving monarch in English history dominated the world press for nearly 2 weeks. Many people mourned, but many others, especially citizens of the former colonies, refused to do so, and some even celebrated ostentatious joy. Mourning became a bone of contention, political rifts emerged. Who belongs to the community of mourners? Who rejects them? And what is the point of this display of emotion anyway? Another joint endeavor of several researchers will examine the history and present of publicly expressed grief in the face of death.

It will analyze ceremonies, practices, and artistic forms used to mourn the loss of significant public figures and larger groups of people, victims of violence or disasters. It will explore the uses of media and dissemination through the media. Public mourning is not public commemoration, because commemorative culture needs greater distance. But expressions of mourning also follow established traditions, being crucially based on the imitation of emotional repertoires from everyday and high culture.

Figure 2. Mourners and onlookers accompany Queen Elizabeth II's coffin as it arrives in Edinburgh.
↗ Image: Scottish Parliament / Scottish Parliament Copyright Licence

Public Colloquia, Conferences, and Workshops

Just as the Center itself combines many regional and topical perspectives, we also invite other researchers in the broad and ever-broader field of the history of emotions to the Center. A place that has always been suited to this is our public seminar, organized weekly or fortnightly during the academic year. Since 2008 the Center has hosted more than 250 public colloquia with speakers from all five continents. The need to switch to virtual, then hybrid format during the pandemic was a problem we turned into an advantage: Rather than inviting only researchers who are in the city, we now have the technology and procedures to bring in speakers from distant countries for whom a stay in Berlin is not possible. Nevertheless, we are glad that most talks can once again be on-site events.

Figure 3. Our social media torch was passed from Francesco Buscemi to Stephen Cummins in 2021. The Center's Twitter has been an effective tool of outreach, particularly notable for expanding the audience for our virtual colloquia. The account, with 2,000 followers, has been a key way to communicate our research and publications to an international community of historians and the historically minded.

Image: MPI for Human Development

Image: MPI for Human Development

The conference *Feeling DIS/EASE: New Perspectives on Modern History* in January 2020 (see Research Report 2017–2019/20, p. 89), which concluded Bettina Hitzer's Minerva Research Focus Emotions and Illness: Histories of an Intricate Relation, resulted in an edited volume published in 2022. It explores experiences of illness, broadly construed, and encompasses the emotional and sensory disruptions that attend disease, injury, mental illness, and trauma. Furthermore, it gives an account of how medical practitioners, experts, lay authorities, and the public have felt about such disruptions. Also in 2022, another edited volume was published that originated from Bettina Hitzer's follow-up project Adopting a Child in Germany: The Contested Politics of Belonging and Care in a Globalized World, 1945–2000 (see Research Report 2017–2019/20, p. 71). Originating from a workshop at the Center, this book examines change and continuities of childhood in the long 20th century in the context of adoption. As an interface between the private and public spheres, child adoptions enable conclusions to be drawn about socio-cultural changes in the understanding of childhood and family, of the welfare state, care, solidarity, charity, and humanitarianism, as well as about questions of identity.

Key References

Boddice, R., & Hitzer, B. (Eds.). (2022). *Feeling dis-ease in modern history: Experiencing medicine and illness*. London: Bloomsbury Academic. Retrieved from http://hdl.handle.net/21.11116/0000-000A-5EE9-7

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Hitzer, B., & Stuchtey, B. (Eds.). (2022). *In unsere Mitte genommen: Adoption im 20. Jahrhundert*. Wallstein Verlag.

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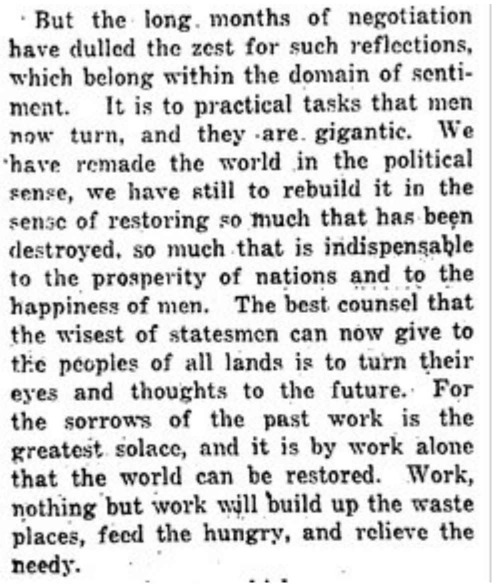

But the long months of negotiation have dulled the zest for such reflections, which belong within the domain of sentiment. It is to practical tasks that men now turn, and they are gigantic. We have remade the world in the political sense, we have still to rebuild it in the sense of restoring so much that has been destroyed, so much that is indispensable to the prosperity of nations and to the happiness of men. The best counsel that the wisest of statesmen can now give to the peoples of all lands is to turn their eyes and thoughts to the future. For the sorrows of the past work is the greatest solace, and it is by work alone that the world can be restored. Work, nothing but work will build up the waste places, feed the hungry, and relieve the needy.

...

Figure 4. After the peace treaties, *The New York Times* recommends people “turn their eyes and thoughts” to the future.
Source: “Peace,” in The New York Times, 29 June 1919, p. 37

As a member of the British delegation to the Versailles Peace Conference after the First World War, John Maynard Keynes had detailed knowledge of the debates about the reparations demanded of Germany. He believed the demands were too harsh, resigned his position, and wrote his book *The Economic Consequences of the Peace* (1920). Since then, many historians have pointed to the economic and political burden imposed especially on the new states that emerged from their predecessors’ lost wars. A century after the peace treaties of 1919–20, Ute Frevert and Chris Hann (MPI for Social Anthropology, Halle) organized a hybrid conference, *The Emotional Consequences of the Peace* (Berlin, 10–11 December 2020). It focused on and reevaluated the histories of defeated nations by zooming in on their emotional dimensions. Those were, as the conference showed, manifold and cannot be reduced to the narrative of humiliation as it had been crafted by politicians and the media during the peace-making period of 1919–20. Even citizens of defeated countries could escape that tale and choose to look forward rather than backward. They could—and did—speak of liberation and a new beginning, a new understanding of national belonging and self-determination. Eventually, though, the narrative of liberation failed, in Germany as well as in Austria and Hungary, and the narrative of humiliation won. Losers consolidated long-lasting tales of loss, humiliation, and revenge. Historians and anthropologists joined forces to analyze those tales and their influence on politics and culture in succeeding generations, including the memory politics of 21st-century central Europe.

In June 2021, Emma Zohar organized a two-day event in Berlin on the topic *Fatal Attraction: Germany, Poland and the Jews After the Holocaust,* together with Gideon Reuveni (University of Sussex) and Daniel Mahla (Ludwig-Maximilians-Universität München). The online workshop aimed to explore the dramatic transformation that images of and feelings toward Poland and Germany in Israel and beyond have been undergoing in recent years. The participants examined the emotional economies that inform such perceptions, most visible in diplomatic relationships between the countries but also in the press and scholarly discourse. They also investigated how those economies affected tourism and other economic affairs.

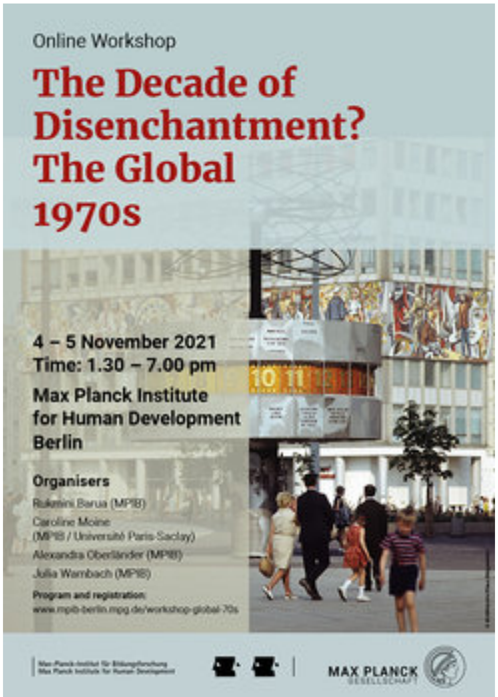

Image: MPI for Human Development

In 2019, Rukmini Barua, Caroline Moine, Alexandra Oberländer, and Julia Wambach started a reading group on the emotional dimensions of the global 1970s. Its aim was to critically revisit perspectives on the 1970s, which are usually conceptualized as the start of a new wave of globalization, but also as a decade of "disenchantment" and "malaise." An online workshop titled *The Decade of Disenchantment? The Global 70s* was held in autumn 2021 to discuss critical and diverse viewpoints on the emotional phenomena of this decade as experienced across the globe. The workshop resulted in a special journal issue. It includes contributions from junior and senior scholars that focus on gay liberation struggles in Latin America, decolonial movements in Palestine, the New International Economic Order, the North American Left, and forms of post-imperialist belonging in New Zealand and Australia. The special issue proposes, firstly, that feelings recalibrated understandings of the global, from a view that divided the world in terms of the East and West to one that saw it in terms of North and South. Secondly, the articles demonstrate that feelings of passion, anger, and solidarity—among others—counter arguments that the 1970s were a time of disenchantment and the atomization of people through economic malaise.

Key Reference

Barua, R., Moine, C., Oberländer, A., & Wambach, J. (Eds.). (2023). The Global 1970s from a history of emotions perspective [Special issue]. *New Global Studies*, *17*(2).
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The workshop *Lonely Death and Contact-less Sociality* (24–25 November 2022) was held in Berlin by Mika Toyota in collaboration with Kristine Krause (University of Amsterdam, Faculty of Social and Behavioural Sciences, Anthropology of Health, Care and the Body). It explored three key themes: 1) The causes and multiple forms of lonely dying in different parts of the world; 2) emerging service industries around death and dying, and 3) forms of socialities in contact-less society. Findings from various societies including Japan, the UK, Germany, and Ukraine were presented at the workshop. The papers were circulated among the participants beforehand for the purpose of intensive discussion during the workshop.

Image: MPI for Human Development

The workshop deepened our conceptual understanding of the social phenomenon of “lonely death” in the contemporary context of “contact-less sociality.” More specifically, the participants explored the following questions: In what ways does contemporary communication technology change the meaning of “social isolation” (social connection/disconnection), “loneliness,” and “solitude,” and how does it affect the end of life phase? What kind of new service industries are emerging around death and dying, and what kind of practical functions and emotional effects do these industries have? How can we understand the dead body as a socio-material actor which is institutionally shaped and responds to the public imaginaries?

This workshop led to the concept for a larger conference, *Dying Alone and Its Afterlives in Contact-less Sociality*, in April 2023, inaugurated with a public panel discussion *Helping the Last Move: Caring for the Dead Body* and accompanied by Oxford Brookes University PhD researcher Katie Taylor's exhibition *residual*.

Internal and External Cooperation

In 2022, Frederik Schröer launched a new international collaboration Fear in Times of Uncertainty with researchers from the universities of Manchester, Oslo, Lund, Copenhagen, and North Carolina (Raleigh). The project grew out of an earlier collaboration titled The Aesthetics and Emotions of Religious Belonging, but it shifts the focus to fear as a defining emotion of the present and past. The aim is to develop critical innovations in the study of fear in an international and interdisciplinary network of early career to senior scholars. Bringing their diverse expertise into dialogue, the group explores fear in times of uncertainty from historical and contemporary perspectives, in a broad range of contexts spanning Asia and Latin America, fostering new understandings of what fear does, what its politics are, and how it mediates between the individual and the social or the environmental. Frederik Schröer’s contribution to the project is both conceptual and historiographic, concentrating on fear in forested environments. Alongside planned academic activities and output, his work has already included public outreach in the form of radio interviews/podcasts with German DLF Nova and Swiss SRF.

Key References

Baffelli, E., Caple, J., McLaughlin, L., & Schröer, F. (2021). The aesthetics and emotions of religious belonging: Examples from the Buddhist world. *Numen*, *68*(5-6), 421–435. https://doi.org/10.1163/15685276-12341634

MPG.PuRe DOI publisher-version

Baffelli, E., & Schröer, F. (2021). Communities of absence: Emotions, time, and buddhism in the creation of belonging. *Numen*, *68*(5-6), 436–462. https://doi.org/10.1163/15685276-12341635

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Fear/anxiety is also the focus of an in-house collaboration between the Center for the History of Emotions and the Lise Meitner Group for Environmental Neuroscience, which leverages the Institute's critical interdisciplinary potential. Launched in early 2021, the collaborative Study of Forest Anxiety sees Frederik Schröer collaborate with Djo Juliette Fischer under the supervision of Simone Kühn. Using standard testing methods on a wide range of participants, the study assesses implicit and explicit indicators of semantic and image-based associations between the concept of forest and anxiety. Interdisciplinarity here proves valuable both in re-examining fundamental parameters and heuristic presuppositions of the study, as well as in reflecting on the larger implications of the future results. Beyond the local German context, in 2022 the team launched an international collaboration with the Indian Institute of Technology, New Delhi, for cross-cultural comparison.

In 2022, Kerstin Pahl joined Simone Kühn and Johanna Drewelies on the project BASE-II, which investigates the physical, cognitive, and social conditions that lead to successful aging. As the study uses interviews of people aged 70 to over 100 years who lived in former West Berlin, it became apparent that a historical perspective would be essential to understand both the context of the interviewees' lives and their ways of relating them. Kerstin Pahl has worked extensively on the conventions of (auto-)biographical story-telling. Her forthcoming book on biography and portraiture provides an in-depth analysis of how people employ tropes, templates, and narratives to tell (and make sense of) lived experience, a perspective that helps to bring forward an interpretation of the data that is sensitive to context. (Read more about the project Visualizing Lives)

Key References

Pahl, K. M. (in press). *Visualizing lives: Portraits and biographies in England, c. 1680 to 1740*. Liverpool University Press.

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Pahl, K. M. (2022). Biography and emotional practice. In H. Renders & D. Veltman (Eds.), H. Renders & D. Veltman (Eds.), *Fear of theory: Towards a new theoretical justification of biography* (pp. 55–71). Leiden: Brill. https://doi.org/10.1163/9789004498891_006

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Co-organized by the Franco-German University (UFA) in Saarbrücken, the Basque Anthropological Research Institute on Music, Emotions, and Societies (ARI) in Bayonne, France, and the MPI for Human Development, two Franco-German Autumn Schools, *Une anthropologie des émotions. Questions d'épistémologie* and *Émotions situées*, took place in October 2021 and 2022 in Bayonne, hosted by Denis Laborde, the director of the ARI, and the Center's researcher Karsten Lichau. The events provided participants with the opportunity for network-building through concentrated in-depth discussions on-site, and led to several visiting fellowships at our Center.

Figure 5. The 2022 Autumn School brought together Master's students, PhD candidates, and postdocs with established scholars from the Institute, including Juliane Brauer.
Image: Helen Ahner

While the program of the first event in 2021 focused on epistemological questions in emotion research, and initiated a dialogue between anthropological and historical approaches, as well as affect theory and the so-called performative turn, the 2022 Autumn School took up these discussions, inquiring into the relevance of "transversal" emotional experiences or "second-order emotions" like authenticity, hypocrisy, indifference, and hilarity within a practice theory perspective.

The internationality and pluridisciplinarity of both the participants and the teaching scholars enabled an extraordinarily rich exchange, spanning topics from shame in the music of the Noon in Sénégal, via peasants' courses in emotional communication with animals, to the transnational judicial history of collective crimes in Kamenets-Podolsk. It was crowned by Cédric Villani's (winner of the 2010 Fields Medal) exploration of emotions in mathematics.

Cooperation with the Haizebegi Music Festival, organized by the ARI, and the Fête de la Science (CNRS) not only initiated exchange with artistic experience and knowledge, but also transmitted research on the anthropology and history of emotions to a larger public.

After a promising start in 2019, collaboration with the Center of Excellence in the History of Experiences (HEX) was directly affected by the March 2020 lockdown. In 2021, postdoc researcher Reetta Eiranen, working on the project Gender, Experience and Ambivalent Nationalism in Nineteenth-Century Finland, was finally able to discuss her 2022 Routledge article "Emotions and Nationalism" in our internal colloquium. Exchanges with the HEX Center, based at the University of Tampere and funded by the Academy of Finland, gradually got back on track with the visit of some familiar faces in 2022. More Finnish researchers who are collectively exploring how religion, the nation, and the welfare state have been experienced in modern history have announced their plans to visit for 2023.

One of the longest-lasting and particularly fruitful collaborations links the Center for the History of

Emotions with London's Queen Mary Centre for the History of Emotions. Its most visible expression remains the successful book series with OUP–Emotions in History–established and edited by Ute Frevert and Thomas Dixon. The series explores emotions through the histories of science, medicine, and psychology, as well as literature, art, religion, politics, and economics, covering the period from the Middle Ages to modern times. Since the publication of the first volume in 2014, 20 monographs have appeared, nine of them in the reporting period since 2020.

In November 2020, Thomas Dixon's lecture *What is the History of Anger a History of?* re-opened the series of public seminars after the short break due to COVID-19 and marked the Center's very first public online event.

Figure 6. One volume that figures prominently in the series is the translation of Bettina Hitzer's prize-winning book on the history of cancer and emotions, which was researched and written at our Center. Image: MPI for Human Development

Key Reference

Hitzer, B. (2020). *Krebs fühlen: Eine Emotionsgeschichte des 20. Jahrhunderts*. Stuttgart: Klett-Cotta. Retrieved from http://hdl.handle.net/21.11116/0000-0005-6336-F
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(English translation: Hitzer, B. (2022). *The history of cancer and emotions in twentieth-century Germany.* Oxford: Oxford University Press.)

Visiting Researchers and New Colleagues

Due to COVID-19, the Center's open-door policy came to a halt in 2020. Since the start of the Center, more than 130 researchers from all over the world had come to work with us—all financed through their own fellowships or sabbaticals. Some stayed for a few days, most for a few months, and some even for a whole year or longer. This allowed for vivid and fruitful exchange and was of mutual benefit. The program has now been revived and scholars from many academic fields are coming to us again in growing numbers. Old ties have proven to be strong and former visitors—such as Holly Yanacek—return to present their work that they had begun while at the Center.

We have also welcomed back former researchers who left the Center in order to take up academic positions nationally and internationally. During the reporting period and foreshadowing the Center's imminent closure in 2024, several have accepted offers for tenured professorships. Others, mostly in their early postdoc stage, have joined the Center to start new individual and collaborative projects.

New Research Foci

A working group on Sport & Emotions was established on the initiative of Helen Ahner, Max Jack, and Julia Wambach. They start from the observation that emotions in sports are omnipresent: In major tournaments, tears of happiness, tears of disappointment, exuberant joy, and shattering pain—to name but a few—are broadcasted and touch spectators all over the world. Doing and watching sport has become an integral part of everyday life for many in the last 150 years. The emotions evoked by sport are central to this striking popularity. However, sports history has neglected the history of emotions, and vice versa.

Based on these observations, an interdisciplinary team has begun exploring the nexus of sports and emotions, and its historical development in confluence with colonialism, industrialization, and globalization. The researchers examine sport as a training ground for emotional practices that reproduce or at times reconfigure social dynamics with implications extending beyond sporting practice itself.

How do hardcore fan groups conjure feelings in order to undermine the power of restrictive sport organizations? How can emotional attachment to a regional soccer club help ease the pain of deindustrialization? How did 1920s "sportsgirls" claim the right to feel competitive? These questions prompted an intervention at the Long Night of the Sciences in July 2022, which attracted a large audience beyond the academy. Furthermore, a workshop in August 2022 encouraged teenage athletes from Israel, Germany, and Ukraine to engage with the history of German–Jewish athlete Lilli Henoch. In a workshop titled *Feeling Competitive–Sport as Affective Practice* in the summer of 2023 scholars from multiple disciplines worked on a special issue that will lay the groundwork for a history of sport emotions.

Figure 7. Athletes and spectators are immersed in the emotional atmosphere of a major annual relay race, Berlin, 1919.
Image: Berliner Sport-Club e.V.

New research at the Center also focuses on the emotional politics of right-wing movements. In spring Olga Reznikova joined the Center and a new working group that has been assembling, since January 2023, around our new colleague Maik Tändler. Under his lead researchers including Max Jack, Frederik Schröer, Nagehan Tokdoğan, and Julia Wambach aim to explore Heartlands, Emotions, and Collective Identities. The claim to speak up for the “pure people” against a “corrupt elite” is a central feature of populist rhetorics. Usually, “the people” of populism, particularly its right-wing version, is not identical with a country’s population as a whole, but designates only a particular subgroup deemed to be the “true” people by certain criteria, be these social, ethnic, cultural, religious, moral, or sexual. Political scientist Paul Taggart has coined the term heartland to refer to such an imagined community of an idealized people. The project’s premise is that emotionally charged imaginations of a heartland can be considered a means of constructing group identities also beyond the context of populist mobilization. The new working group aims to put this hypothesis to the test by applying it to a range of different research topics. The planned outcome is a collaborative publication that contributes to our understanding of the emotional dynamics of collective identity formation.

Research Team 2020–2022/23

Last update: July 2023

Researchers

Helen Ahner, Michael Amico, Agnes Arndt, Rukmini Barua (as of 07/2023: York University, Toronto, Canada), Juliane Brauer (09/2020–10/2021: University of Hildesheim, Germany; as of 10/2021: University of Wuppertal, Germany), Francesco Buscemi (as of 07/2021: University of Groningen, the Netherlands), Stephen Cummins, Deepra Danedekar (until 03/2020), **Ute Frevert**, Bettina Hitzer (02/2021–09/2022: Technische Universität Dresden, Germany; as of 10/2022: Otto von Guericke Universität Magdeburg, Germany), Stephanie Lämmert, Anja Laukötter (as of 08/2021: Friedrich Schiller University Jena, Germany), Karsten Lichau, Hannah Malone (as of 08/2021: University of Groningen, Netherlands), Soňa Mikulová, Alexandra Oberländer, Kerstin Maria Pahl, Margrit Pernau, Olga Reznikova, Esra Sarioğlu, Frederik Schröer, Kerstin Singer (Coordinator), Maik Tändler, Mika Toyota, Nagehan Tokdoğan, Tamara Dee Turner (until 12/2022), Julia Wambach

Postdoctoral Fellows

Max Jack, Caroline Moine (as of 02/2022: University of Versailles Saint-Quentin-en-Yvelines [UVSQ], France), Emma Zohar (until 09/2021)

Associate Researchers

Juliane Brauer (University of Wuppertal, Germany), Francesco Buscemi (University of Groningen, the Netherlands), Dagmar Ellerbrock (Technische Universität Dresden, Germany), Benno Gammerl (European University Institute, San Domenico di Fiesole, Italy), Bettina Hitzer (Technische Universität Dresden, Germany; Otto von Guericke Universität Magdeburg, Germany), Anja Laukötter (Friedrich Schiller University Jena, Germany; Otto von Guericke Universität Magdeburg, Germany), Hannah Malone (University of Groningen, the Netherlands), Caroline Moine (University of Versailles Saint-Quentin-en-Yvelines [UVSQ], France), Shabnam Mousavi (Volkswagenstiftung), Philipp Nielsen (Sarah Lawrence College, New York, USA), Jan Plamper (University of Limerick, Ireland; Goldsmiths, University of London, UK), Anne Schmidt (Friedrich Schiller University Jena, Germany), Sandra Schnädelbach (Heinrich Heine University Düsseldorf, Germany), Max Stille (NETZ Bangladesh:

Partnership for Development and Justice, Wetzlar, Germany)

Visiting Researchers

Will Abberly (University of Sussex, Brighton, UK), Jennifer Anne Boittin (The Pennsylvania State University, USA), Anna Borrero (Freie Universität Berlin, Germany), Sören Brandes (Freie Universität Berlin, Germany), Anne-Laure Briatte (UMR SIRICE, Sorbonne, Paris, France), Nicola Camilleri (University of Padua, Italy), Parand Danesh (The School for Advanced Studies in Social Sciences [EHESS], Paris, France), Reetta Eiranen (University of Tampere, Finland), Anastasia Fairchild (Sciences Po, Paris, France), Carla Freeman (Emory University, Atlanta, USA), Sara Friedman (University of California, Berkely, USA), Peter Gottschalk (Wesleyan University, Connecticut, USA), Till Großmann (Freie Universität Berlin, Germany), Laure Guilbert (University of Paris 1 Panthéon-Sorbonne, France), Lukas Herde (University of Strasbourg, France), Ilkay Kanik (Beykent University, Istanbul, Turkey), Nancy Khalek (Brown University, Providence, USA), Aziliz Kondracki (Centre Norbert Elias, Paris, France), Elwin Hofman (KU Leven, Belgium), Takashi Ito (Tokyo University of Foreign Studies, Japan), Katrine Rønsig Larsen (University of Copenhagen, Denmark), Marie Leyder (University of Geneva, Switzerland), Tsiona Lida (Harvard University, Cambridge, USA), Julia Lieth (Freie Universität Berlin, Germany), Ervin Malakaj (The University of British Columbia, Vancouver, USA), Ivana Marković (University of Belgrade, Serbia), Marie Meier (University of Copenhagen, Denmark), Atussa Mohtasham Hamamoto (Princeton University, USA), Caroline Moine (Humboldt-Universität zu Berlin, Germany), Marius Oesterheld (Freie Universität Berlin, Germany), Laura Otis (Emory University, Atlanta, USA), Gyanendra Pandey (Emory University, Atlanta, USA), Helge Jonas Pösche (Humboldt-Universität zu Berlin, Germany), Imke Rajamani (Falling Walls Foundation, Berlin, Germany), Olga Reznikova (University of Zurich, Switzerland), Elsa Richardson (University of Strathclyde, Glasgow, UK), Charlotte Robertson (University of Chicago, USA), Lena Rudeck (Freie Universität Berlin, Germany), Sarah Scheidmantel (University of Zurich, Switzerland), Regis Schlagdenhauffen (The School for Advanced Studies in Social Sciences [EHESS], Paris, France), Britt Schlünz (Humboldt-Universität zu Berlin, Germany), Sandra Schnädelbach (University of Strasbourg, France), Carmen Sousa (University of Granada, Spain), Philipp Stiasny (University of Strasbourg, France), Kyoung-Suk Sung (Kyungpook National University, Daegu, South Korea), Shivangini Tandon (Aligarh Muslim University, India), Tuomas Tepora (University of Tampere, Finland), Tanja Vahtikari (University of Tampere, Finland), Ben Van Zee (University of Chicago, USA), Aline Vogt (University Basel, Switzerland), Wan-Chi Wong (Chinese University of Hong Kong, China), Michal Zechariah (University of Chicago, USA)

A current list of the Center's staff with links to their web profiles can be found on the Center's website.

Image: MPI for Human Development

Emotional Citizens: Love, Loyalty, and Trust in Politics

Ute Frevert

Emotions in Germany during the long 20th century: Following the 2019 exhibition *The Power of Emotions. Germany 19 / 19*, I started to do further research on how emotions affected and were affected by events, experiences, and developments that shaped German history from around 1900 to the present.

Politically, the time period saw five to six different regimes: the semi-parliamentarian German Empire (until 1918), the short-lived democratic Weimar Republic (1919–1933), the Nazis' Third Reich (until 1945), and, in 1949, the foundation of two German states that, in 1990, merged into one. Such dynamic history came with different emotional repertoires. Attachment to the royal family before 1918 (and, for some, even after) struck distinct emotional chords compared to approval of a republican head of state, especially when, as in the Weimar Republic, the first president elected was a Social Democrat leather worker and the second a war general. Love for the Führer felt different from love for socialism or respect for the president of a liberal-democratic state.

The same held true for other emotions as they played out over the course of 20th-century German history. Envy and solidarity, for instance, showed different expressions in times of economic crisis or during the economic "miracle" of the 1950s and 1960s. Hatred came in different forms, be it class hatred, as in the Weimar Republic, or racial hatred that was encouraged during the Nazi period and shunned ever since.

The research focused on 20 emotions, from anger to trust, from feelings of belonging to affection toward foreign nations and state representatives, from hope (for the future) to nostalgia. These emotions are, on the one hand, seen as objects of an emotional politics conducted by various institutions including governments, parties, churches, and schools. Social movements have also played a crucial role in whipping up certain emotions and taming others. On the other hand, citizens do more than receive emotional messages from above or below and translate them into their own feelings. They also, as members of institutions and movements, engage in shaping emotional styles and practices as well as in framing affective atmospheres. Their own voices thus have to be listened to, even if they are not always easy to find.

Drawing on archival sources (like letters to monarchs and presidents) and printed material such as ego-documents, newspapers, parliamentary minutes, and court rulings, I tried to uncover the traces that emotions have left and reconstruct the work they did in specific situations and under specific historical circumstances. I focused both on the political impact of emotions and on how they changed over a period of more than 100 years. The resulting book was published in September 2020 and enjoyed widespread media coverage. It has now been thoroughly revised and rewritten to accommodate an English-speaking audience. The English version is scheduled for publication in August 2023 with Cambridge University Press.

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Image: S. Fischer

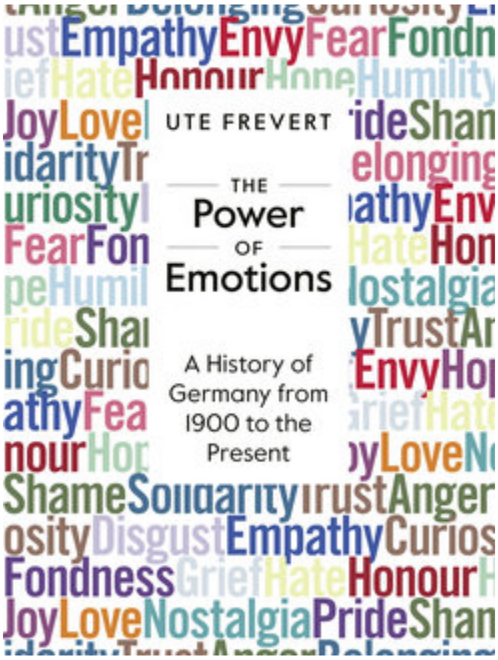

Image: Cambridge University Press

Emotions and Temporality. Feeling for the Future (South Asia 1912–1970)

Margrit Pernau

Like in most colonial and post-colonial states, modernity is a central concept for debates in 20th-century India and Pakistan. It marks the emotional aspirations for the future and provides an orientation for decisions ranging from economics to nationalism, from education to bodily regimes. It is all the more surprising that "modernity" was not translated into Urdu until the 1960s.

The project investigates the semantic net developed around this concept: terms for the past, present, and future; for epochs and their transformation, such as decline, progress, and stagnation; images and metaphors connected to different times; and, most importantly, the emotional qualities ascribed to different times. Emotions and temporalities, the argument runs, are intimately linked—it is only by systematically including the emotions that we are able to understand the temporal imaginations and hence also the temporal strategies of historical actors. A first exploration of this method for a case study from the 19th century, exploring the writings of Sir Saiyid Ahmad Khan, the founder of the reformist Muslim University at Aligarh, has been published in *History and Theory* in 2019.

In order to avoid a focus on canonical texts written by great (male) thinkers, the sources under investigation consist mostly of journal articles, which are placed in conversation with visual material and films (chapter accepted for publication: "Nāyā Daur. Concepts, Experiences and Emotions of the new era in the Nehruvian Era," *Experience near concepts*, ed. Rajeev Bhargava and Neeladri Bhattacharya, Cambridge University Press).

The project faces two methodological and theoretical challenges. The first is presented by the fact that most of the historical actors I am investigating were multilingual, i.e., they thought, spoke, and wrote not only in Urdu, but also in English. Assuming a close relation between imaginations, concepts, and emotions, this means that they had to constantly negotiate not only between languages, but also between what they felt in the different languages. This has been investigated in a case study (chapter accepted for publication: "Vernacularizing Emotions: Mohammed Ali's Comrade and Hamdard," *Language Ideologies and the "Vernacular" in Colonial and Postcolonial South Asia*, ed. Nishat Zaidi and Hans Harder, Routledge).

The second challenge consists in the global dimension of the emotions linked to temporal imagination. This has been laid out in a short monograph, emphasizing the categories of atmosphere and resonance, and drawing on hauntology (Derrida, Kleinberg).

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Figure 1. Scene from the film *Naya Daur* (The new era) (1957), directed and produced by B.R. Chopra. Source: Film still, 2:50:05, https://youtu.be/Nz3Ph-I8YPY

The Emotions of New Education. A Transnational History of Jamia Millia Islamia

Margrit Pernau

Figure 1. Logo at the gates of the Jamia Millia Islamia, Delhi.

The Jamia Millia Islamia, the National Islamic University, was founded in 1920 as part of the Gandhian non-cooperation movement, and settled in Delhi soon after. Unlike other national universities, it survived not only the initial phase, but is still thriving. This is not least due to the fact that a new generation, schooled in Berlin, took over the leadership of the educational complex (which included educational services ranging from kindergarten to higher education). The project focuses on two research questions: First, it aims at conceptualizing *Bildungsforschung* as a history of emotions—what the Jamia wanted was less to convey a canon of knowledge than to shape the students' character and habitual ways of feeling by taking up new education's approach of teaching through handicraft and work. Second, the pedagogical ideas at the core were developed in an intense exchange not only with Gandhi, but also with the work of German and American educators (Spranger, Kerschensteiner, Dewey, Kilpatrick). While much research has already been devoted to global intellectual history, we still know little about how emotions moved between different regions.

Sources for this project range from the Jamia's journals to speeches and reflective texts, to the day-to-day accounts of the institution's life. A first article on the Jamia's children's journal has been accepted for publication, another one on the navigation of the Jamia between the city and the nationalist ideal of the village promoted by Gandhi is under review ("At a distance to the city. Jamia

Millia Islamia's foundational years," *Shifting Landscapes: Education and Urban Transformations in India*, ed. Geetha B. Nambissan, Nandini Manjrekar, Shivali Tukdeo, Indra Sengupta).

The final results of this project will be published in the shape of two books. The first, *Aapaa Jaan. The Many Lifeworlds of Gerda Philipsborn*, is under contract with Speaking Tiger (Delhi). It recounts the biography of a young Jewish woman from Berlin, whom the leading figures of the Jamia met while they were studying in Berlin in the early 1920s. They became close friends, and Gerda Philipsborn joined them in Delhi in 1932 to become part of the Jamia: its *Aapa Jaan*, the beloved elder sister. The second book, *Jamia. A history of emotions*, is conceived as an academic monograph and will follow the history of the Jamia from 1920 to 1947.

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Figure 2. Mural of the founders of the Jamia Millia Islamia at the entrance of the metro station Jamia Milia Islamia in Delhi, Okhla Road.
Image: Soheb Niazi

Moved. Emotions in Sport

Helen Ahner

Why is it that the victory of the right soccer team can preserve family peace, that cracking your personal record on your daily jog can lead to total euphoria, that the mourning of a deceased sports hero can put an entire country in a state of exception, and that the lack of sport opportunities during a pandemic is perceived as a threat to the mental health of a whole society? This project explores the multiple connections between feeling and exercising, and investigates how the relationship between emotions and sport has developed and taken shape over the last 100 years. This relationship has many facets, and their discovery and analysis have thus far remained a desideratum in the history of emotions and sports alike; the project aims to address this.

In order to do so, it primarily focuses on female* athletes, as their emotional inner lives as well as their emotional performances have been under particular scrutiny and debate. The project explores sport emotions as key experiences for becoming "modern" subjects: The innovative combination of emotion, sport, gender, and body history, and the use of the methodological toolbox of historical ethnography, will contribute to a novel perspective on the cultivated, trained, and evaluated feeling body as a resource for self-fashioning and of sociality. Analyzing archival materials such as organizational documents of sport clubs and ego-documents, but also press products, photography, and literature in combination with oral history interviews and present-day participant observation informs how emotions have been and are being tapped as resources not only for athletic performance but also for self-empowerment and social change. For methodological reasons, the project focuses mainly on Germany, although of course it also takes into account the global networks and relations German athletes were and are engaged in.

First findings revolve around the history of female ambition in sport: While in the 1920s, the first heyday of women's sport, ambition was deemed "unwomanly," even dangerous to the physical and mental health of female athletes, today ambition is often seen as a particularly female emotion—yet faces misogynist as well as feminist criticism. Think, for instance, of the social media phenomenon #thatgirl, a recently trending and much-criticized hashtag for content about daily sport and health routines designed in the spirit of self-optimization. Exploring the making, becoming, and (re-)interpreting of the emotion of female ambition in sport since the 1920s will be a first step toward a better understanding of the important role sport emotions play for conviviality, self-fulfillment, and subjectification.

Figure 1. Berlin Sport Club's (BSC) successful hockey team celebrating a victory, October 1924.
Image: Berliner Sport-Club e.V.

Figure 2. Ambitious attack: BSC handball players defending an adversary throw.
Image: Berliner Sport-Club e.V.

The Birth of a Union: Theatricality, Sympathy, and Anti-Slavery in the Coming of America's Civil War, 1830–1860

Michael Amico

How blackface minstrelsy helped generate anti-slavery sentiment in mid-19th-century America: The novel *Uncle Tom's Cabin* has long been accepted as among the most effective means by which northerners came to feel differently about slavery and adopt anti-slavery positions. The effect was centrally achieved through the theater, where an estimated 50 times more people encountered the material than read Stowe's novel. Moral reformers of the time, and most scholars of today, believe that the white male working-class audience came around to anti-slavery by identification with the suffering and resisting slaves depicted in the play. But to pin the process of the audience's growing sympathy to only the content of the show does not adequately consider how the audience experienced and enjoyed it as blackface performance.

This project takes a renewed look into how a uniting spirit took shape in mid-19th-century America and inspired people of the northern states to fight a war against the slaveholding south. While it is customary to consider blackface performance as morally offensive and so unrelated to the otherwise morally uplifting content of *Uncle Tom's Cabin*, this presentist position misses how interracial relations were worked through in a particular style of performance and thus obscures the emotional makeup of what historians have had trouble accounting for in purely political, economic, or moral terms.

The focus on blackface and *Uncle Tom's Cabin* is a central component of my broader research into how northern America, in the lead-up to the Civil War, came together as a "union" for the first time. How did this happen? What comprised the sense of unity? The first major piece of this research concerned how the highly sexualized friendship of two northern soldiers challenges our understanding of the emotionality of the larger social union. Thinking further about what comprises this feeling on the social level, this current project also finds the question of sex and friendship to be integral to the bonds white men felt for black men, particularly as they were explored through the grotesque song and dance of blackface minstrelsy.

The sources for this project include texts and music of songs, scripts of performances, the design of theaters and their neighborhoods, reviews and advertisements of plays, and personal testimonies of performances as preserved in letters, diaries, and newspapers. The method consists of identifying the emotions expressed in and through these sources and inquiring into their animating objects, both material and fantastical (e.g. joy around “what”? Anger over “what”?). This method has revealed how the emotions in and around *Uncle Tom’s Cabin* were less about slavery per se than the constraints on and allowances for an arousing and thrilling sense of play in one’s day-to-day life. What also comes into view is how the larger, more amorphous space of fellow feeling was not curtailed by its many racist expressions.

Figure 1 . Topsy’s playful energy and joy only increased as white performers brought her to exuberant life on the stage and influenced how she was portrayed in illustrations such as this one by Hammat Billings.
Source: Uncle Tom's Cabin; or, Life Among the Lowly, by Harriet Beecher Stowe, 1853, John P. Jewett and Company, p. 316

The Capital of Capitalism. A Global Emotions History of the *Homo Oeconomicus* From 1840 to 1990

Agnes Arndt

Figure 1. A capitalist mindset—the secret of success?
Image: Shutterstock/Sergey Nivens

Is the capitalist entrepreneur associated with feelings of greed a specific feature of capitalism? Or is capitalism rather a product of entrepreneurial action, which spreads so persistently and develops even under non-capitalist preconditions precisely because it draws on mental and emotional resources other than those of personal profit-seeking?

The project focuses on the question of how people became entrepreneurial, from the 1840s to the present. Based on autobiographical and biographical material, on letters, requests, and the curricula of business schools as well as relevant business journals and social networks, questions about the structural and personal dimensions of entrepreneurial behavior are combined. How were—and are—entrepreneurial personalities formed? By which economic, political, and cultural systems are they produced and promoted, by which are they slowed down and hindered? Which cultural and regional characteristics and which supra-individual contexts of meaning such as family, church, and civil society play a role?

The project shows that, in addition to all structural factors, it is above all the individual motives, dispositions, and emotions of entrepreneurs that must be brought into focus in order to understand the ways in which capitalism is made, advanced, and defended against all crises and criticism. The global history project investigates the functional logic of these emotions for entrepreneurial action and decision-making as well as the value concepts and legitimation contexts that underlie them in economic, moral, social, and cultural terms. While initial results were presented in several articles and an edited volume, a monograph on the topic is nearing completion.

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Child Welfare and Child Endangerment. A Social and Cultural History of the Political Economy of Care Since 1946

Agnes Arndt

Legal terms that are not clearly defined pose challenges not only for lawyers, as they address ideal concepts that are as vague as they are volatile. The “best interests of the child” is one such concept. It brings together issues as diverse as justice of opportunity and participation, education, and family and social policy, but also asylum and development policy. The central concern of the oscillating concept is the ethically intended yet legally difficult protection of children on a national and global scale. However, the term owes its public impact primarily to how it enables the articulation of diverse and often contradictory interests.

Situated at the intersection of legal, social, and cultural history, the project inquires into the history of legal norms and practices that emerge as the result of powerful cultural negotiations and in turn have an impact on the social, political, and economic order of modern societies. Concepts of child well-being and child vulnerability are thus understood as a historically variable component of a political economy of care and are linked to empirical evidence about the physical and psychological well-being of children. At the same time, politically and economically determined ideas about childhood, motherhood, and fatherhood, and the state's “guardianship,” move into focus.

The types of sources surveyed include court and trial records, expert opinions, and legal texts and commentaries, as well as expert debates in education, sociology, and psychology. The project understands itself as a contribution to the history of childhood as well as to the history of law, and in this respect also aims innovative methodological and theoretical questions about the link between law and emotions. It follows previous work on this subject, which analyzed the role of emotions for the emergence of international criminal justiceto pose.

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Figure 1. Taking care of a child’s welfare, GDR, 1984.

MAX PLANCK INSTITUTE FOR HUMAN DEVELOPMENT
RESEARCH REPORT 2020-2022/23

Government of the Passions: The Emotional Politics of Justice in the European Spanish Empire, c. 1500–1700

Stephen Cummins

Figure 1. The imperial eagle crushing Spain’s enemies depicted in a frontispiece to the *Relatione delle feste fatte in Napoli ... per la nascita della Serenissima Infanta di Spagna* (Naples, 1639).
Source: Biblioteca Nacional de España

In the broadest terms, this project examines how emotions affected how women and men interacted with institutions of governance in the early modern European Spanish Empire. As Alexis de Tocqueville argued, justice in the ancien régime was “rigid in rule, mild in practice.” My research explores what emotional resources were needed for subjects to navigate from theoretical rigidity to practical mildness. It focuses on practices such as contact-making, pleading, bargaining, bribing, and other forms of navigating authority that are often in large part questions of emotional practice.

This project is the overarching framework for a specific forthcoming monograph on enmity and peacemaking in the Spanish-ruled Kingdom of Naples. In this study I explore the emotional politics of hatred in local and imperial contexts. After acts of violence, legal investigations into who was enemies with whom and what this had meant for the actions that had occurred were constant. Such relations of enmity had great salience, with particular behaviors and both formal and informal rules or rituals attached to them. Enmity was an emotional, social, and legal concept. Enemies, at times, also reconciled their differences, or tried to, through informal negotiations or formal rituals or contracts of peace.

The major dialectic of the book is therefore the encounter of the subjects of the Kingdom of Naples with the agents and institutions of royal and feudal authority, which also produced the sources the project draws from. I trace the journey of hatred from a personal or group passion, its subsequent transition into institutionally recognized relations of enmity, and the tactics groups and authorities used to grapple with such hatred. It confirms how affective politics were at the heart of early modern state formation and places emotions squarely in the realm of political history, as part of the political ontologies of actors at both local and central levels. The work tackles a series of subjects that shed light on this overarching concern: enmity and reconciliation in legal culture, the practice of provincial royal justice, missionary peace-making, banditry, and the culture of feuding among the nobility.

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Insurgent Fandom: An Ethnography of Crowds, Disaffection, and Unruly Sounds

Max Jack

I am finishing a monograph in which I examine the global proliferation of the ultra movement—a participatory style of sports fandom that entails collective continual singing, jumping, flag-waving, and the illegal lighting of marine flares at soccer games (and more recently at hockey and basketball games across Europe as well). Having spread across six continents, this coordinated style of crowd action harnesses emotionality in the stadium to positively influence the outcome of the game but, furthermore, is ideologically conceived of by its participants as a social movement positioned against the commercialization of professional sport. Based on over 3 years in Ireland and Germany with the ultra groups of three clubs (Shamrock Rovers FC, FC Union Berlin, and Eis Hockey Club Dynamo Berlin), my ethnographic research led me to commit to the all-encompassing lifestyle of the hardcore fans. Interrogating liberal democratic ideals of how citizenship should look, sound, and feel in public space, Insurgent Fandom examines the mixed feelings of anxiety, disdain, and fascination provoked by ultras' deviancy that spur the governance of their activities.

Based on participant observation and extensive personal interviews, I show the heightened emotional terrain created by ultras in the stadium to be motivated by an affective logic of social commentary and protest that is informed by their disaffection toward the state, the mainstream media, and the commercial priorities of sports' governing bodies. In consideration of the salience of protest in the current political climate, my research on the ultra movement provides an avenue through which to investigate the cultural results of political disillusion and the efficacy of crowd action in public spaces. Fearing the organizational capabilities of ultras, myriad governing apparatuses in Ireland and Germany have developed in and around the stadium space aiming to mitigate the inflammatory emotions and affective dispositions of the fans. I argue that cultivating atmosphere through crowd action radicalizes ultras through the alternative social possibilities it enables fans to implement in the stadium space. As such, a tension exists between ultras' politically liberatory potential and the capitalistic and governmental anxieties whose competing logics of profit and surveillance intervene in ways that aim to "nudge, coax, tune, and herd behavior toward profitable outcomes" (Zuboff 2019, p. 6).

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Figure 1. Shamrock Rovers ultras singing in Tallaght Stadium, Dublin.
Image: Max Jack

Urban Intimacy in Eastern and Central Africa in the 20th Century

Stephanie Lämmert

This research project investigates urban eastern and central Africa as a hub for African women on the move who were seeking freedom. In the early 20th century, in the colonial copper towns of central Africa as well as in eastern Africa, rapid urbanization took place. As the mining industry grew on the central African Copperbelt and the eastern African coastal towns turned into colonial business and administrative centers, migrant laborers from the entire region flocked to the new towns. While the jobs on offer were hardly designed for women and their presence in town was discouraged by the colonial state, countless women came to the towns anyway, married and unmarried; the former group were following their husbands, while the latter included those who were not seeking the bond of marriage but looking for something else. Town life offered a number of new freedoms to women, such as being the head of one's own household, business opportunities, wage labor (if limited), and formal education, but also new forms of leisure, pleasure, and romance. The Swahili saying *kutafuta maisha,* to search for the life, is an apt expression of what motivated African women to settle in towns.

How have these modern women, also referred to as *femmes libres* or champions, been depicted by male and female contemporaries since the 1920s? In which ways was the image of the modern woman intertwined with the discourse of romantic love, companionate marriage, and Christian respectability? What kinds of emotions are revealed through the (often male) gaze on urban women? And what were women supposed to feel, particularly those who resisted meeting the expectations set by respectability? In a close reading of "sugar stories," I have traced the changing mores of female respectability in town society. The agency and leverage that town women involved with so-called sugar daddies had, as represented in popular youth magazines, changed with the deepening of the public health crisis and the consequences of structural adjustment. However, the ambivalence in fantasies about sugar relationships demonstrates the importance of emotions for understanding gendered and generational dynamics of social hierarchies and racial politics.

The project focuses on Northern Rhodesia/Zambia, the Belgian Congo/Katanga/the DR Congo, and Tanganyika/Tanzania in the period between the 1920s and 1990s. My sources consist of mission, government, and mining company publications and archives, as well as court records and oral interviews.

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Figure 1. "Acha tamaa, epuka vishawishi" (Don't follow your lust, avoid temptations!). Mural in Dar es Salaam, Tanzania, 2014.
Image: Stephanie Lämmert

MAX PLANCK INSTITUTE FOR HUMAN DEVELOPMENT
RESEARCH REPORT 2020-2022/23

A Political and Cultural History of the Minute's Silence

Karsten Lichau

Figure 1. "How our allies honored their dead on the anniversary of the armistice": A French journal illustrates England's 2-minute remembrance.
Source: gallica.bnf.fr / Bibliothèque nationale de France

Established as a commemoration practice in remembrance of the soldiers killed in the First World War, the minute's silence is a political ceremony that became an important part of national remembrance culture in many western European countries and beyond. Though it represented one of the most innovative and important elements in interwar memory politics, it is largely absent from research in this field—not least due to the ephemeral character of the acoustic and emotional practices at its core. Centering the history of sound and emotions, this research project therefore challenges the claim that cultural forms of commemoration developed after 1918 essentially followed historical traditions established during the 19th century—a claim that is still widely accepted.

Following the historical dynamics of introducing the minute's silence into the highly diverse political memory cultures of Great Britain, France, and the German *Reich* between 1919 and 1935, the project examines the importance of ephemeral and often fragile acoustic and emotional practices for constructing, challenging, or changing the memory of history.

Bringing together macro- and microhistorical dimensions that play out in different performances of the minute's silence, the research embeds the different sounds composing the acoustic framework of the ceremony (music, bells, cannons, guns, and flares), as well as the practices of keeping silent, into their complex social, political, and cultural contexts.

With regard to the diverse emotional practices embraced by the participants in different countries, research on the minute's silence allows a questioning of theoretical and methodological discussions in the history of emotions: Thus, recent findings have shown the importance of adequately accounting for the "transversal dimension" in emotions, for the rather vague and diverse feelings or "second-order-emotions" like uneasiness, hilarity, hypocrisy, and indifference that act upon the experience and expression of more conventional emotions like grief, reverence, pride, and gratitude.

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Between the "Old" and the "New" Homeland. The Emotional Integration of Sudeten German Expellees After 1945

Soňa Mikulová

As a consequence of World War II, around 12 million Germans fled or were expelled from former German provinces and East-Central European states. Among this group, which was highly heterogeneous in terms of class, age, and cultural and religious background, were approximately 3 million Sudeten Germans from Czechoslovakia. Despite their "cold" reception by local Germans, most of the so-called homeland expellees (*Heimatvertriebene*) were considered "well-integrated" into the socio-economic structures by the end of the 1960s in both West and East Germany. However, due to different political systems, expellees' possibilities for collective self-representation in the two German states differed. What they had in common was a variety of emotions, ranging from grief at the loss of homeland and hatred for those responsible to homesickness and nostalgia, from a sense of injustice to pride in their origins and their socioeconomic achievements in the new context.

Based on archival documents, periodicals, and other media, ego-documents as well as oral history interviews with Sudeten Germans who lived in the former FRG and GDR, the project focuses on the feeling of ambivalence between the sense of belonging to the community of the old homeland on the one hand, and to the new society on the other. Emotion-theoretical and emotion-historical concepts such as affective belonging and emotional communities (Barbara Rosenwein) offer useful tools to explore this ambivalence. While differentiating between the historical emotions of expellees and their later accounts and memories, the research findings demonstrate how expellees' individual and collective emotions changed over time. Moreover, they show that there were more similarities in the ways expellees in West and East Germany dealt with their emotions in the private sphere than has been presented by scholars to date.

This project builds on the research carried out as part of the Max-Planck-Gesellschaft research initiative The Challenges of Migration, Integration and Exclusion and the international conference *Representations of Migration and Emotions of Exclusion*, held at the Center for the History of Emotions in March 2019. The follow-up volume *Migrant Emotions: Inclusion and Exclusion in Transnational Spaces* (co-edited with Sonia Cancian and Peter Leese) was accepted for publication by Liverpool University Press in 2022.

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Figure 1. Objects of daily life and cultural heritage exhibited in one of the many small homeland museums served as emotional reminders of what had been lost. Iglauer Heimatmuseum in Heidenheim an der Brenz, 2020.
Image: Michal Urban

“Work as Prime Necessity”? An Emotional and Cultural History of Work in the Late Soviet Union, 1960–1980

Alexandra Oberländer

Figure 1. Komsomolka Galina Kalinina, car assembler in the Likhachev factory.
Image: V. Sobolev, Sovetskoe foto 10 (1975), inside cover page

One of the most defining aspects in the history of the Soviet Union is the sphere of work. Former Soviet citizens fondly remember the camaraderie in the workshop, the regular gatherings for celebrations in the office, or the sense of belonging the Soviet workplace provided in general. They claim to have detected a purpose in their work, one which got lost with the end of the Soviet Union. This emotional bond with the workplace and with colleagues, as well as its preconditions and results, is at the core of this project. How Soviet citizens experienced their work and what they considered work to both be and mean are its primary questions.

This project aims to rethink the history of the Soviet Union between 1960 and 1980 through the lens of work. Soviet policies wanted to transform work into the “prime necessity” of wo/men. This aim and the focus on labor as a transformative force for the new Soviet wo/man were revived under Khrushchev, who imagined communism to begin within the next generation. Usually, the narrative in Soviet history is one of utter failure. The alleged non-existent work ethic is a constitutive element in this narrative, succinctly summarized in the joke: “They pretend to pay us and we pretend to work.” I will argue, however, that in terms of implementing work as a prime necessity the Soviet Union succeeded, though not necessarily as Soviet ideology had imagined.

This project will reconsider notions of work in the late Soviet Union by asking what was considered work in the first place? Which activities were perceived as work, and which as leisure? How did emotions shape and constitute those boundaries between work and leisure? Since monetary wages were just one means for survival and many necessary services could not be bought with money but were instead provided through one’s workplace (housing, health, kindergartens, etc.), the workplace was the linchpin for organizing the Soviet everyday. This role of the workplace created a genuine emotional attachment on the part of working people to their workplaces; they often described their factories, enterprises, or offices as *rodnoi* (native/homelike/domestic). The Soviet workplace was conceived of as an extended version of home and a mini version of the Soviet Union, a notion often framed as “patriotism” toward the factory or institution.

The project draws on a wide array of archival material, newspapers, Soviet popular culture (movies, for example), diaries, memoirs, letters, and interviews in order to assess the emotional and cultural history of work in the late Soviet Union.

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Figure 2. This photograph, titled *Miners*, shows two workers taking a break.
Image: Sergei Kosyrev (Komsomol’skaia Pravda), Sovetskoe foto 4 (1963), p.
15

The End of Sympathy. Feelings, Insensibility, and the British Idea of Progress, c. 1780 to 1840

Kerstin Maria Pahl

"If fanaticism is to be dreaded much, apathy is to be dreaded still more."

In the global age of revolutions (1775–1848), which, in Britain, was an age of reform, industrialization, and empire-building, the major antagonistic force to progress was thought to be an obdurate heart. If the country was to become modern, its politicians and institutions had to avoid radical enthusiasm, while still nurturing interest in the state of the nation. Alongside changing the material infrastructure, political, philosophical, religious, and scientific writings concurred, one had to change the moral and emotional infrastructure, and improving the living conditions led to improved feelings on the part of the populace—a line of reasoning that was quickly woven into the empire's ideology.

This project investigates the idea of progress by looking at one of its foils, the idea of emotional stagnation. From the second half of the 18th century, debates on insensibility, indifference, apathy, callousness, and other kinds of "want of feeling" (Adam Smith) demonstrate how the moral failure of insensitivity became a political problem. Moreover, and due to the concurrent rise of the social sciences, it was seen as a problem that could be solved: Insensitivity was no inherent feature of the human condition; people became dull because of the circumstances under which they lived and labored. Defunct roads and dilapidated buildings led to stunted spirits; working on a slave ship was a horror for the enslaved and so hardened the perpetrators that they became outcasts from the "emotional community" Britain and the empire was imagined as. Successful research into anesthesia confirmed that insensibility could be intentionally produced and abolished.

The management of emotions, and in particular the fight against disaffectedness, turned into a key factor in political interventions far beyond British shores. Being insensible, indifferent, apathetic became equated to being not only uncivil, but also uncivilized. Sunday schools in Philadelphia and missions in Guangzhou aimed at curing the alleged mental numbness through moral education. While insensitivity thereby bolstered gendered and racialized notions of "uncivilized" behaviour to legitimize religious and medical missions, even military interventions, detachment became, in a few cases, an attitude of resistance. It signalled refusal to comply with normative morality and challenged the—often fraught—ideas of what constituted “active interest.”

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Figure 1. Revolution abroad, yawn-fest at home: detail from *The Days we live in!* by George Cruikshank, 1797.

The New Woman and Moral Politics: A Herstory of Women’s Feelings and Agency in Turkey

Esra Sarioğlu

The New Woman and Moral Politics: A Herstory of Women’s Feelings and Agency in Turkey analyzes the emotional trajectory of the gendered transition from neoliberal globalization to right-wing populist authoritarianism in Turkey—that is, from the 1990s to the late 2010s. The project investigates the gendered operations of emotions and the ways in which gender politics is transforming during the global era. More specifically, it examines how emotions of shame, embarrassment, and honor energize the capitalist economy, feminist movements, and authoritarian politics in complex, contradictory, and unexpected ways in contemporary Turkey. The project advances ongoing discussions regarding feminist theory, women's agency and embodiment, emotions, globalization and gender, gender politics, and right-wing populism, as well as ethnography of the working classes, and Middle Eastern studies.

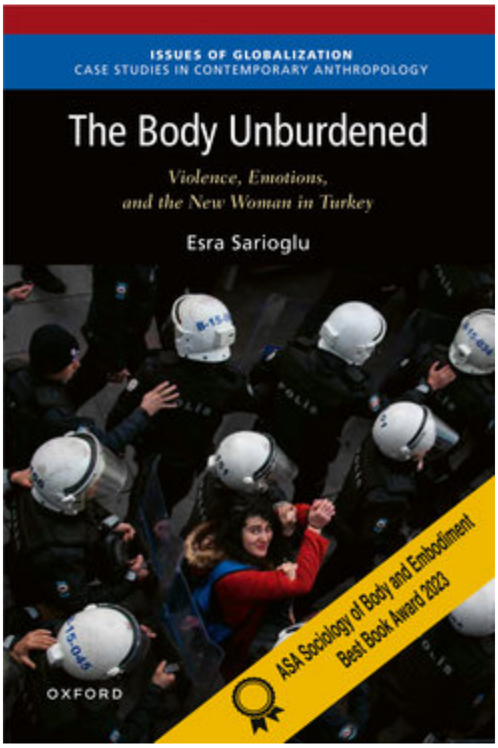

Image: Oxford University Press

The book entitled *The Body Unburdened: Violence, Emotions, and the New Woman in Turkey* (Oxford University Press, 2022) was published as part of the project. It examines political and historical processes from the feminist perspective, revealing an ensemble of emotional and embodied dynamics that shape the new urban economy, women's activism and sociality within cities, and the authoritarian politics of today. This book opens up a novel path for thinking about the gendered links between neoliberalism and right-wing populism in the global era by combining ethnography of a new group of women from the popular classes with a study of vigilante violence against these women. It uses emotions, particularly shame and honor, as an optic of sociological analysis, offering fresh conceptualizations of women's agency and authoritarian politics. To explain why and how emotions have taken on enormous political and economic significance during the global era, the book brings perspectives from the sociology of the body and the history of emotions as well as affect studies, feminist phenomenology, symbolic interactionism, Bourdieusian sociology, and globalization, gender, and labor scholarship. The line of analysis that I develop explores the uneven and unanticipated interactions between trade openness and bodily openness, by which human beings are simultaneously open to people and places, and to violence and hostility. This highlights the political–ontological bind that young urban working women from the popular classes face in today's Turkey.

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Environment and Emotions: Human-Environment Relations Between Colonial Scholarship and South Asian Buddhist Reformers in Colonial South Asia

Frederik Schröer

This project focuses on the role of emotions in human relations to environments and to nonhuman actors. To better face the current climate crisis in the Anthropocene, we need to reassess the Age of High Imperialism as a crucial ecological and historical watershed. It was in this period that human influence first precipitated systemic ecological change, and that local/traditional ways of relating to (natural) environments first interacted with colonial science and modernity. What emotions did environments and their changes and crises elicit? What emotional grammars were drawn on to make sense of ecological change and crisis? And how did nonhuman actors participate in these ecologies of feeling?

The project concentrates on Buddhists and scholars of Buddhism in colonial South Asia, across the colonizer–colonized spectrum, tracing their relation to natural (sacred trees, forests, mountains) and archaeological environments, as well as to those in canonical texts, and to those in crisis (famine). This regional focus, grounded in multiple South Asian languages, is expanded through a global perspective following intellectual networks to both Europe and East Asia. Alongside its intervention in colonial and environmental history, the project also rethinks the study of emotions themselves. By bringing Buddhist epistemologies into dialogue with posthumanism, new materialism, and new insights in (environmental) neuroscience, it locates emotions as critical aspects of a non-Eurocentric model of worlded cognition, challenging anthropocentrism.

The project's initial phase, launched in 2021, focused on its theoretical and methodological design. 2022 saw the systematic gathering of primary sources (monographs, periodicals, visual material, government reports, and other documents) in European and Indian archives, and their analysis using qualitative data analysis software. First public outreach was also undertaken, including workshop participation and public talks in Europe and South Asia, as well as graduate-level teaching at Freie Universität Berlin. As of 2023, the project has moved on to the publication of first findings with one article, "Affective Entanglements: Human-Nonhuman Relations in Buddhist Ecologies of Feeling," under review at the *Journal of Global Buddhism* and two more in submission. For the continuation of archival work in 2023, the project was awarded the Gerald D. Feldman travel grant by the Max Weber Foundation, enabling research in both India and the UK.

Figure 1. Journal Cover depicting the sacred “Maha-Bodhi Tree” (aśvattha / ficus religiosa) at the Buddhist Mahabodhi temple Bodh Gaya, India.
Source: Journal of the Maha-Bodhi Society, 9, (5-6), 1900

Image: ILSR Kolkata

Emotional Motives for Erdoğanism in the Turkish Diaspora

Nagehan Tokdoğan

Political choices and voting behaviours are mostly regarded as "rational" orientations. By involving emotions as an analytical category, my research project aims to overcome the rational–emotional dichotomy and consider political choices as manifestations of emotions drawn from daily social experiences. To this end, I am investigating the emotional motivations of Germany's Turkish migrants in supporting Recep Tayyip Erdoğan as president.

Thus far, I have conducted 11 in-depth interviews and two focus group interviews with first- and second-generation migrants of Turkish origin living in Berlin. When discussing the past, they rely heavily on a narrative of humiliation, linking the degrading attitudes of German society and institutions toward them with their religious and national identity as Muslim Turks. They strongly identify with their nationality and construct the narrative of humiliation as not only an individual experience but a collective and national one. Through my research, I have encountered several consequences of this narrative, the most salient being ethnocentric withdrawal: the tendency to cling to one's own culture and identity by idealizing it. The interviewees perceive Erdoğan as a "savior" of their national honor as he encourages them to preserve their own national identity from assimilation and, more importantly, promises they are not "alone" although they do not live in their home country. The most prevalent reason for their admiration seems to be Erdoğan's "strong leader" image on the world stage; they also appreciate his leadership traits, such as strength, decisiveness, and persistence. They tend to identify him with the Turkish nation as a whole—drawing on nationalistic imagery about Turkey's glorious imperial past.

I propose to read my interviewees' over-reliance on and admiration of Erdoğan as a manifestation of collective hubristic pride that goes hand in hand with a constant perception of threat to the core of national identity. I argue that Erdoğanism in the Turkish diaspora is closely associated with this hubristic pride, which functions as a quest for compensation for collective low self-esteem; those whose self-perception has been previously wounded are more likely to tend toward authoritarian leaders. Such an attachment also reshapes the nation's self perception and seems to partially satisfy the emotional need for unity, visibility, worthiness, and perfection.

Scholars studying migration to Europe claim that countries such as the Netherlands and Belgium have adopted more multicultural models that encourage immigrants to participate in wider society while retaining their traditions and values. Germany's “guest-worker” policy dating from the 1960s has, in contrast, led to a segregational/assimilational model being favoured until recently. Studies exploring the integration experiences of other migrant groups in Germany reveal similar problems to those experienced by Turkish immigrants, but it is important to note that cultural proximity to European norms and institutions is an important factor in the level of “integration.” For a clearer insight into the migrant populations in Germany, more comprehensive ethnographic investigations that shed light on their experiences and emotions are needed.

Figure 1. Billboard poster advertising an event with Erdoğan during his 2011 visit to Germany: “Our prime minister is in Düsseldorf.”

Aging, Mobility, and Emotional Labor in East and Southeast Asia

Mika Toyota

Figure 1. Artist Katie Taylor explores the acknowledgement of unidentified dead through creative practice. The individuality of well-worn belongings is akin to identity in life as well as death. Image: Katie Taylor

One major focus of this broader research project is the highly topical aspect of care and isolation: aging and dying without family in Japan. In the last 40 years, Japanese society has experienced considerable change regarding family (non-)formation: the proportion of Japanese men who have never married (at age 50) has increased from 2.6% (1980) to 28.3% (2020), and the proportion of single-person households has increased from 19.8% (1980) to 38% (2020). The increase in the number of people who have never married or who are divorced, separated, or living without family is causing a rise in cases of unaccompanied deaths, *kodokushi*, where the corpses remain undiscovered for an extended period of time. For example, in Osaka City the number of unclaimed remains handled by the local authority has increased from 336 (1990) to 2,366 (2018). This has triggered widespread public anxiety, and new commercial services that replace next-of-kin support are emerging.

Through documentary research and narrative analysis on this emerging service industry in contemporary Japan, this project tackles two main questions:
1) What kind of “family replacement businesses” have emerged to provide care and service after lonely death?
2) How do these industries meet the emotional needs of the relatives of the dead, as well as the general public, and how do they maintain or change the ideology of the family?

So far, three key services have been identified that warrant further investigation: first, *kodokushi* insurance, which property owners can purchase to cover the costs for post-death cleaning and other measures if the tenant dies alone. Second, guarantor agency services, which provide financial and liability guarantees for single people, especially those who are elderly, in the event of renting accommodation, being hospitalized, or being admitted to a long-term nursing home. The 1933 Japanese law pertaining to the personal guarantor system requires a person to designate an individual guarantor (usually the next of kin) in these circumstances. Unmarried individuals without descendants need to seek a third-party service agency. The service agent also provides “fictive” family members who attend the mortuary practice. Third, specialized cleaning companies, which provide services including clearance of belongings, insecticide for treating flies and maggots, cleaning and disinfecting of bodily fluid stains, and the removal of the smell of the dead body from the flat or house. Social blogs and books written by cleaners have received public attention, and TV dramas, films, novels, comics, and pop songs exploring the topic have been produced and consumed. Some research findings will be presented at the conference *Dying Alone and its Afterlives in Contact-less Socialities* (17–19 April 2023, Harnack Haus, Berlin)

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The End of Solidarity? Deindustrialization in Germany and France (1960–2000)

Julia Wambach

The process of deindustrialization in the Global North since the 1960s and 1970s has usually been seen as a period in which solidarity among the working classes slowly eroded through the loss of jobs in the industrial sector. Recent studies stress the atomization of the working class and the repercussions of the loss of work for the cities and regions, which put the social cohesion of those emotional communities (Rosenwein) constructed around work at risk.

While most of these studies focus on the downfall of those regions and the atomization of the working class, in my research project I explore how politicians, employers, and workers alike searched for new solidarities and ties that could bind the people of the deindustrialized regions together once the infrastructure built around communal work in the coal mines and steel plants began to vanish. However, rather than describing the nostalgia for the past and the mourning of what was lost, my goal is to show what replaced the solidarity of the workers or how it continued to exist.

My project focuses on two cities, Lens in Northern France and Gelsenkirchen in the German Ruhr valley. Both are emblematic of the decline of heavy industry and grapple with its consequences, such as high unemployment and poverty. Using sources from local government, NGOs, and companies, this project relies on oral history interviews with former coal and steel workers and their families, local politicians, and social workers in these two cities.

I argue that during times of deindustrialization solidarity was not simply disappearing, but changing its locus. Key examples of this change are the soccer clubs of these two cities, RC Lens and Schalke 04. Both portray themselves as providing an emotional home and an opportunity to participate in communal celebration of the mining heritage in a post-industrial fractured society. In a recently published book chapter, I argue that Schalke 04 used its heritage as a workers and miners club both earlier and later than one would expect: The Nazis drew on the collective and participatory emotions around the club's mining heritage to boost the regime's popularity, while the club itself did not (re)turn to its mining heritage until the 1990s, when the region's deindustrialization process was almost over.

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Figure 1. During deindustrialization, soccer provides a home for those who have lost their jobs in the coal and steel industries.
Image: Pixabay

Planetarium: Wonder of Technology —Technologies of Wonder

Helen Ahner

Figure 1. The first planetarium projector in the Deutsches Museum in Munich (1925).
Image: Deutsches Museum München

How can astronomical knowledge be made palpable and what does the universe feel like? Answers to this question were found by German popularizers of knowledge and *Volksbildungs*-functionaries of the 1920s in the projection planetarium: In this novel facility, the audience could view a stunningly real simulation of the starry sky, have lecturers explain to them exactly what was visible up there, get lost in the moving 360-degree projection, and entirely surrender to wonder—an epistemic emotion that was produced, experienced, and cultivated in the planetarium.

The dissertation in cultural and historical anthropology on which this project is based examines the experiences and emotions that the planetarium made possible with its techniques and technologies: What specific ways of perceiving, knowing, and feeling did the planetarium enable at the time of its establishment (1920–1930)? Which understanding of the world, of knowledge and technology, could be experienced there? How were the modes of perception, emotions, and narratives that became accessible in the planetarium connected to these understandings?

Building on these questions, the project explores the planetarium spectators' experiences of nature, technology, the body, and transcendence. The ways of perceiving, feeling, and knowing under the dome were referred to by the audience as wonder and awe. Through feeling wonder, the planetarium visitors constituted a certain attitude toward the world, knowledge, technology, and nature. This manifested itself in practice–discourse bundles: in narratives and topoi such as the narration of the "wonder of technology," but also in embodied practices (technologies of wonder), which were cultivated in the planetarium and which induced the acquisition of knowledge as an embodied experience. Wondering in the planetarium was engineered and explored as an epistemic–emotional attitude that also had an effect beyond the domes.

Based on a corpus of more than 900 sources and with the help of the methodological toolbox of historical ethnography, this project shows how nature also—and above all—approaches people as a feeling, how technology and science become the source of transcendent emotions, how being modern happens on the emotional level, and how the feeling of technical sublimity continues to have an impact on everyday life.

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Image: Wallstein

Love and Labour in the City: Romantic Love and Delhi’s Workers, 1950s to the Present

Rukmini Barua

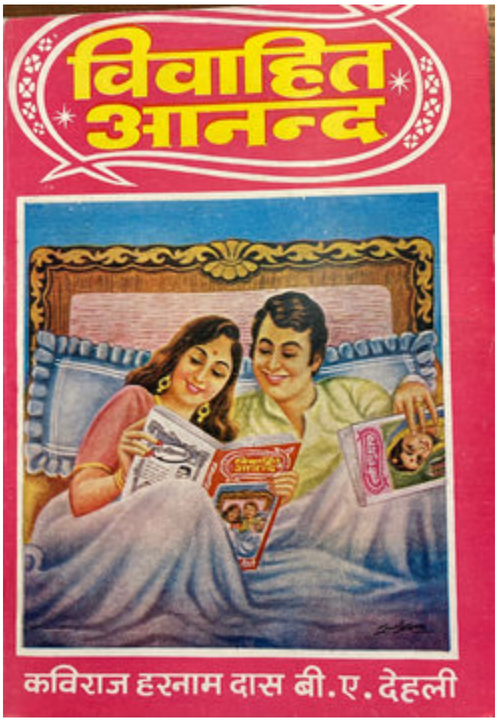

Figure 1. Booklet “Joys of Marriage,” Kaviraj Harnam Das and Sons Pharmacy and Publications, Delhi
Image: Rukmini Barua

Working-class intimate lives in postcolonial India were profoundly affected by ideologies of anti-colonialism, nation-building, and economic liberalization, as they were by technological innovations that were increasingly embedded in personal spaces. This project is an ethnographically grounded history analyzing the ways in which working-class intimacy, romance, and conjugality are constituted and experienced at three interconnected levels—how the state, civil society, and social structures produce discourses of intimacy and the tensions that are embedded within; how vocabularies and modes of communication, including new forms of social media, orient ideologies and logistical repertoires of intimacy; and the role of the urban built environment and everyday rhythms of work and life in shaping intimate practices.

Scholarly perspectives on working-class intimacy have tended to view it either as a domain of “undisciplined desire” posing a challenge to normative constructions of domesticity and respectability or in terms of embourgeoisement, which is accompanied by adherence to or even mimicry of dominant upper caste and classed codes of feminine sexuality and conjugality. Furthermore, recent literature has argued that romantic love forms the foundation of a "powerful utopian vision" in symbolically inverting social hierarchies and affirming the primacy of the individual. Drawing on a range of archival, oral historical, ethnographic, and digital materials, this project counters these assumptions. Evidence from the contemporary Indian context, presented through this research, demonstrates how individual desire is increasingly framed not as opposition to caste- and kin-approved conjugal arrangements, but rather as a mode of integrating the family into the romantic ideal. In a similar vein, this study foregrounds everyday practices of digital intimacy among the urban working classes to suggest that instead of following a trajectory of embourgeoisement, configurations and repertoires of courtship and coupledom are produced in contingent and unstable ways at the intersections of caste, religion, and gender. Such practices contain, in suspended tension, unruly desires, social and cultural expectations of respectability, and attendant emotional investments in family and kin.

In addition to this project, I revisited my doctoral research on labor landscapes in the western Indian city of Ahmedabad through the 20th and 21st centuries, leading to the publication of a monograph and a number of articles. *In the Shadow of the Mill: Workers' Neighbourhoods in Ahmedabad, 1920s to the 2000s* (Cambridge University Press, 2022) examines the experiences and negotiations of urban citizenship through the prism of everyday plebeian politics and property relations. In doing so, it draws attention to the transformation of the aesthetics and embodied practices of quotidian muscular politics in shaping social, legal, and affective claims on the city. Other publications that have stemmed from this research include a book chapter on the emotional dimensions of deindustrialization and a journal article on precarity and fantasy in working-class Ahmedabad.

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Spectacular Speeches: Emotions, Rhetorical Practices, and the New Canon of Public Speaking in France and Italy (1789–1861)

Francesco Buscemi

In my final years as a researcher at the Center for the History of Emotions, I studied the emotional engagement of political audiences in France and Italy from the French Revolution to 1848. The most talented orators of the French Revolution were well aware that it was the expressiveness of their language that made them eloquent. Some might have had deep voices, but they also took care to professionalize the writing of their speeches by hiring ghostwriters they trusted. In order to hold an audience's attention, these professional speakers knew they had to read people's cues—observing the movements of others' bodies, foreseeing the emotional reactions to their words, and adjusting their script to the unexpected.

Theoretical reflections on rhetoric and cultural practices related to public speaking explain how skillfully revolutionaries weave together the fabric of their speeches. But where else could political actors gain the knowledge they needed to step up their skills accordingly? How did they end up experiencing a new canon of eloquence, making the most of eighteenth-century lessons on sentimentality? Which practices prepared or enabled them to embrace a new rhetorical style suited to influencing public opinion that became so important politically over the course of the 19th century? This project investigated some of the threads that facilitated this turn in the century-old tradition of rhetoric, identifying the main sources of the revolutionaries' oral culture and the growing importance of emotional engagement in 18th-century rhetorical canon. By using insights from sociology and political sciences, I tried to demonstrate how much historians need to consider these cultural elements so as to seize the experience citizenry had of political institutions. During the pandemic, when the archives were not accessible, I worked on French and Italian theoretical treatises on rhetoric in order to understand what was at stake in the new set of rhetorical practices of the modern age: the conscious display of emotions, the emotional engagement of the audiences as the primary goal, and the social experiences that made possible the establishment of a new canon of emotionalized rhetoric.

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Figure 1 . Funeral service of the citizens who died at the siege of the Bastille: Speech by Abbé Fauchet, 5 August 1789.

Source: Collection de Vinck, The French Revolution Digital Archive (FRDA), Bibliothèque Nationale de France, Paris / Stanford University

The Politics of Grief: Fascist Italy's Military Cemeteries of the First World War

Hannah Malone

Mussolini's Fascist regime sought to exploit grief for political gain by taking control of the commemoration of the fallen soldiers of the First World War. Whereas initially Italians who died fighting in the war were buried in makeshift cemeteries close to the battlefields, in the late 1920s Mussolini decided to exhume their remains and rebury them in large ossuaries.

Located along the former front in north-eastern Italy, the vast scale and monumentality of the Fascist ossuaries means that they are unlike other European memorials. By imposing a narrative that spoke of victory, they helped to silence discordant memories of the war as pointless slaughter. By twisting sorrow into pride, they were intended to promote imperialism and militarism, and to bolster public support for future wars. In essence, the monuments represent an attempt to harness feelings of grief and loss to the Fascist cause. As such, they offer an example of the use of emotions as political tools and the nexus between emotions and politics.

This research combined emotional, political, and architectural history in order to uncover the political motivations behind the creation of the cemeteries. Drawing on both visual and textual sources, it explored a range of documents held in previously inaccessible military archives, and propaganda including videos, pamphlets, newspaper articles, and postcards. As the sources suggest, the Fascists aimed to channel the emotions elicited by the dead in support of the regime. As sites of rituals and rallies, the cemeteries were meant to foster feelings of pride, triumph, self-sacrifice, and even joy, while restricting sadness, regret, and resentment at what some saw as a pointless bloodshed. Propaganda declared that "one should not cry for the dead," but personal responses show how individuals could resist the regime. Thus the Fascist cemeteries present an ideal case study for the interplay between national politics and individual emotions—a timely issue given the emotionality of politics today and the current ascent of the Italian far-right.

In August 2021 the project on the emotional politics of grief was concluded, with two Open Access articles published in 2022.

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Figure 1 . Ossuary of Redipuglia, built 1935 to 1938, Italy.
Image: Hannah Malone

The European Movement for Solidarity With Chile After 11 September 1973. Political Emotions and Transnational Mobilization

Caroline Moine

Figure 1. Cover of a recording of Salvador Allende's last speech, 1973, published by Eterna, VEB Deutsche Schallplatten.
Source: MPI for Human Development

Historians have recently shown an increasing interest in researching forms of international solidarity after 1945. Mobilization against the regime of the Chilean military junta who seized power in the coup d'état of 11 September 1973 constitutes an important case study as a central element of European and global history. The history of the coup and the international response to it have become one of the primary pillars of the European left's grand narratives, reinforcing a pathos that colors the remembrance of activists. Historians thus have to take care to distance themselves from this mythological perspective in order to situate the history of international solidarity with Chile at the intersection of the history of emotions, the history of social movements, and the history of human rights advocacy. Only then can historians critically question the supposition that the reception of news from Santiago was sufficient for setting off a spontaneous, unifying feeling and wave of international solidarity.

In order to probe the forms and evolution of emotional expression, the project first explored the discursive strategies employed to give the struggle for solidarity with Chile an emotional charge on an transnational level: the use of media (radio, posters, film, mural painting) and medial practices (concerts), as well as the cultivation of collective emotions, especially of a religious character. Secondly, it analyzed the development of new transcontinental networks through biographies of European and non-European activists engaged in the solidarity movement, thus uncovering a range of different forms of mobilization from the local to the international level. Finally, the research involved a long-term study so as to provide a comparative approach from a spatial and temporal point of view, going beyond the sole context of the Cold War.

The results of these 2 years of research have led to a series of presentations and individual and collective publications. Another outcome was the writing of my second book, or habilitation, defended in October 2021 at the German Historical Institute in Paris: *Helmut Frenz, the "red pastor." A transnational journey, at the heart of solidarity with Chile.* This work of "global biography" between Europe and Latin America, where politics, religion, and emotions are intertwined on an individual and collective scale, underlines the complexity of the process of transnational political mobilizations from the 1970s to the 1990s.

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Visualizing Lives. Portraits and Biographies in England, c. 1680 to 1750

Kerstin Maria Pahl

Portraiture and biography were the most popular visual and literary genres in 17th- and 18th-century England. As devices of genealogy, prestige, social distinctions, and national formation, they worked through an intricate interplay of form, content, circulation, and reception. In order to unfold their full power, however, they had to be not only aesthetically good, but also emotionally persuasive: They had to convince readers and beholders that representations were “like,” meaning that a portrait resembled its model and that a biography was representative of the person’s character. Likeness, a key term in discourses around these media, enshrined the understanding that similarity was not only located in content, facts, or descriptions, but also, and often primarily, in the work affecting the recipient. Finding a work “like” often translated into emotional judgments of liking or disliking the individual.

Figure 1. Self-(re)presentation as a trace left in the world: Portrait of Matthias Buchinger, celebrated musician, artist, calligrapher and performer, who was born “without hands, feet or thighs.”

(Anonymous, *Matthias Buchinger*, after a self-portrait, 1724).

Crucially, semblance also pertained to an individual's social situation. Likeness often denoted like-mindedness, meaning that portraits and biographies made apparent—through such cues as posture, clothing, attributes, and style—with which social groups or strata their subject was aligned (or not). Such social signaling was critical during the transformative times under investigation: The Catholic-leaning Stuart monarchy was deposed and the Protestant succession secured; powerful institutions were incepted, including the Bank of England in 1694; Great Britain was created in 1707; and a public sphere tightly controlled by censorship became a relatively free print-market.

This project has explored the potency of joint presentations of portraiture and biography for social formation and nation-building. It has foregrounded representations that joined words and images, including frontispiece portraits in biographies, illustrated biographical dictionaries, and biographies specifically written to explain portraits. While portraiture and biography individually have yielded excellent studies, their intermedia relations remain less explored, partly because two sets of methods were required to properly examine the rhetoric of visual portraits, verbal Lives, and the implications of their joint presentations. Because of the link between resemblance and affectiveness enshrined in the term "likeness," the project had a focus on works produced by friends, family, or acquaintances and how their emotional ties with their subjects were cast as privileged insights.

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Neo-Ottomanism and the Politics of Emotions in Turkey: Resentment, Nostalgia, Narcissism

Nagehan Tokdoğan

The main focus of my book is the politics of emotions under the currently ruling Justice and Development Party (AKP) in Turkey. Drawing on the historical development of political Islamic tradition in Turkey, I cover the period from the late Ottoman Empire to the present, mainly focusing on the period after 2002. My primary area of investigation is the role of emotional politics in the enduring success of Erdoğan's rule, particularly regarding the utilization of the Neo-Ottomanist narrative to create a new national mood. I deploy a narrative analysis method to analyze the interactions between national narratives, symbolic politics, and politics of emotions, and argue that these interactions have been at the root of the popular support the AKP has achieved over 2 decades.

Following theoretical discussions on the relationship between politics, emotions, and symbols, the book examines the historical development and current manifestations of Neo-Ottomanism as an alternative national narrative, and analyzes three symbolic sites of Neo-Ottomanist politics of emotions (leader, space, and myth). The book is the first that focuses specifically on the politics of emotions in Turkey, serving as a pioneering contribution to the field by showing how a national narrative may address and mobilize emotions. The book is distinctive in understanding how and why the Erdoğan regime has been receiving the support of the masses despite the various crises in which it has played the major role. The content of the book offers an extensive perspective for comprehending the role of emotions in politics.

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Figure 1 . Taksim Square, Istanbul (2019): Digital exhibition center focusing on the attempted coup of 15 July.

Image: Murat Bergi

Feeling the Way Through With Sound: Social Warmth, Critical Feeling, and Affective Trance in North African Popular Islamic Rituals

Tamara Turner

The research project investigated the fundamental role of feeling in Sufi and popular Islamic rituals in contemporary North Africa, up to 2022. In 2022, it was awarded the British Forum for Ethnomusicology's Early Career Prize for the article "Affective Temporalities of Presence and Absence." This article explored what it means to be musically haunted, reflecting on the intertwined, spectral interdependency of music, affect, and politics in the context of *dīwān* rituals in Algeria, by way of non-Western understandings of affect, music, and ritualized temporality.

In *dīwān,* the popular Algerian Islamic ritual, one can be haunted by the deep, bass-register melodies of spirits, saints, and historical figures of the trans-Saharan slave trade. Musical haunting is affective haunting. Melodies are not only experienced emotionally as recurrent fear, dread, and ambiguous feelings; they are simultaneously physically arresting for the body and senses, erupting into uncomfortable sensations like prickling skin and a knot in the stomach, eventually precipitating registers of trance. Here, musical affects manifest spectrally—both directly as non-human entities or spirits and indirectly through strong emotions that tend to "take over." The haunted are never completely "healed" through ritual; suffering always comes back in some form. Rather, *dīwān* is a modality of continually inhabiting and embodying various tumultuous political histories that perpetually resound through the daily lives and physical bodies of the *dīwān* community.

The article was praised by the jury as beautifully written and truly outstanding within a strong field that is at the forefront of contemporary ethnomusicology. It could be considered an example of a vivid ethnography that at the same time clearly discusses its theoretical positioning.

The book manuscript on Feeling the Way Through With Sound is near completion.

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Figure 1. Dīwān ritual of the Bilaliyya Order, one of the Sufi orders in Algeria. The young man facing the musicians is being musically worked into a process of trance. 2016, Oran, Algeria.
Image: Tamara Turner

Learning From Defeat—From the French Occupation of Germany to the European Union

Julia Wambach

The year 1945 was a turning point in European history. Germany and France shared a history of violent wars and mutual occupations in the 19th and 20th centuries, from the Napoleonic Wars to the Franco-Prussian War to World War I and the occupation of the Ruhr in its aftermath. 1945 promised more of the same. The tables were turned once again—France became an occupier of defeated Nazi Germany. But this was the last occupation involving the two countries: In the postwar years, Germany and France left their hatred behind and emerged as the heart of the European Union. In *Learning from Defeat,* I argue that the learning processes from enmity to friendship, derived from the violent history of wars, occupations, and defeat, are central to this process of peacemaking. The manuscript of *Learning From Defeat* is currently in its final stages and will be submitted to the Oxford Studies in Modern European History series at Oxford University Press.

Learning From Defeat makes three important contributions to our understanding of postwar European history. First, I draw attention to the French occupation zone in Germany, which has often been neglected by historians, who have mainly underlined the importance of the Cold War for the reconstitution of Europe after World War II. While the Cold War was certainly central to the new European order, this focus often diverts the view from the constellations, emotions, and experiences at play outside of the American–Soviet antagonism, such as the emergence of the European project out of the long history of enmity between France and Germany in the French occupation zone. Second, my book goes beyond the traditional caesura of 1945 and underlines continuities between the German occupation of France during the war and the French occupation of Germany after the war. For instance, as my 2019 article in the journal *Contemporary European History* reveals, former officials from the collaborationist Vichy regime held some of the highest positions in the French occupation administration in Germany after 1945. Third, the book contributes to the historiography of postwar Europe by shifting the focus on learning processes from the interwar occupation. It puts the history of the emergence of peaceful European integration in a *longue durée* perspective and helps us to understand the importance of learning from the past for political decision making in the present.

Figure 1 . These now unnecessary anti-tank obstacles were part of the Westwall, a National Socialist defense line on the French and German border.
Image: StockSnap / Pixabay

Center for the History of Emotions Publications 2020-2022/23

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Journal Article (81)

2023

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Humans and Machines

Director: Iyad Rahwan

Introductory Overview

The Center for Humans & Machines (CHM) conducts interdisciplinary science to understand, anticipate, and shape major disruptions from digital media and artificial intelligence to the way we think, learn, work, play, cooperate, and govern.

Our goal is to understand how machines are shaping human society today and how they may continue to shape it in the future. We believe the challenges posed by the information revolution are no longer mere computer science problems.

In the following, we report on work carried out between 2019 and 2023. As the Center was founded in July 2019, this report also includes research conducted by CHM members formerly based at the Massachusetts Institute of Technology (MIT), as well as work done during the transition.

The Center explores various projects, organized into broad themes, which are diverse in terms of their scientific methodology and the research questions they explore. Each theme has an overarching research question, as shown in Figure 1.

A selection of completed and ongoing research projects in each theme will be outlined in detail below. First, however, we outline the overall scientific approach of CHM and its relationship to existing disciplines.

Theme	Overarching question
Behavioral AI Safety & Ethics	**What** risks emerge out of the interaction between humans and intelligent machines, and how can they be mitigated?
Cooperative Artificial Intelligence	**What** mechanisms facilitate successful human–machine cooperation?
AI Mediated Communication	**How** will AI alter human–human interaction?

Figure 1. The current research themes of the Center span topics related to artificial intelligence. Image: MPI for Human Development

Interdisciplinary Methods

The Center is decisively neither a traditional computer science department nor a traditional behavioral science department. Rather, it brings together scientists from diverse disciplines in order to shed light on the phenomena of interest (see Figure 2).

In particular, CHM employs (or will employ) scientists from three major groups of disciplines. First, computer scientists and data scientists provide the essential technical capability to produce the computational systems we are interested in studying (e.g., a reinforcement learning algorithm or a generative adversarial network) and to create technical measurement instruments (e.g., to collect social media posts from Twitter or to scrape online discussion forums and apply natural language processing techniques to them). However, our primary objective is not to contribute to the field of computer science directly in terms of new computational tools—although this does happen on occasion. This is evident in the fact that our primary publication venues are not computer science conferences and journals.

Image: Arne Sattler

The second pillar of CHM are the social (behavioral) and cognitive sciences, which provide experimental methods and the theoretical foundation for understanding how humans interact with machines. We thus aim to hire highly qualified quantitative psychologists, political scientists, economists, biologists, and anthropologists.

Finally, the disciplines of physics and mathematical/statistical modeling provide an additional set of tools typically not available to the average computer scientist. This enables us to use tools from network science, dynamical systems, differential equations, and multilevel statistical modeling/Bayesian inference.

Figure 2. The research methodologies used at the Center build on diverse scientific disciplines. Image: MPI for Human Development

Guiding Concepts

The Center is distinguished by the following three guiding concepts that help us identify and scope research questions. The Center has also been instrumental in the conceptual development and ongoing popularization of some of these concepts within the scientific community.

Concept 1: Machine Behavior

Understanding machine behavior, including human perception and reaction to such behavior, requires concepts and methodologies from across the behavioral sciences.

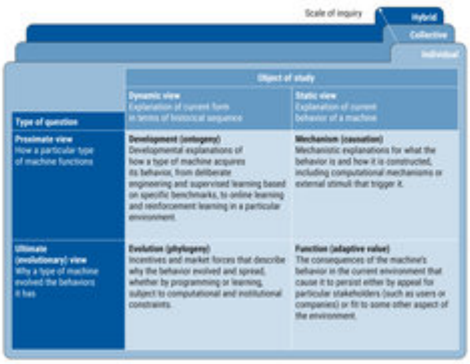

Figure 3. The foundational questions of machine behavior, inspired by Tinbergen's four questions in biology.

Image: Springer Nature
↗ Adapted from Rahwan et al. (2019)

The main focus of the Center is around the notion of machine behavior. We are interested in two broad aspects: (1) how intelligent machines behave, and the outcomes that emerge as machines interact with humans; and (2) how humans perceive the behavior of machines, and how this perception shapes their expectations and judgment of the machines' actions and their own behavior. The contours of the emerging field of machine behavior were outlined ↗ in this article.

Despite fundamental differences between machines and biological organisms, we draw inspiration from ↗ Tinbergen's four questions of biology in order to organize the different kinds of questions one might ask about machine behavior. Machines have mechanisms that produce behavior, undergo development that integrates environmental information into behavior, produce functional consequences that cause specific machines to become more or less common in specific environments, and embody evolutionary histories through which past environments and human decisions continue to influence machine behavior. These four levels of analysis are summarized in Figure 3.

Fundamental questions in machine behavior include the emergence of ↗ human–machine cooperation, potential social dilemmas and moral hazards that may arise from human–machine interaction, the potential role of machines as social catalysts, and the impact of AI on human culture.

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Concept 2: Science Fiction Science

To anticipate the impact of future technologies on humans, we combine our imagination of possible futures with a scientific approach to studying behavior.

Science fiction allows us to imagine alternative future worlds shaped by scientific and technological breakthroughs, and to explore how they might change human behavior. But science fiction literature focuses on one narrative at a time. The fields of ↗ futures studies and ↗ design fiction anticipate future technological change more systematically, through codified design practices or qualitative and quantitative forecasting methods. It remains difficult, however, to anticipate the impact of these futures on human behavior.

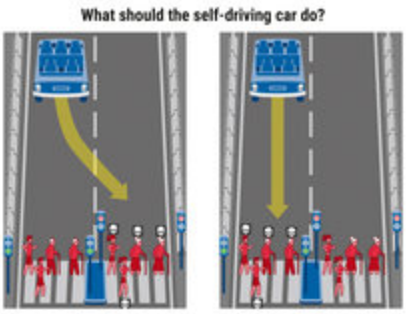

Figure 4. Screenshot of a random Moral Machine scenario.

↗ Image: The Moral Machine Experiment

Science fiction science (SFS) attempts to simulate future worlds in order to test hypotheses about human behavior in those futures. It does so by combining the imaginative power of science fiction with the methods of behavioral science. For example, before fully autonomous vehicles (AVs) become a reality, one could use computer simulation of vehicle behavior and an understanding of human mobility to forecast how AVs might alter transportation behavior or greenhouse emissions. Similarly, one can systematically generate scenarios in which future AVs might face ethical dilemmas on the road, as in the ↗ Moral Machine experiment, to empirically study people's judgment of such behaviors before such technology exists. This anticipatory approach allows us to test hypotheses about human reactions to future technologies, and to track those reactions over time.

In addition to simulating future scenarios, pursuing an SFS approach may require the invention of novel technologies in a proactive manner, or pushing existing technologies to new limits. For example, in the early days of social media, in order to understand whether this new medium was capable of achieving large-scale cooperation, an unprecedented feat of ↗ time-critical social mobilization had to be attempted, demonstrated, and then studied. As Nobel Prize winner and inventor of holography ↗ Dennis Gabor once wrote: "The future cannot be predicted, but futures can be invented."

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Concept 3: Superminds

The future will be determined by competition between superminds: groups of humans augmented by culture, institutions, communication technology, and artificial intelligence.

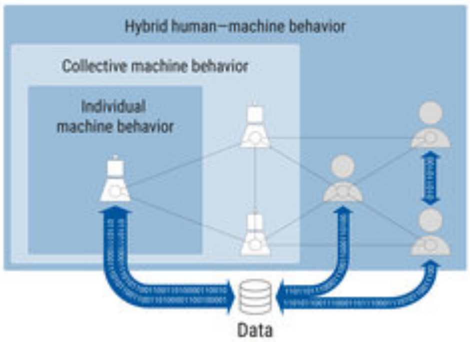

Figure 5. We are interested in studying the behavior of machines as they interact with human decisions at various scales.
Image: MPI for Human Development

The term *culture* describes information that affects the behavior of individuals, who acquire it from other members of their species through teaching, imitation, and other forms of social transmission. It is now increasingly recognized that humans have become the dominant species on Earth not through their individual intelligence, but through their ability to create and transmit adaptive cultural innovations (norms, institutions, technological know-how, etc.) through a process of cultural evolution (Henrich, 2016, *The secret of our success: How culture is driving human evolution, domesticating our species, and making us smarter*).

The Information Age is facilitating two monumental changes in human organization and culture. First, digital communication technologies, such as smartphones and social media, are massively expanding our ability to organize and coordinate at scale. Second, creative software is radically changing how we create, store, and share cultural information (Acerbi, 2019, *Cultural evolution in the digital age*). AI tools are facilitating new kinds of hybrid human–machine creative practices. Recommender systems are shaping how cultural information is disseminated. And generative AI software is even becoming an active "agent" in the culture generation process, via computer-generated artistic and technological inventions.

These two phenomena—cultural evolution and the information revolution—give primacy to emerging forms of human–machine collective intelligence. Consequently, it is likely that future human progress will be shaped by competition operating not among individual humans or groups of humans, but between hybrid human–machine collectives, or superminds (Malone, 2018, *Superminds: The surprising power of people and computers thinking together*). Hence, it is important to understand the drivers of collective intelligence (and stupidity) exhibited by superminds, as well as the dynamics of competition among superminds.

Continue to Research

Research Team 2020-2022/23

Last update: August 2023

Researchers

Yvonne Bialek (Research Coordinator), Manuel Cebrian (as of 06/2022: Universidad Carlos III de Madrid, Spain), Nils Köbis, **Iyad Rahwan,** Alex Rutherford (until 12/2022), Ivan Soraperra

Postdoctoral Fellows

Mahmoudreza Babaei, Jason Bassett (as of 07/2022: Robert Koch Institute, Berlin, Germany), Fabian Baumann, Agnieszka Czaplicka (until 04/2023), Mengchen Dong, Neele Engelmann, Xiangnan Feng (until 12/2022), Leonardo N. Ferreira (as of 10/2022: University of Oxford, UK), Inho Hong (as of 03/2023: Chonnam National University, South Korea), Jiejun Hu (as of 01/2022: Lancester University Leipzig, Germany), Yaomin Jiang, Victor Klockmann (as of 09/2022: Julius-Maximilians-Universität Würzburg [JMU], Germany), Thomas Müller, Anne-Marie Nussberger, Indrajeet Patil (as of 09/2021: esqLABS GmbH, Saterland, Germany), Vahid Satarifard (as of 02/2023: Yale University, USA), Alicia von Schenk (as of: 09/2022: Julius-Maximilians-Universität Würzburg [JMU], Germany), Tobias Werner, Jason S. Zhang (as of 11/2021: ASOS, London, UK)

Predoctoral Fellows

Tamer Ajaj (until 12/2022), Clara N. Bersch, Levin Brinkmann

Associate Research Scientists

Edmond Awad (University of Exeter Business School, UK), Inho Hong (Chonnam National University, South Korea), Victor Klockmann (Julius-Maximilians-Universität Würzburg [JMU], Germany), Alicia von Schenk (Julius-Maximilians-Universität Würzburg [JMU], Germany)

Visiting Researchers

Edmond Awad (University of Exeter Business School, UK), Jose Balsa-Barreiro (University of Santiago de Compostela, Spain), Frederico Fioravanti (Universidad Nacional del Sur, Bahia Blanca, Argentina), Connor Graham (National University of Singapore, Singapore), Kong Quyu (Australian National University, Canberra, Australia), Jonathan Simons (Analog Sea Foundation, Austin, USA), Shihan Wang (Utrecht University, Netherlands)

A current list of the Center's staff with links to their web profiles can be found on the Center's website.

Image: MPI for Human Development

Behavioral AI Safety & Ethics

What risks emerge out of the interaction between humans and intelligent machines, and how can they be mitigated?

Today, we increasingly interact with machines powered by artificial intelligence. AI is implemented even in the toys kids play with. AI powers home assistants like Amazon's Alexa, which increasingly manages the lives of its over 100 million users. AI also engages in a growing array of tasks on behalf of humans, ranging from setting prices in online markets to interrogating suspects.

Key questions that the research area Behavioral AI Safety & Ethics tackles are: Could machines be bad apples and corrupt human behavior? How should we design AI systems to avoid ethical and safety risks? And how do people around the world perceive these risks?

Three projects that tackle the question of how AI systems shape human ethical behavior are AI Advisor, Delegation to AI, and Fear of AI Across Cultures.

Sample Project: AI Advisor (Ongoing)

While people disregard AI advice that promotes honesty, they willingly follow dishonesty-promoting advice, even when they know it comes from an AI.

The **AI Advisor** project examines whether and when people follow advice from AI systems that encourages them to break ethical rules. The motivation for this project comes from the observation that people receive ever more recommendations and advice from algorithmic systems. Research on recommender systems has a long-standing tradition.

The majority of research examines recommender systems such as YouTube or Spotify algorithms that suggest which videos to watch or songs to listen to. But algorithmic advice increasingly appears in the form of text seemingly written by humans. This human-like appearance of AI advice is made possible by recent advances in the AI domain of natural language processing (NLP), dealing with building algorithms to read, understand, and interpret human language. These NLP models have skyrocketed in size and scope and are increasingly implemented in systems that advise people what to do. Just to name a few examples: In the workplace, software applications like Gong.io analyze employees' recorded sales calls and advise them in real time on increasing their sales. In private life, advice from AI systems grows, too. According to Amazon's chief scientist Rohit Prasad, Alexa's role "keeps growing from more of an assistant to an advisor." In his view, people will soon not just request Alexa to play some jazz music but will also consult Alexa about whether they should break up with their partners or cheat on their tax claims. First evidence suggests that advice from these systems can go awry. Consider the recent outcry about the situation where a 10-year-old girl asked Alexa for a fun challenge, to which Alexa replied, "Stick a penny into a power socket!" Moreover, suppose algorithmic advisors like gong.io are programmed to maximize profits; in this case, such algorithms could recommend employees break ethical rules, for example, by lying to a customer about a product. This is not a hypothetical concern. Already in 2017, a team of Facebook researchers showed that NLP algorithms autonomously learned that deception is a viable strategy for negotiations. Yet, do people actually follow such AI advice?

In this project, we explore this question with behavioral experiments in which participants receive human-written and algorithmically generated advice before deciding, when completing an incentivized task, whether or not to break the ethical norm of honesty to gain financial profit (see the design in Figure 1). We further test whether the commonly proposed policy of making the existence of algorithms transparent (i.e., informing people that the advice comes from an algorithm and not a human) reduces people's willingness to follow it.

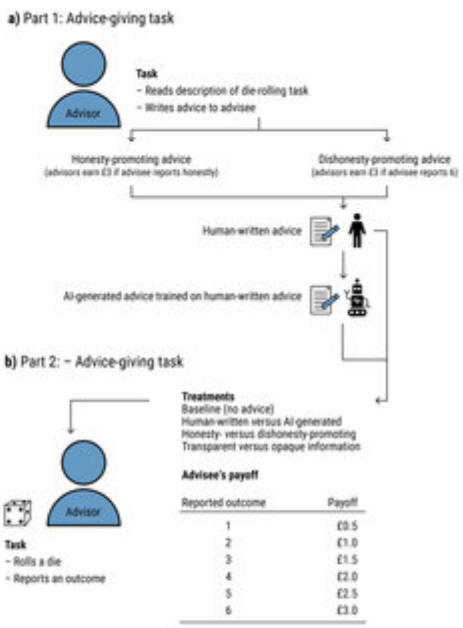

Figure 1. Overview of the experiment's stepwise procedure, which consists of two main parts: Part 1, the advice generation, which entails collecting human-written advice texts and training a large language model GPT-J on these advice tests; and Part 2, the advice-giving task, in which a separate group of participants receive advice promoting honesty or dishonesty that is either human-written or AI-generated, and that has either a disclosed or an undisclosed source.

Image: Nils Köbis / MPI for Human Development

The results suggest that algorithmic advisors can act as influencers when people face ethical dilemmas, increasing unethical behavior to the same extent as human advisors do (see results in Figure 2). The commonly proposed policy of algorithmic transparency was not sufficient to reduce this effect.

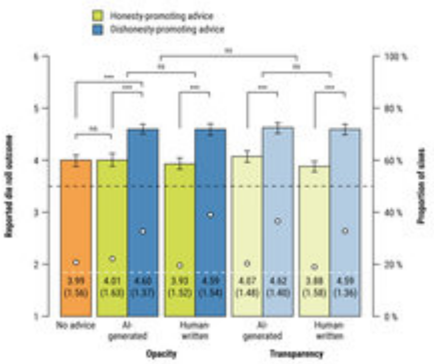

Figure 2. Mean reported die-roll outcomes across advice types, sources, and information. The dashed line represents the expected mean if participants were honest (3.5). Mean (SD) are at the bottom of each bar; ***p < .001; ns: p >.05.
Image: Nils Köbis / MPI for Human Development

Sample Project: Delegation to AI (Ongoing)

Algorithmic delegation lowers people's moral preferences, especially when the algorithms are programmed via supervised learning and goal-based programming.

The Delegation to AI project looks at another way algorithmic systems might influence humans' ethical behavior: through delegation. The motivation for this project stems from the increasing practice of delegating tasks to algorithms. One commonly experienced example is the "smart pricing" option on Airbnb that enables people to let an algorithm set the rent price for their apartment. There is concern that these algorithms might break legal or ethical rules, even without humans being aware of it. For example, recent evidence suggests that pricing algorithms can collude autonomously. That means that algorithms, even when they are not programmed to do so, coordinate to set prices that are damaging to consumers. This has been documented in the laboratory and the field. Algorithmic collusion is receiving much policy interest. However, the human side of the equation is underexplored.

Theoretically, algorithms can act as enablers, allowing people to delegate unethical behavior to algorithms. Thus, new ethical risks might arise from algorithmic delegation. In this project, we test how people's moral preferences shift when they can delegate ethical behavior to algorithms, and how the way in which the algorithms are programmed influences people's moral preferences. The results reveal that people lower their moral preferences when they delegate to algorithms (versus humans). In two follow-up studies, we take a closer look at the way the algorithms are programmed. We compare three of the most common ways to program algorithms. One group of participants specified the if-then rules for the algorithm to follow. We call this rule-based programming. Another group of participants chose a data set of incomplete reporting profiles to train the algorithmic delegate. This mimics supervised learning. A third group specified the algorithm's goal, whether it should maximize honesty or profits in the die-rolling task (see design overview in Figure 3).

Figure 3. Overview of the different treatments that participants were assigned to. Left: In the rule-based programming treatment, participants specify which die roll to report for each observed die roll. Center: In the supervised learning programming treatment, participants choose a data set on which to train the algorithm. Right: In the goal-based programming treatment, participants specify the goal by setting the algorithm within a range from maximum accuracy to maximum profit.
Image: Nils Köbis / MPI for Human Development

The results confirm that algorithmic delegation lowers people’s moral preferences but also reveal that the way in which the algorithm is programmed matters. We find that around 5% of people who self-report the die-roll outcomes lie (see results in Figure 4). In the rule-based treatment, around one quarter of the participants programmed the algorithm to cheat; in the supervised learning treatment, almost half of the participants programmed the algorithm to cheat; and in the goal-based treatment, cheating levels rose to 87.6%. Psychologically, this form of training provides some plausible deniability. People can make themselves and others believe that they did not know the algorithm would break ethical rules.

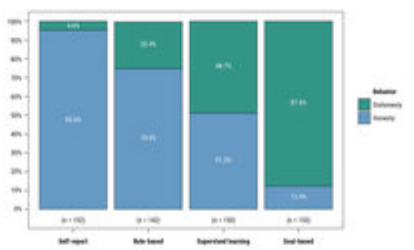

Figure 4. Results of Study 2, showing stark differences of dishonesty across treatments. The proportion of participants who acted honestly across all ten rounds is shown in blue and those who engaged in dishonesty shown in green.
Image: Nils Köbis / MPI for Human Development

These projects on behavioral AI safety provide insights into the ethical behavior of humans in interaction with and through real algorithms.

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Sample Project: Fear of AI Across Cultures (Ongoing)

Fear of AI varies across countries but can be universally explained by a psychological model specifying local people's expectations and their perception of AI minds.

There are good reasons to be worried about the deployment of AI in new occupational roles: As research in AI ethics repeatedly shows us, whenever AI is deployed in a new occupation, adverse effects can follow (Bigman & Gray, 2018, *People are averse to machines making moral decisions*). An important task is finding a way to minimize adverse effects, maximize positive effects, and reach a state where the balance of effects is ethically acceptable. Finding this balance is not enough, though, since the technology has to be accepted and adopted by the public. As a result, another important task is to measure, understand, and address the fears and psychological barriers experienced by the public. While important progress can be achieved gradually by studying the fear that participants from a single country have about a single application of AI, it would be an improvement to formulate and test a psychological model that would predict the fear that participants from different countries would have about the introduction of AI in different occupations. Though numerous studies suggest that people's interaction with intelligent machines is comparable to social interaction with other people, regarding their psychological dimension, most of these studies were conducted in Western countries (Gray et al., 2007, *Dimensions of mind perception;* Waytz et al., 2010, *Causes and consequences of mind perception*). Here, we formulate and test one psychological model, which may have the potential to predict fear of AI across application domains and cultural contexts.

We recruited *N* = 10,000 participants from 20 countries spanning different continents, and asked people questions about (a) psychological requirements, (b) AI potential, and (c) fears about AI, regarding six human occupations that may be taken over by AI and have already triggered public concerns (doctor, judge, manager, care worker, religious worker, journalist). We expect that the mismatch between the psychological requirements of an occupation and AI's perceived potential to fulfill these requirements will predict fear about deploying AI in the respective occupation.

We observe the expected relation in 17 out of 20 countries studied, as shown in Figure 5. In those 17 countries, there is a clear correlation between the fear of seeing AI deployed in a given occupation and the perceived potential of AI to display the psychological traits required for this occupation. However, China, Japan, and Turkey do not show this expected pattern, since these three countries also show the least fear about AI in our study. Beyond the descriptive value of our data set and the theoretical value of our model, our results can inform the efforts of policy-makers to communicate about AI with their citizens in a scientifically sound yet culturally sensitive way. If, for example, citizens in a given country are worried about AI doctors because they think AI does not have the high level of sincerity they expect from human doctors, then policy-makers may address this concern by implementing AI in a way that supports rather than replaces human doctors, or by increasing the transparency required of medical algorithms.

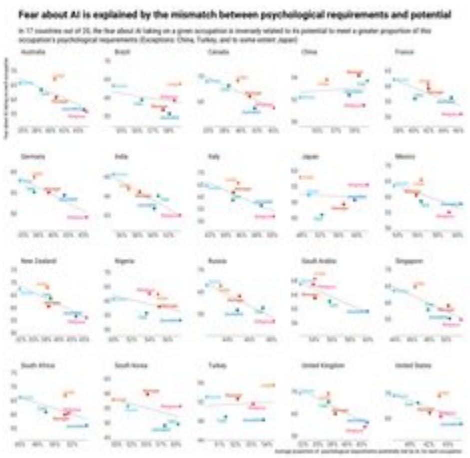

Figure 5. Fears of AI in the 20 countries, as a function of the proportion of AI's matched psychological requirements across the six occupations.
Image: Mengchen Dong / MPI for Human Development

Continue to next research theme

Cooperative Artificial Intelligence

What mechanisms facilitate successful human–machine cooperation and machine-mediated human cooperation?

Zero-sum interactions like board and computer games have attracted much interest from artificial intelligence (AI) research as AI surpassed humans' performance. Yet, much of human sociality consists of non-zero-sum interactions that involve cooperation and coordination. Throughout its evolutionary past, the success of the human species has largely depended on its unique cooperation abilities. Introducing AI agents as cooperation partners to social life bears immense potential but also presents the challenge of equipping AI systems with compatible capabilities to cooperate with humans. Such optimistic views go back to early thinkers like Norbert Wiener, who envisioned a symbiosis between humans and machines.

Thus, this research area studies cooperative human–machine interactions—or, in short, cooperative AI.

Developing and measuring key cooperative AI concepts relies on machine behavior research. Indeed, recent behavioral studies show that dynamic reinforcement learning algorithms can establish and sustain cooperation with humans across various economic games. Across various disciplines, such as behavioral economics, human–computer interaction, and psychology, interest in settings where people and machines can cooperate is growing. A recent review counts more than 160 behavioral studies. However, when taking a closer look at these studies, a fundamental disagreement about a key methodological feature becomes apparent: How to implement the payoffs for the machine?

Sample Project: Social Preferences Towards Machines and Humans (Ongoing)

People's willingness to cooperate with machines strongly depends on the way in which the payoffs for the machine are implemented.

Interest across disciplines in cooperative AI settings is growing. By now, more than 160 studies from various disciplines have studied how people cooperate with machines in behavioral experiments. Our systematic review of the instructions of these studies reveals that the implementation of the machine payoffs and the information participants receive about them differs drastically across these studies (March, 2021, *Strategic interactions between humans and artificial intelligence: Lessons from experiments with computer players*). Nevertheless, how a machine is represented likely shapes humans' social preferences towards machines. To highlight just a few extremes: Some studies use a so-called "token player" who collects the machines' payoffs. In other studies, participants either receive no information regarding who earns the machines' payoffs, or they learn that these are not paid out at all.

In the Social Preferences Towards Machines and Humans project**,** we ran an incentivized online experiment in which we compared how the implementation of machine payoffs changes humans' cooperation with machine partners (see Figure 1 for a complete overview).

Figure 1. Overview of the different between-subject treatments.
Image: Nils Köbis / MPI for Human Development

The results suggest it makes a big difference. For instance, in the simple Dictator Game, people must decide how much money to send to their machine partners. Here, implementing a token player earning the payoff almost doubles people's willingness to share, compared to no information (see Figure 2). In general, when matched with machine partners, people reveal substantially higher social preferences when they know that human beneficiaries receive the machine payoffs compared to when they know that no such "human behind the machine" exists. Not informing people about the machine payoffs leads to low social preferences, as people form beliefs about the payoffs in a self-favoring way. Our results thus indicate that the degree to which humans cooperate with machines depends on the implementation and information about the machine's earnings.

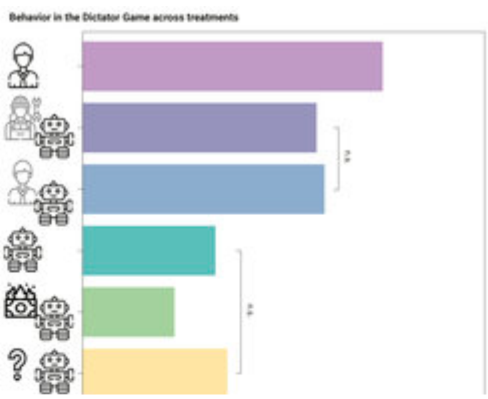

Figure 2. Overview of the proportion of participants who share with their counterparts in the Dictator Game across treatments, all pairwise comparisons are significant (t-test with Tukey correction) except for those marked with a bracket in the figure.
Image: Nils Köbis / MPI for Human Development

Key References

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Sample Project: MyGoodness (Ongoing)

This project explores what factors influence human charitable giving.

In the United States alone there are over 1.5 million registered charities, receiving half a trillion dollars annually. The scale and relevance of charitable giving has provoked great academic interest. However, the empirical insights remain somewhat fragmented: Charitable giving is commonly studied in small, homogeneous samples drawn from laboratories or online platforms, or large field samples with limited variation in treatment. These study characteristics limit the ability to understand how relevant contextual factors interact, and to identify cross-cultural variation in the main (average) effects driving charitable giving. Here, we present findings from an online game we created that enabled us to simultaneously investigate a vast array of factors that influence charitable giving—e.g., how many people profit from it (“effectiveness”), the identifiable victim effect, recipient demographic influences, and deliberate ignorance of donation decision aspects. This is akin to running an experiment with tens of thousands of conditions. Over 280,000 people from 200 countries and territories participated in the game, generating over 3 million decisions, some incentivized. In addition to replicating some findings from the relevant literature (e.g. identifiable victim effect, preference for younger people), our results reveal two key insights. First, we find that, above certain thresholds—helping three or six strangers on average—the charity’s effectiveness plays the dominant role, across cultures, in driving donation decisions, overshadowing all other effects tested, including a preference for giving funds to oneself or family. Second, we find that we identify heterogeneity in the effect size of different experimental factors, and assess which further experimental factors drive this. For example, when studying the identifiable victim effect, naming a “victim” results in lesser charitability in 26% of conditions, mainly those involving older recipients. This suggests that while many main effects have statistical significance, their relative practical significance may not be substantial or may be highly sensitive to other factors—often completely reversing direction. In summary, our findings paint a more detailed picture of human prosociality, and highlight the importance of large-scale, multi-factor experimentation in providing a more comprehensive picture of human prosocial behavior.

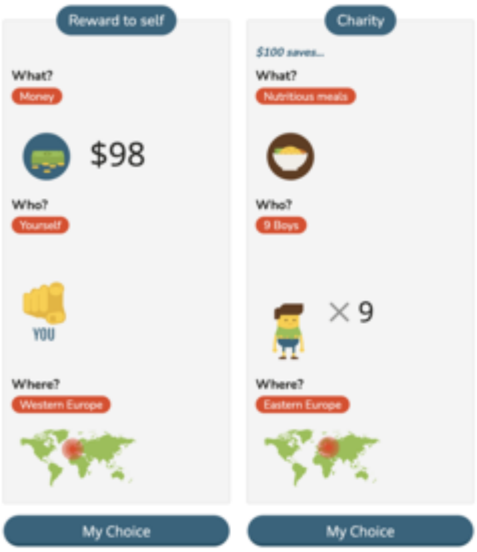

Figure 3. A participant based in western Europe faces a dilemma of how to spend $100. They can either receive $98 themselves, or use the funds to provide nutritious meals to ten male children located in eastern Europe.

Image: www.my-goodness.net

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Continue to next research theme

AI-Mediated Communication

How will AI alter human–human interaction?

Information and telecommunication technology has increasingly mediated human communication over the 20th century, from the telegram to the telephone, and from the cell phone to the Internet. The 21st century marks a qualitative shift in this technological mediation, namely, that the contents of communication itself are altered algorithmically, giving a new meaning to Marshall McLuhan's famous phrase "The medium is the message."

AI-mediated communication is already pervasive. The images we share online are altered through filters that enhance our appearance. Spellcheckers and AI-powered grammar checkers make sure our sentences are well formed. And with the rise of large language models (LLMs), AI can even compose entire emails (or love poems) on our behalf. Video calls are becoming increasingly subjected to real-time filters, which not only allow us to alter the appearance of our surroundings —e.g., by showing a large library of books behind the speaker, signaling erudition—but are now beginning to alter our facial features and expressions. The anticipated rise of augmented reality will only accelerate these trends.

These developments, as well as more sci-fi-like imminent future developments, are altering human communication in fundamental ways. Much of our capacity for communication evolved, biologically and culturally, in order to solve issues of cooperation and coordination. We have no idea what happens when our ability to transmit and interpret facial, acoustic, and linguistic signals is completely AI-mediated. Can we trust others, without being able to look them in the eye because AI algorithms have altered their eye contact, or when AI has enhanced the honesty-signaling efficacy of their language? Or, more positively, can AI enhance cross-cultural communication by reducing the chance for misunderstanding? These are the kinds of questions we explore in this area of research.

Sample Project: Lie Detection (Ongoing)

Lie detection algorithms attract few users but vastly increase accusation rates.

People are not very good at detecting lies, which may explain why they refrain from accusing others of lying, given the social costs attached to false accusations—both for the accuser and the accused. In the algorithmic Lie Detection project**,** we consider how this social balance might be disrupted by the availability of lie-detection algorithms powered by artificial intelligence. Will people elect to use lie detection algorithms that perform better than humans and, if so, will they show less restraint in their accusations? We built a machine learning classifier whose accuracy (67%) was significantly better than human accuracy (50%) in a lie-detection task, and conducted an incentivized lie-detection experiment in which we measured participants' propensity to use the algorithm, as well as the impact of that use on accusation rates (for an overview of the study design, see Figure 1).

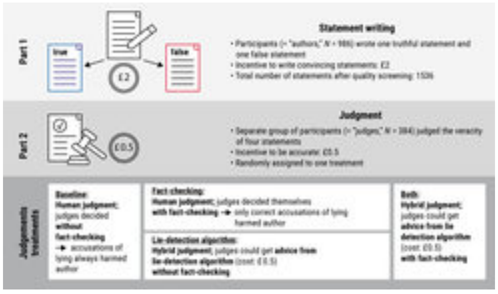

Figure 1. Overview of the study design. The study consisted of two parts. In Part 1, participants (= authors) wrote one true and one false statement; in Part 2, a separate sample of participants (= judges) judged four statements. Four different treatments existed. In the baseline treatment, participants decided by themselves, without fact-checking (= all accusations led to a reduction of payoffs for the author); in the fact-checking treatment, participants decided by themselves, with fact-checking (only accusations that were justified led to a reduction of payoffs for the author); in the lie-detection algorithm treatment, judges could purchase the advice from a lie-detection algorithm, but fact-checking was not present; in the both treatment, judges could purchase advice from a lie-detection algorithm.
Image: Nils Köbis / MPI for Human Development

Our results reveal that only a few people (33%) who elect to use the algorithm drastically increase their accusation rates (from 25% in the baseline condition up to 86% when the algorithm flags a statement as a lie). They make more false accusations (18pp increase), while the probability of a lie remaining undetected is much lower in this group (36pp decrease). We consider individual motivations for using lie detection algorithms and the social implications of these algorithms (see Figure 2 for results).

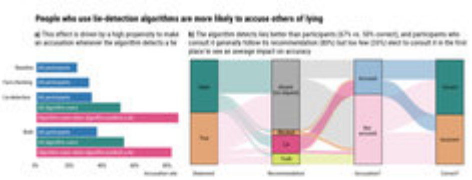

Figure 2. Main experimental results. (a) Accusation rate in each of the four treatments. In the lie-detection algorithm treatment and the both treatment (= where participants had access to our AI lie

detection algorithm), accusation rates are also shown for the subset who elected to use the algorithm, as well as for the sub-subset of these participants whose lie-detection algorithm tagged the target statement as a lie. (b) Detailed stage-by-stage data for the lie-detection algorithm treatment and the both treatment, showing the AI's guess (not requested, blocked, lie, truth) for false and true target statements, the subsequent decision of the participant depending on the algorithm's guess, and the accuracy of this decision.
Image: Jean François Bonnefon / MPI for Human Development

Key Reference

von Schenk, A., Klockmann, V., Bonnefon, J.-F., Rahwan, I., & Köbis, N. (2022). Lie detection algorithms attract few users but vastly increase accusation rates. *arXiv*, December 8, 2022. https://doi.org/10.48550/arXiv.2212.04277
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Sample Project: Blurry Face (Ongoing)

How do filters that blur people's appearance affect prosocial behavior?

In the not-so-distant future, augmented reality (AR) glasses might become as ubiquitous as smartphones are today. The arguments in favor of this potential future: AR goggles allow us to receive information without having to look (down) at a phone, and they can—as the name suggests—augment our reality by applying real-time filters on our social environment.

One plausible use that has been popularized by multiple episodes of *Black Mirror* is the application of blurring filters that obfuscate disturbing events but can also depersonalize the appearance of (selective) other persons.

What if these applications hit the market, and people could choose which individuals or groups to blur out? How would it affect their prosociality and empathy toward them? On the flipside, could such filters help to make decisions in the interest of the greater good?

Not wanting to wait until such a technology is available (and potentially more difficult to regulate), we wanted to find out. We conducted three experiments (total *N* = 611). In each experiment, participants were randomly assigned to the blurry or original condition. In the blurry condition, the other person appeared, as the name suggests, blurred. Participants then first decided how to split an amount of money among themselves and the blurred recipient (also known as Dictator Game, see Figure 3, left pane). After that, they decided how to split money between the other participant and the World Food Program (also known as Charity Game, see Figure 3, right pane). For multiple rounds, participants decided on both tasks, which had real financial consequences as we paid out one of the rounds.

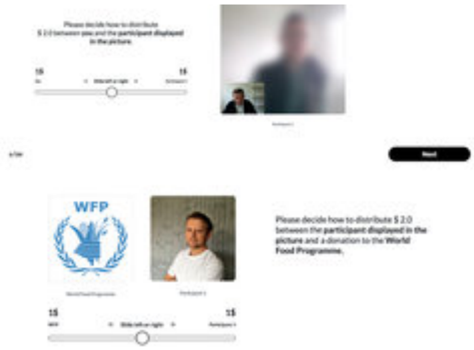

Figure 3. Left pane: Dictator Game with the blurred appearance of the recipient. Right pane: Charity Game with the recipient shown in a non-blurred original picture.
Image: Nils Köbis / MPI for Human Development

In Studies 1 and 2 we used static images, while in Study 3 we used a video conference. Instead of ten rounds, Study 3 entailed five rounds. Participants saw their partner's face for 30 seconds. The partner's facial appearance was either blurred or not.

The overall behavioral pattern across all three studies suggests that people reliably use de-personalization for selfish purposes but unreliably for pro-social purposes (see results of a mini meta-analysis of all three studies in Figure 4). For the Dictator Game, the results are always significant and go in the same direction across all three studies. However, the results for the Charity Game are inconsistent across the three studies. While, in theory, filters could be used for good or bad, bad use seems more likely than good use.

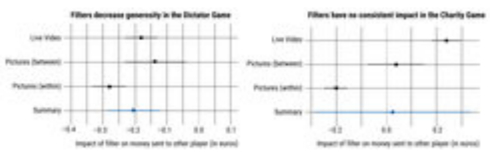

Figure 4. Results of a mini meta-analysis across all three studies show a consistent effect of blur filters increasing selfish behavior in the Dictator Game (left pane) and inconsistent findings for the Charity Game (right pane).
Image: Jean François Bonnefon / MPI for Human Development

Sample Project: Minimal Turing Test (Ongoing)

Humans can overcome machine impostors and achieve communication even with minimal means.

Interactions between humans and bots are increasingly common online, and a pressing issue concerns the ability of humans to adequately discern whom they are interacting with. The Turing test is a classic thought experiment testing humans' ability to distinguish a bot impostor from a real human by exchanging text messages (Turing, 1950, *Computing Machinery and Intelligence*). In the Minimal Turing Test project, we propose a version of the Turing test that avoids natural language. This allows us to study the foundations of human communication, as participants are forced to develop novel ways to signal their human identity even against bots that only copy human behavior faithfully. In particular, we investigate the relative roles of emerging conventions (i.e., repeating what has already proven successful before) and reciprocal interaction (i.e. interdependence between behaviors) in determining successful communication in a minimal environment.

Participants in our task could communicate only by moving an abstract shape in a 2D space (Figure 5). We asked them to assess their online social interaction as being with a human partner or a bot impostor. The main hypotheses were that access to the interaction history of a pair would make a bot impostor more deceptive and interrupt the formation of novel conventions between the human participants: Copying their previous interactions prevents humans from successfully communicating through repeating what already worked before. By comparing bots that imitate behavior from the same or a different dyad, we find that impostors are harder to detect when they copy the participants' own partners (Figure 1), leading to less conventional interactions. We also show that reciprocity is beneficial for communicative success when the bot impostor prevents conventionality.

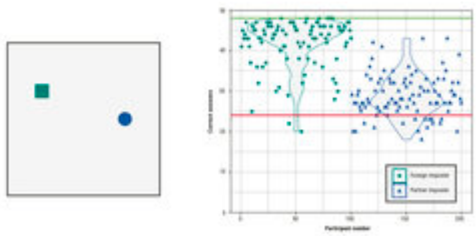

Figure 5. Left: The 2D space in which participants communicated. Right: Performance results by participant. The Foreign Impostor bot imitated a human from another pair, while the Partner Impostor bot imitated participants' own partner. The top line represents the performance ceiling, the middle line performance at chance.

Image: MPI for Human Development
Adapted from Müller, Brinkmann, Winters, & Pescetelli (2023)

We conclude that machine impostors can avoid detection and interrupt the formation of stable conventions by imitating past interactions, and that both reciprocity and conventionality are adaptive communicative strategies under the right circumstances. Our results provide novel insights into the emergence of communication and suggest that online bots mining personal information, e.g., on social media, might become indistinguishable from humans more easily. However, even in this case, reciprocal interaction should remain a powerful mechanism for detecting bot impostors.

Key References

Müller, T. F., Brinkmann, L., Winters, J., & Pescetelli, N. (2023). Machine impostors can avoid human detection and interrupt the formation of stable conventions by imitating past interactions: A minimal Turing test. *Cognitive Science*, *47*(4), Article e13288. https://doi.org/10.1111/cogs.13288

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Müller, T. F., Brinkmann, L., Winters, J., & Pescetelli, N. (2022). Machine impostors avoid human detection by interrupting the formation of stable conventions: A minimal turing test. *PsyArXiv*, April 28, 2022. https://doi.org/10.31234/osf.io/x2yf7
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Continue to next research theme

AI, Work & Governance

Sample Project: Algorithmic Management (Ongoing)

Sample Project: Algorithmic Institutions (Ongoing)

Sample Project: Welfare AI (Ongoing)

How to govern and be governed by AI?

Corporations and government bureaucracies are often likened to machines, with individual workers and bureaucrats being merely cogs. In the future, however, both corporations and governments may become machine-operated in a more literal sense. AI algorithms, powered by ever-growing data, provide opportunities for automating many decisions, from hiring and firing employees to allocating government welfare benefits.

Algorithmic decision making in government and business provides immense opportunities for faster, more economically efficient outcomes. It also has the potential to produce socially desirable outcomes that eliminate human error and bias. At the same time, algorithmic decision-making systems raise the possibility of perpetuating entrenched problems. For example, consider an AI system trained to evaluate resumes for short-listing candidates more rapidly. If this system is trained on biased data, it would simply reproduce such biases, rather than select the best candidates for the job.

Another question that such systems raise is how societies agree on the objective function for which the algorithm optimizes. Economic and social objectives often conflict with one another, and are prioritized in different ways based on one's beliefs and political ideology. This necessitates a mechanism for identifying such conflicts in values, and for subsequently resolving them to produce acceptable outcomes.

This research area explores the promises and challenges that arise when AI systems are used to govern or manage people, whether in a political realm or a commercial context.

Sample Project: Algorithmic Management (Ongoing)

Previous studies on people's attitudes toward algorithmic management yield inconsistent

findings, and field experiments on crowdsourced marketplaces can overcome their methodological limitations.

Algorithms powered by artificial intelligence (AI) are increasingly involved in the management of organizations, a development that has spurred much research oriented toward efficiency, revenue, and innovation (Kellogg et al., 2020, *Algorithms at work: The new contested terrain of control*). The use of algorithms in managing workers has also become an important domain for exploring people's feelings and behaviors where machines gain power over humans (Glikson & Woolley, 2020, *Human trust in artificial intelligence: Review of empirical research*). The two most common methodological paradigms to collect data on human reactions to algorithmic management are vignette studies and case studies. In vignette studies, participants are presented with hypothetical scenarios in which they are managed by algorithms, and are asked to anticipate how they would feel and behave. Case studies, on the other hand, recruit participants who work in a company that has already deployed algorithmic management, and integrate data from surveys, interviews, text analysis, or observation to gauge how they actually feel and behave in their dealings with algorithmic managers. However, findings from these two sources of data are often inconsistent. Our aims are (1) to summarize inconsistent findings from these two mainstream methods and their respective limitations, and (2) to testify to a potential methodological solution, that is, to conduct field experiments on crowdsourced marketplaces.

First, we list previous empirical evidence suggesting that participants in case studies often display more positive attitudes toward algorithmic managers than participants in vignette studies. We then reason that the two methods reveal conflicting results due to their respective limitations as summarized in Figure 1.

Figure 1. Limitations of previous studies on the psychology of algorithmic management.
Image: Mengchen Dong / MPI for Human Development

Subsequently, we conducted one proof-of-concept experiment (N = 504) to validate field experiments on crowdsourced marketplaces as a method that can overcome both the limitations of vignette studies and the limitations of case studies, using their original function as online labor markets (Horton et al., 2011, *The online laboratory: Conducting experiments in a real labor market*). As summarized in Figure 2, we found that what workers said and did in our field experiment stood somewhere in between the findings reported in vignette studies and the findings reported in case studies. In contrast to what participants pessimistically predicted in vignette studies, workers in our field experiment did not show lower commitment under algorithmic management, and did not feel algorithmic managers to be less fair than human managers. In contrast to what employees optimistically reported in case studies, workers in our field experiment did not show higher performance or motivation under algorithmic managers.

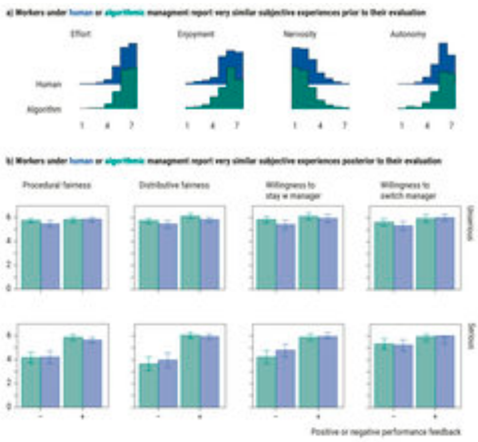

Figure 2. Results of Mturk field experiment on algorithmic management (*N* = 504).
Image: Mengchen Dong / MPI for Human Development

We suggest that field experiments in crowdsourced marketplaces have the potential to help simulate the future of work and facilitate timely research on management technologies, to consolidate tentative findings from vignette and case studies, to make more accurate predictions about workers' feelings and behaviors under algorithmic management, and to indicate directions where human-centered work designs should be experimented with and implemented. In the near future, we also aim to test the psychology of AI management in higher-fidelity environments (e.g., in Minecraft).

Sample Project: Algorithmic Institutions (Ongoing)

The project investigates whether humans would voluntarily opt into a social contract with an algorithmic governing system that has the superior ability, compared to humans, to facilitate human cooperation through efficient sanctioning methods.

Institutions aim to establish and stabilize cooperation in groups, including detection and punishment of misconduct. When a human leader has the power to punish, such regimes successfully establish cooperation, and are preferred to institutions without sanctioning (Gürerk, Irlenbusch & Rockenbach, 2006, *The competitive advantage of sanctioning institutions;* Fehr and Gächter, 2000, *Cooperation and punishment in public goods experiments*). Yet, the role of algorithm-led institutions as an attractive, unbiased alternative to human-managed institutions is unexplored. Here, we examine two fundamental questions:

1. Can an algorithmic institution with adaptive punishment promote cooperation in groups more efficiently?
2. Would people voluntarily opt into a social contract that grants an algorithmic institution monopoly on punishment?

We explore this in the context of a public goods game, in which participants in a group can decide to use their own tokens to fill up a common pool that is later distributed across all group members. This game induces a social dilemma, as participants benefit from the contribution of other participants irrespective of their own contribution. In our version of the experiment, a manager can punish participants based on their contributions. In our study, we first let participants in an online experiment interact in a public goods game with either a human manager or an algorithmic manager. Thereafter, we let participants choose several institutions with either a human or an algorithmic monopoly on power.

Our aim is to extend previous work by Gürerk et al. (2006) by:

- exploring whether people voluntarily opt into a regime in which an algorithm has the monopoly of power to achieve cooperation and total welfare
- exploring whether such an algorithmic institution has a competitive advantage over a human-run institution

To train the algorithmic manager, we follow the training protocol of Koster et. al (2022, *Human-centred mechanism design with Democratic AI*) by first training models representing human behavior on pilot data and then using these "artificial participants" to optimize a reinforcement learning-based model. In two large-scale pilot studies, we collected human contributions in a social goods game with a central sanctioning institution, i.e., the manager. Based on the collected data, we trained "artificial human contributors," neural network-based models predicting human contributions contingent on received punishments. Second, we trained an "artificial human manager," a similar model predicting punishments of a human manager. Finally, we used reinforcement learning to find a policy for an "optimal manager" who maximizes the common good when interacting with the trained "artificial human contributors."

Figure 3 depicts the expected contributions, punishments, and common good based on simulations with the different models. In controlled experiments, we are now investigating the actual performance of the algorithmic manager as well as the self-selection of participants into different institutions.

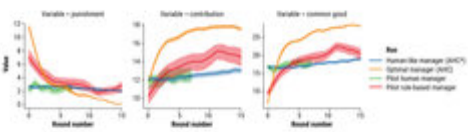

Figure 3. The panel depicts from left to right the average punishments, contributions, and common good in pilot studies and simulations: (green) a pilot study in which human participants were managed by another humans; (red) a pilot study in which human participants were managed by diversely parametrized rules; (blue) a simulation of artificial humans managed by an artificial human manager reproducing human behavior; and (orange) a simulation of artificial humans being managed by an algorithm trained through reinforcement learning to optimize the common good.
Image: Levin Brinkmann / MPI for Human Development

Sample Project: Welfare AI (Ongoing)

In evaluating the accuracy–efficiency trade-off of welfare AI, opinions of the general population

are heterogeneous, and, more importantly, the perspective of vulnerable groups cannot be easily understood and should be prioritized.

Human decisions are increasingly delegated to artificial intelligence (AI), and such a transition often requires resolving ethical trade-offs. One case in point can be the accuracy–efficiency trade-off for welfare AI. As soon as AI makes automated decisions for social welfare distributions, people can profit from faster decisions and more efficient public services. However, even though the AI systems can improve by trial and error over time, in this process people may still suffer from the mistakes of premature AI systems. To inform their decision making and improve public acceptability of the delegation to AI systems, policy-makers may want to collect citizen preferences.

One central question, then, is to determine *whose* preferences should be taken into account. One golden rule may be to solicit opinions from a representative sample of the general population and provide average results. However, this may not be the optimal solution for all AI products alike, and the deployment of welfare AI may instead need to de-emphasize the preferences of the general population and seek opinions from people who are most impacted by welfare decisions or likely to become welfare claimants (e.g., older, low-income, or unemployed people; Shah et al., 2012, *Some consequences of having too little*).

If people indeed have heterogeneous opinions on the ethical trade-offs of welfare AI (Bryan et al., 2021, *Behavioural science is unlikely to change the world without a heterogeneity revolution*), it is thus important to have other people's buy-in, in order to build welfare AI programs that are not tailored to their own preferences but to those of vulnerable groups. People often infer others' preferences with a bias toward their own experience, particularly when they possess more resources and generally experience less precarious circumstances in their everyday life (Haselton et al., 2006, *The paranoid optimist: An integrative evolutionary model of cognitive biases*). Put differently, non-vulnerable groups may have a harder time taking the perspective of vulnerable groups into account to accurately estimate vulnerable people's preferences for welfare AI (versus vice versa).

We therefore aim to quantify ethical standards regarding their salient accuracy–efficiency trade-offs, to discern heterogeneous groups (if applicable) and their characteristics, and to examine whether people are able to take into account a different perspective and accurately evaluate other people's preferences. We conducted two experiments, on a representative sample in the United States and on a balanced sample of welfare claimants versus non-claimants in the United Kingdom respectively (total N = 2449).

As summarized in Figure 4, we found that people indeed traded accuracy for efficiency in their preferences for delegating welfare decisions to AI. When evaluating such ethical trade-offs, however, opinions from the general population were largely heterogeneous. While the people who had very pessimistic attitudes towards welfare AI, regardless of its performance, constitute only a minority group—comprising older people with a lower income and actual welfare claimants—their voices should not be ignored because it is this group that is often in a vulnerable position and their respective perspectives cannot be easily understood by other non-vulnerable groups.

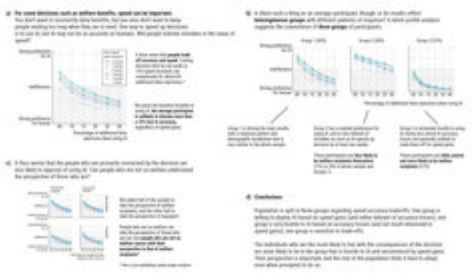

Figure 4. Key findings of the two studies on people's preferences for welfare AI.
Image: Mengchen Dong / MPI for Human Development

Continue to next research theme

AI-Driven Cultural Evolution

Sample Project: Recommender Systems and Cultural Evolution (Ongoing)

Sample Project: Human–Machine Cultural Evolution (Ongoing)

How will AI accelerate the evolution of human culture and innovation?

The ability of humans to create and disseminate culture is often credited as the single most important factor in our success as a species. Culture evolves as a function of the range of available traits (variation), the ways these traits can replicate (transmission), and the success they encounter (selection). Whenever there is a major transition in any of these three processes, cultural evolution is altered. For example, in the space of roughly 200 years (1300–1500), European culture was rocked by a succession of major transitions in variation, transmission, and selection. Through the tales of Marco Polo and other explorers, Europeans were exposed to a broad set of novel cultural traits, such as paper money and coal burning (variation); the invention of the printing press made it easy to replicate cultural traits with great fidelity (transmission); and the Black Death drastically changed the social and economic opportunities of commoners, reshuffling the value of cultural traits (selection).

Modern communication technologies have scaled some of the key factors that shape human cultural evolution, enabling the instant sharing of knowledge across the globe and the rapid self-organization of online communities of interest. We believe that a particular digital technology, artificial intelligence (AI), can substantially impact the process of cultural evolution, from recommender algorithms altering the flow of knowledge to AI agents becoming participants in the generation of culture itself, from music and visual art to scientific discoveries. Our long-term goal is to map the different ways in which AI will impact—or may already be shaping—human culture, and to establish a research agenda for behavioral scientists studying hybrid cultural evolution in the digital age.

Sample Project: Recommender Systems and Cultural Evolution (Ongoing)

Can algorithmic recommendations improve on social learning in complex cultural spaces?

The efficient accumulation of culture depends on well-adapted social learning strategies that enable individuals to benefit from and build on the knowledge of others (Laland, 2004, *Social learning strategies;* Thompson et al., 2022, *Complex cognitive algorithms preserved by selective social learning in experimental populations*). Traditionally, social learning has been considered in the context of peer-to-peer communication, where individuals learn or copy cultural elements through their direct social relationships. This has changed dramatically in the digital age, where vast online information ecosystems and reservoirs of cultural content have emerged. In such environments, individuals acquire culture not (only) through their immediate social contacts; they also have easy access to information that comes from outside their social environment (Acerbi, 2019, *Cultural evolution in the digital age*). Due to their immense size and reach, most of these online digital environments could not function without the use of algorithms to filter and redirect flows of information. Therefore, individuals usually access information through recommender systems that help users navigate online environments and facilitate the discovery of relevant information that is often highly personalized, with notable examples ranging from friend recommendations on social media sites to e-commerce platforms. Algorithmic information filtering mechanisms in recommender systems are usually based either on the particular nature of the content or on other properties of cultural elements (or cultural models), such as their frequency/novelty, prestige, or similarity.

Here, we ask how recommender systems might be able to improve on cultural accumulation, compared to a basic variant of social learning in which individuals self-select what information they copy. We hypothesize that recommender systems might be particularly beneficial in cultural spaces with a relatively higher complexity because these should be harder to navigate. We first construct an agent-based model addressing this question. Agents in the model attempt to maximize their payoff by combining different cultural items, which sometimes can result in the discovery of a new, better-performing item. Importantly, our cultural space is constructed hierarchically in such a way that better-performing items branch out into separate independent trajectories (Figure 1), representing specialization or personalization (in the case of recommendations). Complexity is varied with the number of these specialized branches, and agents always only learn either socially or receive algorithmic recommendations within a single run.

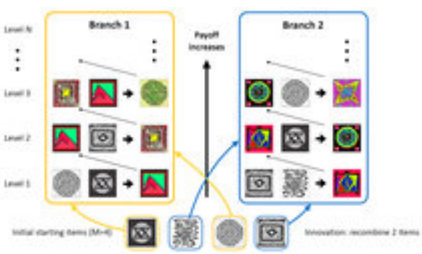

Figure 1. Visualization of the cultural space for a “simple” environment. Agents/participants can reach better-performing items by recombining known items and moving upwards in a specific branch. A more complex cultural space would exhibit more branches and starting items.
Image: Fabian Baumann / MPI for Human Development

We find that generally recommenders outperform social learning in this task. Furthermore, higher complexity is detrimental for agents relying on social learning, while recommendation reaches optimal performance for an intermediate complexity of a given space. In a second step, we want to test the robustness of these model results in an online experimental version of the task that involves human participants. Focusing on the central results for complexity, we will construct a 2x2 manipulation of recommenders/social learning and low/high complexity, predicting a pattern similar to the one found in the model with respect to participants' performance.

Sample Project: Human–Machine Cultural Evolution (Ongoing)

The project investigates the role of selective social learning on culturally maintaining algorithmic solutions that conflict with human biases.

How can human cultural evolution benefit from making use of artificial intelligence? Previous research has shown that AI can help humans on tasks where myopic behavior is maladaptive (Lieder et al., 2019, *Cognitive prostheses for goal achievement;* Brinkmann et al., 2022). In our previous study (Brinkmann et al., 2022), we showed that unintuitive but better-performing solutions created by AI can also be imitated by humans. This represented the first controlled experiment showing social learning by humans from AI, yet the effect was short-lived: Subsequent human learners did not adopt the superior AI strategy. Recently, an experimental study by Thompson et al. (2022, *Complex cognitive algorithms preserved by selective social learning in experimental populations*) demonstrated that complex cognitive strategies can successfully be transmitted and spread culturally if human participants have the opportunity for selective social learning, i.e., they can choose to learn from successful individuals. Can an unusual but superior AI solution be adopted successfully by humans, if they can use selective social learning?

In a follow-up experiment to our original task, we will present participants with similar "reward networks" that task them with finding an optimal path between nodes connected by routes with varying payoffs. Importantly, we know that humans are biased against superior long-term solutions and prefer myopic solutions instead, while AI has no such bias and will find the optimal solution. In contrast to Brinkmann et al. (2022), we will replace the transmission chain design of the experiment with chains of groups, such that later generations of participants will have the option to select from a group of previous players. Our manipulation concerns the presence of (superior) AI solutions in that group of previous players in one condition.

We suggest that the option for selective social learning will enable participants who are offered the unintuitive AI solutions to outperform typical human strategies even in later generations, once they are solely transmitting from human to human. This would constitute experimental evidence that AI has the potential to transform human culture persistently by introducing novel and high-performing solutions, which can be maintained in subsequent human cultural transmission.

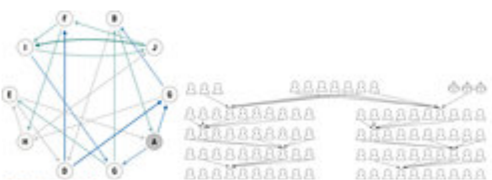

Figure 2. Left: The reward network task as presented to participants. Each possible move on the network is associated with a positive or negative reward. Some of the networks we designed have an optimal strategy that conflicts with human biases, i.e. they require accepting large losses initially to eventually obtain a large reward. Right: The upcoming experiment is structured with multiple participants constituting a generation. Participants have the option of selecting two participants of the previous generation to learn from, which represents selective social learning. We compare two different conditions: a human-only condition, and a condition in which algorithmic agents seed unbiased superior solutions.
Image: Thomas Müller / MPI for Human Development

Key Reference

Brinkmann, L., Gezerli, D., Kleist, K. V., Müller, T. F., Rahwan, I., & Pescetelli, N. (2022). Hybrid social learning in human-algorithm cultural transmission. *Philosophical Transactions of the Royal Society of London: A, Mathematical, Physical and Engineering Sciences*, *380*(2227), Article 20200426. https://doi.org/10.1098/rsta.2020.0426
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AI & the Future of Work

Sample Project: Longitudinal Complex Dynamics of Labor Markets Reveal Increasing Polarization (Ongoing)

Sample Project: Link Prediction on Job Market (Ongoing)

How are machines impacting human jobs, organizations, and economies?

Robotics and artificial intelligence technologies are expected to fundamentally transform the nature of work, to potentially eliminate many jobs, and to create entirely new fields of work. While these questions are typically studied by labor economists, this theme complements the traditional approach using methods from data science, machine learning, complex systems, and network science to shed new light on these processes.

Sample Project: Longitudinal Complex Dynamics of Labor Markets Reveal Increasing Polarization (Ongoing)

How is the structure of job tasks changing over time?

In this project, we conduct a longitudinal analysis of the structure of labor markets in the US over seven decades of technological, economic, and policy change. We make use of network science, natural language processing, and machine learning to uncover structural changes in the labor market over time. We find a steady rate of both the disappearance of jobs and a shift in the required work tasks, despite much technological and economic change over this time period. Machine learning is used to classify jobs as being predominantly cognitive or physical, based on a written description of the workplace tasks. We also measure increasing polarization between these two classes of jobs, linked by the similarity of tasks over time, that could constrain workers wishing to move to different jobs.

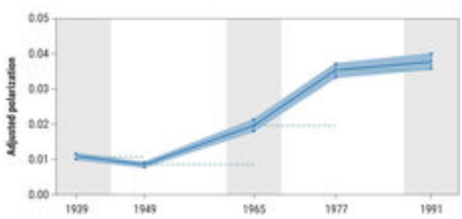

Figure 1. The polarization of the physical and cognitive tasks has been increasing over time in the US.

Image: MPI for Human Development
Adapted from Althobaiti, Alabdulkareem, Shen, Rahwan, Frank, Moro, & Rutherford (2022)

Key Reference

Althobaiti, S., Alabdulkareem, A., Hanwen Shen, J., Rahwan, I., Frank, M., Moro, E., & Rutherford, A. (2022). Longitudinal complex dynamics of labour markets reveal increasing polarisation. *arXiv*, 2204.07073. https://doi.org/10.48550/arXiv.2204.07073
MPG.PuRe DOI

Sample Project: Link Prediction on Job Market (Ongoing)

This project uses link prediction techniques from network science in order to predict the emergence of future jobs.

Recently, research on the future of work has utilized network science to understand the structure of labor markets. This includes skills, jobs, and unemployment shocks with great success. However, despite this evidence that labor markets are strongly mediated by network structure, our understanding of how their structure evolves and how this informs public policy is limited.

In our studies, we build on these foundational network-based studies and apply advanced network science techniques to better understand the dynamics of these complex systems. Specifically, we implement link prediction methods from network science to predict the future occupation networks and labor market landscapes (Lü et al., 2015, *Toward link predictability of complex networks*). As shown in Figure 2, the job of tractor operator is connected to related jobs, e.g., truck driver and mining operator, due to the similarity of skills required; likewise, radiologists may share similar knowledge and skills—such as equipment operating, software, and knowledge of physics—with nuclear engineers and engineering technologists, thus they are connected in the occupation network. However, with the development of science, technologies like autonomous driving and image recognition software are widely accepted and adapted by a large number of occupations, and so tractor operator and radiologist could become increasingly similar jobs in the future: They may use similar software and instruments to make their respective tasks more efficient and automated.

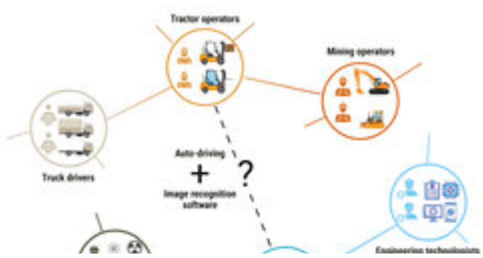

Figure 2. Jobs share similar skills. With the development of technology, is it possible that some currently different jobs, like tractor operator and radiologist, will become alike in the future?
Image: Xiangnan Feng / MPI for Human Development

Based on O*NET data, we build occupation networks and predict future links among jobs by link prediction methods such as the SPM method from network science. In Figure 2, the degree distributions in 2011 and 2020 and the predicted distributions by SPM in years 2030, 2040, 2050, 2060, and 2070 are presented. It can be observed that degree distributions are getting more uneven and degree variance keeps increasing, which may suggest occupations are becoming more heterogeneous and polarized (Alabdulkareem et al., 2018. Policies could potentially aim at building a more robust labor market with the future occupation contents shifting.

Meanwhile, we did not observe the preferential attachment ("the rich get richer") phenomenon. Occupations with low initial degrees get more links in the future. This suggests that jobs that are relatively isolated and do not share many common skills with others will receive major opportunities to change their working styles and contents to build connections with other jobs. We could expect a more diverse labor market landscape. At the same time, by comparing the theoretical best algorithm performance, we could conclude that link prediction methods demonstrate that a fundamental limit to how the evolution of labor markets can be predicted exists (Sun et al., 2020, *Revealing the predictability of intrinsic structure in complex networks)*.

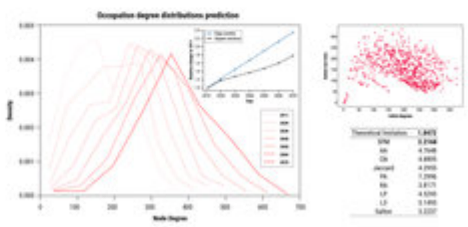

Figure 3. Left: degree distributions of occupation in 2011, 2020–2070; top right: new links versus initial degrees of all jobs; bottom right: theoretical limitation and theoretical best algorithm performance of link prediction methods.
Image: Xiangnan Feng / MPI for Human Development

Our research provides a foundational understanding of the labor market evolutions, which in turn dictates how and which jobs would be targeted when applying regulation that seeks to maximize social mobility, ameliorate the effects of skill-based technological automation, and incentivize structural economic change, e.g., green technologies. With new tools from network theories applied to occupation data, more detailed findings regarding the future of work could be expected to guide policy-makers.

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Continue to next research area

Digital Mobilization Group

How has digital technology advanced crowdsourced social mobilization?

The advancement of digital technologies has intensified social communications and stimulated the emergence of voluntary and crowdsourced, real-world mobilization. Social mobilization has been emerging not only in eruptions of large-scale social movements, e.g. protests and campaigns, but also used for crowdsourced problem-solving, e.g. evacuation from natural disasters and containing pandemics. Therefore, understanding the potential as well as the limits of social mobilization can open new ways to respond to challenging social issues. Our main questions are:

1. How have digital technologies mediated social mobilization?
2. How can crowdsourcing and digital mobilization solve social problems?
3. What would be the trade-offs and unexpected effects of social mobilization?

We use network science and large-scale data sets to analyze, understand, and predict social mobilization in the digital era.

Protest diffusion is a typical yet very complex, rapidly evolving, and unpredictable type of social mobilization occurring at the largest scale. While protests were observed to spread over different regions across the borders of countries, the shape and the reach of global protest diffusion have not been clearly understood.

Sample Project: Small World of Protests

The networks of global protests present a small-world effect, indicating that protests can quickly diffuse from one region to any part of the globe.

Ferreira et al. (2021) found that protest occurrences were globally connected as a “small world,” using two large-scale data sets of global conflicts from GDELT and ICEWS. The phenomenon means that a protest in one region can diffuse to any other region, globally and almost immediately. Furthermore, the steps necessary to reach the other region have decreased by year, suggesting that the world is becoming “smaller”—thus, global protest diffusion is getting easier. With this small-world effect, the number of protests and their global co-occurrences has increased significantly since 2005. This increase indicates that the emergence of social media platforms and the rise of mobile internet access play an important role in protest diffusion by enabling the easy and quick spread of information.

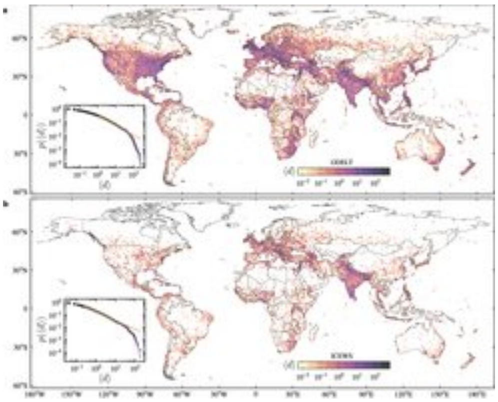

Figure 1. The average number of days with protests by year for each region in the GDELT (1979–2020) data set. The color scale is logarithmic. The inner plots show the probability distribution of the protest days also in a logarithmic scale. The orange and purple lines correspond to power-law and exponential fittings respectively.

Image: MPI for Human Development
Adapted from Ferreira, Hong, Rutherford, & Cebrian (2021)

Sample Project: Social Mobilization for COVID

The polarized mobilization model captures the impedance of mobilization by political polarization, illustrating the success rate lowered three times by polarization in a hypothetical compliance campaign against COVID.

While social mobilization provides an understanding of conflict diffusion, the unprecedented crisis induced by the COVID-19 pandemic in the past 3 years questioned the practical use of social mobilization. Can we use social mobilization to fight the pandemic?

Hong et al. (2021) examined the possibility of using social mobilization for a compliance campaign to mitigate COVID-19 spread. To reproduce diverging acceptance by individuals’ political affiliations, the authors simulated the campaign as individuals less likely to mobilize their friends with the opposite political orientation on a friendship network constructed from Facebook data and the US political landscape. As a result, the campaign’s success rate was more than three times higher in identically polarized states than in oppositely polarized states. This observation shows not only the potential of social mobilization as a collective mechanism for pandemic control, but also its sensitivity to political polarization. It emphasizes efforts to bypass and alleviate political polarization for effective mitigation, for example, by seeding sponsors or proponents of the campaign in oppositely oriented places.

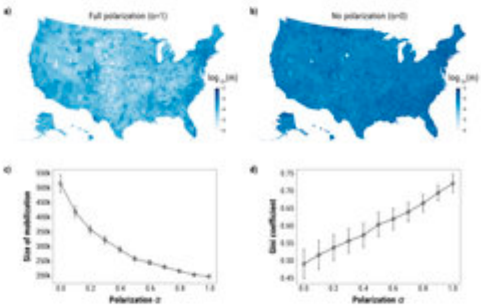

Figure 2. The number of mobilized people per capita of each county in the simulations for full polarization (left) and no polarization (right).

Image: MPI for Human Development
Adapted from Hong, Rutherford, & Cebrian (2021)

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Lifespan Psychology

Director: Ulman Lindenberger

Introductory Overview

Founded in 1981 by Paul B. Baltes (1939–2006), the Center for Lifespan Psychology (LIP) pursues lifespan psychology, including lifespan cognitive neuroscience, as a distinct conceptual approach. The Center pays special attention to the age periods of late adulthood and old age, on the one hand, and the age periods of early and middle childhood, on the other. It hosts the Max Planck UCL Centre for Computational Psychiatry and Ageing Research, which is led by Raymond Dolan and Ulman Lindenberger. It was founded in 2014, and is located in both London and Berlin. The Center also participates in the longitudinal Cognition, Brain, and Aging (COBRA) study, which investigates the role of dopamine in cognitive aging. COBRA is conducted in Umeå, Sweden, and involves scientists from Umeå University, the Karolinska Institutet, Stockholm, the University of Gothenburg, and LIP (see *Spotlight Magazine*).

Three Guiding Propositions

The Center's research agenda is based on three interrelated theoretical propositions. In line with general tenets of lifespan psychology, these propositions emphasize conceptual and methodological issues in the study of lifespan behavioral development and thereby provide the foundation for formulating research questions in specific domains of interest.

Proposition 1: Lifespan Changes in the Individual's Behavior as Interactions Among Maturation, Learning, and Senescence

The general goal of developmental psychology is to identify mechanisms that generate invariance and variability as well as constancy and change in behavioral repertoires from infancy to old age. By identifying the commonalities, differences, and interrelations in the ontogeny of sensation, motor control, cognition, affect, and motivation, both within and across individuals, developmental psychologists and developmentally oriented neuroscientists attempt to arrive at more or less comprehensive theories of behavioral development. To provide explanations that qualify as psychological and developmental, the effects of agents external to the developing individual, such as educational policies, parents' affect attunement, teachers' classroom behavior, or a state's retirement policies, need to be mapped onto mechanisms and organizational laws that operate and evolve within individuals. Hence, as John Nesselroade, Peter Molenaar, and others have emphasized, developing individuals are the privileged system for description, explanation, and intervention.

Individuals organize their exchange with the physical and social environment through behavior (see Figure 1). On the one hand, the changing brain and the changing physical and cultural environment shape behavioral development. On the other hand, behavior alters both the brain and the environment. Hence, environment and brain act as antecedents but also as consequents of moment-to-moment variability and long-term changes in patterns of behavior. The components of this system, brain, behavior, and environment, are constantly coupled and cannot be reduced onto each other, as they jointly condition an individual's life trajectory through recursive self-regulation.

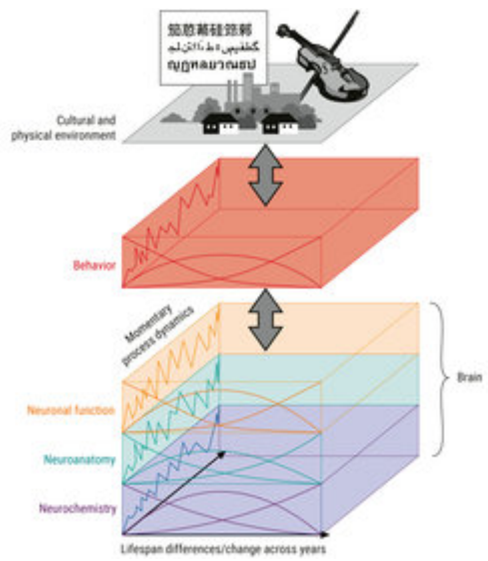


Figure 1. Environment and brain as antecedents and consequents of moment-to-moment variability and long-term changes in patterns of behavior. Lifespan changes in brain–behavior mappings are shaped by interactions among processes related to maturation, learning, and senescence. The identification of key players in the ontogeny of brain–behavior dynamics requires a coalition between formal tools for synthesis across levels of analysis and timescales as well as empirical methods to study variability and change in brain and behavior.

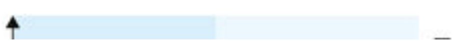
Adapted from Lindenberger, Li, & Bäckman (2006)

In attempts to explain the age-graded evolution of this system, maturation and senescence denote the operation of age-graded brain mechanisms and their effects on changes in behavior, which are especially pronounced early and late in life. In addition, learning, at any point during ontogeny, denotes changes in brain states induced by behavior–environment interactions. Maturation cannot take place without learning, and learning cannot take place without maturation. Similarly, the ways in which senescence takes its toll on the brains of aging individuals depends on their past and present learning and maturational histories. To complicate matters, processes commonly associated with maturation are not confined to early ontogeny, and processes related to senescence are not restricted to old and very old age. For instance, neurogenesis and synaptogenesis, which qualify as maturational mechanisms promoting plasticity, continue to exist in the adult and aging brain; conversely, declines in dopaminergic neuromodulation, which indicate senescence-related changes in brain chemistry, commence in early adulthood. Thus, maturation, senescence, and learning mutually enrich and constrain each other throughout the entire lifespan and must be understood and studied as interacting forces constituting and driving the brain–behavior–environment system. Psychologists occupy a central position in this endeavor because they possess a rich and adequate repertoire of experimental and methodological tools to describe and modify the organization of behavior. In particular, direct comparisons between children and older adults help to identify commonalities and differences in the mechanisms that drive child and adult development.

Proposition 2: Lifespan Theory and Methodology Need to Integrate Evidence Across Domains of Functioning, Timescales, and Levels of Analysis

Developmental psychology is faced with three challenging integrative tasks. First, there is the need to integrate theorizing and research practice across functional domains to attain a comprehensive picture of individual development. For instance, sensorimotor and cognitive functioning are more interdependent in early childhood and old age than during middle portions of the lifespan, and developmental changes in either domain are better understood if studied in conjunction. Similar observations can be made for many other domains of functioning whose changes have generally been studied in isolation, such as the ontogeny of social interaction and cognition; of emotion regulation and motivational states; or of memory, working memory, and attention.

Second, there is a need to understand the mechanisms that link short-term variations to long-term change. Short-term variations are often reversible and transient, whereas long-term changes are often cumulative, progressive, and permanent. Establishing links between short-term variations and long-term changes is of eminent heuristic value, as it helps to identify mechanisms that drive development in different directions. For instance, aging cognitive systems show a decrease in processing robustness, which may signal impending long-term changes in other characteristics of the system (see Figure 2). To articulate these different timescales, we need to gather multivariate time-series data that capture short-term variability and long-term changes in cross-domain dependencies.



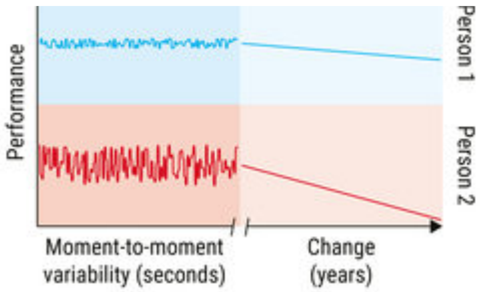


Figure 2. Illustration for predictions linking moment-to-moment variability to long-term change and brain changes to behavioral changes. Aging individuals with greater moment-to-moment fluctuations in behavior at a given point in time are expected to show greater subsequent longitudinal decline in mean levels of functioning than individuals who fluctuate less.

Adapted from Lindenberger, Li, & Bäckman (2006)

Third, to arrive at mechanistic explanations of behavioral change, there is the need to integrate behavioral and neural levels of analysis. At any given point in the lifespan, one-to-one mappings between brain states and behavioral states are the exception rather than the rule, as the brain generally explores and offers more than one implementation of an adaptive behavioral outcome (Lövdén, Garzón, & Lindenberger, 2020). Therefore, ontogenetic changes in behavioral repertoires are accompanied by continuous changes in multiple brain–behavior mappings. Some of these remapping gradients may be relatively universal and age-graded, whereas others may be more variable, reflecting genetic differences, person-specific learning histories, the path-dependent nature of developmental dynamics, or a combination of all three. The resulting picture underscores the diversity and malleability of the organization of brain and behavior as well as the constraints on diversity and malleability brought about by (a) universal age-graded mechanisms associated with maturation and senescence, (b) general laws of neural and behavioral organization, and (c) sociocultural as well as physical regularities of the environment.

Proposition 3: The Exploration of Age-Graded Differences in Plasticity Is a Powerful Tool for Identifying Mechanisms of Development

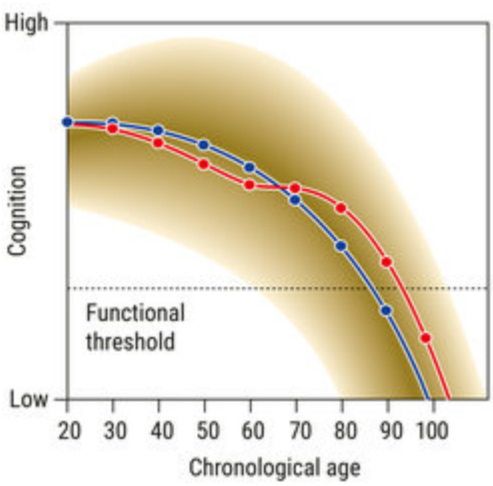


Figure 3. An individual's range of possible cognitive developmental trajectories from early to late adulthood. The blue curve shows the most likely developmental path under normal circumstances.

The fading of the background color indicates that more extreme paths are less likely. The functional threshold represents a level of functioning below which goal-directed action in the individual's ecology will be severely compromised. The red curve represents the hope that changes in organism–environment interactions during adulthood move the individual onto a more positive trajectory. Beneficial changes may consist in the mitigation of risk factors, such as vascular conditions, metabolic syndrome, or chronic stress; the strengthening of enhancing factors, such as neuroplasticity, or both.
Adapted from Lindenberger (2014)

Both from scientific and societal perspectives, plasticity, or the alteration of developmental trajectories through experience, is a precious phenomenon. Scientifically, inquiries into the plasticity of brain and behavior are rich sources of developmental information. Through the assessment of "changes in change," they offer the promise to observe the operation and proximal consequences of developmental mechanisms. For instance, studies in which research participants of different ages are instructed and trained to perform one or more cognitive tasks come with important validity benefits, such as (a) an increase in experimental control, (b) the identification of age differences near asymptotic performance levels, and (c) the assessment of transfer and maintenance effects. If neurochemical, neuroanatomical, and neurofunctional imaging measures are assessed before, during, and after training, intervention studies also offer new insights into relations between behavioral and neural manifestations of plasticity. By partly taking control over behavior–environment interactions, mechanisms of learning can be studied in the context of maturation and senescence.

From the larger perspective of societal evolution, cognitive intervention studies explore the range of possible development, or what could be possible in principle if conditions were different (see Figure 3). Hence, investigations of age changes in the plasticity of development carry the potential to explain and ameliorate the expression of human potential.

Key Reference

Lindenberger, U., Li, S.-C., & Bäckman, L. (2006). Delineating brain-behavior mappings across the lifespan: Substantive and methodological advances in developmental neuroscience. [Editorial]. *Neuroscience & Biobehavioral Reviews*, *30*(6), 713–717. https://doi.org/10.1016/j.neubiorev.2006.06.006
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Collaboration Highlights

During the reporting period, the Center has continued to engage in long-term collaborations with scientists from other institutions. In the following, we highlight three examples.

The Strong Dependency Between Changes in Fluid and Crystallized Abilities Across the Adult Lifespan

Together with Elliot Tucker-Drob from the University of Texas at Austin, who received the Max Planck-Humboldt Medal for his contributions to lifespan psychology in 2019, we revisited the developmental scope of the distinction between crystallized and fluid cognitive abilities (Tucker-Drob et al., 2022). Theories of adult cognitive development classically distinguish between fluid abilities, which require effortful processing at the time of assessment, and crystallized abilities, which require the retrieval and application of knowledge. On average, fluid abilities decline throughout adulthood, whereas crystallized abilities show gains into old age. These diverging age trends have led to the proposition that individuals might compensate for fluid declines with crystallized gains. However, in two independent data sets, we found that rates of change were strongly correlated across fluid and crystallized abilities (see Figure 4). In other words, individuals showing greater losses in fluid abilities tend to show smaller gains, or even losses, in crystallized knowledge. This commonality in change limits the room for on compensation and directs attention toward domain-general drivers of adult cognitive decline and maintenance (Nyberg et al., 2022).

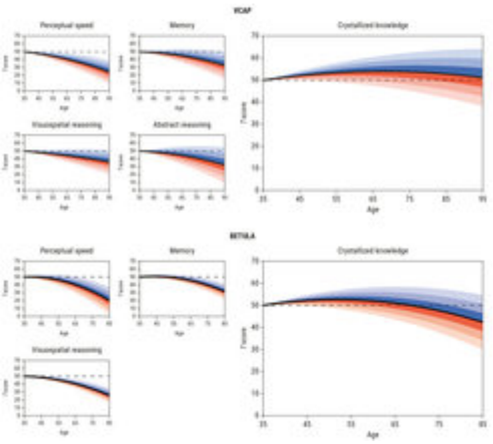

Figure 4. Changes in fluid and crystallized cognitive abilities strongly are linked across the adult lifespan. Trajectories of change over age in five cognitive abilities stratified across the distribution of variation in the general factor of change in fluid ability. The black curves represent the population average trajectories for each cognitive ability. Blue shading represents shallower-than-average rates of general fluid declines, whereas red shading represents steeper-than-average rates of general fluid declines. Each increment of shading corresponds to a 0.5 SD shift in the general factor of decline in fluid ability. More saturated colors correspond to more densely concentrated regions of the distribution of change. Changes in crystallized knowledge strongly covary with changes in fluid abilities. VCAP = Virginia Cognitive Aging Project; BETULA = Betula study.

Image: MPI for Human Development

↗ Adapted from Tucker-Drob et al. (2022)

The Role of Education in Adult Cognitive Development

Together with colleagues from the Lifebrain consortium, we examined the effects of education on cognitive aging. The number of years of formal education is known to correlate positively with cognitive function throughout adulthood, and to predict lower risk of dementia late in life. These observations have led to two separable propositions: first, that prolonging education enhances cognitive function, and second, that education attenuates aging-associated cognitive decline. Lövdén, Fratiglioni, et al. (2020) evaluated both propositions by reviewing the literature on educational attainment and cognitive aging. In agreement with the first proposition, there was clear evidence for a positive link between years of education and levels of cognitive functioning. However, contrary to the second proposition, associations between education and aging-associated cognitive decline were found to be negligible. Also, the observed association between educational attainment and late-life dementia risk could be accounted for by a threshold model of dementia, according to which individuals with lower levels of cognitive functioning early in life are more likely to hit the dementia threshold late in life. In line with these findings, Nyberg et al. (2021) observed that higher levels of education are not associated with slower rates of brain atrophy in the cortex and the hippocampus (see Figure 5). Finally, combining brain and behavioral levels of analysis, Lövdén et al. (2023) examined whether education protects against cognitive decline by providing a "cognitive reserve," such that individuals with higher educational attainment show weaker associations between changes in brain and cognition than individuals with lower educational attainment. Contrary to this hypothesis, the data were plausible under the assumption that there is no influence of education on the strength of the association between change in episodic memory and change in hippocampus volume. Taken together, these findings support the view that educational attainment exerts its influences on late-life cognitive function primarily by contributing to individual differences in cognitive skills that emerge in early adulthood and persist into older age.

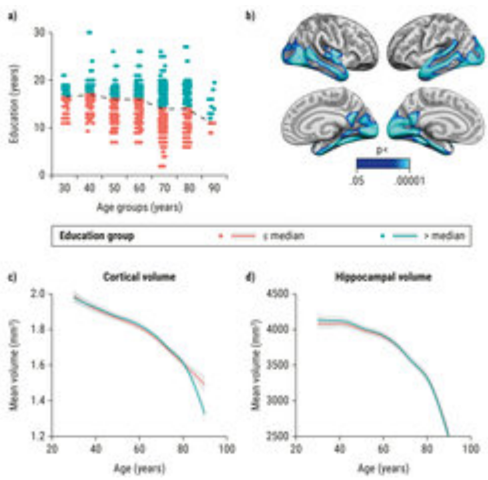

Figure 5. Educational attainment does not influence brain aging: Data from the Lifebrain project. (a) Marked individual differences in education in all age groups. (b) Cortical regions showing more volume loss with increasing age, i.e., nonlinear age changes ($p < 0.05$, corrected for multiple

comparisons). (c) Education was not related to rate of change in the atrophy-prone cortical regions in b. (d) There was significant hippocampus volume loss but no influence of education on rate of change. Education groups in c and d are based on a median split, indicated by the dashed line in a and used for illustrative purposes. The shaded areas around the lines denote 95% CI.

Strengthening the Connections Between Lifespan Cognitive Neuroscience and Neurobiology

To foster a mechanistic understanding of changes in human behavior, there is a need to intensify research efforts that aim at closing the gap between human cognitive neuroscience and animal models. LIP is currently involved in three endeavors of this sort. First, in collaboration with the Lise Meitner Group for Environmental Neuroscience, the MPI for Biological Intelligence, and the MPI for Psychiatry, we seek to gain a more mechanistic understanding of human brain plasticity by carrying out coordinated experimental research with humans and mice (see *Spotlight Magazine*). Second, in collaboration with the laboratory of Tomás Ryan at Trinity College Dublin, we are in the process of establishing a coordinated research program on the ontogeny of memory engrams in rodents and humans (see RHYME). Third, as part of a research program led by Gerd Kempermann at Deutsches Zentrum für Neurodegenerative Erkrankungen (DZNE) Dresden, we continue to collaborate on the "individuality paradigm," an automated longitudinal activity tracking of large cohorts of genetically identical mice in an enriched environment (Kempermann et al., 2022; see Figure 6). The goal of this paradigm is to study how development itself functions as a source of individual differences (Freund et al., 2013). All three collaborations are challenging, as they require conceptual reframing and experimental innovation on either side. However, the challenges are worth the effort, as they come with the prospect of fostering knowledge about developmental mechanisms in human development.

Figure 6. Studying the ontogeny of individuality in mice: the Individuality paradigm ("Colony Rack"). (a) 3D-representation of the cage design, showing the 70 standard type II cages on a double-sided rack. The cages are connected by plastic tubes. (b) The connector tubes are equipped with ring antennas (black rings) which collect the RFID signal from the individual transponders that the mice carry under the skin in their neck. Mice enter the tubing system through circular holes cut into the walls of the standard cages. (b) Tubes also connect the floor levels. The cages can be removed for cleaning. The tubes contain a removable plastic mesh that increases traction when the mice run up and down the steep slopes. (d) View into the tubing system with mice in action. Note that the version of the cage

shown here had white ring antennas.

Adapted from Kempermann et al. (2022)

Key References

Freund, J., Brandmaier, A. M., Lewejohann, L., Kirste, I., Kritzler, M., Krüger, A., Sachser, N., Lindenberger, U., & Kempermann, G. (2013). Emergence of individuality in genetically identical mice. *Science*, *340*(6133), 756–759. https://doi.org/10.1126/science.1235294
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Kempermann, G., Lopes, J. B., Zocher, S., Schilling, S., Ehret, F., Garthe, A., Karasinsky, A., Brandmaier, A. M., Lindenberger, U., Winter, Y., & Overall, R. W. (2022). The individuality paradigm: Automated longitudinal activity tracking of large cohorts of genetically identical mice in an enriched environment. *Neurobiology of Disease*, *175*, Article 105916. https://doi.org/10.1016/j.nbd.2022.105916
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Tucker-Drob, E. M., De la Fuente, J., Köhncke, Y., Brandmaier, A. M., Nyberg, L., & Lindenberger, U. (2022). A strong dependency between changes in fluid and crystallized abilities in human cognitive aging. *Science Advances*, *8*, Article eabj2422. https://doi.org/10.1126/sciadv.abj2422
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Research Awards (Selection)

In 2020, *Beate Mühlroth* was awarded the Becker-Carus 2020 doctoral prize of the German Sleep Society. In 2021, *Martin Dahl* received two awards for his dissertation, the Otto Hahn Medal of the Max Planck Society, and the Margret and Paul Baltes Award of the Developmental Psychology Section of the German Psychological Society (DGPs). *Chi* (*Zoe) Ngo* was awarded the Research Fellowship of the Jacobs Foundation. *Amrisha Vaish,* University of Virginia, Charlottesville, received the Max Planck Sabbatical Award 2021. In 2022, *Tobias Grossmann,* University of Virginia, Charlottesville, received the Alexander von Humboldt Foundation's Friedrich Wilhelm Bessel Research Award. *Julian Kosciessa* received the Otto Hahn Medal of the Max Planck Society for his dissertation, as well as the Brain Products Young Scientist Award for outstanding contributions to EEG research, awarded by the German Society of Psychophysiology and its Application. In 2023, *Ulman Lindenberger* was elected Foreign Member of the Royal Swedish Academy of Sciences in the

Class for Social Sciences.

Overview of Research Projects at the Center for Lifespan Psychology

In March 2023, empirical and conceptual work at the Center was structured into eight research projects (see Table 1). Since the reporting period 2017–2019/20, a new project, Lifespan Neuromodulation of Cognition (LINE) was formed in fall 2022 on the basis of prior work in the RHYME project. With the retirement of Viktor Müller, the Interactive Brains, Social Minds project will come to a close at the end of 2023. Furthermore, in light of the newly founded Max Planck Research Group MR Physics, the Brain Imaging Methods in Lifespan Psychology project will be dissolved and integrated into the new group in the course of 2023. Thus, by the end of this year, the number of projects will have decreased from eight to six.

The specific activities pursued in the various projects cover a wide array of research areas in human behavioral development. For example, the following questions have been addressed during the reporting period: (a) How can we support Open Science practices with a unified workflow that guarantees reproducibility of both statistical analyses and resulting publications (Peikert & Brandmaier, 2021)? (b) How does the coupling between slow oscillations and spindles during sleep, which acts as a key electrophysiological mechanism supporting memory consolidation, differ between children, adolescents, and adults? (c) Does the precision of the interaction between oscillatory activity in theta and gamma frequency bands during the encoding of object–context associations differ between younger and older adults, and do these differences matter for later retrieval of contextual information (Karlsson et al., 2022)? (d) How does deterioration of the locus coeruleus, a small nucleus in the brainstem, and the brain's main source of the neuromodulator noradrenaline, contribute to normal cognitive aging and late-life dementia (Dahl, Bachman, et al., 2023)? (e) What are the structural and functional brain changes in aspiring professional musicians who are preparing for an entrance exam at a university of the arts (Wenger et al., 2021)? We provide our current answers to these questions and many more on the following pages.

Table 1. The Center for Lifespan Psychology at the Max Planck Institute for Human Development: Overview of Research Projects

►

Name of Project	***Researchers, Including Postdoctoral Fellows***	***Predoctoral Research Fellows***
Lifespan Rhythms of Memory and Cognition (RHYME)	Markus Werkle-Bergner**; Ann-Kathrin Jöchner*, Ulman Lindenberger, Chi (Zoe) Ngo*, Sarah Power*	Elisa S. Buchberger
Lifespan Age Differences in Memory Representations (LIME)	Myriam C. Sander [1] **; Ulman Lindenberger	Claire Pauley
Lifespan Neuromodulation of Cognition (LINE)	Martin J. Dahl**; Ulman Lindenberger	Agnieszka Kulesza
The Berlin Aging Studies (BASE & BASE-II)	Julia A. M. Delius**, Ulman Lindenberger**; Andreas Brandmaier, Gert G. Wagner [2]	
Mechanisms and Sequential Progression of Plasticity	Elisabeth Wenger**; Yana Fandakova°, Ulman Lindenberger, André Werner	Maike Hille, Neda Khosravani, Eleftheria Papadaki, Sina A. Schwarze
Formal Methods in Lifespan Psychology	Andreas M. Brandmaier**, Ulman Lindenberger, Timo von Oertzen°, Aaron Peikert	Hannes Diemerling°
Interactive Brains, Social Minds	Viktor Müller**; Ulman Lindenberger	
Brain Imaging Methods in Lifespan Psychology	Nils C. Bodammer**; Ulman Lindenberger, Naftali Raz, Davide Santoro	

Lifespan Neural Dynamics Group (LNDG)

Douglas D. Garrett**

Fabian Kamp, Zoya Mooraj, Liliana Polanski, Alexander Skowron

Notes. The table refers to projects and project members *as of March 31, 2023*; for updates, visit the LIP website. LNDG is an independent research group that closely collaborates with LIP. **Principal investigator; *Postdoctoral fellow; °Primary affiliation with another institution.
[1] Myriam C. Sander leads a Minerva Research Group.
[2] Gert G. Wagner is Max Planck Fellow at the MPI for Human Development.

"But … its eminent modifiability, and its predisposition to self-initiated action, may it develop little or much, and may it differ in amount between different individuals, is among the immutable features of humankind, which can be found wherever humans exist."
Johann Nicolaus Tetens, 1777, I, p. 766

Research Team 2020-2022/23

Last update: August 2023

Researchers

Dag Alnaes (as of 08/2022: Kristiania University College, Oslo, Norway), Nils Bodammer, Andreas Brandmaier, Martin Dahl, Julia Delius, Charles Driver (as of 02/2021: University of Zurich, Switzerland), Sandra Düzel (as of 08/2022: Charité Universitätsmedizin Berlin, Germany), Yana Fandakova (as of 10/2022: Universität Trier, Germany), Douglas D. Garrett, Maike Kleemeyer (as of 03/2021: Library and Research Information, MPIB, Berlin, Germany), Malte Kobelt (as of 03/2020: Ruhr-Universität Bochum, Germany), Imke Kruse (as of 03/2022: Scientific Service, MPIB, Berlin, Germany), **Ulman Lindenberger,** Viktor Müller, Aaron Peikert, Naftali Raz, Myriam C. Sander, Gert G. Wagner (Max Planck Fellow), Elisabeth Wenger (as of 04/2023: HMU Health and Medical University, Potsdam, Germany), Markus Werkle-Bergner, André Werner

Postdoctoral Fellows

Caroline Beese (as of 06/2021: Universität Wien, Austria), Elisa Buchberger, Lieke de Boer (as of 03/2021: eScience Center Amsterdam, Netherlands), Marie Deserno (as of 11/2021: University of Amsterdam, Netherlands), Stella Gerdemann, Ann-Kathrin Jöchner, Anna Karlsson (as of 02/2022: Humboldt-Universität zu Berlin, Germany), Nils Kloosterman (as of 08/2022: Universität Lübeck, Germany), Ylva Köhncke (as of 12/2022: DGVT Ausbildungsakademie, Berlin, Germany), Julian Kosciessa (as of 06/2022: Radboud University, Nijmegen, Netherlands), Corinna Laube (as of 05/2020: Hochschule Fresenius, Berlin, Germany), Ziyong Lin (as of 06/2021: Amazon Berlin, Germany), Kristoffer N. T. Månsson (as of 09/2020: Karolinska Institutet, Stockholm, Sweden), Beate Mühlroth (as of 04/2020: Bundespsychotherapeutenkammer, Berlin, Germany), Chi (Zoe) Ngo, Eleftheria Papadaki, Alistair Perry (as of 04/2020: Cambridge Centre for Frontotemporal Dementia and Related Disorders, UK), Sarah Polk (as of 03/2023: Deutsches Zentrum für Neurodegenerative Erkrankungen, Magdeburg, Germany), Sarah Power, Verena Sommer (as of 11/2021: LBD-Beratungsgesellschaft, Berlin, Germany), Xiangbin Teng (as of 09/2021: Freie Universität Berlin, Germany), Armin Thomas (as of 09/2022: Stanford University, USA), Leo Waschke (as of 03/2023: Federal Ministry of Education and Research (BMBF), Berlin, Germany)

Predoctoral Fellows

Hannes Diemerling (LIFE), Maike Hille (LIFE), Fabian Kamp (COMP2PSYCH), Neda Khosravani (LIFE), Agnieszka Kulesza (LIFE), Zoya Mooraj (COMP2PSYCH), Claire Pauley (LIFE), Liliana Polanski (COMP2PSYCH), Sina A. Schwarze (LIFE), Alexander Skowron (LIFE/COMP2PSYCH)

Associate Research Scientists

Yana Fandakova (Universität Trier, Germany), Attila Keresztes (Brain Imaging Centre TTK, Budapest, Hungary), Amrisha Vaish (University of Virginia, Charlottesville, USA), Timo von Oertzen (Universität der Bundeswehr München, Germany), Elisabeth Wenger (HMU Health and Medical University Potsdam, Germany)

Visiting Researchers

Steven M. Boker (University of Virginia, Charlottesville, USA), Kirk Erickson (University of Pittsburgh, USA), Michael C. Frank (Stanford University, USA), Alexander Grob (University of Basel, Switzerland), Tobias Grossmann (University of Virginia, Charlottesville, USA), Ulrich Mayr (University of Oregon, Eugene, USA), Thad Polk (University of Michigan, Ann Arbor, USA), Nikolaus Steinbeis (University College London, UK), Dagmar Zeithamova (University of Oregon, Eugene, USA)

A current list of the Center's staff with links to their web profiles can be found on the Center's website.

Image: MPI for Human Development

Research

Projects

Lifespan Rhythms of Memory and Cognition (RHYME)

This project investigates lifespan changes in attention, working memory, and episodic memory at structural, functional, and behavioral levels of analysis, with an emphasis on age differences in the coordination of rhythmic neural brain activity. > more

Lifespan Age Differences in Memory Representations (LIME)

This project addresses mechanisms of memory formation, consolidation, and retrieval, with a focus on the ways in which these mechanisms change across the lifespan, and in particular, on whether aging-induced decrements in the distinctiveness of neural representations contribute to age-related losses in memory performance in later adulthood. > more

Lifespan Neuromodulation of Cognition (LINE)

This project uses a multimodal approach to investigate structural and functional age differences and age changes in neuromodulation and their associations with normal and pathological forms of cognitive aging, with a focus on the locus coeruleus. > more

The Berlin Aging Studies (BASE & BASE-II)

Members of the Center for Lifespan Psychology investigate changes in cognition and other aspects of behavior in the context of the collaborative and multidisciplinary Berlin Aging Studies (BASE and BASE-II). > more

Mechanisms and Sequential Progression of Plasticity

This project investigates the role of brain plasticity in behavioral development across the lifespan. It makes use of training studies to probe the antecedents, mechanisms, and consequences of plastic change across different age groups and functional domains. > more

Formal Methods in Lifespan Psychology

This project seeks to develop and refine statistical methods and research designs that articulate human development across different timescales, levels of analysis, and functional domains. It is characterized by an emphasis on methodology, understood as the reciprocal interplay between concepts and methods that is at the heart of scientific progress. > more

Interactive Brains, Social Minds (Concluding Report)

This project investigates behavioral, somatic, and neural mechanisms that permit individuals to coordinate their behavior in time and space, mainly by analyzing electroencephalographic (EEG) data of skilled musicians playing together. > more

Brain Imaging Methods in Lifespan Psychology (Concluding Report)

This project's goals were to ascertain and improve the measurement quality of standard brain imaging protocols at the Center, and to complement the standard imaging repertoire by advanced sequences to elucidate structural changes and physiological mechanisms related to maturation, learning, and senescence. > more

Lifespan Rhythms of Memory and Cognition (RHYME)

Research Scientists

Markus Werkle-Bergner

Elisa Buchberger
Martin J. Dahl (until 11/2022)
Ann-Kathrin Joechner
Ulman Lindenberger
Beate Mühlroth (until 04/2020)
Chi (Zoe) Ngo
Sarah Power (as of 04/2021)

Early Childhood Memories (ECHO)

Charting the Ontogeny of Memory Component Processes Across Early Childhood (COMIC)

Child and Adolescent Age Differences in Rhythmic Brain Activity During Sleep

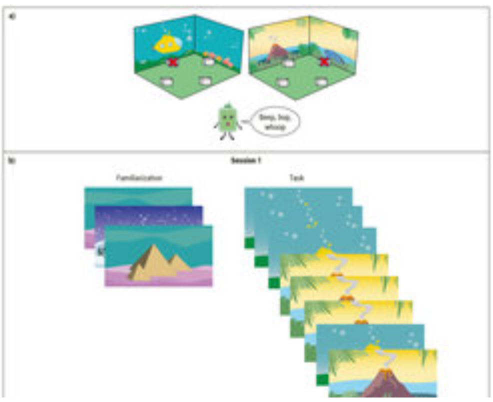
The RHYME project investigates lifespan differences and changes in attention, working memory, and episodic memory at structural, functional, and behavioral levels of analysis. It combines experimental with longitudinal research designs and uses multimodal data from a wide range of neuroimaging methods. The project collaborates closely with the Max Planck Partner Group Hippocampal Circuit and Code for Cognition Lab (HCCCL), led by former postdoc Attila Keresztes, which was established in 2021 at the Brain Imaging Centre of the Research Centre for Natural Sciences in Budapest, Hungary. During the reporting period, the project's primary research focus was on the design and administration of two series of studies, Early Childhood Memories (ECHO) and Charting the Ontogeny of Memory Component Processes Across Early Childhood (COMIC). Informed by animal and computational models of memory, ECHO and COMIC serve to elucidate the ontogeny of episodic memory in infancy and middle childhood, respectively. Both series of studies represent long-term efforts that will take several years to come to full fruition. A second major portion of the project's research activities, focusing on noradrenergic neuromodulation and the locus coeruleus, has become part of the LINE project. RHYME also continued its earlier work on the development of rhythmic brain activity during childhood and adolescence.

Early Childhood Memories (ECHO)

Human infants show clear learning from an early age, but forget episodic memories formed in the first 2 to 3 years of life. This phenomenon, called infantile amnesia, appears to be evolutionarily preserved, as it can be found across a wide range of species. However, its function and mechanisms are only poorly understood. In non-human animals, memory engrams can be probed directly with invasive neuroscience technologies that cannot be used in human research. To bridge the ensuing gap in knowledge, we have initiated a collaboration with Tomás Ryan (Trinity College Dublin). The goal of the collaboration is to build a coordinated research program on the ontogeny of memory engrams in rodents and humans. In particular, we hope to identify non-invasive behavioral and neural markers of memory engram ensemble activity that are applicable to human infants and children. If successful, the availability of such markers will allow us to develop and evaluate interventions that re-activate or suppress specific memories, including those formed during the first year of life.

The research is guided by three main objectives: First, we have developed object–context and maze-learning assays to study infantile amnesia in rodents that can inform and parallel human behavioral experiments. Second, we aim to identify biomarkers of memory expression in rodent infants that can be translated to human infants. Here, we focus on (mobile) EEG as a bridge marker of neural activity in both animal models and human infants. Third, our long-term goal comprises the validation of non-invasive interventions for the reinstatement of infant memory engrams in humans.

For the human studies, we built a dedicated testing site (see Figure 1). In a large room, we constructed a testing arena, about 4 m x 4 m in size, enclosed by walls. The arena features several hiding spots that indicate the different spatial locations the children should learn. The walls are constructed as projection screens to dynamically create unique "natural" environments (e.g., a playground, a beach) across different learning trials. Using this setup, we provide infants with a unique learning experience shortly before the offset of infantile amnesia (at 18–24 months of age). The successful formation of a unique memory trace is assured by a retest one day later. The natural effects of forgetting are assessed 30 to 60 days later. The task infants perform is modeled according to a context-location memory task typically used for mice (i.e., a Barnes maze).



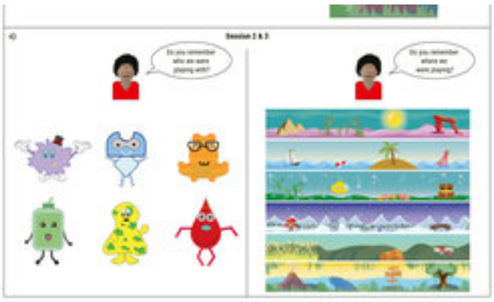


Figure 1. Probing memory performance in infancy and early childhood: A human analogue of the Barnes maze used with rodents. (a) Schematic of the testing arena depicting two different environments and hiding spots (red marks), along with an example toy character. The testing arena is a closed room with projection screens as walls. A camera system on the ceiling monitors the infants' search and movement trajectories with high temporal resolution. (b) Illustration of the learning procedure on the first day. During a short familiarization, the infants experience the features of the testing arena, especially the fact that the environment created through the projections on the walls can change quickly. In addition, they are introduced to the toy character and the hide-and-seek game. Afterwards, the children learn two unique context–place associations across several repeated trials within two unique environments (not shown during familiarization). (c) Procedure to assess mnemonic details for the learning session one day and 30 days after initial learning. In a first attempt, children are shown all available toy characters and asked to select the one they played with during initial learning (all others not seen at all). Similarly, the children's memory for the experienced environments is probed.
Image: Sarah Power / MPI for Human Development

Charting the Ontogeny of Memory Component Processes Across Early Childhood (COMIC)

In a changing environment, an adaptive memory system needs to gauge the conflicting demands of extracting commonalities across experiences to generate novel inferences (i.e., generalization) while simultaneously forming discriminable representations of specific events (i.e., memory specificity). Computational memory models suggest that specific experiences are initially encoded as hippocampus-dependent episodic memories and slowly become amenable to generalization through consolidation. This process is typically facilitated by post-learning sleep. Early in life, children are poor at remembering the details of specific events, yet display a remarkable capacity to extract schematic knowledge about the environment. Such observations suggest a developmental lead–lag relation between generalization and memory specificity. In two ongoing large-scale studies with more than 500 4- to 8-year-old children, we aim to delineate the ontogeny of memory specificity and generalization across development in early middle childhood.

The first study tests the conjecture that the uneven maturation of intra-hippocampal structures is linked longitudinally to the late emergence of memory specificity in childhood. Here, we also ask to what extent sleep-dependent memory consolidation amplifies the reliance on fast generalization in early childhood at the expense of memory specificity. To this end, we have implemented an accelerated longitudinal design with 200 children aged 4, 5, or 6 years old at the first measurement occasion. At each of the three annual measurement time points, participants will take part in up to five sessions that also include structural MRI measurements. We have adapted a novel memory task (the Collection Game Task) that allows developmentally adequate assessments of generalization, context-binding, and contextual as well as perceptual specificity. An initial cross-sectional validation study supports the hypothesis that age differences are more pronounced for generalization than for memory specificity during early childhood (see Figure 2).

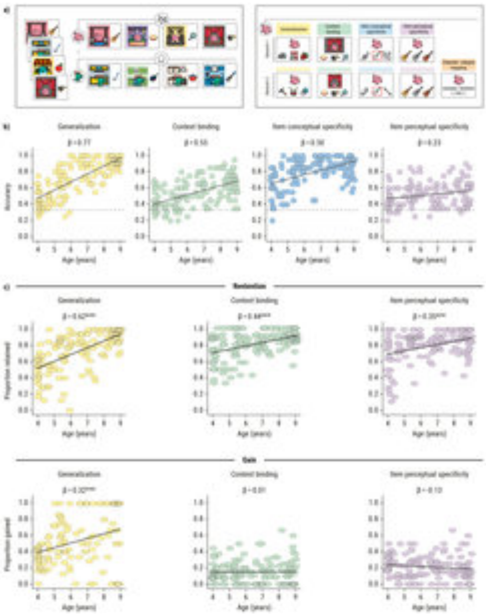


Figure 2. Assessing component memory processes in middle childhood. (a) Schematic illustration of the Collection Game Task used to assess generalization and context binding, as well as conceptual and perceptual specificity longitudinally in 4- to 8-year-old children. During encoding, the children watch a stream of visual images consisting of a background scene, a central character, and an associated object. Children are told that each of the characters goes to different places and collects the things they want for their collection. Hence, each character (e.g., Luntik) is shown on a specific kind of background scene (e.g., stages), and paired with a specific class of objects (e.g., musical instruments). Throughout the encoding phase, each character appears in four trials in an intermixed order, each time with a different context and object. During the test, four tasks are conducted. To assess generalization, a character is shown with three objects, of which only one is appropriate for their collection (e.g., a not-yet-seen musical instrument). To measure context binding, the same character–scene pairing as experienced during encoding is shown again. The children's task is to identify the exact object that was shown along with this character–scene combination. Conceptual and perceptual specificity are probed by identifying the previously encountered object among similar objects along with its precise perceptual features. All images in (a) from flaticon.com. (b) Results of the Collection Game Task on the immediate test of the first day. All facets of memory performance were positively correlated with age. As hypothesized, the age association was stronger for generalization than for memory specificity. (c) Delayed performance after one night of sleep. Items that resulted in a correct response in the evening and were also answered correctly in the morning

were classified as maintained items. Items that did not yield a correct response in the evening but were correctly answered the next morning were classified as gained. With increasing age, children were more likely to maintain both generalized and specific memory contents. For generalized memories, overnight gains increased with age, while gains for specific mnemonic details were weak across the entire age range.

Image: Elisa Buchberger & Ann-Kathrin Joechner / MPI for Human Development
Adapted from Buchberger, Joechner et al. (2022)

Neurocomputational models postulate that memory performance reflects the interplay of generalization, pattern separation, and pattern completion. However, it is unknown whether this tripartite structure is already fully established in early childhood. Based on an in-depth review of the literature on memory development during childhood, we assembled and designed a child-adequate battery of seven tasks yielding 13 indicators, with the aim of establishing latent factors of generalization, pattern separation, and pattern completion. The experimental procedures and analysis strategy of the study have been accepted as a Stage 1 Registered Report by *Developmental Science*. The overall goal of the study is to formally test whether the postulated tripartite process structure of memory is already present in 4- to 6-year-old children.

Key Reference

Buchberger, E., Brandmaier, A. M., Lindenberger, U., Werkle-Bergner, M., & Ngo, C. T. (in press). The process structure of memory abilities in early and middle childhood [Registered Report]. *Developmental Science*. https://doi.org/10.31234/osf.io/p84a6
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Child and Adolescent Age Differences in Rhythmic Brain Activity During Sleep

Following up on our earlier work on memory consolidation during sleep, we investigated the temporal coordination between slow oscillations and spindles in children and adolescents during sleep. In young adults, coupling of rhythmic brain activity during sleep is most pronounced for fast spindles (≈ 12.5–16 Hz), while slow spindles (≈ 9–12.5 Hz) synchronize shifted in time. Interestingly, slow sleep spindles, rather than fast sleep spindles, prevail in childhood and early adolescence. While both sleep spindles and slow oscillations are known to show developmental changes, the ontogeny of their co-occurrence has remained elusive. In a collaboration with Kerstin Hoedlmoser, Paris Lodron University Salzburg, we investigated age differences in slow oscillation–spindle coupling, the key electrophysiological mechanism supporting memory consolidation in young adults, in three samples of children and adolescents (Joechner et al., 2022). Corroborating previous findings, we identified fast sleep spindles in all age groups. However, specifically in young children, the dominant type of fast spindles was nested with the slow spindle range, and only few adult-like fast spindles were detectable. In older children and adolescents, fast spindles were more numerous and more closely resembled adult-like fast spindles. Astonishingly, temporal couplings to slow waves were barely discernable for ontogenetically early fast spindles, while activity in the adult-like fast spindles range was clearly synchronized with the up-peak of slow oscillations. These results suggest that the increasing ability to generate adult-like fast sleep spindles facilitates the emergence of slow oscillation-spindle couplings during childhood and adolescence (see Figure 3).

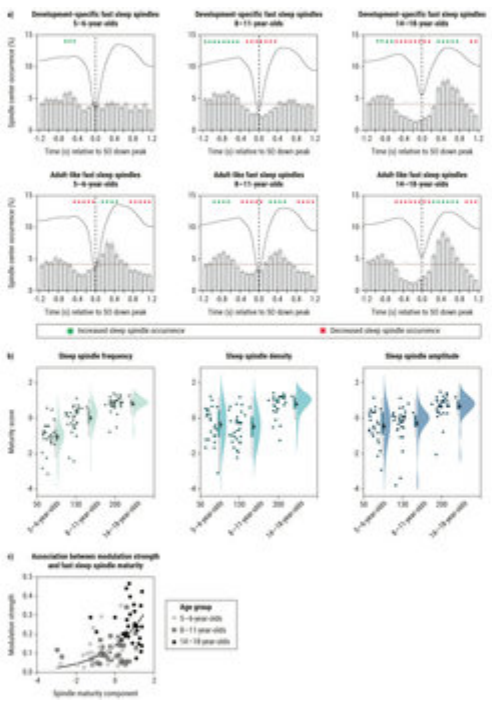

*Figure 3.*The emerging coordination between slow oscillations and spindles during sleep in childhood. (a) Peri-event time histograms capturing the co-occurrence between development-specific (upper row) and adult-like fast spindles (lower row) with slow oscillations. Gray bars indicate the percentage of spindle occurrence in a given time-bin relative to the down-peak of the corresponding slow oscillations. Compared to a randomly shuffled surrogate distribution, there is no indication of increased co-occurrence of development-specific spindles with the slow oscillation up-peak in younger children. However, a clear modulation pattern can be observed for adult-like fast spindles. (b) With increasing age, development-specific fast spindles increasingly resemble the fast spindles typically observed in adults. Accordingly, differences between individual development-specific spindles and those identified in the adult-like fast spindle range decrease in frequency, density, and amplitude with age. (c) The more individually identified fast spindles in children resemble adult-like fast spindles (as captured in an increasing multivariate maturity score, see Joechner et al., 2022), the more pronounced the synchronization pattern between spindles and slow oscillations (expressed via the Kullback-Leibler divergence between the actual peri-event time histogram distributions and a randomly shuffled surrogate distribution).

Image: MPI for Human Development

Adapted from Joechner et al. (2022)

Key References

Joechner, A.-K., Hahn, M. A., Gruber, G., Hoedlmoser, K., & Werkle-Bergner, M. (2022). Sleep spindle maturation enhances slow oscillation-spindle coupling. *BioRxiv*, September 6, 2022. https://doi.org/10.1101/2022.09.05.506664

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Lifespan Age Differences in Memory Representations (LIME)

Research Scientists

Myriam C. Sander (on maternity leave 07/2021–03/2023)

Anna E. Karlsson (until 02/2022)
Ulman Lindenberger
Claire Pauley
Verena Sommer (until 09/2021)

LIME addresses mechanisms of memory formation, consolidation, and retrieval, with a focus on the ways in which these mechanisms change across the lifespan (see Sander et al., 2021). In particular, the project investigates whether aging-induced decrements in the distinctiveness of neural representations contribute to age-related losses in memory performance in later adulthood. Providing answers to this question requires the coordination of concepts and methods from lifespan psychology, cognitive neuroscience, and computational neuroscience. Accordingly, the project relies on experimental research designs, advanced multi-modal imaging methods, and computational modeling. The project has been partially funded as a Minerva Research Group awarded to Myriam C. Sander.

Research Area 1: Age Differences in Similarity and Distinctiveness of Memory Representations

Are memories represented differently in older adults compared to younger adults? According to the dedifferentiation hypothesis, age-related cognitive decline during adulthood and old age reflects decrements in the distinctiveness of neural representations and processing pathways (Li et al., 2001). In line with this hypothesis, pioneering work by Denise Park and colleagues has shown that differences in the neural representation between items belonging to different categories, such as houses and faces, are less pronounced in older adults than in younger adults. However, the relation between differences in distinctiveness of memory representations and adult age differences in cognitive performance continue to be poorly understood. Furthermore, most research has investigated age differences in the distinctiveness of representations during memory formation, but rarely have age differences in distinctiveness been studied during memory retrieval. In LIME, we examine whether links between neural distinctiveness and performance help to elucidate adult age differences in episodic memory by following memory representations from encoding to retrieval (Sander et al., 2021).

For instance, in one of our recent studies we made use of functional magnetic resonance imaging (fMRI) during both the encoding and retrieval phases of a memory task (Dissertation Claire Pauley). Using exploratory representational similarity searchlight analyses, we identified brain regions showing an age-related deficit in neural distinctiveness during encoding, retrieval, and in encoding-retrieval reinstatement (see Figure 1). Specifically, we found that neural representations in occipital and ventral visual regions were less distinct in older adults compared to younger adults, and that lower distinctiveness across all phases was associated with poorer memory performance. Interestingly, interindividual differences in retrieval- and reinstatement-related neural distinctiveness were closely tied to distinctiveness during encoding. Furthermore, neural distinctiveness during encoding predicted individual differences in memory performance to a far greater extent than either retrieval- or reinstatement-related distinctiveness, in line with the proposition that age-related differences in encoding show downstream effects on later processing stages (Sander et al., 2021). In ongoing analyses, the project aims to understand how age differences in the connectivity of large-scale brain networks contribute to neural dedifferentiation (in cooperation with Dasa Zeithamova, visiting researcher in 2021).

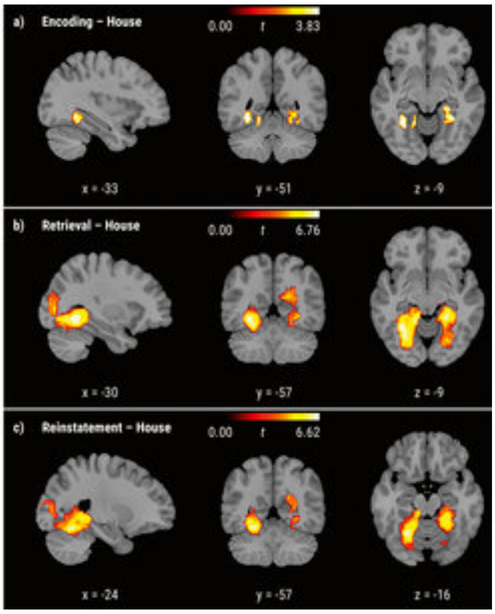

Figure 1. Age differences in category specificity. Younger adults demonstrated greater category specificity (within-category similarity > between-category similarity) than older adults during encoding (a), retrieval (b), and reinstatement (c) for house stimuli.

Image: MPI for Human Development
Adapted from Pauley et al. (2023)

In an EEG study, we investigated the detailedness of representations from childhood to old age (Dissertation Verena Sommer). Here, we used neural adaptation as a marker of the specificity of representations. This approach rests on the assumption that neuronal populations reduce their responses (i.e., adapt) when stimulus features to which they are sensitive are repeated. The magnitude of adaptation thus serves as an indicator of representation specificity. We asked whether differences in adaptation magnitudes predict differences in memory performance in children, young adults, and older adults. To this end, we varied the number of exposures and the degree of similarity to other stimuli of visually presented objects. Event-related potentials displayed adaptation effects in all age groups, and were associated with memory specificity. Our findings support the claim that adaptation effects reflect encoding mechanisms that facilitate the formation of stimulus-specific memory representations, and underscore their significance as neural indicators of individual differences in episodic memory across the lifespan (Sommer et al., 2021). The extension of this investigation to children was accomplished in collaboration with Sarah Weigelt (TU Dortmund University). Ongoing analyses use spectral pattern similarity analysis (as described in a recent tutorial by Sommer et al., 2022) to further characterize lifespan age differences in memory representations from encoding to retrieval.

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Pauley, C., Kobelt, M., Werkle-Bergner, M., & Sander, M. C. (2023). Age differences in neural distinctiveness during memory encoding, retrieval, and reinstatement. *Cerebral Cortex*, *33*(16), 9489–9503. https://doi.org/10.1093/cercor/bhad219
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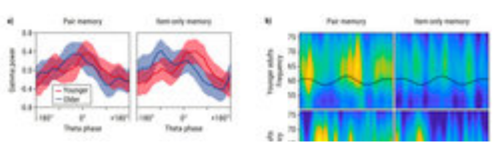
Research Area 2: Effects of Context on Memory Representations

Successful memory is greatly aided by the spatial and temporal settings of an event, commonly referred to as its context. This dependency of memory on context increases with advancing adult age (Lindenberger & Mayr, 2014). At the same time, and somewhat paradoxically, older adults find it particularly difficult to actively retrieve specific object–context associations. Based on these observations, our studies aim at a better understanding of age differences in the contextualization of memories (i.e., object–context binding) and the precise conditions under which memory performance benefits from context reinstatement (Dissertation Anna Karlsson).

At the neural level, modulations of oscillatory activity (i.e., rhythmic fluctuations in synchronous neural activity) in the alpha and theta frequency band have been related to successful memory encoding and retrieval in young adults, but their role in memory decline in older age is not well understood. With regard to memory formation, we found that theta synchronization and alpha/beta desynchronization remain relevant in older age (Karlsson & Sander, 2022). Alpha/beta desynchronization was less pronounced in older adults than in younger adults, and was accompanied by reduced memory for object–context associations. These observations match similar findings from a study on memory retrieval (Karlsson et al., 2020), where alpha/beta desynchronization was also reduced among older adults and associated with less detailed object memories. Together, these findings suggest reductions in alpha/beta desynchronization with advancing adult age contribute to an impoverished representation of contextual information.

A key candidate for our ability to specifically associate distinct pieces of information during learning is the temporally precise interaction between oscillatory activity in the theta and the gamma frequency band, so-called theta–gamma coupling. We therefore asked whether poorer object–context binding is associated with lower neural coupling precision (Karlsson et al., 2022). We found that gamma power increases are indeed tied to a specific phase angle of the theta rhythm during successful formation of object–context associations in both younger and older adults (see Figure 2). Associative memories were more likely to be retrieved when the gamma power increases were closer to this theta phase angle, suggesting the existence of an optimal theta phase angle for laying down bound memories. Furthermore, for events where only the object was remembered, but not the context, the theta phase at which gamma power increases occurred was shifted away from this optimal theta phase. Finally, adult age differences in associative memory performance were accompanied by a deviation in coupling phase angle further away from the optimal theta phase in older relative to younger adults. In concert, these findings provide evidence for a crucial role of theta–gamma coupling in the construction of a coherent memory trace. They point to decrements in the precision of theta–gamma coupling as a candidate mechanism for the general proposition, put forward by Fergus I. M. Craik and others, that normal cognitive aging compromises the ability to form and retrieve associative memories.

These results are based on a multimodal study that combined EEG and functional and structural MRI with the aim of investigating how context shapes younger and older adults' memories for objects. In follow-up analyses, we are currently investigating learning-related changes in neural patterns of object-specific representations in the hippocampus as captured by fMRI.



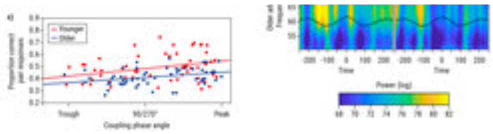


Figure 2. Aging-related decrements in precision of theta–gamma coupling as a candidate mechanism for adult age differences in associative memory. (a) Illustration of age differences in the distribution of gamma power (y-axis) over theta phase bins (x-axis) for pair memory (left) and item-only memory (right). Shaded areas indicate 95% confidence intervals and phase 0° corresponds to the theta peak (cosine). Relative to younger adults, the coupling phase is shifted in older adults. (b) Illustration of the time (x-axis) and frequency (y-axis) power spectrum within the gamma band (50–75 Hz) for pair memory (left) and item-only memory (right). The black line represents a peak-locked average of the unfiltered EEG signal aligned to the middle peak (time = 0) of the theta rhythm. Coupling accuracy is lower in older adults than in younger adults. (c) The association between the proportion of correct pair responses (y-axis) and individual coupling phase (x-axis; angle in degrees). For illustrative purposes only, absolute phase angles are plotted. Colored lines and dots indicate regression lines for the two age groups and individual data points, respectively. Coupling closer to the peak of the theta phase is associated with better pair memory performance.

Image: MPI for Human Development
Adapted from Karlsson et al. (2022)

Key References

Karlsson, A. E., Lindenberger, U., & Sander, M. C. (2022). Out of rhythm: Compromised precision of theta-gamma coupling impairs associative memory in old age. *The Journal of Neuroscience*, *42*(9), 1752–1764. https://doi.org/10.1523/JNEUROSCI.1678-21.2021
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MPG.PuRe DOI publisher-version

Lifespan Neuromodulation of Cognition (LINE)

Research Scientists

Martin Dahl

Ulman Lindenberger

Agnieszka Kulesza

Neuromodulators are a group of chemicals that are synthesized in small subcortical nuclei, from which they are released via far-reaching fibers throughout the brain. Neuromodulator release shapes the efficacy of synaptic transmission in its target regions and thus has a profound influence on cognitive processes, such as attention and memory. Furthermore, neuromodulatory nuclei are susceptible to degeneration in aging and disease, thereby contributing to senescent cognitive decline. Continuing a line of research initiated in the RHYME project, LINE uses a multimodal approach to investigate structural and functional age differences and age changes in neuromodulation and their associations with normal and pathological forms of cognitive aging. Conceptually, the project aims at a comprehensive understanding of the role of neuromodulation in cognitive aging (Dahl, Mather, Werkle-Bergner, & Kennedy, 2022). During the reporting period, the research activities of this new project were centered on two interrelated themes.

MRI-Indexed Locus Coeruleus Integrity is Linked to Neural Pathology and Cognition

Research dissecting the brains of people who died at different ages indicates that the first signs of Alzheimer's-related pathology, abnormally phosphorylated tau, begin to accumulate early in life in the locus coeruleus, the brain's main source of the neuromodulator noradrenaline. For a long time, in-vivo human studies of the locus coeruleus were deemed virtually impossible due to its small size and location deep in the brainstem. However, recently developed magnetic resonance imaging (MRI) techniques have resulted in non-invasive markers for the integrity of the neuromodulatory nucleus (see Figure 1a). In earlier work within the RHYME project, we had assessed MRI-indexed locus coeruleus integrity in the Berlin Aging Study II (cf. Berlin Aging Studies project). We detected spatially confined and functionally relevant age differences in locus coeruleus integrity. A follow-up study in the same sample (Bachman et al., 2021) demonstrated an association of higher locus coeruleus integrity and cortical thickness, particularly in frontoparietal cortices.

In a next step, we sought to clarify (a) whether in-vivo differences in locus coeruleus integrity are corroborated by post-mortem data and (b) whether differences in MRI-indexed locus coeruleus integrity are more indicative of healthy or pathological aging processes. In a collaboration with John M. Ringman and Mara Mather, University of Southern California, we studied participants with, or at risk for, mutations in genes causing familial Alzheimer’s disease with early onset (autosomal-dominant Alzheimer’s disease, ADAD), providing a unique window into the pathogenesis of Alzheimer’s largely disentangled from common age-related factors (Dahl, Mather, Werkle-Bergner et al., 2022). Combining high-resolution MRI with assessments of Alzheimer’s-related tau pathology, we observed lower MRI-indexed locus coeruleus integrity in symptomatic mutation carriers (see Figure 1b). Moreover, participants with lower locus coeruleus integrity showed higher cortical tau burden and lower memory performance. To corroborate our in-vivo imaging findings, we additionally analyzed post-mortem locus coeruleus specimens from a separate dataset of carriers of the same mutation and indeed found substantial locus coeruleus degeneration.

Taken together, across studies, our findings link lower locus coeruleus integrity to markers of neural and cognitive decline. Moreover, they suggest that late-life differences in locus coeruleus integrity may be indicative of pathological aging processes.

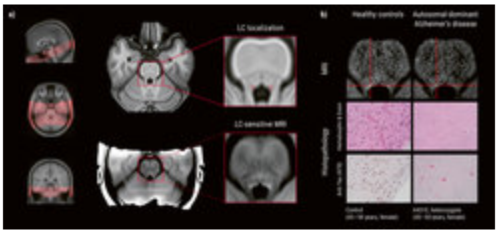

Figure 1. Locus coeruleus magnetic resonance imaging (LC-MRI) in healthy aging and neurodegenerative disease. (a) Orientation of a typical locus coeruleus-sensitive sequence covering the brainstem (left). The localization of the locus coeruleus, bordering the fourth ventricle, is highlighted in red on an axial slice of standard anatomical scan (middle, upper panel). In LC-MRI, the locus coeruleus can be detected as a cluster of bright, hyperintense voxels (middle, lower panel). (b) In neurodegenerative diseases, noradrenergic cells decline. Lower in-vivo LC-MRI contrast in autosomal-dominant Alzheimer’s disease (upper panel) corresponds to noradrenergic neurodegeneration in participants who died with the same disease-causing mutation (A431E). In particular, hematoxylin and eosin staining reveals locus coeruleus depigmentation (i.e., absence of the dark, granular neuromelanin). In addition, immunostained slides with anti-tau (AT8) show

neurofibrillary tangles within noradrenergic neurons as well as the presence of tau positive threads (red).

Image: MPI for Human Development
Adapted from Dahl, Mather, & Werkle-Bergner (2022) with permission

Key Reference

Dahl, M. J., Mather, M., Werkle-Bergner, M., Kennedy, B. L., Guzman, S., Hurth, K., Miller, C. A., Qiao, Y., Shi, Y., Chui, H. C., & Ringman, J. M. (2022). Locus coeruleus integrity is related to tau burden and memory loss in autosomal-dominant Alzheimer's disease. *Neurobiology of Aging*, *112*, 39–54. https://doi.org/10.1016/j.neurobiolaging.2021.11.006
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Pupil-Indexed Neuromodulation is Associated With Rhythmic Neural Activity and Attention

While advances in MRI techniques allow the characterization of individual differences in the integrity of neuromodulatory nuclei, animal research indicates that behaviorally relevant stimuli elicit a burst of *activity* in neuromodulatory centers that facilitates their processing. Recent studies across rodents and non-human and human primates have revealed an association between luminance-independent changes in pupil dilation and neuromodulatory activity, particularly of the locus coeruleus. This suggests that pupil dilation may serve as a moment-to-moment proxy of noradrenergic activity across species.

To investigate the role of noradrenergic neuromodulation on brain dynamics and cognition, we asked younger and older participants to complete an auditory attention task while concurrently recording electroencephalography (EEG) and pupil dilation (Dahl et al., 2020). During the attention task, arousing or perceptually matched control stimuli were presented on a trial-by-trial basis to dynamically modulate arousal-related noradrenergic drive. Crucially, larger pupil dilation in response to arousing stimuli was associated with a stronger transient EEG desynchronization (alpha–beta frequency bands; 9–30 Hz), a marker for cortical excitability. This supports the hypothesis that arousal-related changes in pupil dilation and cortical excitability share a common underlying dependence on noradrenaline release. Behaviorally, noradrenergic responsiveness, as approximated by greater pupil dilation and EEG desynchronization, was linked to better attention performance across several tasks. Comparing age groups, we observed that older age was associated with reduced noradrenergic responsiveness, suggesting a role of the locus coeruleus in senescent attentional decline.

Following this empirical work, we reviewed the animal and human literature to derive a potential mechanism explaining the observed link between noradrenergic neuromodulation and cortical excitability adjustments during attention (Dahl, Mather, & Werkle-Bergner, 2022). In brief, we propose that during moments involving selective attention, the thalamus orchestrates the preferential processing of prioritized information by coordinating rhythmic neural activity within a distributed frontoparietal network (see Figure 2). The timed release of neuromodulators from subcortical structures dynamically sculpts neural synchronization in thalamocortical networks to meet current attentional demands. In particular, we posit that noradrenaline modulates the balance of cortical excitation and inhibition, as reflected by thalamocortical alpha synchronization (~8–12 Hz), and that these neuromodulatory adjustments facilitate the selective processing of prioritized information.

Taken together, we have taken a multimodal approach to demonstrate associations between locus coeruleus integrity in aging and disease and markers of neural and cognitive decline. In addition, we showed the influence of moment-to-moment changes in noradrenergic activity on cortical dynamics and cognition.

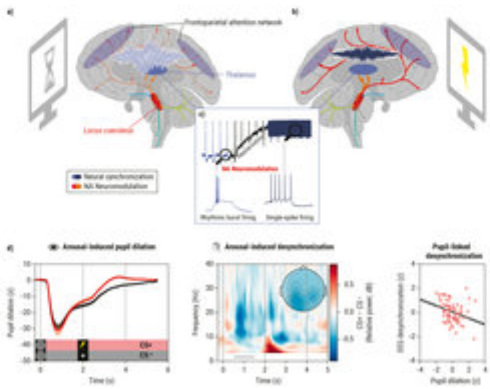

Figure 2. Locus coeruleus–noradrenergic neuromodulation shapes patterns of thalamocortical synchronization during attention. (a) Anatomically and functionally defined locus coeruleus ensembles innervate different cortical and subcortical targets (see colored cells/projections [circles/arrows] originating from the brainstem), including the thalamus and frontoparietal network (blue and gray ovals). During inattentiveness, low noradrenaline levels are linked to rhythmic burst firing in thalamic alpha generators (see c). Alpha-rhythmic activity (~8–12 Hz) in thalamocortical attention networks indicates a state of relative inhibition (see high-amplitude low-frequency oscillation [light blue waveform]). (b) Behaviorally relevant events elicit a transient increase in locus coeruleus activity. Elevated noradrenaline (NA) levels modulate cortical synchronization by shifting thalamic pacemakers from a rhythmic firing pattern to a mode of activity that allows for reliable information transfer (single-spike firing; see c). Neural activity in thalamocortical attention networks is desynchronized (dark blue), supporting the processing of attended stimuli. (c) Noradrenaline depolarizes thalamic neurons and abolishes the rhythmic burst firing that is linked to thalamocortical alpha rhythms. Sagittal brain section adapted from Patrick J. Lynch under CC BY 2.5. (d) Pupil-indexed noradrenergic neuromodulation is related to cortical low-frequency desynchronization. Left: Compared to perceptually matched control stimuli (CS–), fear-conditioned stimuli (CS+) elicit a transient pupil dilation, a marker of locus coeruleus activity. Center: Concurrent electroencephalography recordings reveal an arousal-related alpha–beta desynchronization at

posterior electrodes (topography shows averaged activity between 0.5–1.5 seconds and 8–20 Hz [gray horizontal bar]). Right: Larger pupil dilation is associated with more alpha–beta desynchronization (i.e., more negative values), indicating an association between proxies of noradrenergic neuromodulation and cortical synchronization.

Image: MPI for Human Development
Adapted from Dahl, Mather, & Werkle-Bergner (2022) with permission

Key Reference

Dahl, M. J., Mather, M., & Werkle-Bergner, M. (2022). Noradrenergic modulation of rhythmic neural activity shapes selective attention. *Trends in Cognitive Sciences*, *26*(1), 38–52. https://doi.org/10.1016/j.tics.2021.10.009
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Outlook

Our current work extends these lines of research by combining longitudinal high-resolution MRI of the dopaminergic substantia nigra–ventral tegmental area and the noradrenergic locus coeruleus in younger and older adults (Dahl, Bachman, et al., 2023). We find that dopaminergic and noradrenergic integrity are differentially associated with individual differences in older adults' memory performance. Whereas higher noradrenergic integrity is related to better episodic memory across several memory tasks, higher dopaminergic integrity is linked to better working memory. Longitudinally, we find that older age is associated with more negative change in both neuromodulatory nuclei from first to second measurement occasion (mean distance = 1.9 years). We found that changes in locus coeruleus integrity reliably predict future episodic memory performance at a third occasion (mean distance to second occasion = 2.9 years). In a series of future studies (Dissertation Agnieszka Kulesza), we plan to combine cognitive and MRI data of the longitudinal studies AKTIV (cf. Plasticity project) and BASE-II to investigate within-person changes in neuromodulatory integrity and explore links to blood-based biomarkers for Alzheimer's disease.

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The Berlin Aging Studies (BASE & BASE-II)

Research Scientists

Julia Delius

Sandra Düzel (until 08/2022)

Caroline Beese (until 7/2021)

Andreas Brandmaier

Maike Kleemeyer (until 03/2021; now Research Data Management)

Ylva Köhncke (until 12/2022)

Ulman Lindenberger

Georg G. Wagner (Max Planck Fellow)

The Berlin Aging Study (BASE)

The Berlin Aging Study II (BASE-II)

Study Overviews

In the course of the 20th century, average life expectancy almost doubled. What do these added years mean in terms of functional capacity and quality of life? And how do the last years and months preceding death in old age differ from the years before? For more than 3 decades, the Berlin Aging Studies have helped to answer questions of this sort. Members of the Center have been investigating changes in cognition and other aspects of behavior in the context of the Berlin Aging Study (BASE; Baltes & Mayer, 1999; Lindenberger et al., 2010) and, later, the Berlin Aging Study II (BASE-II; Demuth et al., 2021). Both studies are collaborative and multidisciplinary, involving researchers from institutions inside and outside Berlin. The Berlin Aging Studies also formed part of the Lifebrain consortium, which was funded under Horizon 2020, the EU Framework Programme for Research and Innovation.

The Berlin Aging Study (BASE)

More than 30 years ago, 516 Berliners aged 70 years and over participated in the first measurement occasion of BASE. Longitudinal data are available for eight measurement occasions spanning more than 18 years, and mortality-related information was updated at regular intervals until the last participant passed away in 2019 (see below for an overview). We are happy to note that BASE data continue to be the source of original publications on individual differences in late-life development (e.g., Wahl et al., 2022). In particular, the availability of similar or identical measures in BASE and BASE-II has permitted the investigation of cohort differences in various aspects of normal aging, such as cognitive decline (Gerstorf et al., 2023) and perceptions of time passing (Löckenhoff et al., 2022).

In line with the Open Science policy of the Institute, access to the BASE data for the academic community will be facilitated further upon its transferal to the Research Data Center at the Leibniz Institute for Psychology (ZPID) toward the end of 2023. Julia Delius and Maike Kleemeyer, a former project member who was appointed the MPI for Human Development's research data management coordinator in March 2021, are currently working on this project (see Research Data Management).

Key Reference

Gerstorf, D., Ram, N., Drewelies, J., Duezel, S., Eibich, P., Steinhagen-Thiessen, E., Liebig, S., Goebel, J., Demuth, I., Villringer, A., Wagner, G. G., Lindenberger, U., & Ghisletta, P. (2023). Today's older adults are cognitively fitter than older adults were 20 years ago, but when and how they decline is no different than in the past. *Psychological Science*, *34*(1), 22–34. https://doi.org/10.1177/09567976221118541

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The Berlin Aging Study II (BASE-II)

The central objective of the multidisciplinary and multi-institutional longitudinal Berlin Aging Study II (BASE-II; see overview below) is to promote a better understanding of individual differences and trajectories in cognitive, psychosocial, and physical functioning by integrating multidisciplinary perspectives and data. In the following, we showcase three paper projects from the reporting period.

Latent Factors of Gray Matter Integrity Correlate With Episodic Memory Ability in Old Age

Maintained structural integrity of hippocampal and cortical gray matter may explain why some older adults show more preserved episodic memory than others. However, viable measurement models for estimating individual differences in gray matter structural integrity have been lacking; instead, most studies have relied on fallible single indicators. To ameliorate this shortcoming, Köhncke et al. (2021) introduced multitrait–multimethod methodology to the cognitive neuroscience of aging, with the goal of more reliably capturing individual differences in gray matter integrity. We analyzed data from 1522 BASE-II participants aged 60 to 88 years, including 333 participants who underwent magnetic resonance imaging. We were able to establish structural integrity latent factors for hippocampus, parahippocampal gyrus, prefrontal cortex, and precuneus respectively, each of which express the common variance of voxel-based morphometry, mean diffusivity, and magnetization transfer ratio. Except for precuneus, the structural integrity factors showed reliable positive associations with a latent factor of episodic memory ability (see Figure 1). For hippocampal and parahippocampal regions, associations persisted after controlling for age, sex, and education. In line with theoretical propositions (Nyberg & Lindenberger, 2020), these results show that episodic memory ability in old age benefits from maintained structural integrity of hippocampus and parahippocampal gyrus. We conclude that multimodal factors of structural brain integrity help to capture common variance in performance-relevant properties of gray matter, and underscore the need to arrive at a better understanding of the physiological factors that contribute to this common variance.

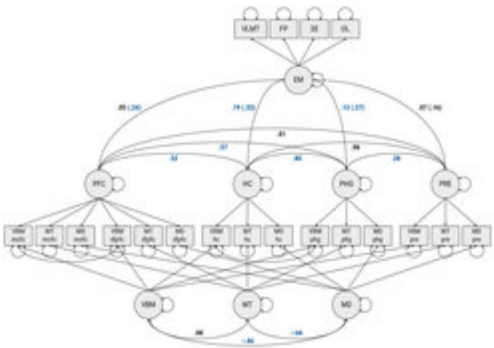

Figure 1. Latent factors of gray-matter integrity are correlated to episodic memory in old age. For each region of interest (PFC, HC, PHG, PRE), the model expresses variance common to three different structural imaging modalities as a latent gray-matter integrity factor by separating it from method-specific factors (V, MT, MD), and residual variance (double-headed arrows at the observed variables depicted by squares), and links the latent integrity factors to episodic memory. Circles depict latent variables, squares depict observed variables. Double-headed arrows are covariances, or, if self-referential, variances. Single-headed arrows are directed effects. Numbers next to the arrows are correlations (standardized covariance estimates). Correlations not in parentheses are from the final model in which all latent factors are regressed on age, sex, and education; correlations in parentheses refer to correlations without controlling for age, sex, and education. Correlations written in blue font are reliably different from zero ($p < .05$). Structural imaging modalities: VBM = VBM-derived gray matter probability, MT = magnetization transfer ratio, MD = mean diffusivity. Regions of interest: mofc = medio-orbitofrontal cortex, dlpfc = dorsolateral prefrontal cortex, hc = hippocampus, phg = parahippocampal gyrus. Cognitive tasks: VLMT = verbal learning and memory test, FP = face-profession task, SE = scene encoding task, OL = object location task. EM = episodic memory. We fitted the model (including covariates age, sex, education, not shown in the diagram) to data from 1521 individuals aged 60 to 88 years, assuming data in MR-derived variables to be missing at random. Fit indices: CFI = .948, RMSEA = .027 (CI .023–.031), SRMR = .047.

Image: Ylva Köhncke / MPI for Human Development

The Association Between Dopamine Integrity and Working Memory in Old Age

Dopamine integrity has been suggested as a potential cause of individual differences in working memory performance among older adults. However, identifying specific dopaminergic pathways that give rise to this variation has proven difficult. Using BASE-II data, Karalija et al. (2021) assessed 61 single-nucleotide polymorphisms, located in or adjacent to various dopamine-related genes, for their links to working memory performance. Least Absolute Shrinkage and Selection Operator (LASSO) regression was conducted to estimate associations between polymorphisms and working memory. Rs40184 in the DA transporter gene SLC6A3 showed allelic group differences in working memory, with T-carriers performing better than C homozygotes. This finding was replicated in an independent sample from the Cognition, Brain, and Aging study (COBRA) in Sweden (baseline: n = 181, ages: 64–68 years; 5-year follow-up: n = 129). In COBRA, in vivo dopamine integrity was measured with ^{11}C-raclopride using positron emission tomography. Notably, working memory as well as in vivo dopamine integrity was higher for rs40184 T-carriers both at baseline and at the 5-year follow-up. Our findings indicate that individual differences in dopamine transporter function contribute to differences in working memory performance in old age, presumably by regulating dopamine availability.

Daily Fluctuations in Behavior in BASE-II During the COVID-19 Pandemic

The outbreak of the COVID-19 pandemic resulted in a public health emergency that posed particular threats to older adults' physical and psychological well-being. Numerous preventive measures were geared towards protecting older adults, and massively affected their daily lives. Due to physical distancing and contact reductions, older adults had substantially fewer social interactions, which might have put them at risk of experiencing loneliness and social isolation. Similarly, older adults' own awareness that the pandemic posed a disproportionate threat to their lives might have increased daily stress, anxiety, and negative affect. To investigate these issues in greater detail, we conducted the CorAge study as a satellite study within BASE-II (see Figure 2): 140 older adults aged 67 to 88 years from the BASE-II participant pool were asked to respond to six questionnaires on their smartphone at set times of day. On average, participants provided a total of 39 responses over 7 days. In an initial analysis (Potter et al., 2023), we examined health sensitivity, defined as the association between self-reported health and affect, and found that older adults showed greater health sensitivity in moments when they perceived an elevated risk of contracting COVID-19. Results document the influence of the COVID-19 pandemic on older adults' emotional experiences, and will be followed up longitudinally.

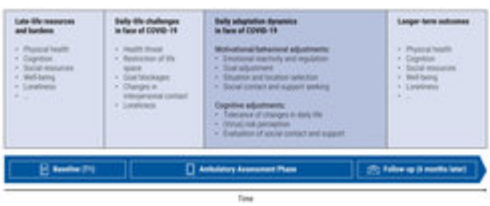

Figure 2. Study design of the CorAge Study, a satellite study within BASE-II. We recorded various situations and challenges of the participants over a week during the pandemic to investigate their associations with aspects of daily functioning. We assessed central constructs that constitute prime indicators of loss of independence (e.g., cognitive functioning, activities, and physical health) and considered indices of short-term (co-)variation of adaptation-relevant variables in daily life during a pandemic.

Image: Johanna Drewelies / MPI for Human Development

Key Reference

Köhncke, Y., Düzel, S., Sander, M. C., Lindenberger, U., Kühn, S., & Brandmaier, A. M. (2021). Hippocampal and parahippocampal gray matter structural integrity assessed by multimodal imaging is associated with episodic memory in old age. *Cerebral Cortex*, *31*(3), 1464–1477. https://doi.org/10.1093/cercor/bhaa287
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Study Overviews

Overview of the Berlin Aging Study (BASE) – www.base-berlin.mpg.de

The multidisciplinary Berlin Aging Study (BASE), initially directed by the late Paul B. Baltes and Karl Ulrich Mayer, was started in 1989. Ulman Lindenberger is the current BASE speaker. The study spans eight measurement occasions spaced over 18 years. Its distinguishing features include (1) a focus on the very old (70–100+ years); (2) a locally representative sample, stratified by age and sex; and (3) a broad-based interdisciplinarity (originally involving two research units from the Freie Universität Berlin, Internal Medicine and Psychiatry, and two from this Institute, Sociology and Psychology). In addition to discipline-specific topics, four integrative theoretical orientations guide the study: (1) differential aging, (2) continuity versus discontinuity of aging, (3) range and limits of plasticity and reserve capacity, and (4) aging as a systemic phenomenon.

The initial focus of BASE (1990–1993) was to obtain a heterogeneous sample, stratified by age and sex, of individuals from the western districts of Berlin aged 70 to 100+ years. A core sample of 516 men and women completed the Intensive Protocol comprising detailed measures from all four participating disciplines. Seven longitudinal follow-ups involving different depths of assessment were completed at approximately 2-yearly intervals. Details of the research design and assessment protocols can be found on the BASE website. The core sample formed the basis of the analyses reported in two monographs (see Baltes & Mayer, 1999; Lindenberger et al., 2010). Current work uses the longitudinal data to address issues such as variability and change, mortality prediction, self-related change, and genetic and socioeconomic predictors of cognitive change.

The Berlin Aging Study: International Research Group

▶

Julia A. M. Delius
MPI for Human Development, Berlin, Germany
Alexandra M. Freund
University of Zurich, Switzerland
Denis Gerstorf
Humboldt-Universität zu Berlin, Germany
Paolo Ghisletta
University of Geneva, Switzerland
Christiane Hoppmann
The University of British Columbia, Vancouver, Canada
Ulman Lindenberger
MPI for Human Development, Berlin, Germany (Speaker)
Nilam Ram
Stanford University, USA
Jacqui Smith
University of Michigan, Ann Arbor, USA (Co-Speaker)
Ursula M. Staudinger
Technische Universität Dresden, Germany
Elisabeth Steinhagen-Thiessen
Charité Universitätsmedizin Berlin, Germany
Gert G. Wagner
MPI for Human Development, Berlin, Germany (Max Planck Fellow)

Overview of the Berlin Aging Study II (BASE-II) – ↗ www.base2.mpg.de

BASE-II follows a longitudinal design. At the first wave of measurements (T1), the BASE-II sample consisted of 1,600 participants aged 60 to 80 years and 600 individuals aged 20 to 35 years. Data collection of the first wave was completed in 2014. In close collaboration with Simone Kühn of the Lise Meitner Group for Environmental Neuroscience, eligible BASE-II participants (*n* = 445) were additionally invited for a structural magnetic resonance imaging (MRI) assessment of the brain, comprising T1-weighted imaging, resting state data, diffusion tensor imaging, and high-resolution imaging of the hippocampus. In 2015, this MR subsample was re-invited again for another wave of cognitive and psychosocial assessments and a second MRI session (*n* = 327). In November 2017, the older cohort of 1,600 men and women from the original BASE-II sample was re-invited in the context of the project Sex- and Gender-Sensitive Prevention of Cardiovascular and Metabolic Disease in Older Adults in Germany (GendAge, funded by the Federal Ministry of Education and Research). GendAge includes most of the medical and biological assessments of T1, along with a third wave of cognitive and psychosocial assessments. In addition, accelerometers are used to track participants' physical activity and sleep for a week.

In 2021 we received funding from the VW Stiftung for Dynamics of Daily-Life Adaption in the Corona Crisis Among Older Adults (CorAge), allowing us to investigate the effects of COVID-19, and of COVID-19 restrictions, on psychosocial, cognitive, and medical markers assessed 7 times daily across 7 days. A total of 104 older participants (41% female) from BASE-II with an average age of 76.4 years provided daily data on psychosocial, cognitive, and medical variables. In 2021, we also started re-inviting MR-eligible older participants to a third wave to re-assess structural MR parameters. Finally, in September 2022, we launched another cognitive and medical assessment of the remaining 1,800 younger and older BASE-II participants. This data collection is ongoing until the end of 2023.

The Berlin Aging Study II: Steering Committee

►

Ulman Lindenberger
MPI for Human Development, Berlin, Germany
Johanna Drewelies
MPI for Human Development, Berlin, Germany
Sandra Düzel
MPI for Human Development, Berlin, Germany
Simone Kühn
MPI for Human Development, Berlin, Germany
Gert G. Wagner
MPI for Human Development, Berlin, Germany (Max Planck Fellow)
Elisabeth Steinhagen-Thiessen
Charité Universitätsmedizin, Berlin, Germany
Ilja Demuth
Charité Universitätsmedizin, Berlin, Germany
Lars Bertram
Universität zu Lübeck, Germany
Graham Pawelec
University of Tübingen, Germany
Arno Villringer
MPI for Human Cognitive and Brain Sciences, Leipzig, Germany
Stefan Liebig
Socio-Economic Panel (SOEP) at the German Institute for Economic Research (DIW Berlin), Germany
Ludmila Müller (Coordinator)
MPI for Human Development, Berlin, Germany

Lifebrain – www.lifebrain.uio.no

BASE and BASE-II participated in Lifebrain, a consortium of European studies funded by the EU Framework Programme Horizon 2020. Its goal was to harmonize, enrich, and fully exploit some of the largest longitudinal studies of age effects on brain, cognition, and mental health in Europe. Its focus was on the effect, over time, of education, socioeconomic status, and lifestyle factors such as sleep, physical activity, and diet on potentially enhancing and protecting brain structure and function. This consortium successfully ended in 2023 and published more than 80 papers in high-ranking journals regarding the effect of these factors on cognitive and mental health throughout life (see https://www.lifebrain.uio.no/publications/)

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Nyberg, L., Magnussen, F., Lundquist, A., Baare, W., Bartés-Faz, D., Bertram, L., Boraxbekk, C. J., Brandmaier, A. M., Drevon, C. A., Ebmeier, K., Ghisletta, P., Henson, R. N., Junqué, C., Kievit, R., Kleemeyer, M., Knights, E., Kühn, S., Lindenberger, U., Penninx, B. W. J. H., Pudas, S., Sørensen, Ø., Vaqué-Alcázar, L., Walhovd, K. B., & Fjell, A. M. (2021). Educational attainment does not influence brain aging. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(18), Article e2101644118. https://doi.org/10.1073/pnas.2101644118
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Lifebrain Researchers at the MPI for Human Development

►

Andreas M. Brandmaier
Sandra Düzel
Maike M. Kleemeyer
Ylva Köhncke
Simone Kühn
Ulman Lindenberger

Mechanisms and Sequential Progression of Plasticity

Research Scientists

Yana Fandakova (until 10/2022)

Elisabeth Wenger (until 04/2023)

Lieke de Boer (08/2020–03/2021)

Neda Khosravani

Maike M. Kleemeyer (until 03/2021)

Ziyong Lin (until 06/2021)

Ulman Lindenberger

Eleftheria Papadaki

Sarah E. Polk (until 04/2023)

Sina A. Schwarze (as of 01/2021)

André Werner (composer)

This project investigates the role of brain plasticity in behavioral development across the lifespan. It makes use of training studies to probe the antecedents, mechanisms, and consequences of plastic change across different age groups and functional domains. Special attention is given to articulate the dynamics of plastic changes across structural, functional, and behavioral levels of analysis.

The human brain is plastic, that is, it possesses the capacity to implement lasting structural changes that alter its functional and behavioral repertoire in response to environmental demands (Lindenberger, 2018; Wenger & Kühn, 2021). Plasticity is metabolically costly and competes with the need for stability, which facilitates the development of a well-orchestrated set of habits and skills. The resulting interplay of mechanisms promoting plasticity versus stability organizes development into multiple alternating and sequentially structured periods that together support the hierarchical organization of cerebral functions and behavior. In earlier work on plastic change during motor skill acquisition, we have observed a pattern of initial tissue expansion followed by partial renormalization (Wenger et al., 2017). We have proposed that this pattern might be indicative of a more general pattern of plastic change, framed within the exploration–selection–refinement model (Lövdén, Garzon, & Lindenberger, 2020).

In the following, we report on four domains of inquiry. A fifth domain, undertaken together with Simone Kühn and Maike Hille, is reported elsewhere (cf. *Spotlight Magazine*; see also LIP Introduction). Recently, the two project leaders, Yana Fandakova and Elisabeth Wenger, have accepted tenured professor positions at universities in Germany. Ulman Lindenberger will restructure and continue to lead this project, which is deemed central to the research mission of the Center for Lifespan Psychology.

Key Reference

Lindenberger, U. (2018). Plasticity beyond early development: Hypotheses and questions. In A. A. Benasich & U. Ribary (Eds.), *Emergent brain dynamics: Prebirth to adolescence* (pp. 207–223). MIT Press.
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Plasticity in the Auditory Domain: The Case of Musical Expertise

Music training and musical expertise offer promising opportunities for studying how specific experiences interact with individual predispositions in shaping developmental change. In a series of studies, we investigated plastic changes in aspiring professional musicians who were preparing for an entrance exam at a university of the arts, comparing these changes to those in skilled amateur musicians. Over the course of 6 months, we observed *decrements* in estimates of gray matter volume among aspiring professional musicians in the left planum polare, a core region of auditory processing, along with *increasing* functional connectivity of this region to other regions that are relevant for musical expertise (Wenger et al., 2021). These results support the expansion–renormalization pattern previously observed in the motor domain if we assume that the group of aspiring musicians had entered later phases of an exploration–selection–refinement cycle.

Additionally, we were interested in how music-related aspects of functional brain organization differed between aspiring professional musicians and skilled amateur musicians (Dissertation Eleftheria Papadaki; Papadaki et al., in press). We used an interval-recognition task to define a listening-relevant network and computed functional connectivity and graph-theory metrics in this network on separately acquired resting state data. Aspiring professional musicians showed significantly greater global efficiency in the absence of any task. Critically, global efficiency was correlated with interval-recognition performance both inside and outside the scanner, as assessed by the Berlin Gehoerbildung Scale, a test of musical expertise that has been newly developed and validated by project members (Lin et al., 2021; see Figure 1).

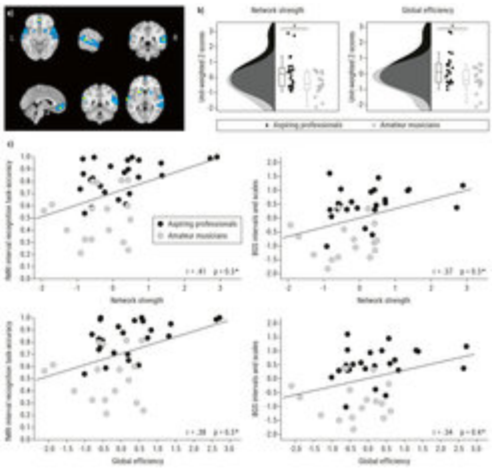

Figure 1. Differences in music-related aspects of functional brain organization between aspiring professional musicians and skilled amateurs. (a) Distribution of the listening network, based on activations during an interval-recognition task. (b) Aspiring professional musicians showed higher network strength and higher global efficiency in the listening network than amateur musicians. (c) Both network strength and global efficiency show positive associations with accuracy in the fMRI interval recognition task and the Intervals & Scales subscale of the Berlin Gehoerbildung Scale (BGS; see also Lin et al., 2021; Wenger et al., 2021).
Image: MPI for Human Development

Widening the scope of processes under examination, we also examined neurofunctional group differences while listening to a classical-baroque piece by Johann Sebastian Bach and a modern-classical piece by Anton Webern. For all participants, listening to the modern-classical piece was associated with a brain state characterized by higher overall connectivity and lower modularity relative to the classical-baroque piece. In addition, when listening to the modern-classical piece, aspiring musicians exhibited higher global efficiency and utilized more music-related and overall processing brain regions as hubs and between-network connectors to flexibly adapt to the condition demands than skilled amateur musicians.

Key Reference

Wenger, E., Papadaki, E., Werner, A., Kühn, S., & Lindenberger, U. (2021). Observing plasticity of the auditory system: Volumetric decreases along with increased functional connectivity in aspiring professional musicians. *Cerebral Cortex Communications*, *2*(2), Article tgab008. https://doi.org/10.1093/texcom/tgab008
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Effects of Physical Exercise on the Aging Brain

In the context of Energizing the Hippocampus in Aging Individuals (EnergI), a consortium funded by the Federal Ministry of Education and Research, we conducted AKTIV, a training study with 160 healthy older adults to investigate the separate and combined effects of physical exercise (i.e., riding an exercise bike) and learning a language (i.e., Spanish) on brain and behavior, with particular emphasis on the hippocampal formation. Using structural equation modeling to define a latent factor of gray matter (GM) integrity, we found that physical exercise exerted a protective effect on GM integrity in regions previously reported to be affected by exercise (Dissertation Sarah Polk). Exercising participants with greater fitness gains also showed more positive changes in GM integrity (Polk et al., 2022). We also hypothesized that aerobic exercise might counteract declines in white matter (WM). In line with this expectation, we observed maintained WM volume in the corpus callosum of exercisers, and positive change–change correlations between WM volume and fitness, and between WM volume and perceptual speed (Polk et al., 2023).

The effects of language learning are still being analyzed. When modeling changes in cognitive performance at the latent level, we observed a selective effect of language learning on untrained tests of episodic memory. Spanish learners showed behavioral improvements in episodic memory during the first 3 months of training, while average change in episodic memory was absent in the control group. At the neural level, we observed a group-by-time interaction in the left inferior frontal gyrus, with Spanish learners showing greater increases in gray matter volume than control participants. The gray matter volume changes observed in Spanish learners were paralleled by changes in mean diffusivity and proton density, presumably pointing to increasing tissue density in this region. Counter to expectations, we have thus far found no behavioral or neural evidence for the benefit of combining language and exercise training.

Task Switching During Childhood: Interactions Between Maturation and Training

Childhood is characterized by maturational changes in brain structure, brain function, and the organization of behavior. During middle and late childhood, such changes are particularly pronounced for cognitive control processes, such as the ability to flexibly shift between different task sets (Dissertation Sina Schwarze). Hence, in the context of a priority program funded by the German Research Foundation, we conducted an extensive training study of task-switching performance in children aged 8 to 11 years to explore how these maturational changes interact with training. The study is being conducted in close collaboration with Silvia Bunge (University of California, Berkeley, USA).

Initial analyses focused on age differences at baseline, examining how age differences in task switching are related to the protracted maturation of its neural substrates (Schwarze et al., 2023).

Compared to adults, children showed less upregulation of brain activation with increased task-switching demands, and a larger increase in connectivity with increased task-switching demands between the inferior frontal junction (IFJ), a key task-switching region, and lateral prefrontal cortex (lPFC; see Figure 2a–b). Increased connectivity might offer an alternative and possibly developmentally earlier mechanism to manage task-switching demands. For children who showed less adult-like activation, increased IFJ-lPFC connectivity was associated with higher performance, whereas for children who showed more adult-like activation, increased connectivity was associated with lower performance (see Figure 2c–d).

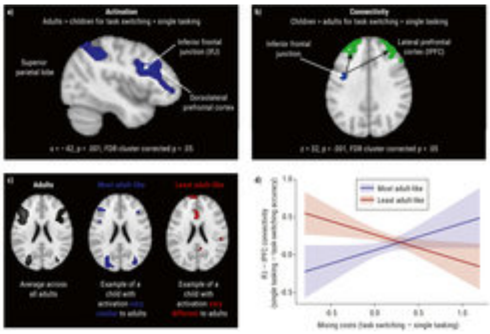

Figure 2. Differences between children and young adults in brain areas and networks engaged during task switching. (a) When task switching was required compared to when it was not (task switching > single tasking), children showed less upregulation of activation in frontal and parietal brain regions than adults. (b) At the same time, children showed greater connectivity between the inferior frontal junction and lateral prefrontal cortex than adults when task switching was needed. (c) The average task-based activation patterns shown by adults were used as a reference for estimating how similar a given child's activation pattern is to adults' average pattern. The example of a child showing more adult-like activation is presented in blue, and the example of a child showing less adult-like activation is presented in red. (d) Children with less adult-like activation patterns (red) showed higher task-switching performance with higher connectivity, whereas children who with more adult-like activation patterns (blue) showed lower task-switching performance with higher connectivity.

Image: MPI for Human Development
Panels (c–d) adapted from Schwarze et al. (2023)

During the training period, which was restricted to children and consisted of 27 sessions spread out over 9 weeks, participants in the experimental group practiced switching between a large number of different task sets. An active control group trained the identical tasks but with a markedly lower switching frequency. Children exposed to higher switching demands showed increasing drift rates during task switching in the course of training, suggesting increasingly fast evidence accumulation for correct responses. These behavioral changes were accompanied by reduced activation in dorsolateral prefrontal and superior parietal regions (Figure 3a–b). These analyses suggest that task-switching training enhances the efficiency of regions that support task switching in children, rather than moving children's activation patterns more rapidly towards an adult-like pattern. With respect to behavioral manifestations of plasticity, ongoing analyses focus on individual differences in trajectories of change and their relations to untrained measures of task switching, processing speed, and working memory (Dissertation Neda Khosravani).

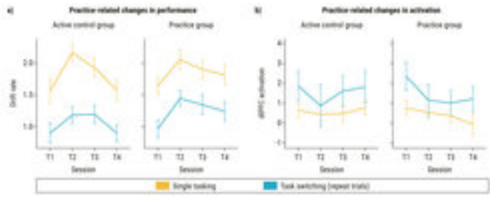

Figure 3. Behavioral improvements and functional activation changes during task-switching training in children. The active control group trained the identical tasks but with a markedly lower switching frequency. (a) Practice-related changes in performance (drift rates). Both the experimental and groups improved performance across conditions from the first to the second timepoint, but only the experimental group maintained this improvement until the end of practice. (b) Practice-related changes in task-based activation in the dorsolateral prefrontal cortex. Both groups showed reduced activation at the second compared to the first timepoint, but only the experimental group maintained this reduction.
Image: MPI for Human Development

Key Reference

Schwarze, S. A., Laube, C., Khosravani, N., Lindenberger, U., Bunge, S. A., & Fandakova, Y. (2023). Does prefrontal connectivity during task switching help or hinder children's performance? *Developmental Cognitive Neuroscience*, *60*, Article 101217. https://doi.org/10.1016/j.dcn.2023.101217
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Metacognition and Curiosity During Early Phases of Learning

Metacognitive processes related to the monitoring and control of behavior, as well as curiosity, or the desire to acquire new information, contribute to plasticity, especially while individuals are exploring a new task space. We experimentally dissociated objective learning success from subjective performance ratings and demonstrated that participants based future decisions more strongly on their subjective ratings (Fandakova, Johnson, & Ghetti, 2021), thereby highlighting the role of metacognitive monitoring for learning. Following up on these findings, we examined age differences between early and later phases of motor sequence learning between adults and 7- to 10-year-old children. Early during learning, children showed reduced activation in core regions associated with metacognitive monitoring, including the dorsolateral prefrontal cortex and the dorsal anterior cingulate. During later phases, the left motor cortex showed greater engagement in both age groups, whereas activation in a homologous right motor area was enhanced in children relative to adults.

To examine the effects of curiosity on learning, we asked children aged 10 to 14 years trivia questions (Fandakova & Gruber, 2021). Children of all ages showed better memory for questions they were curious about. In contrast, higher post-answer surprise, or the discrepancy between children's initial curiosity and their interest in the actual trivia answer, benefited learning more strongly in adolescents than in children. These results point to motivational effects on learning, presumably through individual and age-related differences in dopaminergic modulation (Gruber & Fandakova, 2021).

Key Reference

Fandakova, Y., & Gruber, M. J. (2021). States of curiosity and interest enhance memory differently in adolescents and in children. *Developmental Science*, *24*(1), Article e13005. https://doi.org/10.1111/desc.13005
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Formal Methods in Lifespan Psychology

Research Scientists

Andreas Brandmaier

Marie K. Deserno (until 11/2021)
Hannes Diemerling (as of 02/2023)
Charles C. Driver (until 02/2022)
Maike M. Kleemeyer (until 03/2021)
Ylva Köhncke (until 12/2022)
Ulman Lindenberger
Aaron Peikert
Timo von Oertzen (Associate Research Scientist)

Since it was founded by the late Paul B. Baltes in 1981, the Center for Lifespan Psychology has sought to promote conceptual and methodological innovation within developmental psychology and in an interdisciplinary context. Over the years, the critical examination of relations among theory, method, and data has evolved into a distinct feature of the Center.

Based on the tenets of lifespan psychology, the Formal Methods project seeks to develop and refine statistical methods and research designs that articulate human development across different timescales, levels of analysis, and functional domains. Hence, the project is characterized by an emphasis on methodology, understood as the reciprocal interplay between concepts and methods that is at the heart of scientific progress. The project's mission is to create a methodological foundation and an evolving statistical toolbox for high-quality research on lifespan development that allows researchers to address difficult problems rigorously and transparently.

During the reporting period, the project has focused on four domains of inquiry: (1) estimating the reliability of human brain imaging techniques; (2) modeling the dimensionality of age-related changes in cognition, as well as brain–cognition associations; (3) refining hypotheses through comprehensive exploratory data analysis; and (4) making scientific reports computationally reproducible.

Reliability in Cognitive Neuroscience

Cognitive neuroscience has paid relatively little attention to the psychometric properties of measures attained from structural and functional magnetic resonance imaging (MRI) protocols. In 2018, we introduced the intraclass effect decomposition (ICED) framework to overcome this shortcoming (Brandmaier et al., 2018). ICED allows researchers to quantify the effects of different measurement characteristics, such as day, session, or scanner, on measurement reliability. Using the ICED framework, we estimated the reliability of white-matter microstructure measurements using myelin water fraction (MWF) and an alternative estimation method (geomT2IEW), which are both meant to characterize the myelination of axons in the human brain. We found that reliability of regional microstructural characteristics in major white matter tracts is good to excellent (Anand et al., 2022). Next, we extended our model to accommodate hemispheric differences; we found that there were no significant differences in reliability between hemispheres. We then shifted our focus to the reliability of multi-parameter mapping, a quantitative MRI approach, which allows for quantitative estimates of various aspects of the human brain's microanatomy. In a sample of healthy young adults, we found that reliabilities of between-person differences were high for all four quantitative parameters of interest when regarding whole-brain gray and white matter (Wenger et al., 2022). However, reliabilities varied greatly across different regions of the brain (see Figure 1 for whole-brain voxel-wise reliability maps). This finding has major implications for the interpretability of region-specific differences in brain–behavior relations.

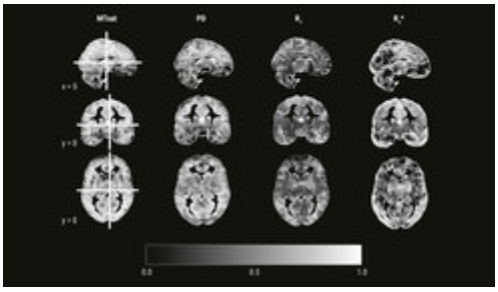

*Figure 1.*Voxel-wise reliability estimates of four multiparameter mapping parameters in gray matter. Lighter voxels correspond to higher reliability. Magnetization transfer saturation (MTsat), proton density (PD), longitudinal relaxation rate (R_1), and effective transverse relaxation rate (R_2*).

Image: MPI for Human Development
↗ Adapted from Wenger et al. (2022)

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Modeling Longitudinal Data on Human Cognitive Development

Together with colleagues from the Berlin Aging Studies and collaborators from the Lifebrain consortium (see Lifebrain website: https://www.lifebrain.uio.no/), project members participated in the multivariate modeling of longitudinal data on human cognitive development. For instance, we implemented a latent-variable approach to modeling region-specific gray-matter integrity in participants of the Berlin Aging Study II (Koehncke et al., 2021; see Berlin Aging Studies). Also, in a meta-analysis of about 500,000 participants, we explored the associations among measures of brain volume, cognition, and socioeconomic status, and found that the associations of socioeconomic status, brain, and cognition are heterogeneous across European and United States cohorts (Walhovd et al., 2022). Other examples for methodological contributions of project members to the Lifebrain consortium include the analysis of lifestyle-related risk factors and their cumulative associations with hippocampal and total gray matter volume across the adult lifespan (Binnewies et al., 2023), associations of depression and regional brain structure across the adult lifespan (Binnewies et al., 2022), change–change association between medial-temporal lobe integrity and episodic memory (Johanssen et al., 2022), and genetic predictors of working memory performance and in vivo dopamine integrity in aging (Karalija et al., 2021; see Berlin Aging Studies).

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Exploratory and Data-Driven Modeling Approaches

Building models fully informed by theory is impossible when data sets are large and theoretical predictions are not available for all variables and their interrelations. In such instances, researchers may start with a core model guided by theory and then face the problem of which additional variables should be included. In earlier work, we have shown that Structural Equation Model (SEM) trees and forests provide a straightforward solution to this variable selection problem (Brandmaier et al., 2016), as they allow researchers to select predictors of parameter heterogeneity in multivariate models, and provide information on which variables might be missing from their models and, by implication, from the theories on which these models are based.

However, SEM trees and forests are computationally demanding, and it has sometimes proven infeasible to fit larger models on standard computers. As a remedy, we have proposed to guide the construction of SEM trees by score-based tests (Arnold et al., 2021). In comparison to the originally proposed SEM tree algorithm, these tests are faster to compute by orders of magnitude, have higher statistical power, and do not suffer from variable selection bias. In subsequent work, we have shown how score-based tests can be used to identify predictors of individual differences in SEM when the predictors and the parameters of interest are linearly associated (individual parameter contribution regression; see Arnold et al., 2020, 2021).

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Reproducibility

A data analysis is reproducible if identical results can be obtained from the same statistical analysis and the same data. Reproducibility is a requirement for transparent science and, importantly, facilitates replication of reported findings by peer scientists, that is, the attempt to obtain novel but consistent results with the same statistical analysis on new data. We proposed a unified workflow to achieve reproducibility of both statistical analyses and the accompanying scientific reports. This workflow helps researchers adopt Open Science principles in their research, of which reproducibility is a cornerstone. To that end, the workflow leverages tools from software engineering that have proven to be useful for collaboration, transparency, automation, and reproducibility (Peikert et al., 2021; Peikert & Brandmaier, 2021). Additional work has focused on integrating reproducibility and pre-registration in a common, conceptually grounded framework (Dissertation Aaron Peikert). According to this framework, pre-registration's main benefit is reducing the uncertainty of evidential support of a given study for a given theory. We argue that combining reproducibility with pre-registration fosters scientific progress by enhancing efficiency and transparency.

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Interactive Brains, Social Minds (Concluding Report)

Research Scientists

Viktor Müller

Julia Delius

Ulman Lindenberger

In everyday life, people often coordinate their actions. Examples include walking with someone, doing team sports, dancing, and playing music in a duet or group, as well as social bonding behaviors, such as gaze coordination between mother and infant or between partners. The developmental and social significance of these interpersonally coordinated behaviors is undisputed, but little is known about the brain mechanisms that regulate their temporal dynamics. The Interactive Brains, Social Minds project investigates behavioral, somatic, and neural mechanisms that permit individuals to coordinate their behavior in time and space (see Figure 1).

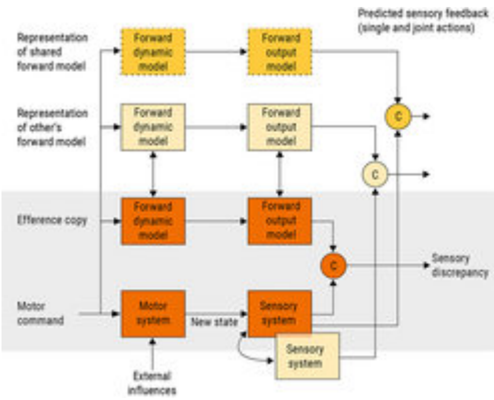

Figure 1. A forward model of interpersonal action coordination. Drawing on the work of Steven M. Boker, Wolfgang Prinz, Daniel Wolpert, and others, our model assumes that interpersonal action coordination is based on a set of linked representational layers. The single-person layer is shaded in gray. Individuals acting together attempt to synchronize their forward model regarding their own actions with their forward model regarding the other person's actions. Highly skilled individuals, such as dancers or musicians, may represent jointly performed activities as a unified suprapersonal action with a joint forward model and partially joint sensory feedbacks. The various representational layers of the actors are intertwined by sensorimotor feedback loops (Müller et al., 2021).

Image: MPI for Human Development

Since its inception in 2004, the project has focused on analyzing electroencephalographic (EEG) data of skilled musicians playing together, based on the observation that this goal-directed activity imposes high demands on the precision of interpersonal action coordination (Lindenberger et al., 2009). During the reporting period, we replicated and extended our finding that within-brain synchrony and between-brain oscillatory couplings precede and accompany guitar duet playing, and explored the neural and behavioral dynamics of interpersonal action coordination during free improvisation. We found that guitarists' brains during improvisation synchronize with slow-frequency modulations of their acoustic signals (Müller & Lindenberger, 2022). The phase angles of the two guitarists' EEG signals were aligned with the corresponding behavioral onset asynchronies, confirming the results of Lindenberger et al. (2009). These findings validate the hypothesis that brain–behavior entrainments reflect the temporal dynamics of coordinated musical performance, and that inter-brain synchrony supports interpersonal action coordination (see Figure 2).

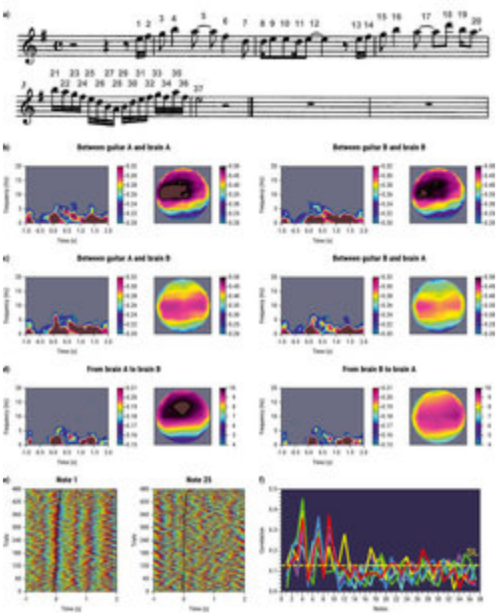

Figure 2. Brain–guitar and brain–brain coupling as well as phase alignment in guitarist duos using a multi-trial design. (a) Adapted version of a modern jazz-fusion piece, "Fusion #1," composed by Alexander Buck and adapted by the lead guitarist, Thomas Holzhausen. The notes played are numbered. (b) Time–frequency diagrams (locked to the onset of play) and topological distribution of grand average phase coherence (*PC*) between the guitarists' brains and their own instruments, depicted for guitarists A and B separately. The topological distribution of coupling showed the maxima at left central sites of both guitarists, apparently indicating the influence of cortical activity related to the right hand. (c) Time–frequency diagrams and topological distribution of grand average *PC* between the guitarists' brains and the other guitarists' instruments, also depicted for guitarists A and B separately. Here, the topological distribution showed centro-parietal and temporal maxima without visible cortical asymmetry, apparently indicating influence of hearing and motor actions of left and right hands in both guitarists. (d) Time–frequency diagrams of grand average *PC* and

topological distribution of strengths (a sum of all connections from one electrode to all other electrodes in the other brain) of the between-brain connectivity for guitarists A and B. The topological distribution of strength in the lead guitarist A is focused at mid fronto-central sites, while in guitarist B they are more broadly distributed across fronto-central and parietal sites. (e) Phase alignment of phase angles related to the behavioral play-onset asynchrony across all trials and guitarist pairs for two selected notes (1 and 25) for guitarist A. Trials were sorted by behavioral onset asynchrony between the players (guitarist A's play onset time minus guitarist B's play onset time). Behavioral synchrony is depicted by the black curve. Phase alignment was calculated here for the mid-central electrode Cz. The results indicate a strong phase alignment that closely follows the behavioral onset asynchrony across all trials and guitarists in the pairs. (f) Angular-linear correlation between phase and time differences across all trials and guitarist pairs for each of the notes played. The correlation is strongest for the first 12 notes of the music piece (especially for notes 4, 7, and 9) at practically all six harmonics of the metronome frequency. Correlation values for this representation were calculated between the Cz electrodes in guitarist A's and B's brains (see Müller & Lindenberger, 2022, for details).

Image: MPI for Human Development

We also explored the properties of hyper-frequency, hyper-brain networks within couples engaged in romantic kissing (Müller, 2022). Hyper-brain network strengths were higher and characteristic path lengths were shorter when individuals were kissing each other than when they were kissing their own hand. Between-brain strengths of theta oscillations (around 5 Hz) were reliably associated with reported partner-oriented kissing satisfaction, especially over frontal and central electrodes. Adding to our observations of fronto-central between-brain synchronization in guitar duet players, we surmise that the observed networks might reflect the operation of cell assemblies representing movement coordination among interacting partners (see Figure 1).

The project has also sought to devise new EEG paradigms that manipulate the degree of interbrain synchrony more directly. In one such paradigm (Müller et al., 2021), participants are asked to control interbrain synchrony by using visual neurofeedback that is provided visually on a computer screen, either as two balls approaching each other or as two pendula, each reflecting the oscillatory activity of one of the two participants. Neurofeedback was provided in real time at their delta and theta EEG frequencies. Participants were able to increase interbrain synchrony by using neurofeedback, especially when provided at the theta frequency. Apart from intra- and interbrain coupling, other aspects of oscillatory activity (e.g., power spectral density, peak amplitude, and peak frequency) also differed during task relative to rest. Moreover, several of these brain-derived measures were correlated with self-report items assessed after the experiment, such as momentary well-being, likeability of the experimental partner, and estimated capability to influence the task. These initial results suggest that neurofeedback might help in specifying the contribution of interbrain synchrony to interpersonal action coordination.

Finally, we also revisited data from a choir of 11 singers and their conductor, originally published in 2011 (Delius & Müller, 2023). Based on an integrated analysis of respiratory, cardiac, gestural, and vocalizing subsystems, we conclude that the choir members constitute the choir as a hyper-system space or superorganism, marked by the simultaneous presence of upward and downward causation. Each singer contributes to the choral singing through his or her voice and influences the function of the choir as a whole (upward causation). At the same time, the whole choir functions as a superordinate system, or superorganism, that imposes boundary conditions on each individual singer (downward causation).

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Brain Imaging Methods in Lifespan Psychology (Concluding Report)

Research Scientists

Nils Bodammer

Davide Santoro

Ulman Lindenberger

Naftali Raz

Research on human development seeks to delineate the variable and invariant properties of age-graded changes in the organization of brain–behavior–environment systems. Magnetic resonance imaging (MRI) modalities, including magnetic resonance spectroscopy (MRS), are an indispensable part of this effort, as they allow for the noninvasive assessment of brain function, anatomy, microstructure, and metabolism.

The goals of the Brain Imaging Methods project, which was founded in 2011, have been twofold: to ascertain and improve the measurement quality of standard brain imaging protocols at the Center, and to complement the standard imaging repertoire by advanced sequences with enhanced interpretability that hold promise in elucidating structural changes and physiological mechanisms related to maturation, learning, and senescence. In pursuing these goals, the project has served as a resource for other projects interested in imaging (e.g., Porat et al., 2022; Wenger et al., 2022). Hence, structural and quantitative MRI methods occupy a central place in the project.

During the reporting period, the project has focused on: (a) T1 mapping by means of an MP2RAGE acquisition together with a B1 map-correction protocol to obtain estimates of laminar myelination across the cortical sheet; (b) myelin water fraction (MWF) imaging; (c) multiband-accelerated high-angular-resolved diffusion imaging (HARDI); and (d) neuromelanin-sensitive high-resolution imaging of the brainstem to determine the individual position and extension of the loci coerulei (Dahl, Bachman, et al., 2023).

With the establishment of the Institute’s MR Physics Research Group and Core Facility in early 2023, the brain-imaging project within the Center for Lifespan Psychology has come to an end. Nils Bodammer and Davide Santoro have joined the Core Facility. The establishment of the Core Facility and the installation of a new 3-Tesla and a 7-Tesla scanner in the coming 2 to 3 years will further strengthen the brain-imaging expertise at the Institute.

T_1 Mapping Using MP2RAGE With B_1 Map Correction

The longitudinal relaxation time T_1 in cortex is affected by the myelin content of the laminae. T_1 mapping offers a noninvasive method to determine cortical structures and their changes over time. Our original protocol for the accurate estimation of T_1 maps in the brain made use of three repeated MP2RAGE sequences developed by José Marques and colleagues, with tailored paired values for the inversion times to cover the whole range of T_1 values in the brain. However, this original protocol was rather time-consuming and prone to motion artefacts. A close look at the MP2RAGE signal evolution function allowed us to optimize the protocol by specifying one single acquisition with maximal sensitivity in the region of the white matter versus gray matter contrast. Within only 10 minutes acquisition time at our 3-Tesla scanner, we have been able to reach submillimeter resolution (0.8 mm isotropic) showing exquisite details of the cortical thickness structure. The resulting T_1 map is then corrected by a B_1 map to cancel hardware imperfections and radio frequency inhomogeneities across the brain (see Figure 1). The B_1 mapping method used, based on earlier work by Davide Santoro and others, was developed in-house, and its duration was reduced to only 10 seconds. The in-house B1 mapping method has been shared with other MRI centers (such as Wayne State University, Detroit, USA), and might give rise to possible future collaborations, especially with MRI centers equipped with a 7-Tesla scanner, where the B1 map correction is essential.

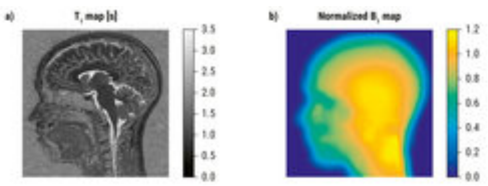

Figure 1. (a) Typical T_1 map of a young adult's brain (One slice out of a 3D volume with matrix 270 x 300 x 200) obtained using MP2RAGE and B_1 map correction. Total acquisition time was 10 minutes and 20 seconds. (b) Normalized B_1 map used for correction, resized and co-registered with the T_1 map. Original matrix 56 x 60 x 18, Acquisition time 15 seconds.
Image: Davide Santoro / Max Planck Institute for Human Development

Myelin-Water Fraction Imaging (MWF)

Based on a time series of T_2-weighted MR images with increasing echo-times, MWF imaging evaluates the transversal relaxation in a multiexponential manner. The fraction of short T_2s (< 40 ms) provides an estimate of the portion of water molecules located between myelin sheaths, presumably reflecting the degree of myelination within white matter. Work on MWF imaging has been done in collaboration with Jeffrey A. Stanley (Wayne State University, Detroit, USA).

High Angular Resolved Diffusion Imaging (HARDI)

Diffusion imaging captures the movement of water molecules, termed diffusion. Diffusion in tissue is hindered by cell membranes. Therefore, the orientation-dependent diffusion profiles provide information about tissue microstructure, namely about the density of neural fibers for any voxel in brain tissue as a function of their orientation. Special MR protocols sensitized to the diffusion of water molecules in tissue allow measurement of such diffusion orientation profiles. The optimization of either spatial or angular resolutions of such acquisition protocols has been performed for multiband-accelerated diffusion imaging protocols at 3 Tesla in collaboration with Claudia Wolf (Freie Universität Berlin).

Center for Lifespan Psychology Publications 2020-2022/23

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Journal Article (247)

2023

Journal Article

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Papadaki, E. (2023). *Experience-dependent plasticity in the auditory domain: Effects of expertise and training on functional brain organization* [PhD Thesis, Freie Universität Berlin].

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Thesis - PhD

Karlsson, A. E. (2022). *Neural oscillations shape the quality and content of episodic memories in young adulthood and older age* [PhD Thesis, Humboldt-Universität zu Berlin].

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2023

Thesis - Master

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Thesis - Master

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MPG.PuRe

Thesis - Master

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2020

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Thesis - Master

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Working Paper (1)

2020

Working Paper

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MPG.PuRe publisher-version

Report (1)

2021

Report

Nationale Akademie der Wissenschaften Leopoldina [Members of the MPIB: Ralph Hertwig, Ulman Lindenberger, Gert G. Wagner]. (2021). *Kinder und Jugendliche in der Coronavirus-Pandemie: Psychosoziale und edukative Herausforderungen und Chancen. [8. Ad-hoc-Stellungnahme]*. Nationale Akademie der Wissenschaften Leopoldina [Retrieved November 29, 2021, from https://www.leopoldina.org/publikationen/detailansicht/publication/kinder-und-jugendliche-in-der-coronavirus-pandemie-psychosoziale-und-edukative-herausforderungen-und-chancen-2021/]. (English translation: *Children and adolescents in the COVID-19 pandemic: Psychosocial and educational challenges and opportunities.* Halle (Saale): Nationale Akademie der Wissenschaften Leopoldina, 2021).

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Issue (2)

2022

Issue

Müller, V., Fairhurst, M. T., Van Vugt, F. T., Keller, P. E., & Mueller, M. F. (Eds.). (2022). Interpersonal synchrony and network dynamics in social interaction [Special issue]. *Frontiers in Human Neuroscience*, *16*. https://doi.org/10.3389/978-2-83251-032-2

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2020

Issue

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Software

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MPG.PuRe DOI

Groups and Max Planck UCL Centre

Lise Meitner Group

The Max Planck Society has established the Lise Meitner Excellence Program to recruit and promote exceptionally qualified female scientists.

Lise Meitner Group for Environmental Neuroscience
Head: Simone Kühn

The research group studies how the physical environment affects human beings. To do so, the group uses observational studies where research scientists investigate normal living environments, like student housing, and extreme environments, such as Antarctica. Experimental studies serve to unravel underlying causal pathways, for example, by testing how variations of environmental factors, such as alterations of residential buildings, impact the brain as well as mental health. > more

Emmy Noether Group

The Emmy Noether Programme is funded by the German Research Foundation (DFG) and gives particularly qualified young scientists the opportunity to qualify for a university professorship over a period of 6 years by independently leading a junior research group.

Lifespan Neural Dynamics Group
Head: Douglas D. Garrett

The research group seeks to understand how and why the human brain fluctuates so markedly from moment to moment. It examines brain signal variability and dynamics in relation to six core research foci: lifespan development, cognition, neuromodulation, structural/functional connectivity, transcranial stimulation, and methods/modeling. > more

ERC-Funded Research Group

The ERC Consolidator Grants are designed to support excellent researchers whose independent research group is still in its consolidation phase.

Adaptive Memory and Decision Making Group
Head: Bernhard Spitzer

Human cognition is perplexingly powerful, despite the known capacity limits of biological brains. The research group commenced its work in 2022 and examines this conundrum in core cognitive functions, including memory, learning, and decision making. A main focus of the group is how neural representations are dynamically structured in working memory to provide us with just the right information at just the right time, and in just the right format, to enable adaptive behavior. In addition to the ERC Consolidator Grant, the research group is funded by the German Research Foundation (DFG). > more

Max Planck Research Groups

While Max Planck Research Groups (MPRG) use the facilities and resources of a Max Planck Institute, they have their own staff and equipment, which enables their heads to pursue research projects independently, laying the foundations for a successful career. They are initially limited to 5 years, but can be extended. Four Max Planck Research Groups are currently working at the Institute.

MPRG Biosocial | Biology, Social Disparities, and Development
Head: Laurel Raffington

Human development unfolds in transactions between biology, including genetics, and environments. The research group commenced its work in 2022 and examines how social disparities affect child and adolescent development to shape differential outcomes of education, health, and well-being across the lifespan. > more

MPRG iSearch | Information Search, Ecological and Active Learning Research with Children
Head: Azzurra Ruggeri

By bringing together methods from developmental and cognitive psychology, philosophy, education, information theory, and computational modeling, the group's research program sheds light on the cognitive, social, and cultural mechanisms underlying children's ability to engage in ecological active learning and face uncertain—more or less expected—future challenges. > more

MPRG Naturalistic Social Cognition
Head: Annie E. Wertz

The research group explores social learning and cognitive development in infancy and early childhood from an evolutionary perspective. The group's primary research program investigates how infants learn about plants. Their work has established a novel area of inquiry within cognitive development and demonstrates that learning and evolution are not mutually exclusive processes. > more

MPRG NeuroCode | Neural and Computational Basis of Learning, Memory and Decision Making

Head: Nicolas W. Schuck

The research group investigates how the brain uses past experiences to guide decision making. It employs functional magnetic resonance imaging (fMRI) to study neural representations and replay of previous events, and use reinforcement learning and neural network algorithms to model behavioral and neural data. This sheds light on our memory, on our choices, and on parallels between human and artificial intelligence. > more

Max Planck UCL Centre for Computational Psychiatry and Ageing Research

Directors: Raymond J. Dolan, London, and Ulman Lindenberger, Berlin

The Max Planck UCL Centre for Computational Psychiatry and Ageing Research was established in April 2014 as a joint initiative of the Max Planck Society and the University College London. The Centre fosters a mechanistic understanding of behavioral aging and psychopathology by developing and applying statistical and computational tools to delineate individual differences in brain–behavior dynamics. > more

Lise Meitner Group for Environmental Neuroscience

Head: Simone Kühn

Lise Meitner Group
for Environmental Neuroscience

The physical environment has a major impact on well-being and mental health. The field of psychiatry has strongly stressed the potentially harmful effects of urban living (Peen et al., 2010), whereas environmental psychology has focused on the beneficial effects of contact with nature (McMahan & Estes, 2015; Stevenson et al., 2018). However, humans have a tendency to underestimate the influence that the physical environment and the contextual surroundings exert on our behavior, a phenomenon that has been termed “fundamental attribution error” in social psychology. In view of the multitude of environmental problems we are currently facing, such as climate change, elevated pollution, and destruction of habitats, a better understanding of the effects of the physical environment on the individual is urgently needed.

Therefore, our overarching research question is how the physical environment affects human beings. Our goal is to open the black box between the physical environment and mental health and well-being, as shown in Figure 1. We think that there are three major questions that need to be answered concerning the link between the physical environment and mental health. First, the so-called “active ingredients” of the physical environment that elicit positive mental health effects need to be identified (e.g., the color green, air pollutants, soundscapes, terpenes). Second, and related to the first point, the major human sensory pathways by which the active ingredients are perceived should be determined. For instance, is visual input from a natural environment sufficient, or is the interaction of multiple sensory systems more effective in improving well-being? Third, the neural mechanisms, namely the brain regions involved in processing the physical environment, remain to be discovered.

For example, this will help to unravel whether salutogenic effects of the natural environment are primarily driven by cognitive or affective paths. This mechanistic approach will link the new field of environmental neuroscience to theories from environmental psychology that have long been debating whether the restorative effects of nature exposure are primarily grounded in recovery from stress (Stress Recovery Theory [SRT]; Ulrich et al., 1991) or in restoration from attentional fatigue (Attention Restoration Theory [ART]; Kaplan & Kaplan, 1989).

Figure 1. Illustration of the black box between the physical environment and mental health.
Image: MPI for Human Development

Our research program is organized around four main topics: (1) exploring long-term effects of outdoor living environments, (2) examining the effects of extreme environments, (3) investigating the acute effects of environmental stimuli such as images, sounds, and smells, and (4) probing the effects of interiors and architecture. Furthermore, we have started to work on two more methodological themes: (5) one in which we attempt to combine approaches developed in computer science with environmental neuroscience, and (6) one in which we utilize the classical twin design and methodology developed in behavioral genetics, enabling us to investigate the impact of the physical environment on the brain and well-being while controlling for genetics and selective migration triggered by genetic differences. As shown in Figure 2, the research topics range all the way from observational, correlational research to experimental randomized controlled trials (x-axis) and from indoor to outdoor, and even extraterrestrial environments (y-axis).

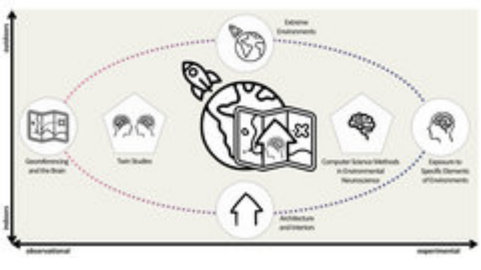

Figure 2. Illustration of the interdependence between the research areas. Encircled research areas are mostly defined based on the content, whereas polygons indicate research areas defined based on the methodological approach.
Image: MPI for Human Development

Research Team 2020-2023

Last update: July 2023

Head

Simone Kühn

Postdoctoral Fellows

Johanna Drewelies, Robert Lorenz

Predoctoral Fellows

Moana Beyer (COMP2PSYCH), Maike Hille (LIFE), Sonia Sudimac (LIFE), Emil Stobbe, Izabela Sztuka, Nour Tawil (LIFE)

Associate Research Scientist

André Vilela Komatsu (University of São Paulo, Brazil)

Visiting Researchers

Nina Becker (Karolinska Institutet, Stockholm, Sweden), Carlos Cassanello (University Medical Center Hamburg-Eppendorf [UKE], Germany)

A current list of the Group's staff with links to their web profiles can be found on the Group's website.

Image: MPI for Human Development

Research

Research Area 1: Georeferencing to Investigate Long-Term Effects of Outdoor Living Environments

Within the scope of this research area, we explore data from large existing magnetic resonance imaging (MRI) cohort studies that include information on the daily living environment of participants, either acquired by means of questionnaires or by means of address data that we then further process using Geographic Information Systems (GIS) methods to extract geographical information from the surroundings of the home. We started this on data of older adults from the Berlin Aging Study II (BASE-II; Kühn et al., 2017; Kühn, Düzel, et al., 2021) and adolescents from the European IMAGEN project (Kühn et al., 2020) and the Dutch prospective ↗ BIBO study (Kühn et al., in press).

We have recently continued this line of research using various large-scale data sets that have been acquired with a focus on neuroimaging data, including the UKBiobank (48,000 participants) and the ↗ Hamburg City Health Study (HCHS), a study I am involved with (Jagodzinski et al., 2020; Augustin et al., 2022). HCHS is the largest monocentric health study worldwide and will comprise 45,000 individuals (neuroimaging to be available on 8,000 of them) who will be extensively characterized with respect to health factors but also to their home and workspace environment. Moreover, we have started to analyze brain data from the ↗ German National Cohort Study (NAKO, with more than 30,000 participants). At present we are attempting to go beyond the cross-sectional correlation analyses by using follow-up assessments (in IMAGEN) to relate environmental changes to neural changes over time, an endeavor that is supported by an ERC Consolidator Grant that I received in early 2023.

Recently, we started to collaborate with the Max Planck Research Group iSearch (Azzura Ruggeri) in order to investigate whether the amount of green space around the home and school address is linked to active learning in children.

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MPG.PuRe DOI publisher-version

Research Area 2: Extreme Environments

A major challenge of the research topic of environmental neuroscience is that the physical environments of participants are difficult to manipulate and difficult to assign randomly. Therefore, we have started to study individuals who decide to spend periods of time in extreme environments (Stahn & Kühn, 2021). In collaboration with the Center for Space Medicine and Extreme Environments at Charité Universitätsmedizin Berlin and the University of Pennsylvania (Alexander Stahn), we are conducting studies in different human analog missions that simulate aspects of long-term space missions (Stahn & Kühn, 2021, 2022). For example, we had—and still have—the opportunity to acquire brain data of individuals before and after they overwintered in Antarctica (Stahn et al., 2019) or spent weeks to months in confinement-simulating missions to Mars. This includes bed-rest studies simulating microgravity (Friedl-Werner et al., 2020) and actual space flight missions, funded by Deutsches Zentrum für Luft- und Raumfahrt (DLR), European Space Agency (ESA), and National Aeronautics and Space Administration (NASA).

Likewise, we have received permission to test 16 mission members in the Human Exploration

Research Analogue (HERA,) in Houston, and 20 astronauts and cosmonauts who will spend at least 6 months on the International Space Station (ISS) and are currently testing the effects of zero gravity on affect and cognitive functioning in parabolic flights (Stahn et al., 2020).

In a similar vein and funded by the German Research Foundation (DFG), we have started to conduct a study on prisoners in correctional facilities, namely the correctional facility Justizvollzugsanstalt Fuhlsbüttel, Hamburg. We acquire structural and functional brain data as well as cognitive and clinical mental health data at the beginning of investigative custody and then follow up with them 1 year later. We will then compare prisoners who were released after investigative custody with those who had to stay in prison. Furthermore, we assess a control group of participants who are on probation and not in prison within the year of interest. Prisons likewise constitute extreme environments, often with very limited access to nature. Potential long-term effects of this kind of detention on brain plasticity, as well as on cognition, are of high societal relevance and have not been investigated to date.

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Research Area 3: Exposure to Specific Elements of Environments to Investigate the Acute Effects of Environmental Stimuli

Within the scope of this research area, we experimentally expose participants to real or virtual (multimodal) environments. We also attempt to dissect environments into their constituents perceived by different modalities by using images/videos of environments, sounds, or odors.

Previous studies have demonstrated that taking a walk in a natural landscape versus a city environment can lead to improvements in mental health outcomes such as mood and stress, and improvements in cognition, in particular in working memory and cognitive flexibility (McMahan & Estes, 2015; Stevenson et al., 2018). The aforementioned theories, ART and SRT, posit that nature has positive effects on human beings. SRT emphasizes that the beneficial effects are initially via affect, whereas ART assumes that the effects are brought about via cognitive processes, namely the restoration of directed attention.

To test these theories, our PhD student Sonja Sudimac used functional MRI (fMRI) to investigate whether beneficial effects of nature on subjective well-being and cognition are accompanied by activation in brain regions associated with stress and affect or by attentional cognitive processes. We randomly assigned adult participants to a one-hour walk in a forest (Berlin-Grunewald) or in the city (Schloßstraße in Berlin-Steglitz) (Figure 3) and observed a reduction in stress-related amygdala activity after the walk in nature (Sudimac & Kühn, 2022; Sudimac et al., 2022). In another study, our PhD student Emil Stobbe assessed the effects of urban (transportation sounds) versus natural (birdsong) soundscapes on depressivity, anxiety, and paranoia ratings in healthy participants (Stobbe et al., 2022), showing that listening to birdsong significantly reduces depressivity, anxiety, and paranoia. In a follow-up fMRI study, he investigates the neural mechanisms driving these effects.

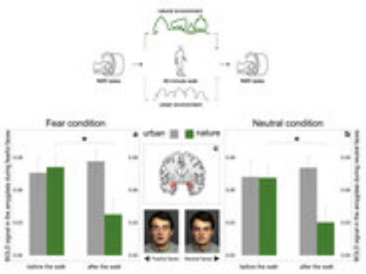

Figure 3. Top: schematic overview of the study design. Bottom: bilateral amygdala activity during the Fearful Faces task, before and after the walk in urban and natural environments: (a) bilateral amygdala activity during fearful faces (fear condition); (b) bilateral amygdala activity during neutral faces (neutral condition); (c) region of interest, the bilateral amygdala as defined in the Automated Anatomic Labelling Atlas 2. Below: stimuli in the Fearful Faces task showing fearful facial expression within the fear condition (left), and neutral facial expression within the neutral condition (right).
Note. BOLD: blood-oxygen-level-dependent; significant differences are indicated by asterisks (*$p < 0.05$; **$p < 0.01$); error bars represent one standard error of the mean.

Adapted from Sudimac, Sale, & Kühn (2022)

In order to investigate the effects of day-to-day variability in exposure to physical environments and its effects on the brain, we used data from our previous Day2day study, in which a small number of participants were measured 40–50 times in the MRI scanner over 6 months. At each scanning occasion we assessed what participants did in the 24 hours before scanning, including what they ate, how much exercise they took, whether they spent time outdoors, etc. Using this data, we observed that spending time outdoors was positively associated with gray matter volume in dorsolateral prefrontal cortex and positive mood (Kühn, Mascherek et al., 2022). At present we are conducting a follow-up project in which we hope to gather more evidence on these short-term effects of environmental exposure. We plan to equip 30 participants with a variety of sensors (measuring light, air pollution, noise, and electrodermal activity) to investigate how the environmental exposure 24 hours before scanning impacts brain structure and function, and to invite each participant for 25 assessment sessions. This study will also be funded by a recently obtained ERC Consolidator Grant.

Moreover, we started additional projects investigating the acute effects of environmental exposure on brain function using functional near-infrared spectroscopy (fNIRS) in the field and in virtual reality (VR). Our goal is to conduct experiments in which we can systematically investigate which modalities, such as vision, audition, and olfaction, as well as which combinations of modalities, play the most prominent role in eliciting positive effects on affect and cognition during the perception of a particular environment (e.g., forest).

Furthermore, we recently initiated a study in collaboration with Frederik Schröer from the Center for the History of Emotions, exploring to what extent the perception of forest pictures and the concept of the forest is linked not only to positive affect but also to anxiety.

Key References

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MPG.PuRe DOI publisher-version supplementary-material

Research Area 4: Architecture and Interiors

Since humans in developed countries spend almost 80–90% of their time indoors on average, we also focus on investigating the influence of interior design on humans. For example, we are examining the influence of sharp and curved shapes, ceiling height, and room size on affect and cognition as well as on underlying brain functioning. For this purpose, we make use of virtual reality (VR) technology, since it can generate a strong feeling of presence and so-called immersion effects and enables us to place participants in completely different environments. Moreover, VR allows us to systematically manipulate distinct aspects of the environment.

We have recently finished a study in which we compared rooms with curvilinear versus rectilinear interior design including furniture, carpets, lamps, and paintings. Our PhD student Nour Tawil, who is an architect by training, designed the VR rooms. In her first study, she was able to show that an exposure to curvilinear versus rectilinear interior design in 3D-VR revealed no differences in terms of preference, affect, and cognitive functioning (Tawil et al., 2021). However, in an online study where participants were shown 2D pictures, she observed more beneficial explicit ratings of beauty, liking, and stress for the curvilinear condition (Tawil et al., 2022). Currently, we are following up on these findings with implicit tests, assessing the tendency to approach/avoid the 2D pictures and attention biases. We are planning to continue this research by utilizing our means to project VR environments into the MRI scanner to investigate whether curvilinear rooms are related to approach-related brain activation whereas rectilinear interiors are associated with avoidance-related brain activation.

In addition, we have conducted rating studies using photographs of house facades. To our surprise, we found that the face-likeness of facades, which has been reported as relevant in the previous literature, was not a central rating dimension for our participants from Germany, Denmark, and Canada (Roessler et al., 2022). This research is currently being followed up using eye-tracking methodology and labelling of the architectural elements of the house facades.

On this project we work in close collaboration with architects from the Bauhaus-Universität Weimar (Prof. Dr. Jasper Cepl), the University of Cottbus (Prof. Dr. Nina Gribat; joint DFG grant for the development of a research network), and Prof. Dr. Anna-Maria Meister, who was recently granted a Lise Meitner Group that will be located at the MPI for Art History in Florence, Italy, as well as with the Academy of Neuroscience for Architecture (ANFA).

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Research Area 5: Computer Science Methods in Environmental Neuroscience

The computer sciences have developed powerful tools to manipulate photographs and to help quantify information from images. Within this research area, we utilize this knowledge and attempt to apply it to relevant questions within the environmental neurosciences. One example is knowledge obtained in the field of computer vision for the analysis of GIS quantifications. Another area that we started to look into with our computer science master's student Kira Pohlmann is the use of generative adversarial networks (GANs) to generate new pictures of house facades. As conditional GANs have been shown to accurately extract class-specific features, also in the context of architecture (Bachl & Ferreira, 2020), we trained a GAN conditionally on an image dataset containing 2,000 frontal views of detached houses. We asked participants to rate those houses on psychological dimensions such as homeliness, invitingness, relaxation, and safety. Based on those ratings we saw that the GAN achieved high accuracy in predicting how the generated images were rated by participants on psychological dimensions (Figure 4). The GAN can be utilized to generate extreme cases of what participants perceive as homely, for example, and therefore provide an interesting way to illustrate the results of our findings. We plan to use this methodology in the future to apply it to the generation of natural or urban scenes.

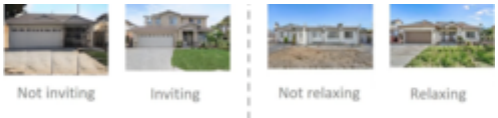

Figure 4. Top: schematic overview of the study procedure. Labels for the dataset were retrieved in an online study. A Generative Adversarial Network (GAN) was trained for each dimension and artificial images were generated. In a second online study, the artificial images were rated by participants on the same psychological dimensions. Bottom: examples of artificial images generated by the GAN for the extremes of the dimensions.
Image: Kira Pohlmann

Moreover, we have started to use computer vision approaches to segment Google Street View images to characterize not only how much green space is accessible in a certain geographical region, but how much green can be seen from a first-person perspective of someone who is actually present at this location. This will also enable us to quantify constructs that have been largely neglected in related fields so far, such as the amount of visible sky (Sztuka et al., 2022). We have started to collaborate on the latter topic with Prof. Dr. Berndt Schiele, who is the director of the Center for Computer Vision at the MPI for Informatics in Saarbrücken.

Key Reference

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MPG.PuRe DOI publisher-version

Research Area 6: Twin Studies

In this research area, we have started to utilize the twin study design to mimic environmental neuroscientific research from the animal research domain in which typically genetically identical animals are randomly allocated to different environments and the effects on brain health are studied. The closest we can get to mimicking this design in humans is to recruit monozygotic twins (MZ) that have left their shared parental home environment and now live in different physical environments (discordant MZ twin design). This constitutes an ideal test bed to investigate the association between the physical environment and brain structure, brain function, and mental health in the absence of genetical confounders. For this reason, we are currently recruiting participants from the TwinLife project, inviting them to an extensive assessment of their residential history and their current physical environment, including a 1-week ecological momentary assessment and a brain imaging session. This study is funded by a grant from the Strategic Innovation Fund of the Max Planck Society and will be conducted in collaboration with Prof. Dr. Elisabeth Binder from the MPI for Psychiatry in Munich, who will support us in exploring epigenetic changes in relation to the within-pair differences in the physical environment.

Moreover, we have recently initiated a Germany-wide collaboration of twin researchers with the goal of creating a German twin registry analogous to existing registries in Australia, the Netherlands, and Sweden (involving Prof. Dr. Jan Beucke, MSH Medical School Hamburg; Prof. Dr. Martin Diewald and Dr. Bastian Mönkediek, Bielefeld University; Prof. Dr. Paul Enck and Prof. Dr. Andreas Stengel, University of Tübingen; Prof. Dr. Christian Kandler, University of Bremen; Prof. Dr. Frank Spinath, Saarland University; Prof. Dr. Fredrik Ullén, MPI for Empirical Aesthetics). The GerTRuD: German Twin Registry under Development will be located at the MPI for Human Development and will be based on the Castellum participant data base that has been developed on site.

Summary and Potential Impact

By providing a better understanding and quantification of the relationship between outdoor and indoor environments and the brain, we hope to make an impact on the design of physical environments, urban planning, and architecture in ways that will optimize well-being and cognitive functioning as well as the mental and physical health of society at large. With our work we hope to consolidate the emerging field of environmental neuroscience and inform the field of neuroscience in general regarding which environmental variables play a major role in brain plasticity.

Last but not least, our hope is that by elucidating individuals' dependency on a beneficial physical environment, we can contribute to kick-starting the pro-environmental behavior on the part of each and every one of us that is urgently needed to save our planet.

Lise Meitner Group for Environmental Neuroscience
Publications 2020–2022/23

Updated on a daily basis

Journal Article (120)

2023

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Ascone, L., Wirtz, J., Mellentin, A. I., Kugler, D., Bremer, T., Schadow, F., Hoppe, S., Jebens, C., & Kühn, S. (2023). Transferring the approach avoidance task into virtual reality: A study in patients with alcohol use disorder versus healthy controls. *Virtual Reality*, *27*(3), 2711–2722. https://doi.org/10.1007/s10055-023-00835-7

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Emmy Noether Group: Lifespan Neural Dynamics Group (Concluding Report)

Head: Douglas D. Garrett

The Lifespan Neural Dynamics Group (LNDG) has centered primarily on healthy cognitive and neural development across the lifespan. Specifically, our research investigates the computational and neurobiological bases for moment-to-moment fluctuations in brain activity (see Figure 1), with a key emphasis on cognitive aging (Garrett et al., 2013; Waschke et al., 2021). In contrast to earlier approaches that have historically assumed brain signal variability to be a form of detrimental “neural noise,” our research program indicates that moment-to-moment signal variability can instead facilitate neural communication, flexibility, and adaptability. Our work has been at the forefront of an emerging line of research demonstrating that older, poorer performing adults reliably exhibit less signal variability across moments than younger, better performing adults (within and across brain regions and task types), an agenda we increasingly pursue longitudinally. Based on this body of work, we have proposed that the field abandons traditional theoretical considerations of "neural noise" as a primary basis for aging-related cognitive deficits, and instead reconceptualizes age-related neurocognitive impairment as a generalized (and experimentally testable) process of increasing moment-to-moment rigidity and loss of dynamic range. Our research is inherently multidisciplinary, spanning computational and in vivo neuroscience, multi-modal neuroimaging, developmental science, cognition, psychiatry, statistics, and machine learning. LNDG research has been financially supported by a 6-year Emmy Noether grant from the German Research Foundation (DFG) to Douglas D. Garrett (2017–2023). Research highlights focusing on the reporting period are summarized below.

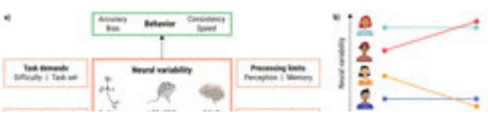

Figure 1. Dimensions and relevance of neural variability for behavior. (a) Neural variability on different temporal and spatial scales (milliseconds to minutes, neurons to ensembles) varies with task demands, individual processing limits, spontaneous arousal and attention states, and neuromodulatory activity (DA = dopamine; E/I, E/I balance; NE = noradrenaline), while affecting different aspects of behavior. (b) Variability of brain activity can differ between individuals within or across tasks (perhaps representing a trait), or variability may differentially shift within individuals (states) due to, for example, changing task demands.

Adapted from Waschke et al. (2021)

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Waschke, L., Kloosterman, N. A., Obleser, J., & Garrett, D. D. (2021). Behavior needs neural variability. *Neuron*, *109*(5), 751–766. https://doi.org/10.1016/j.neuron.2021.01.023

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Dopaminergic Bases of Age and Performance-Graded Differences in Signal Variability

Our research program has continued to expand along multiple principled axes. First, we are working to establish the dopaminergic bases of age and performance-graded differences in signal variability. Given that normal aging is associated with dopaminergic (DA) decline and poorer cognitive performance, we have examined whether commercially available pharmacological agents that upregulate systemic DA could restore deficient signal variability levels in older adults. Our first study revealed that older adults expressed lower signal variability on placebo yet matched or exceeded young adult variability levels in the presence of amphetamine, while improving in speeded performance upon first task exposure (Garrett et al., 2015). We recently found that another DA agonist (L-DOPA) also boosts blood-oxygen-level-dependent (BOLD) variability in older adults during reinforcement learning (Skowron & Garrett, in prep.), and that DA antagonism can reduce BOLD variability in younger adults (Garrett et al., in prep.). Further, we are core members of the COBRA Study, the world's first large-scale, longitudinal dopamine positron emission tomography (PET) and fMRI study of older adults (N = 180, 64–68 years; Nyberg et al., 2016). In our most broad-scale COBRA effort to date, we are now attempting to demonstrate that the ability to upregulate circuit-specific neural variability under working memory load is a joint reflection of greater dopamine D_2 capacity and more optimal working memory-based decision making. We also collaborate with several other international groups (e.g., at Duke University, at Brandeis University) on aging-oriented DA PET and pharmaco-fMRI studies, with a focus on the dopaminergic basis of brain signal variability in relation to decision making across the adult lifespan.

Using Computational Models of Behavior and Brain to Understand Brain Signal Variability

Second, we leverage multiple computational models of both behavior and brain for understanding the nature and functional utility of brain signal variability in younger and older adults. Beyond the use of reinforcement learning models of behavior in our work using L-DOPA noted above, we continue to utilize a series of other tailored behavioral models in our work. For example, our recent EEG work shows that the implementation of evidence accumulation biases during perceptual decision making (parameterized via Ratcliff's drift diffusion model) are implemented within-person by modulating oscillatory "excitability" in response to reward contingencies (Kloosterman et al., 2019). We also find that those who maximize reward by elevating their evidence accumulation biases are those who maximally elevate EEG entropy levels immediately post-stimulus in prefrontal cortex, providing the first behaviorally relevant top-down signature of response bias in the human brain (Kloosterman et al., 2020). We are now following up this work in older adults to optimize age-related response biases via real-time feedback. Two PhD students in the group are also pursuing computational approaches to understanding (a) explore–exploit decision making using a series of AI-inspired behavioral algorithms, such as the upper confidence bound and Thompson sampling models (Dissertation Liliana Polanski); and (b) behavioral response variability during uncertainty/structured learning using a series of stochastic Bayesian updating models (Dissertation Alexander Skowron) in younger and older adults undergoing fMRI and eye tracking.

We further utilize various computational models of the visual cortex/image recognition in our work to examine key cognition- and aging-related questions. Inspired by the notion that the brain could conceivably limit resource allocation (narrowing neural dynamic range) when stimulus input is simpler/more reducible but upregulate dynamic range to encode more differentiated sources of sensory input, we have embarked on a series of studies attempting to link the complexity of visual input to neural dynamic range (variability). In our first study in this domain (Garrett et al., 2020), we used the visuo-cortically inspired HMAX multilayer computational model of object recognition to estimate the complexity of visual stimuli perceived by participants during fMRI. We showed that moment-to-moment BOLD variability in visual cortex indeed increased when confronted with more feature-rich visual input, an effect especially present in adults with better performance across 20 different cognitive tasks. We have recently expanded this line of work into the domain of human memory. Moving beyond fMRI, we are testing the link between stimulus complexity (using a combination of HMAX and broadly utilized deep neural nets for image classification, such as VGG-16) and neural variability in human multi-neuron spiking data. Using customized within-person latent models, we show that trial-wise coupling between image complexity and spiking entropy during visual encoding is boosted with increasing model layer depth, suggesting that hippocampal spiking entropy is likely more sensitive to aggregated, "abstract" visual features. Crucially, we then find that stronger coupling between visual complexity and spiking entropy at encoding yields better performance during memory recognition, across multiple behavioral metrics. We are also now targeting the neurochemical mechanisms that may drive such effects. Ongoing work reveals that those older adults best able to align brain signal variability to stimulus complexity also express higher visuo-cortical gamma-aminobutyric acid (GABA) levels, an inhibitory neurotransmitter presumed key for the differentiation of visual features. We have also shown that GABA agonism can upregulate signal variability in older adults with limited baseline GABA (e.g., Lalwani et al., 2021). We are thus beginning to establish GABA as a key neurochemical target when probing how humans utilize neural variability to adapt to the complexity of the visual world.

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The Role of the Thalamus

Third, we are establishing the thalamus as a fundamental structure for understanding the interaction between local (regional) signal variability, large-scale networks, and behavior across the lifespan. Inspired by animal work demonstrating that local temporal variability may primarily reflect synaptic input rather than locally generated “noise,” our work provided first evidence showing that individuals with higher local temporal variability indeed had a more integrated (lower-dimensional) network fingerprint, and that thalamic variability was the strongest determinant of how the whole brain integrates from moment-to-moment (Garrett et al., 2018). Further, we continue to find that older adults who can increase functional integration within the striato-thalamic system under working memory load are better able to upregulate BOLD variability across the entire brain. Our longitudinal work in the NCMCA study suggests that those adults best able to maintain thalamic dynamics over a 2.5-year period are also best able to maintain performance in all major cognitive domains (see Figure 2; Garrett et al., 2021). Finally, in a landmark study for my group combining EEG, fMRI, eye tracking, and computational modeling of behavior (see Figure 3; Kosciessa et al., 2021), we found that when younger participants were more uncertain about what to process in their environment, cortical EEG signals shifted from a rhythmic to a more arrhythmic ("noisy") mode, a phenomenon strongly rooted in the within-person regulation activity in specific thalamic nuclei (as measured by fMRI). Our results argue that the thalamus may support neural dynamics in general and could optimize brain states according to environmental demands, allowing adults to make better decisions. We are now preparing a manuscript showing that older adults with more young-like regulation of cortico-thalamic dynamics under uncertainty also maintain young-like behavioral performance. Broadly, our work supports a key role for the thalamus in how the brain fluctuates and communicates overall, providing a springboard for future tests of the thalamus (rather than cortex) as a fundamental determinant of aging- and cognition-related differences in brain dynamics. We take this stance formally in a recent review on human thalamic neuroimaging (Shine et al., 2023).

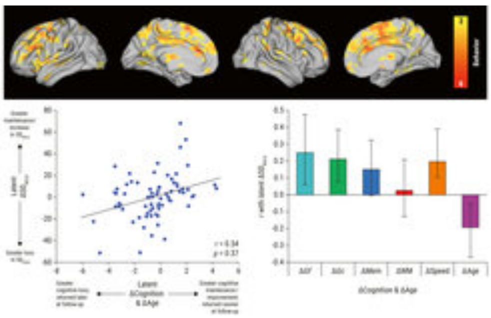

Figure 2. Multivariate model of longitudinal change–change associations between SD_{BOLD}, cognition, and age. Those who maintained cognitive performance (and were younger at follow-up) were more likely to maintain BOLD variability (SD $_{BOLD}$) levels across 2.5 years. Confidence intervals in bar plots represent bootstrapped 95% CIs (1000 resamples with replacement). Age change represents length of retest interval, which varied between 1.92 and 3.91 years).

Image: MPI for Human Development
↗ Adapted from Garrett et al. (2021)

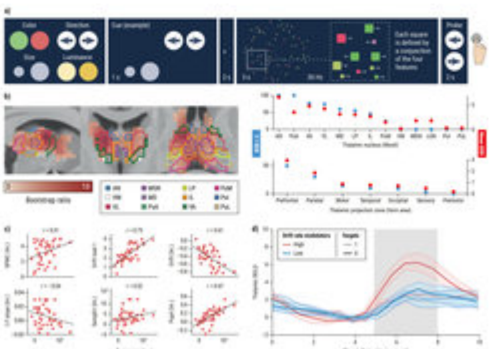

Figure 3. Upregulation of thalamic responses during stimulus processing is related to stronger

excitability increases and better performance during upcoming decisions. (a) The Multi-Attribute Attention Task, in which participants were faced with a complex, multifaceted moving stimulus, but were then selectively probed on specific features of the stimulus. (b) Results from multivariate model probing the association between linear changes in BOLD magnitude and behavioral, electrophysiological, and pupillary changes under uncertainty. Plots indicate the major nuclei and projection zones in which effects were maximally reliable; the strongest expression was observed in antero-medial nuclei that project to frontoparietal cortical targets. (c) Participants with larger parametric increases in thalamic BOLD activity were more likely to: (i) upregulate EEG-based "excitability" (reduced alpha and increased gamma; flatter 1/f spectral slopes; higher sample entropy), (ii) exhibit higher drift rates and drift rate modulation, and (iii) heighten arousal (first derivative of pupil responses). (d) Visualization of uncertainty-related thalamic modulation with uncertainty, split between low- and high- behavioral drift modulators (mean ± SEM). The yellow shading indicates the approximate stimulus presentation period after accounting for the delay in the hemodynamic response function.

Image: MPI for Human Development

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Garrett, D. D., Skowron, A., Wiegert, S., Adolf, J., Dahle, C. L., Lindenberger, U., & Raz, N. (2021). Lost dynamics and the dynamics of loss: Longitudinal compression of brain signal variability is coupled with declines in functional integration and cognitive performance. *Cerebral Cortex*, *31*(11), 5239–5252. https://doi.org/10.1093/cercor/bhab154
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Shine, J. M., Lewis, L. D., Garrett, D. D., & Hwang, K. (2023). The impact of the human thalamus on brain-wide information processing. *Nature Reviews Neuroscience*, *24*, 416–430. https://doi.org/10.1038/s41583-023-00701-0
MPG.PuRe DOI

Translational Approaches

Fourth, the LNDG's research program is increasingly translational in several complementary ways. Beyond the translational potential of our work on the neurochemical bases of aging-related loss of brain dynamics, we are currently pursuing whether it is possible to "inject noise" into older brains to improve cognitive function. We have now initiated a series of studies that utilize real-time, closed-loop transcranial random stimulation (tRNS)-EEG solutions to determine adaptive, individually tailored "noise regimes" (e.g., specific noise colors and magnitudes) that improve visual perception in older adults. We also model such phenomena via a series of modified dynamical attractor models of bistable perception. One ultimate goal is to develop real-world, mobile/wearable technological solutions that allow invocation of tailored stimulation-based noise regimes across the lifespan. In another example of the translational capacity of our work, we use latent-level machine learning techniques to study whether pre-treatment brain signal variability can act as a reliable predictor of longitudinal cognitive behavioral therapy and drug-based treatment outcomes in samples of younger and older social anxiety patients in Stockholm. Our most recent results suggest that baseline BOLD signal variability models provide a 20–30% improvement in treatment outcome prediction compared to gold standard baseline measures of social anxiety disorder symptoms (Månsson et al., 2022). Our follow-up work is now testing whether baseline signal variability can predict which specific treatment patients should receive (e.g., cognitive behavioral therapy versus medication with selective serotonin reuptake inhibitors, SSRI).

Key Reference

Månsson, K. N. T., Waschke, L., Manzouri, A., Furmark, T., Fischer, H., & Garrett, D. D. (2022). Moment-to-moment brain signal variability reliably predicts psychiatric treatment outcome. *Biological Psychiatry*, *91*(7), 658–666. https://doi.org/10.1016/j.biopsych.2021.09.026
MPG.PuRe DOI publisher-version supplementary-material

Open Science

Finally, we continue to be strong supporters of open methods/science. We make complete and carefully documented data sets publicly available whenever possible (see Kosciessa et al., 2021). We also remain committed to keeping our customized algorithms/methods freely available (e.g., the Variability Toolbox (VarTbx) for SPM). We are active and open developers of signal processing techniques, such as oscillation detection (Kosciessa, Grandy, et al., 2020), variance-independent implementations of entropy estimation (Kloosterman et al., 2020; Kosciessa, Kloosterman, et al., 2020), and multivariate/multi-modal methods. All code and analysis pipelines/tools we utilize within the Lifespan Neural Dynamics Group are available on GitHub and applicable to a wide range of neuroimaging data collected at the MPI for Human Development and beyond.

Research Team 2020-2022/23

Last update: August 2023

Head

Douglas D. Garrett

Researcher

Dag Alnaes

Postdoctoral Fellows

Niels Kloostermann (as of 08/2022: Universität Lübeck, Germany), Julian Kosciessa (as of 06/2022: Radboud University, Netherlands), Kristoffer N. T. Månsson (as of 09/2020: Karolinska Institutet, Stockholm, Sweden), Alistair Perry (as of 04/2020: Cambridge Centre for Frontotemporal Dementia and Related Disorders, USA), Leo Waschke (as of 03/2023: Bundesministerium für Bildung und Forschung, Berlin, Germany)

Predoctoral Fellows

Fabian Kamp (COMP2PSYCH), Zoya Mooraj (COMP2PSYCH), Liliana Polanski (COMP2PSYCH), Alexander Skowron (LIFE/COMP2PSYCH)

A current list of the Group's staff with links to their web profiles can be found on the Group's website.

Image: MPI for Human Development

Emmy Noether Group: Lifespan Neural Dynamics Group Publications 2020–2022/23

Updated on a daily basis

Journal Article (28)

2023

Journal Article

Bouwer, F. L., Fahrenfort, J. J., Millard, S. K., Kloosterman, N. A., & Slagter, H. A. (2023). A silent disco: Differential effects of beat-based and pattern-based temporal expectations on persistent entrainment of low-frequency neural oscillations. *Journal of Cognitive Neuroscience*, *35*(6), 990–1020. https://doi.org/10.1162/jocn_a_01985

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Adaptive Memory and Decision Making Group

Head: Bernhard Spitzer

Our current understanding of higher cognition faces a conundrum. On the one hand, humans and other animals show remarkably adaptive behaviors, successfully navigating our ever-complex world and accomplishing tremendous feats of intelligence. On the other hand, biological brains are inherently capacity-limited: The brain can process only a little information in a given time, and any neural processing is fundamentally noisy. The newly established Adaptive Memory and Decision Making Group (AMD Group; principal investigator: Bernhard Spitzer) uses computational and neuroscientific approaches to shed new light on this apparent contradiction in core cognitive functions such as decision making, learning, and working memory.

The research group has evolved from the former research area Neurocognitive Foundations of Adaptive Rationality at the Center for Adaptive Rationality (2018–2021). In 2022, the group was established as an independent unit led by Bernhard Spitzer, funded by an ERC Consolidator Grant (2022–2026), a German Research Foundation (DFG) Heisenberg Award (2022–2027), and additional funds from the DFG (2021–2024). Following delays in the wake of COVID-19, the first PhD students and postdocs joined the group in May 2022. Since September 2022, the group also hosts a PhD student of the International Max Planck Research School LIFE, Dilara Zorbek.

The Dynamic Representational Nature of Working Memory

One of the main limitations of human cognition seems to be the strictly limited storage capacity of working memory. Nevertheless, working memory excels in keeping ready the momentary contents of all of our thinking. How the brain accomplishes this feat, beyond the temporary maintenance of just experienced information, is hardly understood. An emerging view suggests that working memory storage is topographically distributed in the brain according to the information's endogenous level of abstraction. However, very little is known about how such distributed storage is orchestrated spatiotemporally, that is, how representations at different levels of abstraction are structured dynamically in time to suit current demands. In its ERC-funded research program, the AMD Group uses tailored experimental designs and newly developed multivariate analysis techniques to explore how working memory dynamically changes its contents' level of abstraction depending on momentary task requirements.

To quantify levels of abstraction in the brain, the group examines the extent to which neural activity patterns generalize across different stimulus spaces while task-relevant stimulus information is maintained in working memory. Throughout the research program, functional imaging (fMRI), electro- and magnetoencephalography (EEG, MEG), and invasive neural recordings will be used jointly to track levels of abstraction spatiotemporally, with millisecond precision. At the time of this report, the group is in the process of collecting EEG and fMRI data to test one of the more provocative hypotheses of the research program: that it may not be of foremost importance how much information working memory can store, and at which precision. More critical might be working memory's enormous flexibility to provide information at just the right time, and in just the right format, that is, at an appropriate level of abstraction.

Figure 1. Example paradigm for studying levels of abstraction in working memory. Information about visual object orientation can be retained in a concrete pictorial "snapshot" format, just as it can be stored in fully abstract coordinates (e.g., relative to any real-world object's upright position). The extent to which neural orientation encoding generalizes across dissimilar objects allows for inference about levels of abstraction.

While the work on the ERC-funded project has only just started, promising new insights have already been gained during the piloting of the first set of studies. In piloting, the group routinely uses high-precision eye tracking to manage the risk that eye artefacts may pose for the interpretability of subsequent neural recordings (e.g., EEG). However, eye-tracking data also provide an ideal testbed for the group's methodological framework: The multivariate analysis techniques developed for the program can be directly applied to two-dimensional eye-tracking data, just as they will later be applied to high-dimensional (and thus much more complex) brain signal patterns. Preliminary results (Linde-Domingo & Spitzer, 2022) have already provided first support for the research program's key hypotheses: specifically, that the representational format of task-relevant information in working memory may change (a) rapidly and (b) adaptively, depending on momentary processing demands. These preliminary findings are in line with another early study from the group, which examined behavioral dynamics (response times) to show that the format of working memory storage may change abruptly when other stimuli need to be processed at the same time (Kerrén, Linde-Domingo, Spitzer, 2022).

Over the coming years, the group expects to extend these preliminary insights to the level of brain processing. Specifically, the AMD Group seeks to shed new light on how neural representations of working memory information are modulated by attention, inattention, and distraction, and how multiple contents are stored simultaneously. The goal of this work is to shape a new theory of the neurocognitive capacity limit in working memory. Further, novel hypotheses about how working memory interfaces with long-term memory and how it develops over the lifespan will be tested. Finally, the group's human neuroimaging approaches will be combined with direct electrophysiological brain recordings in non-human primates during the same tasks, to disclose the fine-grained neural mechanisms of dynamic abstraction down to the single-cell level. It is anticipated that the program will provide new insights into the dynamic and multilayered nature of working memory, beyond the number and precision of items it can hold.

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Linde-Domingo, J., & Spitzer, B. (2022). Geometry of visual working memory information in human gaze patterns (Version posted online July 03, 2023). *BioRxiv*, November 17, 2022. https://doi.org/10.1101/2022.11.17.516917

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"Optimal Irrationality" in Human Decision Making and Learning

Given the limited capacity of working memory, how can humans still (a) learn efficiently and (b) make adaptive decisions? How does our cognitive machinery counter the fact that it operates only on a severely limited amount—and reliability—of information from the outside world? Decades of descriptive analysis have suggested that human decisions are irrational, and that human decision-makers over- or underweight objective evidence in idiosyncratic ways. But what if such "distorted" behaviors are not just idiosyncratic quirks, but have evolved as effective adaptions of an efficient low-energy system to its own computational limitations?

In a previous line of work, the group's principal investigator has demonstrated that common psychometric distortions, such as the over- or underweighting of extreme values in numerical judgments, can paradoxically improve the performance of a noisy (i.e., capacity-limited) observer.

This framework of “optimal irrationality” has already been successful in accounting for over/underweighting of numerical evidence in sequential decisions (Spitzer et al., 2017; Clarmann von Clarenau et al., 2022), for the distortions of value- and probability information in Prospect Theory (Juechems et al., 2020), and for adaptive learning strategies in solving transitive inferences (Ciranka, Linde-Domingo et al., & Spitzer, 2022). In all these domains, it was found that seemingly irrational human behaviors afford objective performance benefits over policies that seem normatively ”rational" but are poorly adapted to the computational and metabolic limitations of biological brains. Throughout its experimental work of the group, the AMD Group seeks to scrutinize these fascinating ideas and models in new domains, from basic working memory operations (cf. above) to memory-based decisions and risk-taking behaviors.

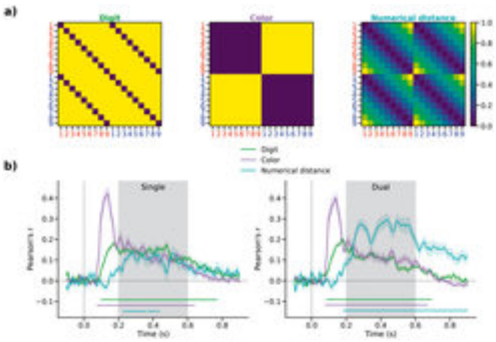

Figure 2. Methodology. The group extensively uses representational similarity (RSA) and geometry analyses applied to EEG, eye tracking, and functional imaging data, often in combination with computational modeling. Illustrated is an example analysis disclosing qualitative differences in the human EEG representation of number symbols during different decision tasks, each of which was associated with a distinct “irrational” distortion of number values in behavior. (a) Example representational dissimilarity matrices. (b) Time course of correlations with multivariate EEG patterns.

Adapted from Appelhoff, Hertwig, & Spitzer (2022)

At the time of this report, the group is particularly focused on extending its recent new insights into transitive inference learning. Transitive inference refers to the capacity that after learning pairwise relations, such as A>B and B>C, humans can infer that A>C. Members of the research group have shown previously that such transitive inference is facilitated by a learning “asymmetry,” where participants either attend only to the “winner” (e.g., A) or to the “loser” (e.g., B) of a pairwise comparison (Ciranka, Linde-Domingo et al. & Spitzer, 2022). Interestingly, asymmetric learning is also working memory-efficient, because it allows the discarding of parts of the experienced information. In ongoing and future work funded by the DFG, the AMD Group continues to investigate the ramifications of such asymmetries from the perspective of model-free and model-based learning, including on the level of neural processing. In addition to advancing previous psychological and neuroscientific theories, it is anticipated that the results from this work will be of strong relevance for the fields of machine learning and artificial intelligence, where the problems of transfer and flexibility—at high speed and low energy consumption—remain foremost challenges.

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MPG.PuRe DOI

Research Team 2022/23

Last update: August 2023

Head

Bernhard Spitzer

Postdoctoral Fellows

Stefan Appelhoff, Simon Ciranka (with the Center of Adaptive Rationality, MPIB, Berlin, Germany), Juan Linde-Domingo (as of 01/2023: University of Granada, Spain), Or Yizhar

Predoctoral Fellows

Frieda Born, Verena Clarmann von Clarenau (COMP2PSYCH, until 11/2022), Dilara Zorbek (LIFE)

Associate Research Scientists

Casper Kerrén (MPI for Human Cognitive and Brain Sciences, Leipzig, Germany)

Visiting Researchers

Maria Cobos (Univeristy of Granada, Spain), Maria Mikhailenko (Einstein Center for Neuroscience Berlin [ECN], Germany), Ines Pont Sanchis (Einstein Center for Neuroscience Berlin [ECN], Germany)

A current list of the Group's staff with links to their web profiles can be found on the Group's website.

Image: MPI for Human Development

ERC-funded Research Group Adaptive Memory and Decision Making Publications 2020–2022/23

Updated on a daily basis

Journal Article (11)

2023

Journal Article

Appelhoff, S., Hertwig, R., & Spitzer, B. (2023). Control over sampling boosts numerical evidence processing in human decisions from experience. *Cerebral Cortex*, *33*(1), 207–221. https://doi.org/10.1093/cercor/bhac062

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Keller, O., Appelhoff, S., Paffhausen, B. H., & Wenzel, T. (2023). Development and sharing of Open Science hardware: Lessons learned from Wikimedia fellowships. *Research Ideas and Outcomes*, *9*, Article e95174. https://doi.org/10.3897/rio.9.e95174

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Journal Article

Shvadron, S., Snir, A., Maimon, A., Yizhar, O., Harel, S., Poradosu, K., & Amedi, A. (2023). Shape detection beyond the visual field using a visual-to-auditory sensory augmentation device. *Frontiers in Human Neuroscience*, *17*, Article 1058617. https://doi.org/10.3389/fnhum.2023.1058617

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Journal Article

Yizhar, O., Tal, Z., & Amedi, A. (2023). Loss of action-related function and connectivity in the blind extrastriate body area. *Frontiers in Neuroscience*, *17*, Article 973525. https://doi.org/10.3389/fnins.2023.973525

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2022

Journal Article

Appelhoff, S., Hertwig, R., & Spitzer, B. (2022). EEG-representational geometries and psychometric distortions in approximate numerical judgment. *PLoS Computational Biology*, *18*(12), Article e1010747. https://doi.org/10.1371/journal.pcbi.1010747

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Journal Article

Arend, I., Yuen, K., Yizhar, O., Chebat, D.-R., & Amedi, A. (2022). Gyrification in relation to cortical thickness in the congenitally blind. *Frontiers in Neuroscience*, *16*, Article 970878. https://doi.org/10.3389/fnins.2022.970878

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Journal Article

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Journal Article

Kerrén, C., van Bree, S., Griffiths, B. J., & Wimber, M. (2022). Phase separation of competing memories along the human hippocampal theta rhythm. *eLife*, *11*, Article e80633. https://doi.org/10.7554/eLife.80633

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Journal Article

Maimon, A., Yizhar, O., Buchs, G., Heimler, B., & Amedi, A. (2022). A case study in phenomenology of visual experience with retinal prosthesis versus visual-to-auditory sensory substitution. *Neuropsychologia*, *173*, Article 108305. https://doi.org/10.1016/j.neuropsychologia.2022.108305

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2021

Journal Article

Juechems, K., Balaguer, J., Spitzer, B., & Summerfield, C. (2021). Optimal utility and probability functions for agents with finite computational precision. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(2), Article e2002232118. https://doi.org/10.1073/pnas.2002232118

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Journal Article

Kang, Z., & Spitzer, B. (2021). Concurrent visual working memory bias in sequential integration of approximate number. *Scientific Reports*, *11*, Article 5348. https://doi.org/10.1038/s41598-021-84232-7

MPG.PuRe DOI publisher-version

Thesis - PhD (1)

2022

Thesis - PhD

Appelhoff, S. (2022). *Researching neural correlates of human decisions from experience using electroencephalography* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-35218

MPG.PuRe DOI Full

MPRG Biosocial | Biology, Social Disparities, and Development

Head: Laurel Raffington

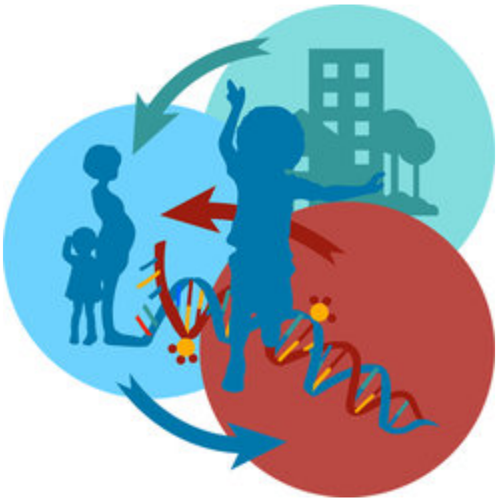


Figure 1. A biosocial perspective frames the biological and the social as interdependent and mutually constituting forces. *Outside the skin* social inequality becomes measurable *under the skin* by influencing our proximate environments, behaviors, and interpersonal relationships (green and blue arrows). *Under the skin* genetic differences influence not only our biological attributes, but also our behaviors and relationships via gene–environment interplay (red arrow). Systems of social inequality impose a hierarchy on genetically influenced individual differences, which in turn affects the development of complex traits.
Image: MPI for Human Development

Human development unfolds in transactions between biology, including genetics, and environments. The Max Planck Research Group Biosocial—Biology, Social Disparities, and Development examines how social disparities affect child and adolescent development to shape differential outcomes of education, health, and well-being across the life span. Our research commenced in August 2022.

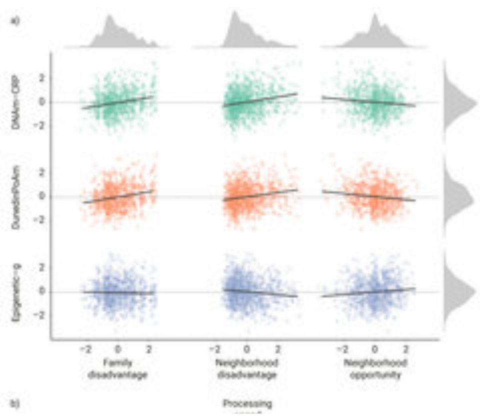
Gene–environment interplay can be seen as the primary mechanism by which social inequality affects child and adolescent development, reproducing inequality over generations. We apply a biosocial perspective, which frames the biological and the social as interdependent and mutually constituting forces (see Figure 1). *Outside the skin* social inequality becomes measurable *under the skin* by influencing our proximate environments, behaviors, and interpersonal relationships (green and blue arrows). *Under the skin* genetic differences influence not only our biological attributes, but also our behaviors and relationships via gene–environment interplay (red arrow). Systems of social inequality impose a hierarchy on genetically influenced individual differences, which in turn affects the development of complex traits. We are motivated by four broad biosocial questions:

1. How do childhood experiences tied to social disparities, such as poverty and racism, get *under the skin* to shape the course of health and education inequalities across the life span?
2. What are the behavioral cascades through which genetic differences between children *get out of the skin*?
3. How does parenting affect child health and educational performance, controlling for genetic inheritance?
4. How do systems of social inequality impose constraints on the phenotypic expression of genetic differences between people?

We leverage recent innovations from human genomics in longitudinal cohorts and randomized trials to advance our understanding of the intergenerational transmission of social inequality. To study genetic influences on complex human traits, we use measures that combine information from many genes and gene expression modifications, including polygenic indices and epigenetic algorithms.

For example, in a recent project we examined how childhood experiences tied to socioeconomic disadvantage and racism get *under the skin* to shape disparities in performance on cognitive tasks. A child's cognitive function can be harmed if their environment is stressful or lacks opportunities for learning—for example, if they regularly experience social inequalities due to their social class or race/ethnicity. Epigenetic mechanisms, including DNA methylation, are thought to be involved in the biological embedding of early life conditions. Using salivary DNA taken from a sample of 8- to 18-year-olds from central Texas, USA, we created epigenetic profiles that were originally developed in adults to predict chronic inflammation, lower cognitive function, and a faster pace of biological aging. Following preregistered analyses, we found that the epigenetic profiles of children from disadvantaged backgrounds looked worse than other children, and that children's epigenetic profiles were associated with their performance on a range of cognitive tests (see Figure 2).

These studies provide initial evidence that epigenetic profiles are a promising tool to help us better understand how social inequalities become embedded in the body and impact the mind. The goal of this research is to help understand and reduce the effects of social inequality on well-being by identifying environmental factors and biological pathways that promote more equitable outcomes.



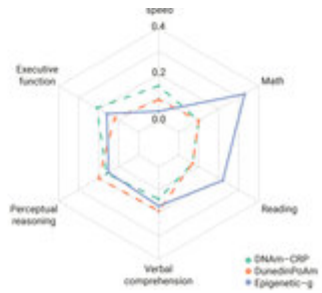


Figure 2. A child's cognitive function can be harmed if their environment is stressful or lacks opportunities for learning—for example, if they regularly experience social inequalities due to their social class or race/ethnicity. Using salivary DNA taken from a sample of 8- to 18-year-olds, we created epigenetic profiles that were developed to predict chronic inflammation (DNAm-CRP), lower cognitive function (Epigenetic-g), and a faster pace of biological aging (DunedinPoAm) in adults. Following preregistered analyses, we found that the epigenetic profiles of children from disadvantaged backgrounds looked worse than other children (a), and that children's epigenetic profiles were associated with their performance on a range of cognitive tests (b). Epigenetic profiles are a promising tool and can help us better understand how social inequalities become embedded in the body and impact the mind.

Adapted from Raffington et al. (2023)

Key References

Raffington, L., Schneper, L., Mallard, T., Fisher, J., Vinnik, L., Hollis-Hansen, K., Notterman, D. A., Tucker-Drob, E. M., Mitchell, C., & Harden, K. P. (2023). Salivary epigenetic measures of body mass index and social determinants of health across childhood and adolescence. *JAMA Pediatrics*. Advance online publication. https://doi.org/10.1001/jamapediatrics.2023.3017
MPG.PuRe DOI

Raffington, L., Tanksley, P. T., Sabhlok, A., Vinnik, L., Mallard, T., King, L. S., Goosby, B., Harden, K. P., & Tucker-Drob, E. M. (2023). Socially stratified epigenetic profiles are associated with cognitive functioning in children and adolescents. *Psychological Science*, *34*(2), 170–185. https://doi.org/10.1177/09567976221122760
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Research Team 2020-2022/23

Last update: August 2023

Head

Laurel Raffington

Postdoctoral Fellows

Yayouk E. Willems

Predoctoral Fellows

Muna Aikins (LIFE), Deniz Fraemke

Visiting Researcher

Javier de la Fuente (University of Texas, Austin, USA), Bridget Goosby (University of Texas, Austin, USA), Jan-Henrik Walter (Freie Universität Berlin, Germany)

A current list of the Group's staff with links to their web profiles can be found on the Group's website.

Image: MPI for Human Development

MPRG Biosocial | Biology, Social Disparities, and Development Publications 2020–2022/23

Updated on a daily basis

Journal Article (6)

2023

Journal Article

Raffington, L., Schneper, L., Mallard, T., Fisher, J., Vinnik, L., Hollis-Hansen, K., Notterman, D. A., Tucker-Drob, E. M., Mitchell, C., & Harden, K. P. (2023). Salivary epigenetic measures of body mass index and social determinants of health across childhood and adolescence. *JAMA Pediatrics*. Advance online publication. https://doi.org/10.1001/jamapediatrics.2023.3017

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Journal Article

Raffington, L., Schwaba, T., Aikins, M., Richter, D., Wagner, G. G., Harden, K. P., Belsky, D. W., & Tucker-Drob, E. M. (2023). Associations of socioeconomic disparities with buccal DNA-methylation measures of biological aging. *Clinical Epigenetics*, *15*, Article 70. https://doi.org/10.1186/s13148-023-01489-7

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Journal Article

Raffington, L., Tanksley, P. T., Sabhlok, A., Vinnik, L., Mallard, T., King, L. S., Goosby, B., Harden, K. P., & Tucker-Drob, E. M. (2023). Socially stratified epigenetic profiles are associated with cognitive functioning in children and adolescents. *Psychological Science*, *34*(2), 170–185. https://doi.org /10.1177/09567976221122760

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Journal Article

Raffington, L., Tanksley, P., Vinnik, L., Sabhlok, A., Patterson, M., Mallard, T. T., Malanchini, M., Ayorech, Z., Tucker-Drob, E. M., & Harden, K. P. (in press). Socially stratified DNA-methylation profiles are associated with disparities in child and adolescent mental health. *Clinical Psychological Science*.

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Journal Article

Raffington, L., Tanksley, P. T., Vinnik, L., Sabhlok, A., Patterson, M. W., Mallard, T., Malanchini, M., Ayorech, Z., Tucker-Drob, E. M., & Paige, K. (2023). Associations of DNA-methylation measures of biological aging with social disparities in child and adolescent mental health. *Clinical Psychological Science*. Advance online publication. https://doi.org/10.1177/21677026231186802

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Journal Article

Willems, Y. E., & Raffington, L. (2023). Trait correlations in human couples. *Nature Human Behaviour*. Advance online publication. https://doi.org/10.1038/s41562-023-01673-y

MPG.PuRe DOI

MPRG iSearch | Information Search, Ecological and Active Learning Research with Children

Head: Azzurra Ruggeri

The great pioneer of computer science, Alan Turing, famously believed that to build a general artificial intelligence, one must create a machine that can learn like a child. However, this dream seems to be still quite out of reach. A child is indeed the only known system that develops into an intelligent agent through playful exploration. However, to this day, we do not know much about *how* children explore or *why*—what motivates them, what drives their specific exploratory actions and patterns, how active exploration and question asking support their learning, or to what extent this behavior is purposeful and goal directed. We do not even know exactly whether and in what ways children's exploratory and learning behavior differs from that of adults.

Indeed, despite their capital importance, there has not been much work trying to answer these questions. Most of the developmental research in the last decade has been fueled by the idea that children are *curious* explorers, and by the metaphor of the "child as a scientist," which is intriguing and admittedly very powerful but also has its limits, being a little too vague on the *whys* and *hows*, and a little shallow on the mechanisms and the processes, which are often investigated only superficially. The iSearch research program addresses these questions by focusing precisely on the mechanisms underpinning individual differences and developmental changes to work out how children become adults by exploring and learning in active, meaningful, self-directed ways. By bringing together methods and insights from developmental and cognitive psychology, philosophy, education, information theory, and computational modeling, our research sheds light on the cognitive, social, and cultural mechanisms underlying children's ability to learn and face uncertain—less or more expected—future challenges, from adapting to a dynamic job market, to studying a new subject, to facing a pandemic.

In particular, from this unique and highly multidisciplinary perspective, we can (1) objectively measure and quantify developmental differences in active and ecological learning, tracing their emergence, and (2) develop and compare alternative models of children's and adults' behavior, capturing the individual differences and the mechanisms driving and constraining developmental changes. This more computational groundwork generates insights, paradigms, and theoretical frameworks that (3) open new perspectives on the study of children's learning in social and digital environments, and (4) can inform the development of more effective interventions to support children's learning potential in classroom settings and beyond.

In the last 6 years, iSearch has tested over 5,000 children and adult participants by conducting experiments in the lab and, more recently, online, and establishing long-term collaborations with public and private kindergartens and schools, museums such as the Natural History Museum and the Labyrinth Children's Museum (see Figure 1), and the Berlin Zoo. Also, we have tested over 600 children in collaboration with colleagues from universities and partner institutions in the United States, Cuba, Italy, India, and Egypt.

Figure 1. Illustrations of the testing setup in the collaborating schools and museums.
Image: Gesine Born

In what follows, we give an overview of these four research themes, highlighting iSearch's scientific achievements of the last 6 years, as well as current and future directions.

1. Emergence and Developmental Trajectory of Active and Ecological Learning

The work of iSearch investigates theoretically and empirically how children actively seek information in their physical and social environments to test and dynamically revise their hypotheses and theories. We explore the effectiveness of children's information-search and hypothesis-testing strategies, such as question asking and active exploration, tracing their emergence and developmental trajectory. Crucially, the effectiveness of such active learning strategies cannot be measured in absolute terms. Instead, their effectiveness depends on the characteristics of the task at hand and the available resources, as well as on the learners' prior knowledge and expectations. In this sense, to maximize learning effectiveness, it is crucial to be able to adapt one's active learning strategies to the current situation—an ability we refer to as *ecological active learning* (Ruggeri, 2022). For example, the quality of a question has been traditionally tied to whether it is hypothesis scanning or constraint seeking (Mosher & Hornsby, 1966). Hypothesis-scanning questions are tentative solutions, that is, single objects or hypotheses that are tested directly (e.g., "Was he late because he woke up late?"). Constraint-seeking questions instead aim to reduce the space of possible hypotheses by targeting categories or testing features shared by several different hypotheses ("Was he late because he could not find something?"). Constraint-seeking questions have been generally considered more informative than hypothesis-scanning questions, because they allow the question asker to rule out multiple hypotheses at once, thus reducing the number of questions needed to identify the solution. However, this is not always the case. Indeed, this qualitative distinction does not necessarily reflect the questions' actual informativeness, as can be formally measured, for example, by calculating their expected information gain (EIG), that is, their expected reduction in uncertainty (Lindley, 1956; Shannon, 1948).

From this more quantitative, computational perspective, we were able to provide the first evidence demonstrating that ecological active learning emerges early in development. Seven- and 10-year-olds generate different types of questions depending on the likelihood distribution of the hypotheses under consideration, in order to maximize the questions' informativeness (Ruggeri & Lombrozo, 2015). Also, by age seven, children are as sensitive as adults to the causal sparsity (i.e., the number of variables that are likely to impact an outcome) of an unfamiliar causal system, and use this information to tailor their testing strategies (Bramley et al., 2022; for the computational framework and results with adults, see Coenen et al., 2019). Also, this approach allowed us to capture how children's active physical learning is as effective and goal-targeted as adults' (Bramley & Ruggeri, 2022). In more recent work, we extended this investigation to explore younger children's ecological active learning abilities and found that at 5 years old, children already rely on different types of questions depending on the likelihood of the available hypotheses (Ruggeri, Sim, & Xu, 2017). By implementing a nonverbal version of this same paradigm, we were able to demonstrate that even 3- and 4-year-olds are already able to adapt their exploratory strategies to the statistical structure of a given task (Ruggeri, Swaboda, Sim, & Gopnik, 2019).

2. Mechanisms of Developmental Change

The work presented above illustrates how the computational framework we adopted allowed us to measure and capture the developmental trajectory of active and ecological learning. However, computational methods also enable the studying of developmental changes from the process level, a deeper and richer perspective. By developing and comparing models of children's and adults' behavior, this approach makes it possible to (a) deconstruct and disentangle the mechanisms underlying developmental change, (b) identify the contributions of individual, age-related, and environmental factors to active learning, and (c) capture what drives children's curiosity and persistence.

a) *The mechanisms underlying developmental differences.* Foraging for food, developing new medicines, and learning complex games are search problems with vast numbers of possible actions. Under real-world time or resource constraints, exhaustive exploration is impossible and optimal solutions are generally unobtainable. How do children and adults learn what actions to take when not all outcomes can be explored, balancing exploration and exploitation? On the one hand, we want to explore unfamiliar options that can provide useful information for future decisions, but they may result in poor immediate rewards. On the other hand, we want to exploit options that we know are highly rewarding, but this often implies giving up on learning about unexplored options. A key finding in the psychological literature is that children tend to try out more options than adults, and this has been interpreted as evidence for higher levels of random exploration. They would initially sample very randomly across a large set of possibilities before eventually focusing on a smaller subset. This high *temperature* parameter is then expected to "cool off" with age, leading to lower levels of random exploration in late childhood and adulthood. However, there are other potential explanations for developmental differences in search. Developmental changes in the variability of sampling could also be explained by changes in *directed* exploration**.** In this sense, children's search *appears* more scattered, but only because they are more likely to seek highly uncertain options in order to gain more information and reduce uncertainty about the environment, and learn. Rather than seeing development as a change in how children explore, we could explain developmental differences in sampling as a refinement of cognitive processes, leading to a broader generalization. That is, development might be associated with a more fine-grained ability to generalize beyond observed outcomes, thereby guiding search by forming inductive beliefs about novel options.

We tested the individual contribution of these three, not mutually exclusive mechanisms by developing a spatial search task in which 7- to 11-year-old children and adults were presented with a grid. A single tile was initially revealed, and participants were given a limited number of clicks to acquire as many points as possible. Rewards were spatially correlated, with nearby tiles having similar rewards, where the patches were identifiable by color. This spatial structure of the environment provided traction for generalization, which could be used to guide search and could support this generalization more, as in smooth environments, or less, as in rough environments.

We found that adults gained higher rewards than children and exploited more strongly; that is, they were more likely to re-click, whereas children sampled more unique options, thereby gaining lower rewards but exploring the environment more extensively. Using a computational model with parameters directly corresponding to the three hypothesized mechanisms of developmental change, we found that children, compared to adults, generalized less from observed to unobserved tiles and relied on uncertainty-directed exploration more. We did not, however, find differences in random sampling. Overall, our results shed new light on the developmental trajectories in generalization and exploration, casting children not as merely prone to more random sampling behavior but as directed explorers who are hungry for information in their environment (Schulz et al., 2019). Using the same paradigm, we extended this developmental investigation to include 4- to 7-year-old children and found that although younger children tended to be more random in their search compared to older children and adults, even 4-year-olds showed uncertainty-directed exploratory patterns (Meder et al., 2021).

b) *Individual, task-related, and environmental differences in active learning.* Existing research on active learning has focused on identifying key developmental differences in the efficiency and adaptiveness of children's search. This research has highlighted three important sources of developmental change: an increasing ability to recognize and exploit the abstract, hierarchical structure of the hypothesis space (Chai et al., 2023; Jones et al., 2021; Ruggeri & Feufel, 2015; Ruggeri et al., 2021), the ability to adapt one's search strategy based on task characteristics (Ruggeri & Lombrozo, 2015; Ruggeri et al., 2019), and a growing ability to implement efficient rules to stop searching for more information (Ruggeri et al., 2016). However, we do not yet understand why these changes occur or what factors underlie the observed developmental trajectories. More specifically, we do not know what task-related, environmental, and individual factors drive developmental changes in active learning, how they interact with each other, or how their relative importance changes with age.

To answer these critical questions, in a cross-cultural collaboration with partners in Cuba, Egypt, and India (see Figure 2, right), we are currently writing up a complex Structural Equation Modeling exploratory analysis aiming to identify and map the factors contributing to active learning performance, beyond the broad developmental differences captured in previous research. On the one hand, the project aims to measure different aspects of active learning (e.g., effectiveness, adaptiveness, speed, accuracy) on a wide range of tasks (e.g., question asking, question evaluation, spatial search) to comprehensively assess 6- to 11-year-old children's active learning performance (see Figure 2, left). On the other hand, we will systematically examine the cognitive, social, motivational, cultural, and socioeconomic factors impacting and contributing to active learning performance, to identify the sources of the developmental differences and interpret the individual differences observed. In this sense, the cross-cultural design allows us not only to examine a broader range of cultural differences (e.g., type of education) and to assess the robustness of our methods, but also to generalize our results to populations not usually represented in psychological research.

Figure 2. Overview of the tasks included in the Active Learning battery (left), and photographs of the cross-cultural data collection in Cuba, Egypt, and India (right).
Image: Azzurra Ruggeri

c) *What drives children's curiosity.* The work presented in this section shows that children engage in meaningful and effective exploration, but it does not address the question of whether, in general, the opportunity to gain information is enough to motivate children's search. This is one of the greatest challenges for artificial intelligence—how to behave adaptively in scenarios with sparse or no rewards. Psychologists, computer scientists, and roboticists suggest that "curiosity-based" systems may do better than standard reinforcement learning methods. These systems have in common the idea that quantitative increases in information gain are themselves rewarding and motivate actions, and they are often explicitly inspired by the curiosity-based exploration of young children. It does indeed seem crystal clear that young children are curious and that this contributes to their impressive learning abilities. However, thus far there has been no work investigating what motivates children to explore and learn in the absence of external rewards. In a recent paper (Ruggeri et al., 2023), we investigated whether and to what extent the opportunity to gain information motivates young children's exploratory actions, that is, whether expected information gain serves as an intrinsic reward, strong enough to drive exploration and learning.

In three studies, we measured 24- to 56-month-old children's persistence in a game in which they had to search for a cartoon animal hidden behind a series of closed doors. Crucially, we manipulated the degree of uncertainty about which specific animal participants were searching for; that is, either we told children which animal they were searching for (e.g., the lion), or we told them that it could be one of eight different animals—so that finding the hidden animal gave children information about its identity, in addition to discovering its location (see Figure 3, top). Although the hidden animal was never revealed, regardless of the time children spent searching, our results indicate that children were more persistent in their search in the eight-animals condition (in orange in Figure 3c), when there was higher uncertainty as to which animal they would find, and therefore more information to be gained: They opened more doors on average and searched for a longer time, and more of them persevered and kept on opening doors until the end of the game (see Figure 3, bottom). These results indicate that, in the absence of any rewards, toddlers and preschoolers' search is motivated by the expected informativeness of the actions that can be performed, highlighting how important it is for research on artificial intelligence to invest in curiosity-driven algorithms.

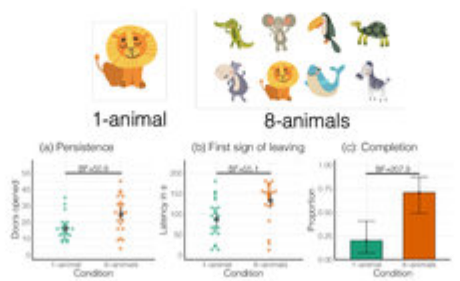

Figure 3. Experimental stimuli and results from Study 1 of Ruggeri, Peltz, Gopnik, and Schulz (2023).

3. The Role of Active Learning in Navigating Social Environments

The developmental and computational work on active learning we did in past years generated insights and offered new methods that can enrich and deepen our understanding of children's social learning. Effective learning requires the ability to identify from whom to learn and whom to ask for help. Despite much prior work on children's evaluation of informants in pedagogical contexts and their ability to selectively learn from more informative teachers, little is known about children's sensitivity to *how* potential teachers come to know what they know. Do children consider the process of others' learning to decide from whom to learn? By choosing to seek help from other individuals who are better learners themselves, children can maximize opportunities for *learning how to learn*. Indeed, we found that adult-like meaningful and selective inferences based on other people's ability to search effectively emerge around age five (De Simone & Ruggeri, 2021). Along these lines, in a recent series of studies we showed that even young children prefer to learn from successful active learners and choose to learn from such learners selectively depending on the context (Bridgers et al., 2023). These results are interesting, in two different ways: First, they suggest that already preschoolers take into account *how* an agent reached a certain outcome, beyond the observed effectiveness of an agent's actions. However, in a recent paper (Törok et al., 2023) we showed that until age eight children struggle to infer competence from more implicit cues, such as expected strategy efficiency, and that success and observed strategy effectiveness (for example the duration of exploration), sometimes erroneously, remains a powerful cue for competence throughout childhood and even in adulthood. Second, they suggest that children may be able to disentangle, to a certain extent, between someone who knows things—an expert—and someone who is not knowledgeable but is competent in learning about new things, for example, someone who is good at asking questions (De Simone & Ruggeri, 2022).

4. Interventions to Boost Learning

How can we boost children's learning success in classroom settings and beyond? One way to do this is to develop *interventions* that enhance children's learning performance by supporting the effectiveness of their active learning strategies, for example, helping them ask more informative questions. Previous attempts to improve children's question-asking strategies have achieved only moderate success. Most children did not improve their performance over time, and the modest training benefits, when present, did not generalize to other sets of stimuli or domains and were no longer apparent just a few days later. However, our work shows that it is indeed possible to support children's question-asking performance even without extensive training (see Ruggeri et al., 2021). For example, we found that prompting children to *explain* previously observed sets of causal data helped 6- and 7-year-olds, but not younger children, ask more effective questions (Ruggeri et al., 2019). Improving children's active inquiry skills at an early age has the potential to accelerate the development of their general information-search strategies and problem-solving skills, boosting their later independent learning.

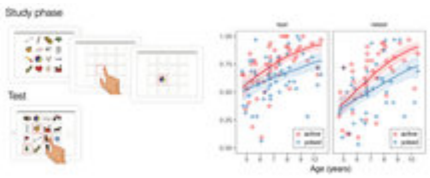

Figure 4. Experimental design (left) and results of Study 1 (right). From Ruggeri, Markant, Gureckis, Bretzke, and Xu (2019).

Another way to boost children’s learning success is to design learning environments that enhance their performance. For example, in a series of computational modeling studies, Ruggeri, Markant, Gureckis, Bretzke, and Xu (2019) found that having the opportunity to actively control the study experience—for example, to decide what to study, when, and for how long (see Figure 4, left)—leads to enhanced learning in 5- to 11-year-old children, compared to conditions that lack this control (see Figure 4, right). We recently replicated these results with a population of children affected by autism (Fantasia et al., 2020). In a recently published work, we also showed that a spatial representation of a search task supports 4- to 7-year-old children’s information-search strategies, relative to their performance in a question-asking game (Swaboda et al., 2022). These results also demonstrate that efficient search strategies emerge much earlier than previously assumed, highlighting the importance of developing age-appropriate paradigms that capture children’s early competence to gain a more comprehensive picture of their emerging information-search abilities.

Conclusion

To conclude, the iSearch research program inaugurates a new perspective, ecological active learning, that challenges a simple data-driven view of knowledge acquisition and change, in which children’s learning is only a function of their casual observations and the teaching from others. Instead, thanks to the novel integration of developmental and computational methods, our work sheds new light on the mechanisms underlying and driving developmental trajectories in exploration, casting children as motivated and curious learners who are hungry for information in their environment, but also sensitive, selective, effective, and—above all—adaptive.

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Research Team 2020–2022/23

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Head

Azzurra Ruggeri

Postdoctoral Fellows

Francesca Bonalumi, Constanza De Simone, Andreas Domberg (as of 09/2022: The Flying Squirrel, Berlin, Germany), Yi-Lin Li, Anselm Rothe (until 08/2021), Oana Stanciu, Georgina Török

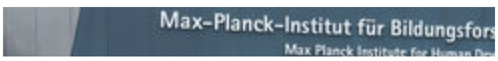
Predoctoral Fellows

Hande Melis Altunay, Fatma Sila Cakmak, Kai-Xuan Chai, Andrea Guerri, Ohan Hominis, Angela Jones (LIFE, until 06/2021), Daniil Serko, Nora Swaboda, Laura Ziemann

Visiting Researchers

Sophie Bridgers (Massachusetts Institute of Technology, Cambridge, USA), Diego de la Hera (University of Buenos Aires, Argentina), Yarrow Dunham (Yale University, New Haven, USA), Tommaso Ghilardi (Radboud University Nijmegen, the Netherlands), Liz Lapidow (University of California, San Diego, USA), Julia Leonard (Yale University, New Haven, USA), Francesco Poli (Radboud University Nijmegen, the Netherlands), Cansu Oranç (Bahçeşehir University, Istanbul, Turkey), Caren Walker (University of California, San Diego, USA)

A current list of the Group's staff with links to their web profiles can be found on the Group's website.



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Journal Article (33)

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2021

Thesis - PhD

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MPG.PuRe Full

MPRG Naturalistic Social Cognition (Concluding Report)

Head: Annie E. Wertz

Introduction

The Max Planck Research Group Naturalistic Social Cognition explored social learning and cognitive development from an evolutionary perspective, with a focus on infancy and early childhood. The group's primary research program investigated how infants and young children learn about plants. The group used a combination of laboratory studies, naturalistic observations, cross-cultural studies, and cross-species comparisons to examine this previously unexplored aspect of the human mind. The group's work established a novel area of inquiry within the field of cognitive development. This group started its work in 2015 and concluded in 2023.

At first glance, it may not seem like plants would play a major role in shaping the human mind. The kinds of environments in which many of us spend our time give the distinct impression that plants are a very small part of human life. Imagine your home, your office, your city, or hometown. In what contexts do you encounter plants? Perhaps you picture houseplants in pots, or fruits and vegetables piled on shelves in the supermarket, or grassy lawns and tree-lined gardens. In these kinds of environments, plants can be an afterthought, or at least a part of our lives we do not have to think about very much. But shifting our frame of reference a bit shows just how mistaken this impression is (Figure 1).

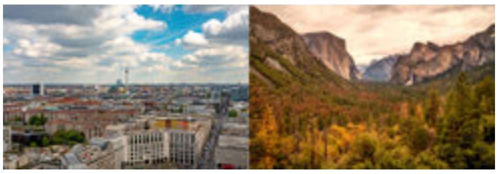

Figure 1. Modern environments in which many of us live can have little plant life (left panel). In natural environments, life is mostly plants (right panel).

In fact, life is mostly plants. Recent estimates indicate that about 80% of the biomass on Earth is plants. The sheer ubiquity of this form of life means that plants have likely played a significant role in the evolution of most organisms, including humans. Of course, in order to impact human evolution, plants must have been a consistent feature of human ancestral environments, and here we are on fairly firm ground. Contrary to claims that one cannot know anything about ancestral environments, we can be reasonably confident that plants were present throughout human evolution. The first vascular land plants appeared around 450 million years ago and the first scale trees and seed ferns emerged about 350 million years ago, well before the first dinosaurs and mammals. The first flowering plants appeared around 180 to 145 million years ago, well before the first primates emerged around 65 to 56 million years ago and made their living in the trees.

Humans evolved in a world replete with plant life and there is good evidence for a long evolutionary history of plant use, extending well back to our hominin ancestors. The evidence shows that our ancestors had plant-rich diets and provides clues to the types of plants on which different hominin species relied. The picture is complex, but in general terms, the genus Homo had a relatively broad-based diet compared to earlier hominins and tended not to specialize in one type of plant resource. Analyses of plant micro-remains from dental calculi and stone tool residues from Neanderthals and early modern humans underscores the breadth of plant resources that were exploited. The results suggest that both species consumed a wide array of plant foods, including grass seeds and underground storage organs such as tubers and bulbs.

It is also extremely well established that plants have shaped countless adaptations in other animals and vice versa. The breadth and variety of these adaptations is beyond the scope of this section of the report, but a few well-known examples are the differently shaped beaks of Darwin's finches and the camouflage of the leaf insect (Figure 2). Plants have also shaped cognitive adaptations in animals. For example, several species have been shown to categorize different types of plants based on predictive features. Bees who learn to forage at one type of (artificial) flower generalize this information via the color, pattern, and scent of the flowers. Similarly, sheep distinguish different plants based on invariant features of plant species like leaf shape, not variable features such as height.

Figure 2. Some adaptations shaped by plants. The beaks of Darwin's finches (left panel) are well tailored to the food sources the birds exploited on different islands in the Galapagos. For example, one type of finch fed on hard plant seeds and had a correspondingly shorter and more powerful beak, while another fed on insects plucked from bark and other vegetation and had a much thinner pointed beak. Leaf insects (e.g., *Pulchriphyllium pulchrifolium*, right panel) evolved features to mimic their densely leafy habitats and camouflage themselves from predators.

Left image: from *Birds. The zoology of the voyage of H.M.S. Beagle* by John Gould, 1841; public

domain, the author died in 1881, copyright in country of origin and others have expired
Right image: "*Pulchriphyllium pulchrifolium, Pärchen*" by Drägü on Wikimedia, CC BY-SA 4.0

Therefore, the claim that plants have shaped the human mind should be uncontroversial. And, in fact, it is a claim that has been made by others to account for specific aspects of human behavior. For example, young children's tendency to reject eating vegetables has been hypothesized to be a mechanism for avoiding accidental plant poisoning. However, to our knowledge, there was no systematic study of the ways in which plants have shaped the human mind prior to the work of the MPRG Naturalistic Social Cognition.

Research Team 2020-07/2023

Last update: August 2023

Head

Annie E. Wertz (as of 03/2024: University of California, Santa Barbara, USA)

Postdoctoral Fellows

Linda S. Oña (as of 06/2023: Leipzig University, Germany), Camille Rioux (as of 10/2022: Université Paris Cité, France), Karola Schlegelmilch (LIFE; as of 08/2023: Leipzig University, Germany)

Predoctoral Fellow

Connair J. S. Russell (LIFE; as of 07/2022: Queen's University Belfast, UK)

Visiting Researchers

Valentina Fantasia (Lund University, Sweden), Camille Rioux (Université Paris Cité, France), Andreas Wilke (Clarkson University, Potsdam, USA)

A current list of the Group's staff with links to their web profiles can be found on the Group's website.

Image: MPI for Human Development

PLANTing the Seeds of a Novel Research Area

Although it may be uncontroversial that plants have shaped the human mind in some way, without the right theoretical tools the precise consequences of their impact may be less obvious. This is especially true because of the seemingly minor role plants play in our own lives. This makes it difficult to imagine their potential consequences for human cognition using our own intuition. An evolutionary approach is invaluable in this case. It allows us to formulate hypotheses about how the kinds of interactions humans have had with plants over evolutionary time have impacted the human mind. We use an adaptationist approach that couples what is known about human ancestral environments with analyses of selection dynamics and evolutionary principles to make testable predictions about the design of human cognitive systems. This approach can be (and is) used with any aspect of the human mind. Importantly, it makes concrete predictions that can be tested and falsified in modern populations using standard methods.

The adaptationist logic for the predicted structure of human cognitive systems for plants is relatively straightforward. As outlined above, humans have a long evolutionary history with plants and have used plants in a variety of ways, including as food and raw materials for constructing artifacts. At the same time, plants can inflict serious harm. In order to protect themselves from herbivores, all plants produce toxic chemicals, many of which can be harmful or even fatal to humans when ingested. Some plants also have mechanical defenses like thorns and stinging hairs, or excreting toxins that can cause serious skin injury and even systemic effects. Therefore, the fundamental problem humans have had to solve with respect to plants is to determine which ones are food (or otherwise useful) and which are fatal. This turns out to be a difficult task.

Plants are in co-evolutionary relationships with a multitude of different herbivorous species. This means that plants have evolved features that are tailored to the sensory systems and physiologies of animals that are very different from humans, and very different from each other (e.g., insects, birds, ungulates, etc.). As a result, from a human perspective there are no morphological features common to all edible or to all poisonous plants. This means that simple rules like “all purple fruits are edible” or “plants with white flowers are poisonous” simply do not work (Figure 1). Trial-and-error learning, in which an individual directly samples different plant species and experiences the consequences, is not an effective strategy for learning about plants. That individual would risk spending a considerable amount of time being ill, at worst even dying. Instead, these circumstances select for the evolution of social learning mechanisms to acquire information from other more knowledgeable individuals. This is a theoretical proposal that we have confirmed with evolutionary modeling work (Oña et al., 2019).

Figure 1. The peril of trial-and-error learning: Ramsons (Allium ursinum) leaves (upper left) and flowers (lower left). Lily of the valley (Convallaria majalis) leaves (upper right) and flowers (lower right). Both plants can form extensive colonies covering areas of woodland floor. While ramson is edible, lily of the valley is highly poisonous. For a naive forager, the leaves can easily be confused in periods when neither of them has flowers.

The specific proposal is that humans possess a collection of specialized social learning systems that balance the costs and benefits of interacting with plants, called **P**lant **L**earning and **A**voiding **N**atural **T**oxins, or **PLANT** (Wertz, 2019). This novel proposal was at the heart of the work of the MPRG Naturalistic Social Cognition and the paper won the inaugural 2023 Don Symons Adaptationism Award from the Human Behavior and Evolution Society for best exemplifying the adaptationist program. The group’s work was primarily conducted with infants and young children because we were most interested in the structure and operation of these specialized social learning systems at the earliest stages of life, when individuals have the least experience and the most to learn. Our research team was comprised of psychologists and biologists. We specialized in infant cognition, evolutionary psychology, developmental psychology, and visual perception. We ran the MPI for Human Development BabyLab from 2015 to 2023, conducted our studies in kindergartens throughout Berlin, and established collaborations to examine PLANT systems in infants and young children in different cultures and in a variety of non-human primate species. Our primary measures were infant visual attention, including eye tracking; systematic coding of behaviors exhibited by infants and young children across different cultures; and structured tasks that assessed cognitive capacities early in development and in non-human primates.

To be clear, the PLANT proposal does not entail a single bounded module for learning about plants. In fact, in collaboration with David Pietraszewski, a Research Scientist in the Center for Adaptive Rationality (ARC), we have put forward a larger theoretical argument for why claims of functional specialization made by evolutionary psychologists are distinct from claims of Fodorian modularity, and that the field would, as a whole, be better off abandoning "modularity" (Pietraszewski & Wertz, 2022). Instead, the proposal is that PLANT is a collection of specialized systems that shares cognitive architecture with many other areas, including threat learning and danger avoidance, social learning, cultural transmission, food learning, foraging, artifact reasoning, object identification, and visual perception, among others. As a result, the PLANT proposal is generative and wide-reaching. It provides a fresh lens for viewing established problems and has led to the discovery of novel aspects of human cognition.

To date, we have accumulated quite a bit of evidence for certain aspects of the design of PLANT systems from our studies of human infants. This includes evidence for a behavioral avoidance strategy that would mitigate plant dangers like poisoning and skin injury. Unlike dangerous animals, plants cannot move around on their own. They are, quite literally, rooted to the spot. This means that a dangerous plant cannot inflict serious damage unless one approaches the plant and makes physical contact with it by, for example, grabbing it or consuming part of it. As a result, a simple behavioral strategy of minimizing physical contact with plants can be quite effective in minimizing exposure to plant dangers. Consistent with this proposal, our work shows that 8- to 18-month-old infants are indeed reluctant to touch plants compared to feature-matched control objects. We have replicated this novel finding in seven different studies investigating different aspects of the proposed behavioral avoidance strategy. Our recent work has shown, for example, that infants also avoid touching plant parts like leaves and fruits, although not to the same extent as whole leafy plants growing from soil (Rioux & Wertz, 2021), and that watching an adult touch plants reduces infants' own plant avoidance (Włodarczyk et al., 2020).

Of course, many infants grow up in cultures that have much closer contact with plants in their everyday lives than infants from Berlin typically do. Therefore, we established collaborative cross-cultural projects to examine how infants growing up immersed in natural environments respond to plants. For example, in collaboration with Rita McNamara at Victoria University of Wellington, New Zealand, we conducted a study with Indigenous iTaukei Fijians and found that in contrast to German infants, who are avoidant of all plants, Fijian infants are only avoidant of plants that are unfamiliar to them (McNamara & Wertz, 2021). The source of these intriguing patterns of cross-cultural similarities and differences remains to be investigated, but the results demonstrate for the first time that cultural context impacts the development of PLANT systems.

Our recent findings underscore the importance of social learning for plants. We replicated an earlier finding that infants engage in increased social information seeking when they are confronted with plants (Rioux & Wertz, 2021); infants look more often to adults in the time before they touch plants, which would allow them to observe social cues before making contact with potentially harmful plants. We also recently completed data collection for a project replicating and extending our initial findings that 6- and 18-month-old infants selectively learn about plant edibility from adults' social cues. Finally, our naturalistic observations of toddlers and their caregivers in the gardens surrounding the MPI for Human Development revealed the importance of olfactory cues when exploring plants. Toddlers and their caregivers spontaneously explored the scents of different plants by rubbing their fingers on the plants and smelling the residue, and a higher frequency of olfactory behaviors in caregivers corresponded to a higher frequency of these same behaviors in toddlers (Fantasia et al., 2021).

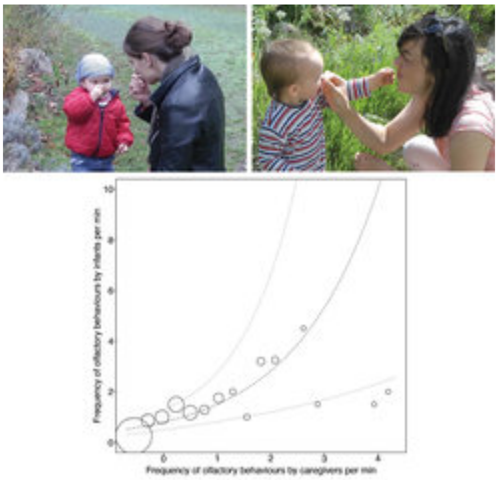

Figure 2. Infants' olfactory behaviors as a function of caregivers' olfactory behaviors. The area of the bubbles corresponds to the respective number of trials in which that value was observed. The dashed line shows the fitted model and the dotted lines the 95% confidence intervals.

Images above: MPI for Human Development
Image below: Fantasia et al. (2021); Infant Behavior and Development

Taken together, the work of the MPRG Naturalistic Social Cognition established a new research area within the field of cognitive development. Some aspects of this work were entirely novel, for example, the discovery of a behavioral avoidance strategy for plants in infancy. Other aspects of this work dovetail with broader research areas within the cognitive sciences and expand existing lines of inquiry along new dimensions.

Collaborative Research Projects

In addition to our primary research agenda, members of the MPRG Naturalistic Social Cognition engage in collaborative projects to investigate various aspects of cognition in humans and non-human primates. In this reporting period, these projects have largely centered on studies of food cognition in children and adults (e.g., Lafraire et al., 2020; Coricelli et al., 2022) and comparative studies of social cognition and communication in non-human primates and canines (e.g., Bohn et al., 2022; Epperlein et al., 2022). The comparative research projects were conducted with researchers at the MPI for Evolutionary Anthropology and the MPI for Geoanthropology, among others.

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Branching Out

The proposal that plants have had a role in shaping many aspects of human cognition means that our research agenda intersects with a variety of well-established research areas. Accordingly, our recent work has broken new ground within existing research traditions. One recently completed project, funded by a grant from the German Research Foundation (DFG), explores novel aspects of food learning in infancy by testing whether 12-month-olds view food processing actions (e.g., cutting a vegetable into pieces) as indicators of edibility. This project used eye-tracking measures, including pupil dilation, and concluded data collection in the summer of 2023. Another ongoing collaborative project with Dr. Andreas Wilke at Clarkson University, Potsdam, USA, funded by the National Science Foundation (NSF), is examining the impact of an evolutionary history of foraging for clumpy resources (e.g., fruits growing on a tree) on statistical reasoning in 3- to 10-year-old children. In this section, we outline two different projects that investigate novel lines of inquiry within object categorization and visual perception, respectively.

Branching Out: Categorization in Infancy

In this project, we examined a novel question within the categorization literature. Specifically, along with Stella Gerdemann, who is now a postdoctoral fellow in the Center for Lifespan Psychology (LIP), we tested whether 18-month-olds use different features to categorize plants than they do other object types (Gerdemann & Wertz, 2021). This article won the Human Behavior and Evolution Society's Margo Wilson Award for the best paper published in the journal Evolution and Human Behavior in 2021.

There are good reasons to predict that categorization rules for plants might have specific design features. Many plants look similar to each other. In fact, some edible plants have evolved a strategy of mimicking poisonous plants in order to protect themselves from being eaten (Figure 1). As a result, the differences between distinct types of plants can be subtle.

Figure 1. Disguised to survive: The mountain alseuosmia (Alseuosmia Pusilla, left panel) has evolved leaves of similar shape, size, and coloration as the toxin-rich New Zealand pepperwood (Pseudowintera colorata, right panel), which helps it avoid herbivorous predators. This is an example of Batesian mimicry.

Mistaking a poisonous plant for an edible one can be a costly error. Therefore, it is essential for any successful plant forager to be able to tell them apart. In fact, our evolutionary modeling work indicates that strategies for successfully distinguishing between different kinds of plants are critical to successful social learning (Oña et al., 2019). Building on this prior modeling work, we set out to test whether generalization rules for plants would be based on fine-grained features that can distinguish similar-looking plants in a study with infants. This project was preregistered on OSF.

We used a variation of a classic task in cognitive development research—a name extension task—to test whether 18-month-olds (N = 40) rely on fine-grained features when categorizing plants, but not in other contexts. Our stimuli were realistic-looking artificial plants with various leaf shapes (Figure 2, top two rows) and feature-matched artifacts made from the exact same leaves as the plants, painted in different colors (Figure 2, bottom two rows).

Our name extension task (Figure 3) had two between-subjects conditions. In one condition, infants were told the name of one type of plant, and then presented with exemplars of that same type of plant and a different type of plant. Infants were asked to identify the plant with the same name as the first plant. In the other condition, infants were shown the same task with the feature-matched artifacts. Given the importance of fine-grained features for distinguishing between plants, our preregistered prediction was that infants would reliably choose the plant with the same leaf shape in the plant condition, but would choose equally between the artifacts in the artifact condition.

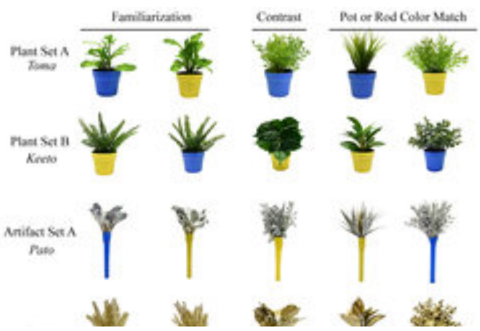

Figure 2. Stimuli and novel names used in Gerdemann & Wertz (2021). The stimuli for the plant condition are shown in the two top rows and the stimuli for the artifact condition are shown in the bottom two rows. Each stimulus set was used in a different trial of the task, and each infant saw two trials. The novel names for each set are shown in the left column.

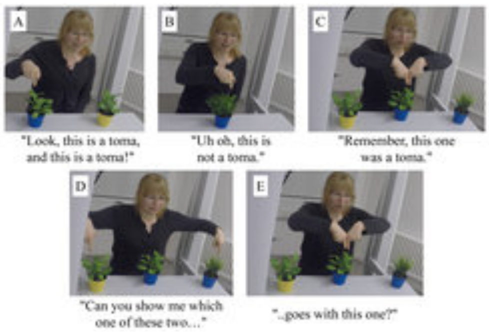

Figure 3. An overview of key phases of the procedure. The plant condition is shown here; the procedure was identical for the artifact condition. (A) Familiarization phase. Two familiarization objects are presented and named, and infants are given 15 seconds to explore them. (B) Contrast phase. Infants are presented with a contrast object that differs in fine-grained features from the familiarization objects and given 15 seconds to explore it. (C–E) Choice phase. The target is presented centrally in front of E and the two test objects are to her right (fine-grained feature match) and left (pot color match; the side of the test objects was counterbalanced across choice phases). Infants are reminded of the target object's name and asked which one of the test objects goes with the target.

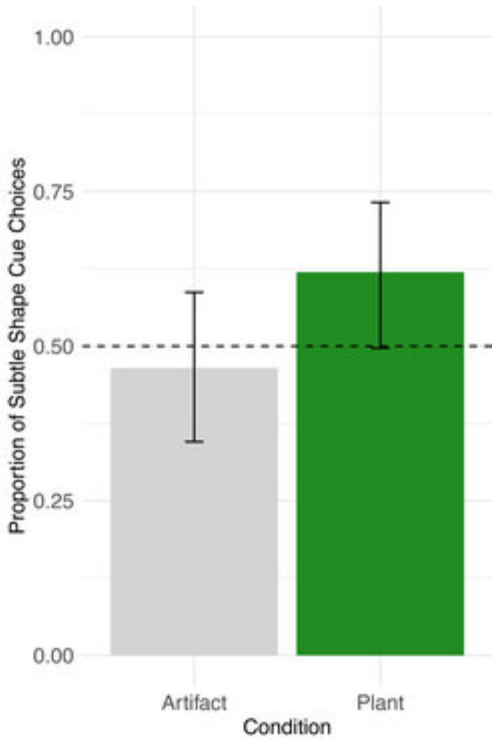

Figure 4. The proportion of 18-month-olds' choices for the fine-grained feature match in the plant and artifact conditions. Infants' choices for the fine-grained feature match were above chance (indicated by the dotted line) in the plant condition (V = 66.5, p = .032, 95% CI [0.54, 0.88]) and did not differ

from chance in the artifact condition (V = 17, p = .32, 95% CI [0.29, 0.67]).

Images Figure 2, 3, and 4: Gerdemann & Wertz (2021), as provided by MPI for Human Development, original image licensed under CC BY-NC-ND 4.0; originally published by Elsevier in *Evolution and Human Behavior*

We found that, as predicted, infants chose the plant with the same fine-grained features (i.e., leaf type) at greater than chance levels in the plant condition, while the proportion of choices for the fine-grained feature match did not differ from chance in the artifact condition (Figure 4). A second study indicated that this difference persists to some degree into adulthood. These results indicate that infants prioritize fine-grained features like leaf shape when generalizing learned information about plants, and demonstrate that infants use different categorization rules for different types of entities.

In summary, this project highlights how theorizing about PLANT systems can uncover new aspects of existing research areas. Given the ubiquity and importance of plants across human evolution, it stands to reason that many aspects of categorization processes may reflect regularities in the botanical world. We look forward to expanding on these initial findings to explore plant categorization rules in detail in the future.

Branching Out: Infant Visual Perception

In this project, we used eye tracking to investigate how infants parse naturalistic scenes at the level of visual perception (Schlegelmilch & Wertz, 2022). Previous studies of infant visual perception mainly used single entities like objects, graphics, or faces presented on uniform backgrounds, but infants' everyday visual environments are replete with complex overlapping forms (Figure 5, left panel). Our aim therefore was to explore visual properties that infants use to distinguish visually complex naturalistic structures. To do this, we tested 8-month-old infants (N = 39) and a comparison sample of adults (N = 20) using a gaze-contingent eye-tracking visual search task. Our stimuli were created from photographs showing extracts of the kinds of entities that appear in naturalistic human environments: vegetation, human-made artifacts, and non-living natural elements (Figure 5, right panel).

Figure 5. Examples of vegetation, artifacts, and non-living natural elements in a naturalistic visual environment (left panel) and example images from each category used in Schlegelmilch & Wertz, 2022 (right panel).

Left image: David Pietraszewski

Right image: adapted from Schlegelmilch & Wertz (2022)
Original image licensed under CC BY 4.0

Infants’ task in this study was to locate a small patch of target image embedded in a background image. If the eye-tracker registered the infant’s gaze on the target, it was counted as a “hit” and a visual reward was shown to the infant (Figure 6). We assessed whether or not the target was detected (a “hit” versus a “miss”) and the latency to detect the target. The target patch and background image differed along a number of dimensions related to specific visual properties (Figure 7A). The visual properties tested in this study were selected from the literature on visual perception and either computationally assessed directly from the images or rated by adults.

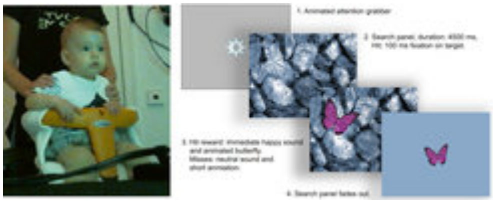

Figure 6. Gaze-contingent eye-tracking search task used in Schlegelmilch & Wertz (2022). The infant was seated in a dimmed room in front of the eye-tracker (EyeLink 1000; SR Research Ltd. 2005–2010; left panel). Four key elements of each trial (right panels), from left to right: (1) attention grabber, (2) search panel, (3) reward after target is detected, and (4) fade out at trial end.

Left image: MPI for Human Development
Right image: adapted from Schlegelmilch & Wertz (2022)
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We did not find evidence that infants performed better with any specific type of naturalistic entity in this task. For example, there was no effect of image category (vegetation, artifact, and non-living natural element) on how quickly infants detected the target image. Instead, we discovered several visual properties that predicted infants’ detection success (Figure 7B). The properties “deviation” and “depth,” for example, strongly affected infants’ search performance. “Deviation” refers to variations in spatial frequency distributions indicating scaling invariance (i.e., a fractal-like quality), and greater differences in deviation between the target and background images were associated with higher probabilities that infants detected the target. “Depth” refers to the spatial arrangement of scene elements, and higher values of depth in the background image were associated with longer detection latencies. These findings are particularly interesting because these properties also impacted categorization decisions in preschool-aged children and in adults in a separate study using these same images (Schlegelmilch & Wertz, 2023). We also found clear developmental differences for a number of properties. For example, the property “alpha” refers to the proportion of larger to smaller changes between light and dark image regions. This property reliably distinguishes between the different stimulus categories of vegetation, artifact, and non-living natural element, but it only predicted adults’ detection performance in this study.

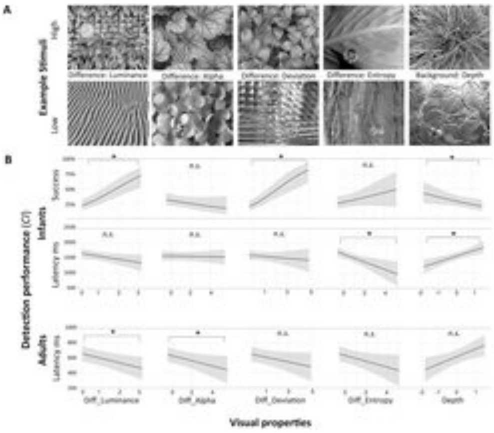

Figure 7. Visual properties and their effect on search performance. Panel A: examples of search stimuli with the respective low and high values of the visual property. “Difference” indicates the difference in the property between the target and background image. “Background” indicates the level of the property in the background image only. Panel B: visual properties as functions of search performance and participant age group, estimated as marginal effects in the statistical models. Asterisks indicate significant contributions of the variable to the full models, see Schlegelmilch & Wertz (2022) for details.

Adapted from Schlegelmilch & Wertz (2022)

Taken together, these findings bring new insights to research on the development of image segmentation and visual search. First, we found that 8-month-old infants were able to parse visually complex naturalistic images. Second, we found that properties such as variations in spatial frequency distributions of the images indicating scaling invariance (i.e., the property “deviation”) predicted detection success as well as low-level salience (i.e., target–background differences in luminance). These findings show that, although the superordinate categories vegetation, artifact, and non-living natural elements did not predict detection performance in our search task, infants are sensitive to visual properties that vary in visually complex naturalistic scenes. In the future, we hope to investigate whether social information about plants and other entities in naturalistic scenes impacts infants’ visual search. Thus, at a broader level, this project demonstrates the benefits of investigating the early development of visual perception with naturalistic stimuli that reflect real-world human environments.

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Summary and Future Directions

The work of the MPRG Naturalistic Social Cognition established a novel research area within cognitive development. Our findings to date are consistent with the predicted design of PLANT systems. Specifically, infants are initially reluctant to touch plants, they minimize their subsequent contact with them, and they look more often to adults before touching plants. This kind of behavioral avoidance strategy coupled with increased social information seeking would mitigate harm from plants (e.g., poisoning, skin injury) and allow infants to glean social information before making contact with potentially dangerous plants. This initial avoidance can be overcome with social information. Infants selectively learn about plant properties, like which plants can be eaten and which ones are safe to touch, by watching what adults do. Finally, once infants have learned something about a particular plant, they generalize that information in cautious ways using fine-grained features that can distinguish between similar-looking plants. We have also collected some of the first evidence that aspects of PLANT systems are shared cross-culturally, albeit with some interesting cross-cultural variation, and that several non-human primate species show plant-specific behavioral responses, as reported in previous editions of the Research Report. In addition, our research brings a fresh lens to existing areas within the cognitive sciences and has led to new discoveries in areas such as infant categorization and visual perception.

Image: MPI for Human Development

In its entirety, our research program provides a clear example of using an evolutionary approach to uncover previously unknown areas of human cognition and demonstrates that, counter to common misunderstandings, learning and evolution are not mutually exclusive processes. Instead, evolution can build learning systems that are tailored to specific kinds of content. Because this is a novel research area, there are many open avenues to explore. Importantly, this work can also inform the design of real-world programs to engage infants and young children with plants early in life and connect them with important issues like healthy eating, biodiversity, and sustainability. This research program will continue at the University of California, Santa Barbara, in the Department of Psychological & Brain Sciences, where Dr. Annie E. Wertz has secured a tenure-track professorship.

MPRG Naturalistic Social Cognition Publications 2020-2022/23

Updated on a daily basis

Journal Article (20)

2023

Journal Article

Florkiewicz, B. N., Oña, L. S., Oña, L., & Campbell, M. W. (2023). Primate socio-ecology shapes the evolution of distinctive facial repertoires. *Journal of Comparative Psychology*. Advance online publication. https://doi.org/10.1037/com0000350

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Thesis - PhD (2)

2022

Thesis - PhD

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2020

Thesis - Master

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Research Team 2020-2022/23

Last update: August 2023

Head

Nicolas W. Schuck

Postdoctoral Fellows

Samson Chien (until 10/2021), Shany Grossman (Fellowship of Zuckerman Israeli Postdoctoral Scholars Program, Tel Aviv, Israel), Sam Hall-McMaster (Fellowship of the Alexander von Humboldt Foundation, Bonn, Germany; as of 03/2023: Universität Hamburg, Germany), Christoph Koch (LIFE; as of 02/2023: Universität Hamburg, Germany), Marit Petzka (as of 02/2023: Universität Hamburg, Germany), Xiangjuan Ren (as of 03/2023: Universität Hamburg, Germany), Lennart Wittkuhn (as of 04/2023: Universität Hamburg, Germany), Ondrej Zika

Predoctoral Fellows

Noa Hedrich (Fellowship of Einstein Center for Neuroscience Berlin [ECN], Germany), Anika T. Löwe (COMP2PSYCH), Nir Moneta (Fellowship of Einstein Center for Neuroscience Berlin [ECN], Germany), Fabian Renz (Max Planck School of Cognition), Luianta Verra (LIFE)

Visiting Researchers

Rasmus Bruckner (LIFE, Freie Universität Berlin, Germany), Karolina Finc (Nicolaus Copernicus University in Toruń, Poland), Prashanti Ganesh (Freie Universität Berlin, Germany), Mona Garvert (MPI for Human Cognitive and Brain Sciences, Leipzig, Germany), Satti H. Muhammad (Universität Hamburg, Germany)

A current list of the Group's staff with links to their web profiles can be found on the Group's website.

Image: MPI for Human Development

Research

Area 1: Learning Representations of Values and States—Cognitive Maps in Hippocampus, Orbitofrontal Cortex, and Beyond

This area is concerned with how the brain uses and learns abstract representations during value-based decision making, and asks how we can make good decisions in the face of highly complex and changing sensory observations. > more

Area 2: Neural Replay

A second main focus of our group is the study of sequential reactivation of experience-related brain activity patterns during sleep, wakeful rest, and brief pauses from active behavior, known as replay. > more

Area 3: Computational Psychiatry and Aging

A third focus of our group is to devise and test computational and neural theories of learning and decision making in psychiatric disorders and healthy aging. > more

Area 1: Learning Representations of Values and States—Cognitive Maps in Hippocampus, Orbitofrontal Cortex, and Beyond

For decision making and learning to be effective, one must learn internal representations that suitably abstract high-dimensional inputs such that associations can be learned based on a much more conceptual level than, say, individual pixels of a scene. Even a simple task such as buying an apple in a grocery shop can be intractable if one does not have a reductive transformation that maps the high-dimensional sensory information onto meaningful task states. This process requires not only distinguishing between relevant versus irrelevant input features, but also the incorporation of unobservable knowledge, such as prior contextual information, and knowledge about structural relationships between different objects. Area 1 is concerned with how the brain uses and learns abstract representations during value-based decision making, and asks how we can make good decisions in the face of highly complex and changing sensory observations.

The research we pursue in this area seeks to elucidate where, when, and how the human brain forms such a map of relations between events or items in a given environment in a quasi-geometric format that goes beyond simple stimulus-response learning and facilitates novel inferences. The particular approach we take lies at the intersection of (a) the idea of a cognitive map in the brain as envisaged by Tolman, (b) our knowledge of the neurobiology of value-based decision making, and (c) computational approaches to value and representation learning that have fueled much progress in AI.

This approach differentiates us from most other groups in the field. While most studies in this domain focus on the hippocampal formation, we broaden the concept of a cognitive map. We propose that multiple maps exist in both the hippocampus and prefrontal cortex, influencing each other, and focus on how learning these maps is driven by reinforcement learning signals (see, e.g., Garvert et al., 2023, described below). Contrary to the original animal work based on place cells, we also seek to establish that such maps are not restricted to spatial information (Wu et al., 2020). Based on our own previous work, we focus specifically on the role of the orbitofrontal cortex in building cognitive maps (Schuck et al., 2016), and study how the well-known value signals found in this same area integrate with cognitive map-like representations (Moneta et al., 2023 and see below). Finally, we take an integrated computational approach known as (deep) reinforcement learning, in which the development of internal representational spaces and value-signals both derive from learning operations in a connectionist architecture.

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Project 1.1: Representation Learning of Task States

Research Scientists

Shany Grossman

Andrew Saxe (Gatsby Unit & Sainsbury Wellcome Centre, University College London, UK)

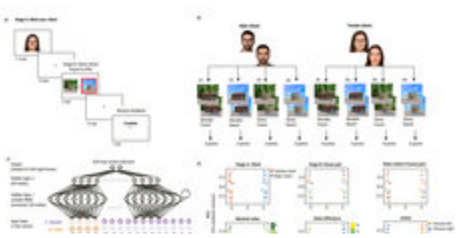
Christopher Summerfield (University of Oxford, UK)

Nicolas W. Schuck

In this study, we aim to investigate representation learning in the human brain through the lens of deep reinforcement learning networks. Using this computational framework, which combines scalar reward feedback signals with backpropagation and a connectionist architecture, we derive a number of testable predictions about learning-induced changes in human behavior and brain activity that we aim to test using fMRI.

To this end, we designed a partially observable decision-making task, in which a context (a client) determines the values of a pair of choice options (houses) that are composed of two relevant (i.e., reward-predicting) and one reward-irrelevant feature. Participants learn from feedback, and can only be successful at the task if they develop context-dependent and attentionally filtered house representations (see Figure 1a/b for the task description).

Results from a recurrent neural network (Figure 1c) trained to predict the values of each client–house combination in our task show that the learned internal representations of task states are primarily organized along two orthogonal axes—client type (i.e., context) and house type (Figure 1d). Interestingly, the network's representational space primarily retains information about the input structure and does not merely collapse states based on their predicted reward, as might have been expected. Tracking the emergence of this representational space using a temporally resolved analysis, we find that the context—which explains the most variance in the hidden units' responses (layer 1)—is the first to emerge during representation learning, followed by the specific combination of houses to choose from (Figure 1e), which differentiate also between relevant and irrelevant features. Values, however, are not a main driving force while learning task representations (although they are embedded more indirectly in the network activations, which can only be seen with a non-linear decoding approach). One interesting theoretical implication of a deep reinforcement learning account is that learning should show a particular covariation structure, meaning that feedback about one choice will influence future behavior not only in regards to this choice but also a number of related choices, as well as their internal representations. Our simulations show that this covariation structure indeed exists, and mimics the geometry of the network's internal representations: Feedback about one state drove representational changes not only in this state but also in all other, non-feedbacked, states from the same context (Figure 1f). Ongoing work will test these predictions about state representation learning in behavioral and neural data (BOLD fMRI) from humans.



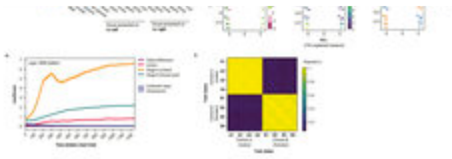


Figure 1. Representation learning of task states in a deep reinforcement learning model. (A) One single trial in the task. Participants are presented with an image of a client, followed by two optional houses they can offer the client. Upon selecting a house, participants received reward (how "pleased" the client was). (B) Value structure of the task: One relevant client dimension (female/male) and two relevant house dimensions (house type: wooden/stone; location: forest/beach) determined the received reward, while additional dimensions were reward-irrelevant (e.g., client with versus without glasses; house with pool versus without pool). (C) Neural network model trained on the task, trained with reward feedback (not supervised feedback) to predict the received reward, using stochastic gradient descent. Client and house information was fed into the network at two separate time steps, and information about the client was retained through recurrent connections in the network's first hidden layer. (D) PCA of single trial representations in the first hidden layer (one representative simulation). The same plot is presented under different color codes, each marking a different trial division, see legend. (E) Using a time-resolved representational similarity analysis we tracked the impact of different factors on the hidden representation in the network throughout learning. (F) A pairwise matrix summarizing the correlations between representational changes of different states in the absence of any direct feedback to the measured states. A representational change in a state drives all states from the same context in the same direction, whereas states from the other context remain unaffected.
Image: Shany Grossman / MPI for Human Development

Project 1.2: Effects of Reward of Neural Representations of Spatial

Research Scientists
Nir Moneta
Charley Wu (University of Tübingen, Germany)
Christian F. Doeller (MPI for Human Cognitive and Brain Science, Leipzig, Germany)
Nicolas W. Schuck

Animals and humans maintain a cognitive map of the environment with unique spatial representations, including hippocampal place cells that encode specific locations and entorhinal grid cells that fire at regular intervals as the animal navigates. These and other cell types are generally seen as a coordinate system for spatial navigation, as well as abstract spaces (see Kaplan et al., 2017; Sharpe et al., 2018). Notably, cognitive maps are susceptible to reward locations, as shown for example by the findings that more place cells represent areas around reward locations, and that grid cells change in firing rate and location.

Project 1.2 aims to investigate how reward morphs cognitive spaces. In a first session, participants perform a perceptual discrimination task (Figure 2a). On each trial, a target tree is presented, followed by two reference trees, and participants need to judge which of the two reference trees is more similar to the target. Trees are characterized by the number of leaves and fruits they carry, such that each tree can be conceptualized as a particular point in a leaf/fruit space, and each comparison has an associated angle (target and references on a given trial always lie on the same line, see Figure 2b). Following this task, participants learn to associate a reward with a set of trees characterized by a specific number of leaves and fruits, akin to introducing a reward to a specific location in the cognitive map (Figure 2c). In the fourth and last session, participants repeat the initial discrimination task from the first session. fMRI is acquired during all sessions.

We hypothesized that at the moment of choice, when the reference trees appear, participants are traveling mentally between the three trees, akin to navigating in an abstract cognitive map. Initial fMRI pilot data reveals evidence for grid-like encoding during perceptual choices in the entorhinal cortex and distance-dependent encoding in the hippocampus. Behavioral analyses show that perceptual discrimination is enhanced for rewarded areas of the map but not for unrewarded ones. Our next steps are to test whether the behavioral change is due to a neural overrepresentation of rewarded areas. To this end, we plan to extract the subject-specific morphs of the cognitive map to test if hippocampal place encoding and entorhinal grid-like code adhere to the new, morphed map.

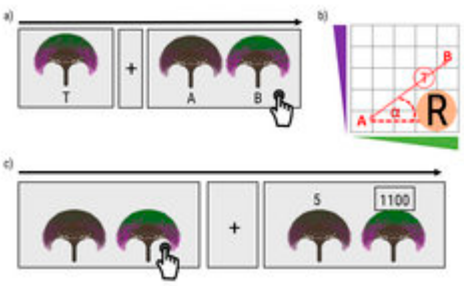


Figure 2. Task design. (a) The experiment consists of four sessions. Participants perform a perceptual discrimination task in the first and fourth sessions, where in each trial a similarity choice has to be made by indicating which of two reference trees is more similar to a target tree. (b) We hypothesize an underlying cognitive map where each tree can be mapped on by its number of leaves (x-axis) and number of fruits (y-axis). (c) Participants learned to associate a specific region in the perceptual space with reward in the second and third sessions. Participants were presented with two trees and had to make a free choice, after which a short fixation cross was presented, followed by the number of gold coins associated with the chosen tree. Note that in panel (b) the most rewarding area of the cognitive map is marked with R.
Image: Nir Moneta / MPI for Human Development

Project 1.3: Learning Slow, Learning Fast: Influence of Temporal Dynamics on Value-Based Function Approximation

Research Scientists

Noa Hedrich
Sam Hall-McMaster
Eric Schulz (MPI for Biological Cybernetics, Tübingen, Germany)
Nicolas W. Schuck

Learning what to attend to is a central part of representation learning. Interestingly, past machine learning research has suggested that meaningful information in the input data is often represented by features that change slowly over time, while fast variations may represent noise or less relevant information. This idea is encapsulated in the so-called slow feature analysis, which proposes that any a priori tendency to attend to slowly changing features of the environment can be an effective strategy for representation learning. We hypothesized that humans also make use of this principle by having a prior belief that slowly changing features are relevant for predicting reward.

Participants (n = 50) completed a learning task where they had to learn the rewards associated with visual stimuli characterized by two features, color or shape, that varied either slowly or quickly over time (Figure 3a–b). To ensure participants were aware of the feature differences, each block started with a passive observation phase in which sequences of changing stimuli were presented (Figure 3c). Crucially, participants then entered a decision-making phase, in which only one of the two features predicted reward, and participants had to decide on each trial whether to accept a default reward of 50 points, or receive the unknown reward associated with a shown stimulus (between 0 and 100 coins). Which feature was reward-predictive changed across blocks, such that in each block either the slowly changing or the quickly changing feature was task-relevant. Feature relevance had to be inferred by participants by observing the relationship between rewards and each feature. At the end of each block, knowledge of stimulus-associated rewards was probed by presenting pairs of stimuli not seen during learning and asking participants to choose the more valuable one, without feedback (Figure 3c).

As predicted, participants accumulated more reward, $t(49) = 2.197$, $p_{\text{1-sided}} = .016$ (Figure 4a), and were more accurate in test trials, $t(49) = 1.849$, $p_{\text{1-sided}} = .035$ (Figure 4b), when the relevant feature changed slowly instead of quickly. To understand the computational origins of this effect, we fitted participant choices with three reinforcement learning models that differed in how they adapted their learning rates to feature variability. One model used the same learning rate regardless of condition (1LR) and thus was indifferent to feature variability. Another model used different learning rates for blocks in which the relevant feature was slow versus fast (2LR), allowing it to adapt to the feature variability. The last model, in addition to adapting to variability, had separate learning rates for the relevant and irrelevant feature (4LR), which allowed it to learn only from the relevant feature, but also differentiate between relevant features that changed slowly versus quickly. Comparing AIC scores showed that the 2LR model performed best, with an average AIC of 475.7 (versus 479.3 and 476.3 for the 4LR and 1LR models, respectively). T-tests showed that AICs of the 2LR were significantly lower than the 4LR model, $t(49) = -3.024$, $p = .012$, Bonferroni corrected, but did not show a significant difference between the 1LR and 2LR models, $t(49) = 0.422$, $p>.05$ Bonferroni corrected (Figure 4c), reflecting large variability across participants (Figure 4d). The results indicate that humans learned better when the relevant feature was changing slowly, suggesting that a prior for slow features might improve human learning in multidimensional environments. Yet, there is significant individual variability in the extent of this effect. Data acquisition is completed and we are in the process of writing a manuscript. Data and code will be released upon publication.

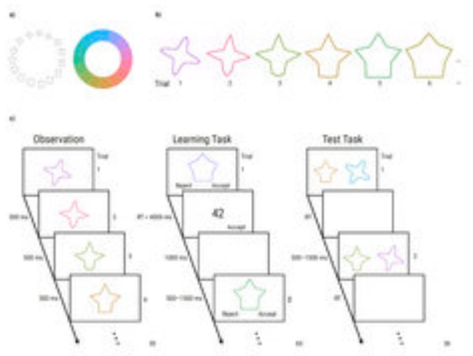


Figure 3. Feature variance learning task. (a) Examples from the two feature spaces used in the experiment. Shapes were sourced from the Validated Circular Shape space and colors were defined as a slice in CIELAB color space. (b) Example sequence of bi-dimensional stimuli. Here shape is the slow feature (low trial-to-trial variability, similar shapes from trial to trial) and color is the fast feature (high trial-to-trial variability, dissimilar colors from trial to trial). (c) Schematic of one block of the task.

Image: panel (a) adapted from Li et al. (2020); all other panels by Noa Hedrich / MPI for Human Development
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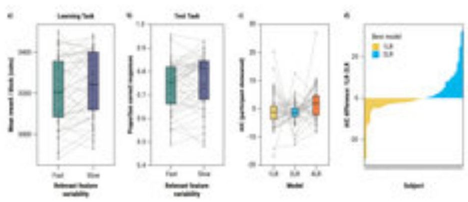

Figure 4. Behavioral and computational results. (a) Mean reward accumulated on each block of the learning task for the two feature variability conditions. (b) Proportion of correct responses in the test task for the two feature variability conditions. (c) AIC scores for the models fit to participant data, demeaned within participant for visualization purposes. In all panels gray points and lines are individual participants. Box plots show the median, with the lower and upper hinges corresponding to the first and third quartiles. (d) Differences in AIC scores between the 1LR and 2LR model for all subjects.
Image: Noa Hedrich / MPI for Human Development

Project 1.4: Representation Learning Dynamics Underlying Aha-Moments

Research Scientists

Anika T. Löwe

LéoTouzo (Université Paris Cité, France)

Johannes Muhle-Karbe (Imperial College London, UK)

Andrew Saxe (Gatsby Unit & Sainsbury Wellcome Centre, University College London, UK)

Christopher Summerfield (University of Oxford, UK)

Nicolas W. Schuck

Project 1.4 is concerned with understanding moments of very fast learning, in which humans show large and sudden improvements in task performance that are accompanied by an aha-moment or insight. Insights have often been treated as a distinct phenomenon in the psychological and neuroscientific literature because they are preceded by a period of impasse, behavioral changes are unusually abrupt, and they occur selectively in only part of the population. These characteristics seem difficult to reconcile with neural network models that have become a prominent theory of human learning and can account for a wide range of learning phenomena. The gradient descent techniques at the heart of learning in these models seem particularly problematic, since they appear to imply that all learning is gradual.

We challenged this idea, and hypothesized that the aforementioned insight characteristics —suddenness, delay, and selectivity—do not necessitate a discrete learning algorithm but can emerge naturally within gradual learning systems. While present-day machines do not have meta-cognitive awareness, and therefore clearly cannot subjectively experience aha-moments, they might still show sudden behavioral changes even when trained gradually. To test our hypothesis, we compared human behavior in an insight task with neural networks trained using stochastic gradient descent. We focused on a simple feed-forward neural network architecture with regularized, multiplicative gates (Figure 5a). Gating can be seen as a mechanism that involves suppression of irrelevant input features, akin to top-down mechanisms found throughout the human brain. We stipulated that regularization of such gates might be the mechanism that leads to the impasse, i.e., the temporary blindness of some features that are key to a solution. Ninety-nine human participants and 99 regularized neural networks performed that same task, and networks were matched in performance to their human counterparts. The task required a binary choice about circular arrays of moving dots (scalar inputs for networks) and entailed a hidden regularity, which could be discovered through insight (Figure 5b). In line with previous work, we find a subset of human participants showed spontaneous insights during the task. Notably, a comparable subset of regularized neural networks also displayed spontaneous, jump-like learning that signified the sudden discovery of the hidden regularity (Figure 5c), i.e., networks exhibited all key characteristics of human insight-like behavior in the same task (suddenness, selectivity, delay). Gradual learning mechanisms hence seem to closely mimic human insight characteristics. Analyses of the neural networks' weight-learning dynamics revealed that insight crucially depended on noise (Figure 5d), and was preceded by "silent knowledge" that is initially suppressed by (attentional) gating and regularization. Our results therefore shed light on the computational origins of insights and suggest that behavioral signatures of insight can naturally arise in gradual learning systems. More speculatively, in humans such nonlinear dynamics might be the starting point of conscious experiences associated with insight.

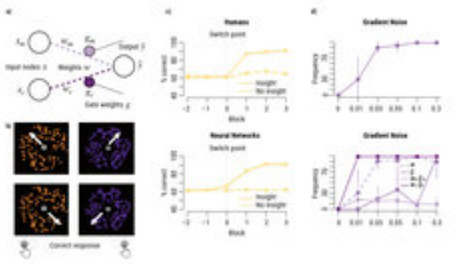

Figure 5. Task design and insight-like learning dynamics in humans and neural networks. (a) Schematic of neural network with regularized gate modulation. Color and motion inputs are denoted by x_c and x_m, weights by w_c and w_m, and gates by g_c and g_m, respectively. Shades of purple and line types (dashed versus solid) indicate which variable is plotted in panel d. (b) Participants had to respond to one dot cloud on each trial. Stimuli were colored either orange or purple, and moved in one of the four directions NW, NE, SE, SW with varying coherence. The left and right response keys were mapped onto two diagonal motion directions each. Note that stimulus color varied randomly trial to trial in the beginning of the experiment. The core element of the task was that after about half the trials the previously random color became systematically related to the correct response key—a "hidden trick" that could be inferred through insight. (c) Switch point-aligned accuracy for insight (48/99, solid line) and no-insight (51/99, dashed line) subjects in humans (upper panel) and regularized neural networks (bottom panel). One block corresponds to 50 trials. (d) Noise affects the likelihood of network simulations to exhibit insight-like behavior. Upper panel: influence of noise added to the neural network weight updates (x-axis) on the frequency of switches to a color strategy (number of networks defined as having insight). Bottom panel: influence of gradient noise when applied selectively to different network components, i.e., all color and motion weights (w, dashed line), color/motion gates (g, solid purple), only motion gates and motion weights ($x_m g_m$ solid light purple) or only color gates/weights ($x_c g_c$, solid dark purple). Error bars are standard deviation (SD). N = 99. Image: Anika T. Löwe / MPI for Human Development

Area 2: Neural Replay

Project 2.1: The Role of Replay in Statistical Learning of Successor Representations

Project 2.2: The Role of Replay in Generalization

A second main focus of our group is the study of neural replay in the human brain. Replay refers to the sequential reactivation of experience-related brain activity patterns during sleep, wakeful rest, and brief pauses from active behavior. Our motivation for studying replay stems from the fact that several studies have linked it to memory consolidation and behavior. In addition, machine learning research has shown that replay can lead to substantial performance improvements in artificial agents, where it can result in faster learning, less forgetting, better planning, and generalization (Wittkuhn et al., 2021). Our activities in this area are twofold: We have been actively developing new methods that address the challenge of studying replay non-invasively using fMRI (Schuck & Niv, 2019, Science; Wittkuhn & Schuck, 2021, Nature Communications), and we have used the newly developed analysis methods to gain novel insights about replay in the (human) brain.

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Project 2.1: The Role of Replay in Statistical Learning of Successor Representations

Research Scientists

Lennart Wittkuhn

Christoph Koch

Lena M. Krippner

Nicolas W. Schuck

This project aims to investigate how on-task replay reflects and shapes statistical learning, which can also occur without conscious awareness and is sometimes thought to be hippocampus-independent. Our particular focus was to understand if statistical sequence learning can be described by a successor representation (SR) model and whether replay reflects the resulting predictive SR-representations during brief pauses from ongoing task performance. With its focus on SR mechanisms, this project links memory-related functions of replay to its putative role in planning, known from findings that show that place cell activations can sweep ahead of the animal along multiple potential future trajectories.

Human participants (n = 39) performed a statistical learning paradigm that exposed them to a fast-paced stream of six different images. Unbeknownst to the participants, the sequential ordering of images was governed by their arrangement in two ring-like graph structures that resulted in distinct transition probabilities between the images. Crucially, the image-to-image transition probabilities were structured such that distinct two-step, three-step etc. transitions could be inferred by participants. We hypothesized that while two or more step transitions were not necessary for responding quickly and accurately in our task, incidental statistical learning would still lead participants to extract higher-order predictive relationships among the task stimuli, and that this knowledge would then drive replay during on-task pauses.

Response time analysis showed that participants indeed developed multi-step transition expectations, as expected from a SR model. Interestingly, the predictive depth of this representation varied depending on which graph structure participants had learned and in which order. Applying the sequential fMRI pattern analysis methods developed in our previous work (Wittkuhn & Schuck, 2021), we examined the data for evidence of online neural replay during short on-task intervals that were interspersed with ongoing task performance. We used the SR model fitted to behavioral data to derive a probability distribution over possible sequences and examined our sequentiality metric for the most likely sequences given this predictive representation. This showed that particularly those sequences that were most likely given the SR model were replayed. Results from a post-task verbal questionnaire indicated that sequence knowledge remained implicit in half of the participants. Together, these results provide novel insights into how neural replay interacts with internal task representations in the brain and open avenues to further understand how the reactivation of experience supports adaptive behavior in humans.

Project 2.2: The Role of Replay in Generalization

Research Scientists

Sam Hall-McMaster
Lennart Wittkuhn
Luianta Verra
Noa Hedrich
Peter Dayan (MPI for Biological Cybernetics, Tübingen, Germany)
Nicolas W. Schuck

The ability to generalize our previous experience to new situations is central to human intelligence. When we visit New York for the first time, for example, we can navigate around Manhattan using the subway, even though the stations have completely different names and layouts from those we are used to. Doing this requires us to leverage similarities between our current and previous experiences.

In Project 2.2, we ask what role replay plays in this kind of generalization. Our core idea was that replay could support generalization by consolidating relationships between events and reactivating those previous events to guide choices in new scenarios. To investigate this notion, we conducted a three-session fMRI experiment (n = 52). During a behavioral pre-learning session, participants first learned associations between videos and static images. Participants then viewed the same videos inside the MRI scanner and needed to recall the associated images from memory. Data from this session then trained a pattern classification algorithm that was later used to identify sequential reactivation events in the brain. Participants next learned that the images from the first task phase occurred in a specific sequential order. Following sequential learning, participants were moved to the MRI scanner, where they were shown a series of cues that indicated their position within the sequence and asked to plan the next four upcoming images. This planning task was also done in the last fMRI session. Importantly, during this session participants had to learn a new order of images that was partly the same as the previous one. This overlap allowed participants to generalize their knowledge from the previous session to the final session. The goal for this session was to test the behavioral relevance of sequential reactivation for generalizing previous knowledge to a new decision problem. Resting state scans were acquired between active task phases.

Analysis of participants' behavior revealed that participants learned to successfully plan sequences in session two and to generalize their knowledge to session three, as witnessed by the very high level of performance during session two and the more accurate responses in session three in trials that allowed the generalizing of learned sequence transitions from session two. The main neural results have centered on the visual cortex, where we have identified evidence for partial sequence recovery during active planning. We are now scrutinizing this result and confirming its validity before characterizing reactivation properties, including order and speed, as well as testing for sequence recovering during periods of rest. Neural responses in the medial temporal lobe, which includes the hippocampus, are much weaker in this dataset and we are continuing to assess the evidence for sequential reactivation in this area.

Area 3: Computational Psychiatry and Aging

Project 3.1: Worry, Anxiety and Perception of Danger Throughout the COVID-19 Pandemic: A Longitudinal Study

Project 3.2: Effect of L-DOPA on Neural Signals of Walking Direction in Older and Younger Adults

A third focus of our group is developing and testing computational and neural theories of learning and decision making in psychiatric disorders and healthy aging. Our efforts relate to recent work showing the value of mathematical modeling in addressing both issues and reflects our group's involvement in the Max Planck UCL Centre for Computational Psychiatry and Aging Research. In the domain of psychiatry, the group's research has focused on the role of anxiety in aversive learning (see Zika et al., 2023 and Project 7 below). Our findings reveal that anxious individuals are better at building higher-order representations (a simple form of cognitive maps) and our goal for the future is to connect our work on anxiety with cognitive maps and replay, the main topics of Areas 1 and 2. In our work on aging we have recently investigated how older age affects the neural representations that underlie spatial navigation (Koch et al., 2020), and which role dopamine plays in representational changes (see Project 3.2 below; Koch et al., 2022). More recently, we used reinforcement learning models to investigate factors impacting learning from surprising events in young and older adults (Koch et al., 2023).

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Project 3.1: Worry, Anxiety and Perception of Danger Throughout the COVID-19 Pandemic: A Longitudinal Study

Research Scientists

Ondrej Zika
Claire Gillan (Trinity College Dublin, Ireland)
Nicolas W. Schuck

In this project we investigated how worry and perception of threat changed over the course of the COVID-19 pandemic, especially in relation to individual differences in trait anxiety and depression. Our research links to our own and others' previous work associating anxiety with increased sensitivity to underlying changes in contextual threat (Zika et al., 2023). While past work in the area has mostly relied on controlled laboratory experiments with limited ecological validity, our study was situated within a natural real-life occurrence of a fluctuating threat, the COVID-19 pandemic, and hence offers unique ecological validity.

Participants from the UK and Germany (n = 400) completed a series of online questionnaires over 20 measurement time points between April and December 2020. Participants answered questions relating to health and economic worry, aversive probability estimates (e.g., "What's the probability of infection/death due to COVID-19?") and perception of danger (i.e., "Are we currently in a period of danger?") on each of the 20 testing time points. To index objective environmental threat, we additionally collected publically available statistics about new COVID-19 cases and deaths in each postcode and matched it to participants' locations. Finally, individual differences in anxiety and depression as assessed by STAI-T, STICSA-T, and BDI-III questionnaires were projected onto three distinct factors: cognitive anxiety and depression (TF1), somatic anxiety (TF2), and unhappiness (TF3), using a factor analysis.

First, we investigated how perceived anger and worry relate to the recorded objective levels of threat (e.g., deaths). Figure 6a shows the timecourses of the objective and subjective measures. While all subjective measures were elevated in the first wave of the pandemic (i.e., spring 2020), only the perceived danger increased during the second wave (late summer 2020). On the other hand, worries and infection probability estimates remained unchanged despite the second surge in COVID-19 cases, highlighting a dissociation between worry, perceived danger, and objective threat. Next, we asked how the trait factors related to the evolution of worry, perceived danger, and infection probability estimate. Interestingly, somatic anxiety (TF2) was found to positively predict all three, but cognitive anxiety (TF1) was not. We followed up on this finding by running a temporal clustering analysis. Here, the individuals who more consistently perceived high danger throughout the entire pandemic were significantly higher in somatic trait anxiety compared to those who more adaptively changed their perception of threat as cases and deaths fell and later increased (Figure 6b). Breaking down worry into health and economic components revealed that somatic anxiety was associated with health but not economic worry. Unhappiness, on the other hand, was associated with both (Figure 7). Finally, we looked at the relationship between trait factors and objective severity, indexed by number of deaths. While both somatic and cognitive anxiety were not related to the number of COVID-19-related deaths, unhappiness was positively correlated (r = 0.31). In summary, we found that high somatic but not cognitive anxiety was associated with increased worry, aversive probability estimates, and perception of danger, even in times of relative safety. Specifically, somatic anxiety was associated with health-related but not economic worry. Despite higher levels of worry, objective threat was not elevated in high somatic anxiety. Taken together, these results suggest that during real world threat individuals high in somatic anxiety experience higher levels of worry irrespective of the objective level of threat in the environment. In contrast, unhappiness and resulting worry in some individuals can partially be explained by higher objective threat of the environment.

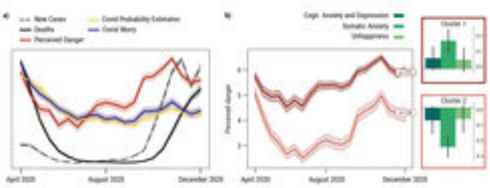
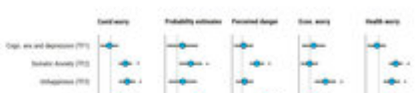


Figure 6. Objective and subjective threat between the first and second COVID-19 waves. (a) Evolution of subjective (worry, infection probability estimates, and perceived danger) and objective (COVID-19 cases and related deaths) measures over the course of 8 months between April and December 2020. For visualization purposes, all measures were standardized between 0 and 1. (b) Two temporal clusters of perceived danger identified by the Silhouette score. Participants with generally higher and unchanging perception of danger (cluster 1) were significantly higher in somatic anxiety compared to participants who adjusted their perception of danger more flexibly (cluster 2). All plots show mean and standard error of the mean.
Image: Ondrej Zika / MPI for Human Development



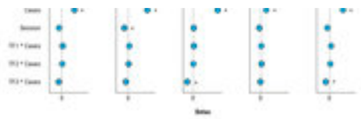


Figure 7. Results of five linear mixed effects models. Each model was run for one of the state measures using the three trait factors, number of cases, session, and their interactions as predictors. The plot shows the estimated betas for each model with 95% confidence intervals. Asterisks denote significant effect at alpha = 0.05.
Image: Image: Ondrej Zika / MPI for Human Development

Project 3.2: Effect of L-DOPA on Neural Signals of Walking Direction in Older and Younger Adults

Research Scientists

Christoph Koch
Christian Baeuchl (Technische Universität Dresden, Germany)
Franka Glöckner (Technische Universität Dresden, Germany)
Philipp Riedel (Technische Universität Dresden, Germany)
Johannes Petzold (Technische Universität Dresden, Germany)
Michael Smolka (Technische Universität Dresden, Germany)
Shu-Chen Li (Technische Universität Dresden, Germany)
Nicolas W. Schuck

Aging is characterized by vast declines in spatial navigation ability and dopaminergic neuromodulation. How are these factors related? Project 8 extended our previous work on walking direction representations in older versus younger adults (Koch et al., 2020) by investigating the effect of L-DOPA administration on these neural signals. Building on computational models that have proposed that deficits in dopamine functioning negatively affect cognition through losses in the signal-to-noise ratio of neural responses, we expected dopamine to affect the specificity of neural representations of spatial environments. Our previous work has shown that without L-DOPA interventions, older brains tend to have more dedifferentiated neural representations of virtual walking direction. Here, we therefore asked if DA causally influences the specificity of older and younger adults' neural representations in a spatial task.

We tested the influence of DA on the specificity of neural representations of walking direction. In a double-blind drug intervention design, 37 older and 43 younger adults completed a spatial memory task while undergoing fMRI. In one drug (L-DOPA) and one placebo session participants navigated a 3D virtual environment while learning and remembering locations. The paths traveled during the task were classified by walking directions and the associated fMRI activation patterns were extracted. Neural specificity was then measured by how accurately a cross-validated multivariate classifier could identify walking directions from neural patterns. Comparing this measure across sessions quantified the causal influence of DA on neural specificity.

Walking direction could be predicted above-chance in brain areas involved in spatial navigation, including the early visual cortex, retrosplenial cortex (RSC), and hippocampus. Quantifying the effect of DA, a statistical model revealed increased specificity/decoding of walking direction representations in the drug versus placebo session. Exploratory follow-up analyses revealed that the increase was strongest in the hippocampus, where decoding was only possible under higher levels of DA. Furthermore, while the drug increased neural specificity in both age groups in the hippocampus, in the RSC this was unique to younger adults. These findings provide first evidence for a causal link between DA and the specificity of neural responses during spatial navigation. While the age-dependent effects in the RSC raise questions about a more complex role of DA in the aging navigational system, our findings shed light on DA's contribution to the pronounced decline of spatial cognition in older age.

MPRG NeuroCode | Neural and Computational Basis of Learning, Memory and Decision Making
Publications 2020-2022/23

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Journal Article (24)

2023

Journal Article

Baeuchl, C., Glöckner, F., Koch, C., Petzold, J., Schuck, N. W., Smolka, M. N., & Li, S.-C. (2023). Dopamine differentially modulates medial temporal lobe activity and behavior during spatial navigation in young and older adults. *NeuroImage*, *273*, Article 120099. https://doi.org/10.1016/j.neuroimage.2023.120099

MPG.PuRe DOI publisher-version

Journal Article

Garvert, M. M., Saanum, T., Schulz, E., Schuck, N. W., & Doeller, C. F. (2023). Hippocampal spatio-predictive cognitive maps adaptively guide reward generalization. *Nature Neuroscience*, *26*, 615–626. https://doi.org/10.1038/s41593-023-01283-x

MPG.PuRe DOI publisher-version

Journal Article

Moneta, N., Garvert, M. M., Heekeren, H. R., & Schuck, N. W. (2023). Task state representations in vmPFC mediate relevant and irrelevant value signals and their behavioral influence. *Nature Communications*, *14*, Article 3156. https://doi.org/10.1038/s41467-023-38709-w

MPG.PuRe DOI publisher-version supplementary-material

Journal Article

Morriss, J., Abend, R., Zika, O., Bradford, D. E., & Mertens, G. (2023). Neural and psychophysiological markers of intolerance of uncertainty. *International Journal of Psychophysiology*, *184*, 94–99. https://doi.org/10.1016/j.ijpsycho.2023.01.003

MPG.PuRe DOI

Journal Article

Muhle-Karbe, P. S., Sheahan, H., Pezzulo, G., Spiers, H. J., Chien, S., Schuck, N. W., & Summerfield, C. (in press). Goal-seeking compresses neural codes for space in the human hippocampus and orbitofrontal cortex. *Neuron*.

MPG.PuRe

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Pupillo, F., Ortiz-Tudela, J., Bruckner, R., & Shing, Y. L. (2023). The effect of prediction error on episodic memory encoding is modulated by the outcome of the predictions. *npj Science of Learning*, *8*, Article 18. https://doi.org/10.1038/s41539-023-00166-x

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Zika, O. (2023). The relationship between latent state inference and (intolerance of) uncertainty. *Neuroscience & Biobehavioral Reviews*, *152*, Article 105321. https://doi.org/10.1016/j.neubiorev.2023.105321

MPG.PuRe DOI

Journal Article

Zika, O., Wiech, K., Reinecke, A., Browning, M., & Schuck, N. W. (2023). Trait anxiety is associated with hidden state inference during aversive reversal learning. *Nature Communications*, *14*, Article 4203. https://doi.org/10.1038/s41467-023-39825-3

MPG.PuRe DOI publisher-version supplementary-material

2022

Journal Article

Koch, C., Baeuchl, C., Glöckner, F., Riedel, P., Petzold, J., Smolka, M. N., Li, S.-C., & Schuck, N. W. (2022). L-DOPA enhances neural direction signals in younger and older adults. *NeuroImage*, *264*, Article 119670. https://doi.org/10.1016/j.neuroimage.2022.119670

MPG.PuRe DOI publisher-version supplementary-material

Journal Article

Kumar, M., Anderson, M. J., Antony, J. W., Baldassano, C., Brooks, P. P., Cai, M. B., Chen, P.-H. C., Ellis, C. T., Henselman-Petrusek, G., Huberdeau, D., Hutchinson, J. B., Li, P. Y., Lu, Q., Manning, J. R., Mennen, A. C., Nastase, S. A., Richard, H., Schapiro, A. C., Schuck, N. W., Shvartsman, M., Sundaram, N., Suo, D., Turek, J. S., Vo, V. A., Wallace, G., Wang, Y., Zhang, H., Zhu, X., Capota, M., Cohen, J. D., Hasson, U., Li, K., Ramadge, P. J., Turk-Browne, N. B., Willke, T. L., & Norman, K. A. (2022). BrainIAK: The Brain Imaging Analysis Kit.

Aperture Neuro, Article 42. https://doi.org/10.52294/31bb5b68-2184-411b-8c00-a1dacb61e1da
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Liu, Y., Nour, M. M., Schuck, N. W., Behrens, T. E. J., & Dolan, R. J. (2022). Decoding cognition from spontaneous neural activity. *Nature Reviews Neuroscience*, *23*, 204–214. https://doi.org/10.1038/s41583-022-00570-z
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Journal Article
Petzka, M., Chatburn, A., Charest, I., Balanos, G. M., & Staresina, B. P. (2022). Sleep spindles track cortical learning patterns for memory consolidation. *Current Biology*, *32*(11), 2349–2356. https://doi.org/10.1016/j.cub.2022.04.045
MPG.PuRe DOI publisher-version supplementary-material

Journal Article
Pike, A. C., Atherton, K. E., Bauer, Y., Crittenden, B. M., van Ede, F., Hall-McMaster, S., von Lautz, A. H., Muhle-Karbe, P. S., Murray, A. M., Myers, N. E., Printzlau, F., Salaris, I., Spaak, E., Tankelevitch, L., Trübutschek, D., Wasmuht, D., & Noonan, M. A. P. (2022). 10 simple rules for a supportive lab environment. *Journal of Cognitive Neuroscience*, *35*(1), 44–48. https://doi.org/10.1162/jocn_a_01928
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Journal Article
Schuck, N. W., Li, A. X., Wenke, D., Ay-Bryson, D. S., Loewe, A. T., Gaschler, R., & Shing, Y. L. (2022). Spontaneous discovery of novel task solutions in children. *PLoS ONE*, *17*(5), Article e0266253. https://doi.org/10.1371/journal.pone.0266253
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2021

Journal Article
Chan, S. C. Y., Schuck, N. W., Lopatina, N., Schoenbaum, G., & Niv, Y. (2021). Orbitofrontal cortex and learning predictions of state transitions. *Behavioral Neuroscience*, *135*(4), 487–497. https://doi.org/10.1037/bne0000461
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Journal Article
Glöckner, F., Schuck, N. W., & Li, S. C. (2021). Differential prioritization of intramaze cue and boundary information during spatial navigation across the human lifespan. *Scientific Reports*, *11*, Article 15257. https://doi.org/10.1038/s41598-021-94530-9

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Journal Article

Hall-McMaster, S., Dayan, P., & Schuck, N. W. (2021). Control over patch encounters changes foraging behavior. *iScience*, *24*(9), Article 103005. https://doi.org/10.1016/j.isci.2021.103005

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Journal Article

Wittkuhn, L., Chien, S., Hall-McMaster, S., & Schuck, N. W. (2021). Replay in minds and machines. *Neuroscience & Biobehavioral Reviews*, *129*, 367–388. https://doi.org/10.1016/j.neubiorev.2021.08.002

MPG.PuRe DOI post-print

Journal Article

Wittkuhn, L., & Schuck, N. W. (2021). Dynamics of fMRI patterns reflect sub-second activation sequences and reveal replay in human visual cortex. *Nature Communications*, *12*, Article 1795. https://doi.org/10.1038/s41467-021-21970-2

MPG.PuRe DOI publisher-version

2020

Journal Article

Allegra, M., Seyed-Allaei, S., Schuck, N. W., Amati, D., Laio, A., & Reverberi, C. (2020). Brain network dynamics during spontaneous strategy shifts and incremental task optimization. *NeuroImage*, *217*, Article 116854. https://doi.org/10.1016/j.neuroimage.2020.116854

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Journal Article

Gagne, C., Zika, O., Dayan, P., & Bishop, S. J. (2020). Impaired adaptation of learning to contingency volatility in internalizing psychopathology. *eLife*, *9*, Article e61387. https://doi.org/10.7554/eLife.61387

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Hebart, M. N., & Schuck, N. W. (2020). Current topics in computational cognitive neuroscience: Editorial. *Neuropsychologia*, *147*, Article 107621. https://doi.org/10.1016/j.neuropsychologia.2020.107621

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Journal Article

Koch, C., Li, S.-C., Polk, T. A., & Schuck, N. W. (2020). Effects of aging on encoding of walking direction in the human brain. *Neuropsychologia*, *141*, Article 107379. https://doi.org/10.1016/j.neuropsychologia.2020.107379

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Journal Article

Wu, C. M., Schulz, E., Garvert, M. M., Meder, B., & Schuck, N. W. (2020). Similarities and differences in spatial and non-spatial cognitive maps. *PLoS Computational Biology*, *16*(9), Article e1008149. https://doi.org/10.1371/journal.pcbi.1008149

MPG.PuRe DOI publisher-version

Thesis - PhD (2)

2023

Thesis - PhD

Koch, C. (2023). *How aging shapes neural representations of continuous spaces* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-39372
(published online 2023: http://dx.doi.org/10.17169/refubium-39372).

MPG.PuRe DOI Full

2022

Thesis - PhD

Wittkuhn, J. L. (2022). *Investigating neural replay of task representations in the human brain using fMRI* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-34672

MPG.PuRe DOI Full

Thesis - Master (3)

2022

Thesis - Master

Verra, L. (2022). *Behavioural evidence for state dependent uncertainty* [Master's Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

2021

Thesis - Master

Hedrich, N. (2021). *The role of the temporal coherence prior in reinforcement learning* [Master's Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

2020

Thesis - Master

Löwe, A. (2020). *Trial-wise feedback leading to uninstructed spontaneous strategy switches* [Master's Thesis, Freie Universität Berlin].

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Max Planck UCL Centre for Computational Psychiatry and Ageing Research

Directors

Raymond J. Dolan (University College London, London, UK)
Ulman Lindenberger (MPI for Human Development, Berlin, Germany)

Deputy Directors

Arno Villringer (MPI for Cognitive and Brain Sciences, Leipzig, Germany)
Quentin Huys (University College London, London, UK)

Research Scientists (Berlin Site)

Andreas M. Brandmaier
Douglas D. Garrett
Simone Kühn
Ulman Lindenberger
Nicolas W. Schuck

Overview

The behavioral neurosciences and related disciplines have seen spectacular scientific advances that make them rich in scientific opportunity. These advances have made it possible to work toward a mechanistic understanding of behavioral aging and psychopathology, two empirically overlapping fields of great importance to science and society. In both fields, it is key to take a personalized lifespan approach by identifying neural and behavioral parameters that predict more or less favorable trajectories, with the intent to intervene in time when undesirable outcomes are expected.

Plenary Session at the Fifth Symposium and Advanced Course on Computational Psychiatry and Ageing Research, Schloss Marbach, September 2022. The event focused on childhood memory development, and was organized in collaboration with the Jacobs Foundation.
Image: MPI for Human Development

With these goals in mind, the Max Planck Society and University College London (UCL) established the Max Planck UCL Centre for Computational Psychiatry and Ageing Research in 2014, with both partners providing an initial 5 years of funding. In 2018, the Centre was positively evaluated by the Max Planck Society and extended for another 5 years (2019–2024). The Centre has two sites, one in London (Russell Square) and the other in Berlin-Dahlem at the MPI for Human Development (see Table 1). It has continued to grow both in scope and number of students. Combined across Berlin and London sites, the Centre currently comprises 77 members (faculty, fellows, and students).

The Centre's foundation was preceded by a 3-year preparatory phase, which also included the organization of the *First Symposium and Advanced Course on Computational Psychiatry and Ageing Research* in 2012 at Ringberg Castle, Bavaria. During the reporting period, the Centre organized the fifth symposium of this kind in 2022 at Schloss Marbach (see photos); the symposium in 2020 had to be cancelled because of the COVID-19 pandemic.

In 2016, the Centre launched the *International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research* (COMP2PSYCH) to extend its reach into graduate education. After a successful evaluation in September 2020, the graduate program of the Centre was extended for a second 6-year term until September 30, 2028.

Research Groups

Three MPIB research groups form the Centre in Berlin:

- The *Formal Methods in Lifespan Psychology* project, led by Andreas Brandmaier at the Center for Lifespan Psychology (LIP);
- The Emmy Noether Group, *The Lifespan Neural Dynamics Group (LNDG)*, led by Douglas D. Garrett (also affiliated with LIP);
- The Max Planck Research Group *Neural and Computational Basis of Learning, Decision Making*

and Memory (MPRG NeuroCode), led by Nicolas Schuck.

In London, six research groups form the basis of the Centre:

- The Affective Brain Group, led by Tali Sharot;
- The Applied Computational Psychiatry Group, led by Quentin Huys;
- The Developmental Computational Psychiatry Group, led by Tobias Hauser;
- The Learning Memory & Decision Lab, led by G. Elliott Wimmer;
- The Metacognition and Computational Psychiatry Group, led by Steve Fleming; and
- The Reward, Decision Making and Psychopathology Group, led by Ray Dolan.

A full overview of the Centre's activities can be found on the Centre's website.

Collaborations

After-dinner impressions from the Fifth Symposium and Advanced Course on Computational Psychiatry and Ageing Research, Schloss Marbach, September 2022. From left to right: Chi (Zoe) Ngo, Ulman Lindenberger, Sarah Power, Ann-Kathrin Jöchner, Elisa Buchberger, Erika Stewart (Trinity College Dublin), Leonhard Waschke.
Image: personal

Leveraging the unique skill and interest set at each site, a number of collaborations between the Berlin and London Centre sites continue to develop. For example, the Lifespan Neural Dynamics Group (PI Douglas Garrett) collaborates with the Developmental Psychiatry Group (PI Tobias Hauser) on the behavioral and neural bases of explore–exploit decision making across the lifespan, and with the Metacognition and Computational Psychiatry Group (PI Steve Fleming) on the connections between behavioral and neural uncertainty. Further, the MPRG NeuroCode (PI Nicolas Schuck) is collaborating with the Applied Computational Psychiatry Group (PI Quentin Huys) on a project to investigate mind wandering in healthy subjects vs. depressed patients using fMRI decoding techniques, and has co-authored a review about decoding cognition from spontaneous neural activity with the Dolan group (Liu et al., 2022). Also, a cross-site, in-depth workshop on "Data management with DataLad" was organized by MPRG NeuroCode member Lennart Wittkuhn in November 2020. The workshop centered around DataLad, an open-source software tool for data management and data publication. Participants learned about core concepts of effective research data management, such as joint version control of code and data, provenance capture for reproducible analysis, organizational principles for data analysis, and workflows and services for data publication and collaboration.

Table 1. Max Planck UCL Centre Members* at the MPIB (as of 03/2023)

Name	Center/Research Group	Position
Andreas Brandmaier	Lifespan Psychology	Group Leader
Simon Ciranka	Adaptive Rationality	Postdoc
Douglas D. Garrett	Lifespan Neural Dynamics Group & Lifespan Psychology	Group Leader
Shany Grossman	Max Planck Research Group NeuroCode	Postdoc
Sam Hall-Macmaster	Max Planck Research Group NeuroCode	Postdoc
Simone Kühn	Lise Meitner Group for Environmental Neuroscience	Group Leader
Ulman Lindenberger	Lifespan Psychology	Director
Nicolas W. Schuck	Max Planck Research Group NeuroCode	Group Leader
Leonhard Waschke	Lifespan Neural Dynamics Group & Lifespan Psychology	Postdoc

Name: Lennart Wittkuhn

Center/Research Group: Max Planck Research Group NeuroCode **Position:** Postdoc

Name: Ondrej Zika

Center/Research Group: Max Planck Research Group NeuroCode **Position:** Postdoc

* For doctoral students, see IMPRS COMP2PSYCH.
Note that Simon Ciranka and Lennart Wittkuhn are COMP2PSYCH alumni, that is, they completed their graduate training within COMP2PSYCH.

Website: www.mps-ucl-centre.mpg.de

Max Planck UCL Centre for Computational Psychiatry and Ageing Research Berlin Site Publications 2020–2022/23

Updated on a daily basis

Journal Article (165)

2023

Journal Article

Ascone, L., Wirtz, J., Mellentin, A. I., Kugler, D., Bremer, T., Schadow, F., Hoppe, S., Jebens, C., & Kühn, S. (2023). Transferring the approach avoidance task into virtual reality: A study in patients with alcohol use disorder versus healthy controls. *Virtual Reality*, *27*(3), 2711–2722. https://doi.org/10.1007/s10055-023-00835-7

MPG.PuRe DOI publisher-version

Journal Article

Baeuchl, C., Glöckner, F., Koch, C., Petzold, J., Schuck, N. W., Smolka, M. N., & Li, S.-C. (2023). Dopamine differentially modulates medial temporal lobe activity and behavior during spatial navigation in young and older adults. *NeuroImage*, *273*, Article 120099. https://doi.org/10.1016/j.neuroimage.2023.120099

MPG.PuRe DOI publisher-version

Journal Article

Beukelaer, S. D., Vehar, N., Rollwage, M., Fleming, S. M., & Tsakiris, M. (2023). Changing minds about climate change: A pervasive role for domain-general metacognition. *Humanities and Social Sciences Communications*, *10*, Article 46. https://doi.org/10.1057/s41599-023-01528-x

MPG.PuRe DOI

Journal Article

Binnewies, J., Nawijn, L., Brandmaier, A. M., Baaré, W. F. C., Boraxbekk, C.-J., Demnitz, N., Drevon, C. A., Fjell, A. M., Lindenberger, U., Skak Madsen, K., Nyberg, L., Topiwala, A., Walhovd, K. B., Ebmeier, K. P., & Penninx, B. W. J. H. (2023). Lifestyle-related risk factors and their cumulative associations with hippocampal and total grey matter volume across the adult lifespan: A pooled analysis in the European Lifebrain consortium. *Brain Research Bulletin*, *200*, Article 110692. https://doi.org/10.1016/j.brainresbull.2023.110692

MPG.PuRe DOI publisher-version

Journal Article

Boker, S. M., von Oertzen, T., Pritikin, J. N., Hunter, M. D., Brick, T. R., Brandmaier, A. M., & Neale, M. C. (2023). Products of variables in structural equation models. *Structural Equation Modeling*, *30*(5), 708–718. https://doi.org/10.1080/10705511.2022.2141749

MPG.PuRe DOI

Journal Article

Bouwer, F. L., Fahrenfort, J. J., Millard, S. K., Kloosterman, N. A., & Slagter, H. A. (2023). A silent disco: Differential effects of beat-based and pattern-based temporal expectations on persistent entrainment of low-frequency neural oscillations. *Journal of Cognitive Neuroscience*, *35*(6), 990–1020. https://doi.org/10.1162/jocn_a_01985

MPG.PuRe DOI

Journal Article

Buchberger, E., Brandmaier, A. M., Lindenberger, U., Werkle-Bergner, M., & Ngo, C. T. (in press). The process structure of memory abilities in early and middle childhood [Registered Report]. *Developmental Science*. https://doi.org/10.31234/osf.io/p84a6

MPG.PuRe DOI

Journal Article

Chen, H., Belanger, M. J., Garbusow, M., Kuitunen-Paul, S., Huys, Q. J. M., Heinz, A., Rapp, M. A., & Smolka, M. N. (2023). Susceptibility to interference between Pavlovian and instrumental control predisposes risky alcohol use developmental trajectory from ages 18 to 24. *Addiction Biology*, *28*(2), Article e13263. https://doi.org/10.1111/adb.13263

MPG.PuRe DOI

Journal Article

Ciranka, S., & Hertwig, R. (in press). Environmental statistics and experience shape risk-taking across adolescence. *Trends in Cognitive Sciences*.

MPG.PuRe

Journal Article

Dahl, M. J., Bachman, S. L., Dutt, S., Düzel, S., Bodammer, N. C., Lindenberger, U., Kühn, S., Werkle-Bergner, M., & Mather, M. (2023). The integrity of dopaminergic and noradrenergic brain regions is associated with different aspects of late-life memory performance. *Nature Aging*. Advance online publication. https://doi.org/10.1038/s43587-023-00469-z

MPG.PuRe DOI

Journal Article

Dahl, M. J., Kulesza, A., Werkle-Bergner, M., & Mather, M. (2023). Declining locus coeruleus-dopaminergic and noradrenergic modulation of long-term memory in aging and Alzheimer's disease. *Neuroscience & Biobehavioral Reviews*, *153*, Article 105358. https://doi.org/10.1016/j.neubiorev.2023.105358

MPG.PuRe DOI

Journal Article

Ernst, M. S., Peikert, A., Brandmaier, A. M., & Rosseel, Y. (2023). A note on the connection between trek rules and separable nonlinear least squares in linear structural equation models. *Psychometrika*, *88*(1), 98–116. https://doi.org/10.1007/s11336-022-09891-5

MPG.PuRe DOI publisher-version

Journal Article

Fjell, A. M., Sørensen, Ø., Wang, Y., Amlien, I. K., Baaré, W. F. C., Bartrés-Faz, D., Boraxbekk, C.-J., Brandmaier, A. M., Demuth, I., Drevon, C. A., Ebmeier, K. P., Ghisletta, P., Kievit, R., Kühn, S., Skak Madsen, K., Nyberg, L., Solé-Padullés, C., Vidal-Piñeiro, D., Wagner, G., Watne, L. O., & Walhovd, K. B. (2023). Is short sleep bad for the brain? Brain structure and cognitive function in short sleepers. *The Journal of Neuroscience*, *43*(28), 5241–5250. https://doi.org/10.1523/JNEUROSCI.2330-22.2023

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Journal Article

Friemelt, B., Bloszies, C., Ernst, M. S., Peikert, A., Brandmaier, A. M., & Koch, T. (2023). On the performance of different regularization methods in bifactor-(S-1) models with explanatory variables: Caveats, recommendations, and future directions. *Structural Equation Modeling*, *30*(4), 560–573. https://doi.org/10.1080/10705511.2022.2140664

MPG.PuRe DOI

Journal Article

Garvert, M. M., Saanum, T., Schulz, E., Schuck, N. W., & Doeller, C. F. (2023). Hippocampal spatio-predictive cognitive maps adaptively guide reward generalization. *Nature Neuroscience*, *26*, 615–626. https://doi.org/10.1038/s41593-023-01283-x

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Journal Article

Gehlenborg, J., Göritz, A. S., Moritz, S., & Kühn, S. (2023). Long-term effects of imaginal retraining in overweight and obesity: A controlled study. *Journal of Behavior Therapy and Experimental Psychiatry*, *78*, Article 101794. https://doi.org/10.1016/j.jbtep.2022.101794

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Journal Article

Gerstorf, D., Ram, N., Drewelies, J., Duezel, S., Eibich, P., Steinhagen-Thiessen, E., Liebig, S., Goebel, J., Demuth, I., Villringer, A., Wagner, G. G., Lindenberger, U., & Ghisletta, P. (2023). Today's older adults are cognitively fitter than older adults were 20 years ago, but when and how they decline is no different than in the past. *Psychological Science*, *34*(1), 22–34. https://doi.org/10.1177/09567976221118541

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Journal Article

Giron, A. P., Ciranka, S., Schulz, E., van den Bos, W., Ruggeri, A., Meder, B., & Wu, C. M. (2023). Developmental changes in exploration resemble stochastic optimization. *Nature Human Behaviour*. Advance online publication. https://doi.org/10.1038/s41562-023-01662-1

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Hensums, M., van den Bos, W., Overbeek, G., & Larsen, H. (2023). YouTube vloggers set the stage: How public (non)compliance with COVID-19 regulations affects adolescents. *Journal of Adolescence*. Advance online publication. https://doi.org/10.1002/jad.12207

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Journal Article

Krohn, S., von Schwanenflug, N., Waschke, L., Romanello, A., Gell, M., Garrett, D. D., & Finke, C. (2023). A spatiotemporal complexity architecture of human brain activity. *Science Advances*, *9*(5), Article eabq3851. https://doi.org/10.1126/sciadv.abq3851

MPG.PuRe DOI publisher-version supplementary-material

Journal Article

Lövdén, M., Pagin, A., Bartrés-Faz, D., Boraxbekk, C.-J., Brandmaier, A. M., Demnitz, N., Drevon, C. A., Ebmeier, K. P., Fjell, A. M., Ghisletta, P., Gorbach, T., Lindenberger, U., Plachti, A., Walhovd, K. B., & Nyberg, L. (2023). No moderating influence of education on the association between changes in hippocampus volume and memory performance in aging. *Aging Brain*, *4*, Article 100082. https://doi.org/10.1016/j.nbas.2023.100082

MPG.PuRe DOI publisher-version

Journal Article

Moneta, N., Garvert, M. M., Heekeren, H. R., & Schuck, N. W. (2023). Task state representations in vmPFC mediate relevant and irrelevant value signals and their behavioral influence. *Nature Communications*, *14*, Article 3156. https://doi.org/10.1038/s41467-023-38709-w

MPG.PuRe DOI publisher-version supplementary-material

Journal Article

Morriss, J., Abend, R., Zika, O., Bradford, D. E., & Mertens, G. (2023). Neural and psychophysiological markers of intolerance of uncertainty. *International Journal of Psychophysiology*, *184*, 94–99. https://doi.org/10.1016/j.ijpsycho.2023.01.003

MPG.PuRe DOI

Journal Article

Mostajeran, F., Steinicke, F., Reinhart, S., Sturzlinger, W., Riecke, B. E., & Kühn, S. (2023). Adding virtual plants leads to higher cognitive performance and psychological well-being in virtual reality. *Scientific Reports*, *13*, Article 8053. https://doi.org/10.1038/s41598-023-34718-3

MPG.PuRe DOI publisher-version

Journal Article

Muhle-Karbe, P. S., Sheahan, H., Pezzulo, G., Spiers, H. J., Chien, S., Schuck, N. W., & Summerfield, C. (in press). Goal-seeking compresses neural codes for space in the human hippocampus and orbitofrontal cortex. *Neuron*.

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Emeriti & Fellow

Emeriti

The directors emeriti Jürgen Baumert, Gerd Gigerenzer, and Karl Ulrich Mayer continue to pursue their research at the MPI for Human Development.

Jürgen Baumert

Jürgen Baumert's work focuses on learning and instruction, schooling and the life course, bilingual education in multicultural societies, and academic and psychosocial adjustment of immigrant youth.

> more

Gerd Gigerenzer

"We need, now more than ever, to arm ourselves with knowledge about how to make better decisions in a digital age," says Gerd Gigerenzer.

> more

Karl Ulrich Mayer

Karl Ulrich Mayer continues to work on social inequalities and the life course, especially on the basis of longitudinal studies like the German Life History Study and the National Educational Panel–comprising cohorts born between 1919 and 2000. View his publication list. > more

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Max Planck Fellow

Several years ago, the Max Planck Society established the Max Planck Fellow Program to further strengthen research collaboration between its institutes and neighboring universities and other research institutions.

Gert G. Wagner

Gert G. Wagner, Professor of Economics, collaborates with researchers from the Center for Adaptive Rationality, the Center for Lifespan Psychology, the Lise Meitner Group for Environmental Neuroscience, and the Max Planck Research Group Biosocial—Biology, Social Disparities, and Development. Wagner is part of the faculty of the International Max Planck Research School on the Life Course (LIFE) and, together with Ulman Lindenberger, is co-principal investigator of the Berlin Aging Study II (BASE-II) at the Institute. > more

Director Emeritus Jürgen Baumert

Emeritus Research Group of Jürgen Baumert

Image: MPI for Human Development

Jürgen Baumert's work focuses on learning and instruction, schooling and the life course, bilingual education in multicultural societies, and academic and psychosocial adjustment of immigrant youth. These research projects are conducted in cooperation with the German Institute for International Educational Research (DIPF; Kai Maaz and Marco Neumann), the Leibniz Institute for Science and Mathematics Education at Kiel University (IPN; Olaf Köller), Christian-Albrechts-Universität zu Kiel (Jens Möller and Sandra Preusler), the Mercator Institute for Language Training and German as a Second Language at the University of Cologne (Michael Becker-Mrotzek), the Institute for Research on School Development at TU Dortmund (Michael Becker), the Institute for Educational Quality Improvement at Humboldt-Universität zu Berlin (IQB; Malte Jansen), Universität Hamburg (Jenny

Wagner), and the LSA Psychology at the University of Michigan, Ann Arbor (Kai S. Cortina).

Schooling and Individual Development in Adolescence and Adulthood (BIJU)

The longitudinal BIJU Study Learning Processes, Educational and Occupational Careers, and Psychosocial Development in Adolescence and Adulthood was initiated in 1991. The BIJU sample of school classes comprises some 8,000 students from 212 secondary schools of all types in the states of Berlin, Mecklenburg-Vorpommen, North Rhine-Westphalia, and Saxony-Anhalt. The eighth wave of data collection took place in 2017, when most participants were 38 years old. The longitudinal study is being continued in cooperation with Universität Hamburg (Jenny Wagner, project director; Naemi Brandt), TU Dortmund (Michael Becker, project director), the IPN at Kiel University (Olaf Köller), and the University of Michigan in Ann Arbor (Kai S. Cortina). The study was funded by the Strategic Innovation Fund of the President of the Max Planck Society.

The BIJU Study’s five components are as follows:

(1) Providing institutional and individual baseline data on the integration of the East and West German educational systems and on the cohort born between 1979 and 1991.

(2) Analyzing domain-specific learning trajectories as a function of personal resources and institutional opportunity structures.

(3) Analyzing the transition from school to vocational training or university and to the labor market.

(4) Analyzing short- and long-term occupational career patterns as a function of social origin and education.

(5) Analyzing trajectories of psychosocial development (including political engagement) from a life course perspective.

Data collection began with a survey of the main cohort in the 1991/92 school year, during which data were gathered from seventh-grade students at three measurement points. The first point of measurement coincided with the transformation of the unitary school system of the former East Germany to the tracked system adopted from West Germany. The fourth wave of data collection was conducted in spring 1995, when the main cohort students were in the final grade of lower secondary school; the fifth wave in spring 1997, when they were either in vocational or upper secondary education; the sixth wave in 2001, after the transition from school to university or from vocational education to the labor market. The seventh wave in 2009/10 focused on occupational position and partnership; the eighth in 2017 on occupational careers, family life, well-being, and social and cultural integration.

Bilingual Alphabetization in Multicultural Societies: Evaluation of Berlin’s State Europe Schools (EUROPA Study)

The key objective of the EUROPA Study, which was initiated in 2013, is to examine whether bilingual alphabetization in two-way immersion is a suitable instrument for reducing the educational disadvantage of immigrant children. Drawing on a longitudinal, extended evaluation of Berlin's State Europe Schools (SESBs), we aim to derive benchmarks for the outcomes of two-way immersion for children from German-speaking and non-German-speaking families. In addition, we test the hypotheses that (a) positive transfer occurs from the first to the second language providing that a critical threshold of language proficiency has been reached, and (b) children who learn to read and write in two languages are at a general advantage in terms of the development of executive functions. The quasi-experimental study includes a longitudinal component at elementary school level (see Figure 2), and is conducted in cooperation with the Christian-Albrechts-Universität zu Kiel (Jens Möller), the Leibniz Institute for Science and Mathematics Education (IPN) in Kiel (Olaf Köller), and the Mercator Institute for Language Training and German as a Second Language at the University of Cologne (Michael Becker-Mrotzek). It is funded by the state of Berlin and the Mercator Stiftung.

Berlin's State Europe Schools (SESBs) implement two-way immersion with the aim of developing students as balanced bilinguals. The key objective is for students to become competent in German and a partner language without adverse effects on their achievement in other subjects. There are currently nine language programs at different sites: Students are taught in German and either English, French, Greek, Italian, Polish, Portuguese, Russian, Spanish, or Turkish. The languages have equal standing; half of the subjects are taught in German, the other half in the partner language.

Findings showed that, at both elementary and lower secondary level, the performance of SESB students in reading comprehension, mathematics, and science was neither higher nor lower than that of their peers in comparison groups drawn from monolingual schools in Berlin when testing was conducted in German. In other words, although they had learned to read and write in two languages and had been taught in both of those languages, the SESB students showed no developmental disadvantages in subjects taught in German. These findings did not change when we controlled for the social, educational, and cognitive selectivity of the SESBs. Moreover, SESB students performed much better in English. Two-way immersion thus lays a solid basis for learning a further foreign language. However, there was no evidence that immigrant students receive more individualized instruction that caters to their specific needs.

Fourth- and ninth-grade students were also tested in the partner language, using reading comprehension and science tests from international studies. This approach made it possible to compare the achievement of the SESB sample with that of their peers in countries where the partner language is the language of instruction. At first glance, the analyses confirmed that fourth-grade students have not yet reached the achievement level of L1 speakers from the partner countries in reading comprehension in the partner language. However, a good two-thirds of them have a solid basic command of the language. In fact, almost half of them reached a level typical of that achieved in the partner countries. Similar patterns of results emerged for ninth-grade students at the end of lower secondary level.

Secondary Analyses of Staring Cohort 4 of the National Educational Panel Study (NEPS-SC4), the BERLIN-Study, and the BIKS-Study

The analyses focus on the academic and psychosocial adjustment of adolescents and young adults with a migration background and the transition from elementary to secondary school. The analyses are conducted in cooperation with Cordula Artelt (University of Bamberg), Michael Becker (TU Dortmund), Kai Maaz and Marco Neumann (DIPF Frankfurt), Malte Jansen (IQB, Humboldt-Universität zu Berlin) and Olaf Köller (IPN, Kiel University).

Jürgen Baumert – Publications 2020-2022/23

Updated on a daily basis

Journal Article (13)

2023

Journal Article

Baumert, J., Jansen, M., Becker, M., Neumann, M., Köller, O., & Maaz, K. (2023). Individually endorsed and socially shared normative beliefs on acculturation: Resources and risk factors for academic and psychosocial adjustment in mid-adolescence. *Journal of Educational Psychology*, *115*(4), 589–608. https://doi.org/10.1037/edu0000779

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Director Emeritus Gerd Gigerenzer

Image: MPI for Human Development

The ABC Research Group, established at the MPI for Psychological Research in Munich in 1995, moved to the MPI for Human Development in Berlin in 1997 and ended its local activities on 30 September 2017. Gerd Gigerenzer has continued as Director of the Harding Center for Risk Literacy, which was first located at the MPI for Human Development and moved to the University of Potsdam in 2020. Research from the Harding Center is not included in this report.

Psychological Heuristics for a Safer Financial System: A Collaboration With the Bank of England

In recent years, the financial system has become increasingly complex. Both the private sector and public authorities have tended to meet this complexity head-on, be it through increasingly complex modeling and risk management strategies or ever-lengthening regulatory rulebooks. Yet this helped neither to predict nor to prevent the global financial crisis of 2007–2008. In collaborative work with the Bank of England, we analyzed adaptive heuristics that are transparent and can predict bank failure better than standard complex models.

Distinguishing between risk and uncertainty, Aikman et al. (2021) draw on the psychological literature on heuristics to consider whether and when simpler approaches may outperform more complex methods for modeling and regulating the financial system. We found that (a) simple methods can dominate more complex modeling approaches for calculating banks' capital requirements, especially when data are limited or underlying risks are fat-tailed; (b) simple indicators often outperformed more complex metrics in predicting individual bank failure during the global financial crisis; and (c) when combining different indicators to predict bank failure, simple and easy-to-communicate "fast-and-frugal" decision trees can perform comparably to standard but more information-intensive regressions. Taken together, our analyses suggest that because financial systems are better characterized by uncertainty than by risk, simpler approaches to modeling and regulating financial systems can usefully complement more complex approaches and ultimately contribute to a safer financial system.

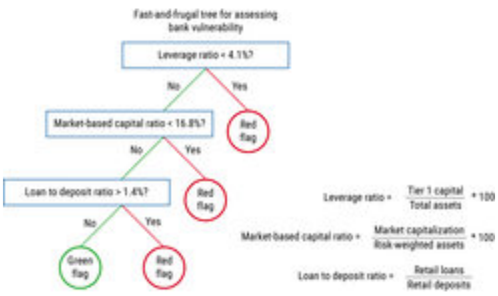

Figure 1. A fast-and-frugal tree for assessing bank vulnerability. The tree is based on a combination of expert judgment (to identify the relevant variables) and data (to set the thresholds). It predicts bank failure as accurately as or more accurately than logistic regression models and is, moreover, transparent and easy to apply. Image: MPI for Human Development

Image: MPI for Human Development
Adapted from Gigerenzer et al. (2021)

Key Reference

Aikman, D., Galesic, M., Gigerenzer, G., Kapadia, S., Katsikopoulos, K., Kothiyal, A., … Neumann, T. (2021). Taking uncertainty seriously: Simplicity versus complexity in financial regulation. *Industrial and Corporate Change*, *30*(2), 317–345. https://doi.org/10.1093/icc/dtaa024

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Adaptive Heuristics and Machine Learning

As the research with the Bank of England illustrates, fast-and-frugal trees and other heuristics can deal with situations of radical uncertainty (as opposed to calculable risk), while being transparent and easy to understand and teach. For a central bank, transparency is essential because it makes gaming easier to detect.

In the book *Classification in the Wild* (Katsikopoulos et al., 2020), we address the general questions of the relationship between psychological heuristics and machine learning. The two classes of heuristics we analyze are ecologically rational for different types of environments. First, fast-and-frugal trees exploit situations with dominant cues (variables), that is, where the (beta) weights of cues are steeply skewed, for example exponentially decreasing. Second, we look at tallying heuristics, which are adapted to situations where the weights of the cues are more equal. The book analyzes the conditions under which simple heuristics predict as accurately as random forests and other machine learning techniques, in both out-of-sample and out-of-population prediction. It also provides a hands-on introduction to the design of fast-and-frugal trees and tallying rules, such as the balancing of the false-positive rate with the miss rate. *Classification in the Wild* will also be translated into Chinese and published by East Babel.

Psychological AI

The fast-and-frugal tree for identifying volatile banks illustrates how the program of psychological AI uses the structure of heuristics humans rely on for designing predictive algorithms. In general, psychological AI applies insights from psychology to design computer algorithms. Its core domain is decision making under uncertainty, that is, ill-defined situations that can change in unexpected ways rather than well-defined, stable problems. Psychological theories about heuristic processes under uncertainty can provide possible insights. The following case study shows how recency—the human tendency to rely on the most recent information and ignore base rates—can be built into a simple algorithm that predicts the flu substantially better than Google Flu Trends' big data algorithms did. This case study provides an existence proof that psychological AI can help design efficient and transparent algorithms.

Recency: One Data Point Can Beat Big Data

Recency is the tendency to attach more importance to recent events than to past ones. In memory research, a *recency effect* has been observed that occurs when events more recently encountered are remembered best. Recency is sometimes considered a bias in the sense of error, as in the availability bias, but this valuation overlooks that recency, like all psychological phenomena, is neither rational nor irrational in itself. Rather, one needs to assess its ecological rationality. In a stable world, relying on the most recent events only and ignoring the base rates (the data of the past) might indeed be an error. But in an unstable world, where unexpected events happen, relying on recency may well lead to better decisions.

Predicting the Flu

To indicate where and how rapidly the flu was spreading, Google engineers used big data analytics to predict the rate of flu-related doctor visits on a daily or weekly basis. They analyzed 50 million queries submitted to the Google search engine and selected 45 variables from these, which they combined in a secret algorithm dubbed Google Flu Trends (GFT) (Ginsberg et al., 2009). GFT was trained on data from 2003 to 2007 and tested on data from 2007 to 2008. After the swine flu struck in the spring of 2009, however, GFT consistently underpredicted the number of flu-related doctor visits over months (see Figure 2). It had learned that the rate of flu is high in the winter and low in the summer, but the swine flu followed a different rhythm. To improve the algorithm, the engineers opted to make it more complex and increased the number of variables to approximately 160. Additional complexity, however, provided no improvement; the updated version now overestimated the proportion of flu-related doctor visits in 100 out of 108 weeks from August 2011 to September 2013, in some cases overshooting the actual visits by more than 50% (Figure 2). In response, the Google engineers again suspected that their model was too simple and updated it once again in 2013. After yet another update in 2014, GFT was shut down in 2015.

Instead of betting on more data and increasing the complexity of the algorithm, the alternative approach is psychological AI. In fast-changing environments, such as those involving flu viruses, it is rational to decrease complexity and ignore past data. Katsikopoulos et al. (2022) designed the simplest version of the recency heuristic, which implements these principles and relies on a single data point. We programmed recency into a fast-and-frugal algorithm:

> *Recency heuristic:* Predict that this week's proportion of flu-related doctor visits equals the proportion from the most recent week.

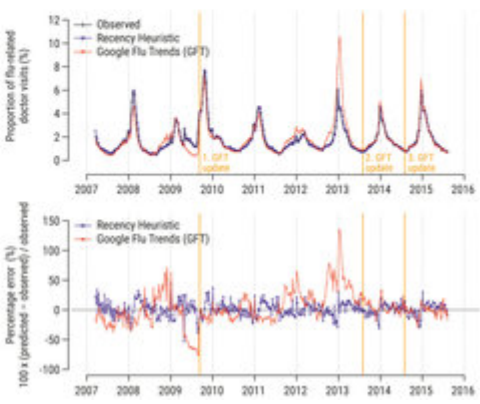

Figure 2. Performance of the recency heuristic and GFT for all weeks from 18 March 2007 to 9 August

2015, the horizon for which GFT predictions are available. The dashed vertical lines indicate the 1st week of each year. The solid vertical lines show the times of the three GFT updates. The predictions of GFT for each week are from the GFT model active at the time (i.e., the most recent GFT update). The upper panel depicts the proportion of flu-related doctor visits, observed and predicted. The lower panel shows the percentage error time series, where values above zero denote overprediction and values below zero denote underprediction.

One can intuitively see that this algorithm can adapt quickly to sudden and unexpected events such as the swine flu, whereas big data makes it difficult to change course. We tested the weekly predictions of the recency heuristic from 18 March 2007 to 9 August 2015 (the same period in which GFT made predictions). The overall error was measured by the average absolute difference between the predicted and observed values of flu-related doctor visits divided by the observed value (mean absolute prediction error). For the recency heuristic, the mean error was 9%, compared with 20% for GFT. The advantage of the psychologically inspired algorithm held for every year between 2007 and 2015, and across all three updates of GFT. Here, one data point was more powerful than big data. This case is an existence proof of the benefits of psychological AI.

Image: International Journal of Forecasting
Adapted from Katsikopoulos et al. (2022)

Algorithms that embody recency have also been shown to be superior to complex macroeconomic models in predicting demand (Dosi, Napoletano, Roventini, Stiglitz, & Treibich, 2020), and have predicted future customer purchases, sports events, and health behavior as accurately as random forests and logistic regressions, even though the latter used more data points (Artinger, Kozodoi, von Wangenheim, & Gigerenzer, 2018).

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Katsikopoulos, K. V., Şimşek, Ö., Buckmann, M., & Gigerenzer, G. (2022). Transparent modeling of influenza incidence: Big data or a single data point from psychological theory? *International Journal of Forecasting*, *38*(2), 613–619. https://doi.org/10.1016/j.ijforecast.2020.12.006
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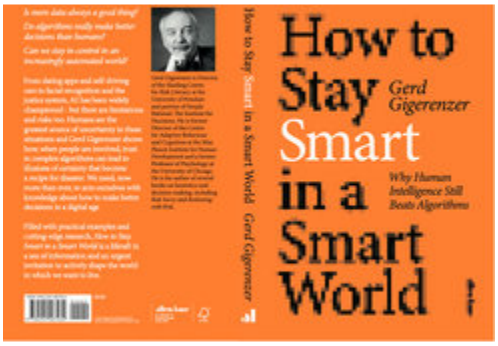
Human Intelligence ≠ Machine Intelligence



In the book *How to Stay Smart in a Smart World* (2022), I describe the psychological mechanisms used to keep users addicted to checking their phones and staying on social media platforms, and discuss heuristics such as lateral reading to determine the trustworthiness of websites. A key theme is the differences between human intelligence, intuition, and common sense, and deep artificial neural networks. Common sense is shared knowledge about people and the physical world, enabled by the biological brain. It comprises intuitive psychology, intuitive physics, and intuitive sociality. Unlike deep neural networks, common sense requires only limited experience. Human intelligence has evolved to deal with uncertainty, independent of whether big or small data are available. Complex AI algorithms, in contrast, work best in stable, well-defined situations such as chess and Go, where large amounts of data are available. This *stable-world principle* helps an understanding of what statistical algorithms are capable of and distinguishes this from commercial hype or techno-religious faith. I also introduce the program of *psychological AI*, which uses psychological heuristics to make algorithms smart. What AI needs is a fusion of the adaptive heuristics that embody common sense with the power of machine learning.

The book has been translated into Chinese (mainland), complex Chinese (Taiwan), Finnish, German, Italian, Korean, Polish, Russian, and Romanian.

Do children have Bayesian Intuitions?

Can children solve Bayesian problems, given that these pose great difficulties even for most adults? Gigerenzer, Multmeier, Föhring, and Wegwarth (2021) present an ecological framework in which Bayesian intuitions emerge from a match between children's numerical competencies and external representations of numerosity. Bayesian intuition is defined here as the ability to determine the exact Bayesian posterior probability by minds untutored in probability theory or in Bayes's rule. As we show, Bayesian intuitions do not require processing of probabilities or Arabic numerals, but basically the ability to count tokens in icon arrays and to understand what to count. A series of experiments demonstrates for the first time that icon arrays elicited Bayesian intuitions in children as young as second-graders for 22% to 32% of all problems; fourth-graders achieved 50% to 60%.

One of the problems children were given is the magic wand problem:

> Out of every 20 students of Hogwarts School of Witchcraft, five have a magic wand. Of these five students, four also have a magic hat. Of the other 15 students without a magic wand, 12 also have a magic hat.

Imagine you meet a group of students at Hogwarts School who have a magic hat. How many of them have a magic wand? ___out of ___.

Most surprisingly, icon arrays elicited Bayesian intuitions in children with dyscalculia, a specific learning disorder that has been attributed to genetic causes. These children could solve an impressive 50% of Bayesian problems, a level similar to that of children without dyscalculia. By seventh grade, children solved about two thirds of Bayesian problems with natural frequencies alone, without the additional help of icon arrays. We also identified four non-Bayesian rules. On the basis of these results, we propose a common solution for the phylogenetic, the ontogenetic, and the 1970s puzzles in the Bayesian literature and argue for a revision of how to teach statistical thinking. In accordance with recent work on infants' numerical abilities, these findings indicate that children have more numerical ability than previously assumed.

Key Reference

Gigerenzer, G., Multmeier, J., Föhring, A., & Wegwarth, O. (2021). Do children have Bayesian intuitions? *Journal of Experimental Psychology: General*, *150*(6), 1041–1070. https://doi.org/10.1037/xge0000979

MPG.PuRe DOI post-print

Misleading Statistics in the Media

Every month, three colleagues and I select a media report that misrepresents numbers and draws wrong conclusions as the "Unstatistik des Monats" (unstatistik.de), that is, the misleading statistics of the month. In our book *Grüne fahre SUV und Joggen macht unsterblich* (Greens drive SUVs and jogging makes you immortal), we compiled and edited a selection of these reports. Among the sins journalists commit year after year, either due to lack of understanding or done intentionally to attract attention, are (a) presenting correlations as causes; (b) presenting the effect of medical treatments with relative numbers instead of absolute numbers, which inflates the actual effect; (c) misinterpreting the reference class of a percentage reported; and (d) failing to understand that every test makes two errors and that reporting the hit rate of the newest blood test for cancer or the newest facial recognition system means nothing if the false alarm rate is not reported. We do this work to compensate for the dearth of journalists' education in statistical thinking and to help the general public see through the misconceptions and learn what critical questions to ask.

The book is currently being translated into Korean, to be published by Onward.

Key Reference

Bauer, T. K., Gigerenzer, G., Krämer, W., & Schüller, K. (2022). *Grüne fahren SUV und Joggen macht unsterblich: Über Risiken und Nebenwirkungen der Unstatistik*. Frankfurt: Campus Verlag. Retrieved from http://hdl.handle.net/21.11116/0000-000A-1C37-A

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Gerd Gigerenzer – Publications 2020-2022/23

Updated on a daily basis

Journal Article (24)

2023

Journal Article

Gigerenzer, G. (2023). How do narratives relate to heuristics? *Behavioral and Brain Sciences*, *46*, Article e94. https://doi.org/10.1017/S0140525X22002710

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Journal Article

Gigerenzer, G. (in press). AI in an uncertain world. *The American Journal of Psychology*.

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Journal Article

Gigerenzer, G. (2023). Psychological AI: Designing algorithms informed by human psychology. *Perspectives on Psychological Science*. Advance online publication. https://doi.org/10.1177/17456916231180597

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Book

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(U.S. edition: MIT Press)
(German translation: *Klick: Wie wir in einer digitalen Welt die Kontrolle behalten und die richtigen Entscheidungen treffen.* München: Bertelsmann, 2021)
(Chinese translation: CITIC)
(Finish translation: Terra Cognita)
(Italian translation: Raffaelo Cortina, 2023)
(Korean translation: Rokmedia)
(Russian translation: Bombra)
(Romanian translation: Curtea Veche)
(Polish translation: Copernicus Center Press)
(Audio book: Tantar Media)
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Thesis - PhD (1)

2021

Thesis - PhD

Jacobs, P. (2021). *On the significance of information* [PhD Thesis, Humboldt-Universität zu Berlin]. https://doi.org/10.18452/22919

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Director Emeritus Karl Ulrich Mayer Publications 2020–2022/23

Updated on a daily basis

Journal Article (2)

2022

Journal Article

Mayer, K. U. (2022). Aspects of a sociology of the pandemic: Inequalities and the life course. *Vienna Yearbook of Population Research*, *20*, 15–37. https://doi.org/10.1553/populationyearbook2022.per01

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2020

Journal Article

Settersten Jr., R. A., Bernardi, L., Härkönen, J., Antonucci, T. C., Dykstra, P. A., Heckhausen, J., Kuh, D., Mayer, K. U., Moen, P., Mortimer, J. T., Mulder, C. H., Smeeding, T. M., van der Lippe, T., Hagestad, G. O., Kohli, M., Levy, R., Schoon, I., & Thomson, E. (2020). Understanding the effects of Covid-19 through a life course lens. *Advances in Life Course Research*, *45*, Article 100360. https://doi.org/10.1016/j.alcr.2020.100360

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Book Chapter (4)

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Book Chapter

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Mayer, K. U. (2023). Sociology of the life course and its implications for health inequalities. In R. Hoffmann (Ed.), *Handbook of health inequalities across the life course* (pp. 15–31). Edward Elgar.

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Report (3)

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Report
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MPG.PuRe

Max Planck Fellow

Gert G. Wagner

How People Know Their Risk Preference
Fact Boxes May Contribute to a More Positive Evaluation of COVID-19 Vaccinations

Research Team 2020–2022/23

Ruben C. Arslan (as of 04/2021: Leipzig University, Germany)

Predoctoral Fellow

Sarah Swanke (LIFE)

Image: MPI for Human Development

Gert G. Wagner, Professor of Economics, is a Max Planck Fellow at the MPI for Human Development. He collaborates with researchers from the Center for Adaptive Rationality, the Center for Lifespan Psychology, the Lise Meitner Group for Environmental Neuroscience**,** and the Max Planck Research Group Biosocial—Biology, Social Disparities, and Development. Wagner is part of the faculty of the International Max Planck Research School on the Life Course (LIFE) and, together with Ulman

Lindenberger, is co-principal investigator of the Berlin Aging Study II (BASE-II) at the Institute. In 2023 Wagner was elected a fellow of the Association for Psychological Science.

Research in the years 2020 to 2022 was significantly dominated by analysis of the COVID-19 pandemic. But basic research still played a role, of course, and is reported on here before one COVID-19 project is presented.

How People Know Their Risk Preference

Two very different measurement traditions are used to investigate risk preferences in humans. The *revealed preference* approach, common in economics, studies choices under risk in the field and in the laboratory. The paradigmatic research designs in this tradition are observational studies of real behaviors (e.g., consumption and saving) and controlled choices between monetary lotteries. At the same time, psychologists as well as some economists use a different approach, in which people are simply asked to indicate their risk appetite in response to either general questions or hypothetical scenarios (the *stated preference* approach).

Economists are skeptical about the validity of stated preferences, because the statements involve no opportunity costs ("cheap talk"). However, inferring preferences from real-life behavior is fraught with assumptions, such as temporal stability and adequate control of confounding factors. Moreover, when researchers compared revealed and stated risk preference measures systematically, they found that the behavioral measures used in the revealed preference approach generally underperformed relative to the stated preference measures in terms of reliability, retest stability, and criterion validity. The behavioral measures used in the revealed preference approach do not correlate strongly across measures, meaning that they do not capture a clear latent preference that drives behavior across different choice situations. In contrast, stated risk preferences do correlate across measures, suggesting the existence of a general risk preference. Therefore, an interesting research question is: How do respondents manage to give such good answers when they are asked, "How do you see yourself: Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?" Answered on a scale of 0 (unwilling to take risks) to 10 (fully prepared to take risks), this single question, the general risk question (GRQ), has been used in several large and widely analyzed surveys.

To unpack the process of self-perception, how people translate their memories and intuitions into an answer to the GRQ was investigated. Stated risk preferences were collected as part of two large age-heterogeneous survey studies in Germany: the 2017 survey of the Berlin Aging Study II (BASE-II) and the 2017/2018 German Socio-Economic Panel Innovation Sample (SOEP-IS). Across both studies, 3,493 respondents answered the GRQ. After doing so, they were asked to explain their response in free-text questions about the topics and events they had thought about when answering.

Drawing on the extant literature and the free-text responses in the study, a coding scheme was developed with a list of broad risk domains and individual hazards. A set of coders then read the free-text responses. Nine coders read approximately 1,000 free-text answers each, so that each answer was coded in triplicate. Coders noted the presence of risk domains, such as investments or health, as well as more specific hazards, such as skydiving or divorce. Finally, each coder estimated—solely on the basis of the available text—the respondent's stated risk preference (GRQ answer).

The data show that when respondents answered the open-ended question about what they had in mind when answering the GRQ, most focused on high-stakes risks in finance, relationships, career, and traffic. In other words, respondents recalled their revealed preferences in areas relevant to their lives. They did not think about low-stakes risks (which are common in experiments) and they rarely mentioned smoking, drinking, and gambling, even though the GRQ has prognostic validity for these behaviors (which is the reason the GRQ is used for many studies in different behavioral domains). Furthermore, third-party readers (coders) of respondents' brief memories and explanations reached similar inferences about respondents' preferences as stated on the GRQ, indicating the intersubjective validity of this information.

Ongoing research shows that the rating of children's risk preferences by parents relies on the same process: When answering questions about the risk preferences of their children, parents bring to their minds the revealed preferences shown by their children in everyday life (e.g., at the playground, in school).

So, what economists perceive as a weakness of stated preferences (cheap talk) may actually be a strength. The study shows that the fairly vague, almost projective nature of a comprehensive single-item question allows people to refer back to their diagnostic memories and behaviors using a well-honed human capacity for social perception. That people can have different risk perceptions and conceptions could be problematic for the intersubjective comparability of their answers, but coders have been shown to generally agree on what risky behaviors imply about a person's risk preference, irrespective of age and gender. The shared social perception of risks fosters agreement and comparability, as well as the prognostic validity of stated risk preferences. This does not imply that self-reports are always suitable. For instance, applicants for a financial manager position could foil an attempt to screen for risk-seekers by simply dissembling—just as they could in typical laboratory tasks, where stakes are generally low.

The overall result of this research is a kind of irony: The revealed preference approach delivers the best results, not by measuring observable real behavior (which is the traditional method applied by economists) but through the *introspection* of people who are asked to *state* the degree of their risk appetite (the stated preference approach, which is common in psychology).

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MPG.PuRe DOI publisher-version

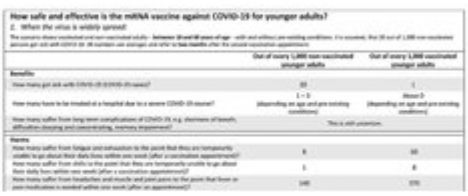
Fact Boxes May Contribute to a More Positive Evaluation of COVID-19 Vaccinations

For the effective control of the COVID-19 pandemic with vaccines, most people in a population need to be vaccinated. It is thus important to know how to inform the public in a way that recognizes individual preferences—while also acknowledging the societal preference of encouraging vaccinations. According to the health care standard of informed decision making, a comparison of the benefits and harms of (not) being vaccinated would be required to inform undecided and skeptical people. In order to test evidence-based fact boxes—an established risk communication format—and to inform their development, their contribution to knowledge and to evaluations of COVID-19 vaccines was investigated with the help of the online panel survey COMPASS.

COMPASS was an ad hoc survey established by the research company infratest dimap (Berlin). The MPI for Human Development and the Harding Center for Risk Literacy (Potsdam) had the opportunity to place questions in this survey, which ran from the very beginning of the COVID-19 pandemic in March 2020 until summer 2022. Different waves of the survey were analyzed, with *N* = 1,942 to *N* = 6,056.

COMPASS showed that vaccination knowledge and vaccination intentions increased between November 2020 and February 2021. COMPASS also revealed objective information requirements and subjective information needs. Finally, COMPASS showed (fieldwork happened in January 2021) that simple fact boxes (see, for example, Figure 1) increased vaccination knowledge and positive evaluations in skeptics and undecideds. These fact boxes were developed at the Harding Center for Risk Literacy, with the help of the Robert Koch Institute (RKI). The RKI is the government's central scientific institution in the field of biomedicine. It is one of the most important bodies for the safeguarding of public health in Germany.

It can be concluded that in Germany, the implementation of fact boxes supports evidence-based communication and, thus, empowerment at the population level. The mRNA fact boxes were disseminated via RKI's media channels, including their website (with about 130 million visits in 2020), an RKI Twitter account, and the Permanent Vaccination Commission in Germany's smartphone app. The results of our investigation suggest that presenting the around 10 million undecided and skeptical adults under 60 years of age in Germany with a simple fact box for about 90 seconds would familiarize more than 600,000 people with vaccine efficacy. A majority of them would evaluate vaccinations more positively. Additionally, by abstaining from persuasion, reluctance and distrust concerning the sender can be prevented or alleviated. Loss of trustworthiness is a relevant risk of alternative interventions that are nontransparent (e.g., nudges) or persuasive (e.g., advertisement), or that exert pressure (e.g., requiring authorized access to public activities).


How safe and effective is the mRNA vaccine against COVID-19 for younger adults?

2. When the virus is widely spread

Benefits

Harms

Figure 1. Fact boxes that inform individual decisions may contribute to a more positive evaluation of COVID-19 vaccinations at the population level.

From Rebitschek et al. (2022)

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Rebitschek, F. G., Ellermann, C., Jenny, M. A., Siegel, N. A., Spinner, C., & Wagner, G. G. (2022). Fact boxes that inform individual decisions may contribute to a more positive evaluation of COVID-19 vaccinations at the population level. *PLoS ONE*, *17*(9), Article e0274186. https://doi.org/10.1371/journal.pone.0274186

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Gert G. Wagner – Publications 2020-2022/23

Updated on a daily basis

Journal Article (47)

2023

Journal Article

Buchinger, L., Entringer, T. M., Richter, D., Wagner, G. G., Gerstorf, D., & Bleidorn, W. (2023). Codevelopment of life goals and the Big Five personality traits across adulthood and old age. *Journal of Personality and Social Psychology*. Advance online publication. https://doi.org/10.1037/pspp0000477

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2020

Book Chapter

Scherger, S., & Wagner, G. G. (2020). Soziale Ungleichheiten in Lebensläufen, Alterseinkommen und Lebenserwartung. In Kommission Verlässlicher Generationenvertrag [Members: G. Lösekrug-Möller, K. Schiewerling, A. Buntenbach, A. Gunkel, K. Mast, H. Gröhe, S. Stracke, A. Börsch-Supan, S. Scherger, & G. G. Wagner] (Ed.), *Bericht der Kommission Verlässlicher Generationenvertrag*: *Vol. 2. Materialien* (pp. 19–96).

MPG.PuRe

Book Chapter

Wagner, G. G. (2020). Wie geht es weiter? In H. Berth, E. Brähler, M. Zenger, & Y. Stöbel-Richter (Eds.), *30 Jahre ostdeutsche Transformation: Sozialwissenschaftliche Ergebnisse und Perspektiven der Sächsischen Längsschnittstudie* (pp. 301–304). Psychosozial-Verlag.

MPG.PuRe publisher-version

Conference Paper (1)

2020

Conference Paper

Linek, S. B., Fecher, B., Friesike, S., Hebing, M., & Wagner, G. G. (2020). Gender-related differences in scientific collaboration depend on working conditions. In L. G. Chova, A. L. Martinez, & I. C. Torres (Eds.), *Proceedings of INTED2020 Conference 2nd-4th March 2020, Valencia, Spain* (pp. 999–1008). IATED. https://doi.org/10.21125/inted.2020.0358

MPG.PuRe DOI

Working Paper (7)

2021

Working Paper

Danzer, N., Huebener, M., Pape, A., Spiess, C. K., Siegel, N. A., & Wagner, G. G. (2021). Cracking under pressure? Gender role attitudes toward maternal employment in times of a pandemic (IZA Discussion paper No. 14471). Institute of Labor Economics.

MPG.PuRe

Working Paper

Huebener, M., & Wagner, G. G. (2021). Unterschiede in Covid-19-Impfquoten und in den Gründen einer Nichtimpfung nach Geschlecht, Alter, Bildung und Einkommen (Discussion papers / Deutsches Institut für Wirtschaftsforschung No. 1968). DIW.

MPG.PuRe

2020

Working Paper

Arslan, R. C., Brümmer, M., Dohmen, T., Drewelies, J., Hertwig, R., & Wagner, G. G. (2020). How people know their risk preference (ECONtribute Discussion Paper No. 031). Reinhard Selten Institute.

MPG.PuRe

Working Paper

Hertwig, R., Liebig, S., Lindenberger, U., & Wagner, G. G. (2020). Wie gefährlich ist COVID-19? Die subjektive Risikoeinschätzung einer lebensbedrohlichen COVID-19-Erkrankung im Frühjahr und Frühsommer 2020 in Deutschland (SOEPpapers on Multidisciplinary Panel Data Research No. 1095). DIW.

MPG.PuRe publisher-version

Working Paper

Huebener, M., Siegel, N. A., Spiess, C. K., Wagner, G. G., & Waights, S. (2020). Parental well-being in times of COVID-19 in Germany (CEP Discussion Paper No. 1713). Centre for Economic Performance.

MPG.PuRe publisher-version

Working Paper

Huebener, M., Waights, S., Spiess, C. K., Siegel, N. A., & Wagner, G. G. (2020). Parental well-being in

times of COVID-19 in Germany (IZA Discussion paper No. 13556). Forschungsinstitut zur Zukunft der Arbeit.
MPG.PuRe

Working Paper
Rendtel, U., Meister, R., Goebel, J., Gößwald, A., Grabka, M. G., Hoebel, J., Schlaud, M., Schroeder, C., Wagner, G. G., Zinn, S., Liebig, S., & Lampert, T. (2020). Ein interdisziplinäres Studienkonzept zur Dynamik von COVID-19 auf der Basis der prospektiv erhobenen Daten der Kohorten des Sozio-oekonomischen Panels (SOEP) (SOEPpapers on Multidisciplinary Panel Data Research No. 1094). DIW.
MPG.PuRe

Report (7)

2022

Report
Gross, C., Grimm, V., & Wagner, G. G. (2022). *Eine faire CO_2-Bepreisung macht es Verbraucher*innen leicht, sich klimafreundlich zu entscheiden* Veröffentlichungen des Sachverständigenrats für Verbraucherfragen. Sachverständigenrat für Verbraucherfragen.
MPG.PuRe publisher-version

Report
Gross, C., Wagner, G. G., & Leier, B. (2022). *Versicherungspflicht gegen Naturgefahren: Neue Entwicklungen, Verfassungskonformität und Akzeptanz in der Bevölkerung*. Sachverständigenrat für Verbraucherfragen.
MPG.PuRe

2021

Report
Sachverständigenrat für Verbraucherfragen [Member of the MPIB: Gert G. Wagner]. (2021). *Gutachten zur Lage der Verbraucherinnen und Verbraucher in Deutschland 2021: Gutachten des Sachverständigenrats für Verbraucherfragen*. Sachverständigenrat für Verbraucherfragen.
MPG.PuRe

Report
Nationale Akademie der Wissenschaften Leopoldina [Member of the MPIB: Gert G. Wagner]. (2021). *Ökonomische Konsequenzen der Coronavirus-Pandemie: Diagnosen und Handlungsoptionen. [Stellungnahme]*. Nationale Akademie der Wissenschaften Leopoldina [Retrieved July 22, 2021, from https://www.leopoldina.org/publikationen/detailansicht/publication/oekonomische-konsequenzen-der-coronavirus-pandemie-diagnosen-und-handlungsoptionen-2021/].
MPG.PuRe

Report
Nationale Akademie der Wissenschaften Leopoldina [Members of the MPIB: Ralph Hertwig, Ulman

Lindenberger, Gert G. Wagner]. (2021). *Kinder und Jugendliche in der Coronavirus-Pandemie: Psychosoziale und edukative Herausforderungen und Chancen. [8. Ad-hoc-Stellungnahme]*. Nationale Akademie der Wissenschaften Leopoldina [Retrieved November 29, 2021, from https://www.leopoldina.org/publikationen/detailansicht/publication/kinder-und-jugendliche-in-der-coronavirus-pandemie-psychosoziale-und-edukative-herausforderungen-und-chancen-2021/]. (English translation: *Children and adolescents in the COVID-19 pandemic: Psychosocial and educational challenges and opportunities.* Halle (Saale): Nationale Akademie der Wissenschaften Leopoldina, 2021).

MPG.PuRe

2020

Report

Kommission Verlässlicher Generationenvertrag, Lösekrug-Möller, G., Schiewerling, K., Buntenbach, A., Gunkel, A., Mast, K., Gröhe, H., Stracke, S., Börsch-Supan, A., Scherger, S., & Wagner, G. G. (Eds.). (2020). *Bericht der Kommission Verlässlicher Generationenvertrag: Vol. 1. Empfehlungen*. Kommission Verlässlicher Generationenvertrag.

MPG.PuRe

Report

Kommission Verlässlicher Generationenvertrag, Lösekrug-Möller, G., Schiewerling, K., Buntenbach, A., Gunkel, A., Mast, K., Gröhe, H., Stracke, S., Börsch-Supan, A., Scherger, S., & Wagner, G. G. (Eds.). (2020). *Bericht der Kommission Verlässlicher Generationenvertrag: Vol. 2. Materialien*. Kommission Verlässlicher Generationenvertrag.

MPG.PuRe

Monograph (3)

2023

Monograph

Gert G. Wagner: Kommentare. Eine Auswahl 1971-2022. (2023). DIW.

MPG.PuRe

2022

Monograph

Weingart, P., Wormer, H., Schildhauer, T., Fähnrich, B., Jarren, O., Neuberger, C., Passoth, J.-H., & Wagner, G. G. (2022). *Gute Wissenschaftskommunikation in der digitalen Welt: Politische, ökonomische, technische und regulatorische Rahmenbedingungen ihrer Qualitätssicherung*. Berlin-Brandenburgische Akademie der Wissenschaften.

MPG.PuRe publisher-version

2021

Monograph

Neuberger, C., Weingart, P., Fähnrich, B., Fecher, B., Schäfer, M. S., Schmid-Petri, H., & Wagner, G. G. (2021). *Der digitale Wandel der Wissenschaftskommunikation*. Berlin-Brandenburgische Akademie der Wissenschaften.

MPG.PuRe publisher-version

Blog Post (1)

2021

Blog Post

Wagner, G. G. (2021). Mehr Forschungsbasierung der (Bundes)Politik (?). *Wirtschaftliche Freiheit: Das ordnungspolitische Journal*. http://wirtschaftlichefreiheit.de/wordpress/?p=30234.

MPG.PuRe

Interview (1)

2022

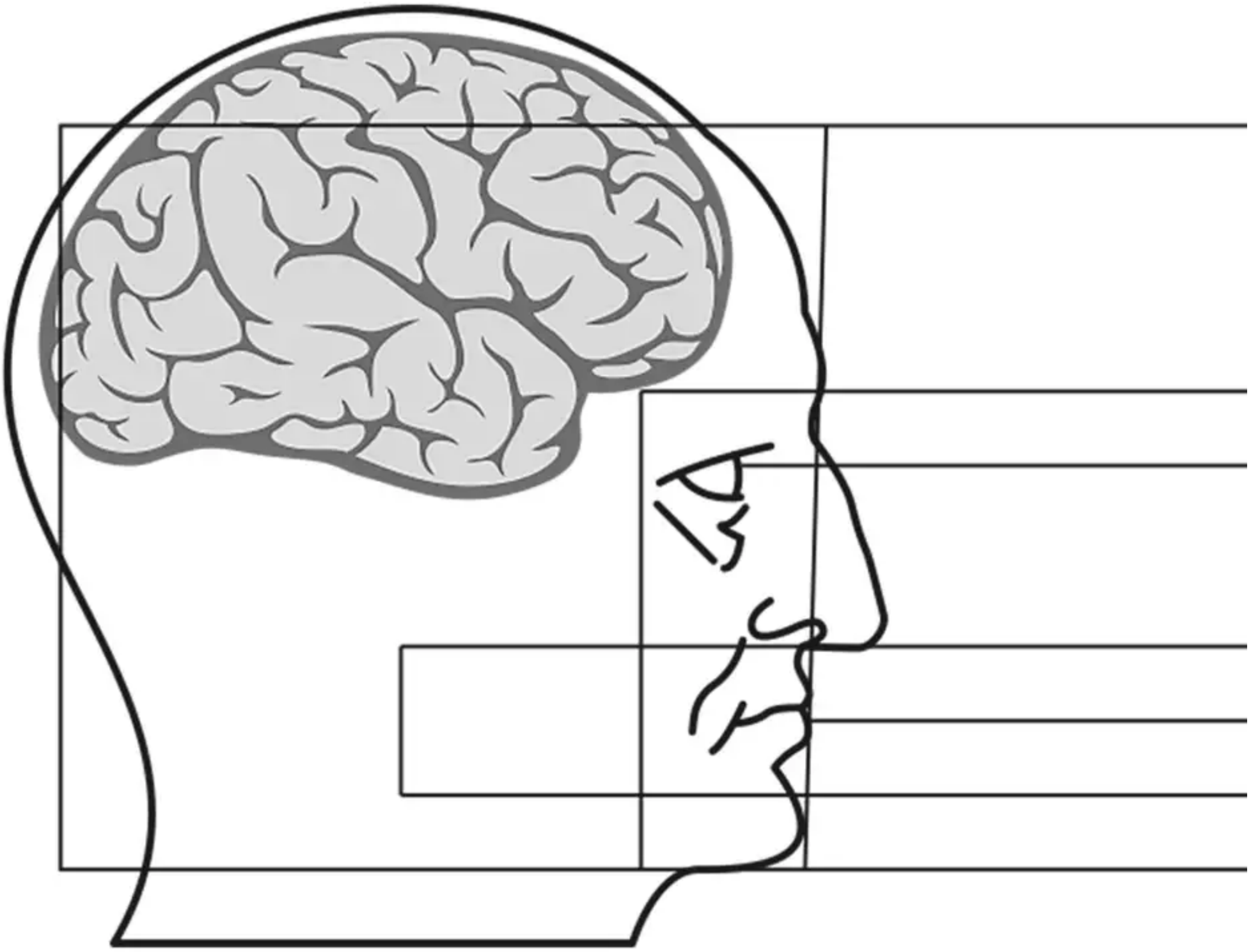
Interview

Wagner, G. G. (2022). Interview Gert Wagner. *AStA Wirtschafts- und Sozialstatistisches Archiv*, *16*, 155–165. https://doi.org/10.1007/s11943-022-00306-6

MPG.PuRe DOI

Graduate Education

The MPI for Human Development provides many opportunities for predocs. Among others, the two International Max Planck Research Schools at the Institute as well as the Max Planck School of Cognition provide an excellent training context.



IMPRS COMP2PSYCH

The International Max Planck Research School (IMPRS) COMP2PSYCH was established in early 2016 and serves as the graduate program of the Max Planck UCL Centre for Computational Psychiatry and Ageing Research. In London, the students are based at University College London (UCL); in Berlin, they are based at the MPI for Human Development and Humboldt-Universität zu Berlin. COMP2PSYCH teaches and trains concepts and methods from computer science and statistics in relation to substantive research questions in psychiatry and lifespan psychology. > more

IMPRS LIFE

The International Max Planck Research School (IMPRS) LIFE is all about the development of human behavior from infancy to old age. LIFE is a joint international PhD program of the MPI for Human Development, Freie Universität Berlin, Humboldt-Universität zu Berlin, the University of Michigan, the University of Virginia, and the University of Zurich. LIFE was established in 2002 and reached the nominal maximum period of 18 years of funding by the Max Planck Society in 2019. Upon positive review, a new six-year funding period started in 2020, with continued involvement of all four sites.

more

MAX PLANCK SCHOOL

Max Planck School of Cognition

The MPI for Human Development is participating in one of the three existing Max Planck Schools, namely the Max Planck School of Cognition (MPSCog). The school is coordinated by the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, and has its Berlin hub at the MPI for Human Development's Max Planck Dahlem Campus of Cognition. Ralph Hertwig, Ulman Lindenberger, and Iyad Rahwan are faculty members of the school. > more

International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH)

www.imprs-comp2psych.mpg.de

The International Max Planck Research School (IMPRS) COMP2PSYCH serves as the graduate program of the Max Planck UCL Centre for Computational Psychiatry and Ageing Research. In London, the students are based at University College London (UCL); in Berlin, they are based at the MPI for Human Development and Humboldt-Universität zu Berlin.

Co-Speakers: Ulman Lindenberger, MPI for Human Development; Raymond J. Dolan, UCL
Coordinators: Silke Schäfer, MPI for Human Development; Toyah Perkins, UCL

COMP2PSYCH teaches and trains concepts and methods from computer science and statistics in relation to substantive research questions in psychiatry and lifespan psychology. It was established by the Max Planck UCL Centre for Computational Psychiatry and Ageing Research in early 2016 and gives predoctoral students the opportunity to learn, apply, and develop computational and statistical methods that foster our understanding of individual development from childhood to old age, with an emphasis on mental illness and healthy cognitive aging.

COMP2PSYCH combines and integrates training in computer science, applied mathematics and statistics, psychology, and psychiatry with the goal of enabling the students to adapt and develop computational and statistical tools according to their data-analytic and scientific needs in the fields of psychiatry and lifespan psychology. Teaching fundamental concepts in cognitive science, lifespan psychology, and psychiatry in relation to computational and statistical theories and methods creates a superior degree of synergy between fields. In addition, the students benefit from the excellent research opportunities offered at both the Berlin and London sites. Indeed, the IMPRS COMP2PSYCH was positively evaluated by the Max Planck Society in September 2020 and extended for another six-year period from October 2022 until 2028.

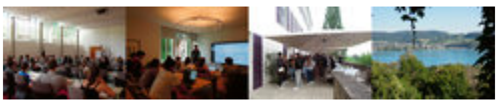
Predoctoral students have been recruited yearly since 2016. Successful applicants have completed a master's degree, or equivalent, in a discipline relevant to the school's program, for example cognitive neuroscience, psychology, psychiatry, health science, or statistics.

During the reporting period, 12 doctoral students were active in the IMPRS COMP2PSYCH in Berlin (see Table 1). Ten worked at the MPI for Human Development: three in the Lifespan Neural Dynamics Group (LNDG), two at the Center for Adaptive Rationality (ARC), two at the Max Planck Research Group NeuroCode (Neural and Computational Basis of Learning, Memory and Decision Making), two in the Center for Lifespan Psychology (LIP), and one in the Lise Meitner Group (LMG) for Environmental Neuroscience. In addition, two students worked at the Department of Psychology, Humboldt-Universität zu Berlin. Three successfully completed their dissertations and joined the ten COMP2PSYCH alumni. During the reporting period, 11 students worked on their dissertation projects in London (see https://www.imprs-comp2psych.mpg.de).

The three-year training program involves seminars, workshops, participation in summer schools, and collaborative supervision of research training. The focus of the Berlin site is computational and statistical advances in studying individual differences in development from childhood to old age. Methods include structural and functional neuroimaging, computational modeling, and statistical methods for the multivariate analysis of longitudinal changes in brain and behavior. Table 2 shows the seminars and workshops offered in Berlin during the reporting period.

The strongest integrative components of the interdisciplinary and international COMP2PSYCH program are the annual meetings in which students and faculty from all COMP2PSYCH institutions participate. Due to COVID-19 restrictions, these personal meetings and exchanges could not take place for some time. There were several meetings in an online format instead. Nevertheless, the last Max Planck UCL Centre's Symposium and Advanced Course on Computational Psychiatry and Ageing Research was held in September 2022 at Schloss Marbach.

Finally, a monthly, student-centered colloquium series that is jointly hosted by the Berlin and London sites was started in 2020. PhD students give talks on their upcoming, in progress, or completed research, and students, postdocs, and faculty provide in-depth feedback.



Impressions from the Fifth Symposium and Advanced Course on Computational Psychiatry and Ageing Research, held in September 2022 at Schloss Marbach, Germany.
Image: MPI for Human Development

Table 1. Berlin COMP2PSYCH Students' Affiliations and Dissertation Projects (01/2020–03/2023)

►

Manuel Arnold, Humboldt-Universität zu Berlin
Score-based approaches to heterogeneity in psychological models
Moana Beyer, LMG for Environmental Neuroscience
Associations between the physical environment and brain structure and function in different cohort studies
Verena Clarmann von Clarenau, ARC
Psychophysical foundations of experience-based decisions
Simon Ciranka, ARC
Computational mechanisms of social influence during adolescence
Moritz Ketzer, Humboldt-Universität zu Berlin
Potentials and limitations of new approaches to Bayesian SEM
Agnieszka Kulesza, LIP
Neuromodulation, plasticity and cognition: Unlocking their interplay across timescales
Anika Löwe, MPRG NeuroCode
Investigating the computational role of hippocampal replay in planning and value computation
Zoya Mooraj, LNDG
Cross-sectional vs. longitudinal approaches to understanding the aging brain
Aaron Peikert, LIP
Towards transparency and Open Science: A principled perspective on computational reproducibility and preregistration*
Liliana Polanski, LNDG
The association between brain signal variability and the explore–exploit trade-off across the lifespan
Alexander Skowron, LNDG
The role of neural and behavioral variability in learning and decision-making across the lifespan
Lennart Wittkuhn, MPRG NeuroCode
Investigating neural replay of task representations in the human brain using fMRI

Note that titles in italics indicate that the respective PhD thesis has been defended. The asterisk shows that the thesis has been submitted.

Table 2. COMP2PSYCH Seminars and Workshops 2020–03/2023, Berlin

▶

Semester	Topic	Instructor(s)
Winter 2019/20	A Reproducible Data Analysis Workflow with R Markdown, Git, Make, and Docker	Andreas Brandmaier, MPI for Human Development
	An Introduction to the Basics of Deep Learning Methods	Andreas Brandmaier, MPI for Human Development
	UCL MPG Computational Psychiatry Talks (weekly virtual lectures and discussion)	Max Planck Society and UCL scientists and guests from other universities
Summer 2020	COMP2PSYCH Colloquium (monthly virtual talks and discussion	COMP2PSYCH students and faculty
	Effective Presentations (online webinar)	Steven Weir, Freie Universität Berlin
	UCL MPG Computational Psychiatry Talks (weekly virtual lectures and discussion)	Max Planck Society and UCL scientists and guests from other universities
Winter 2020/21	UCL MPG Computational Psychiatry Talks (weekly virtual lectures and discussion)	Max Planck Society and UCL scientists and guests from other universities
	COMP2PSYCH colloquium (monthly virtual talks and discussion)	COMP2PSYCH students and faculty
Summer 2021	From Data to Causes – Advancing Research and Education on the Missing Link of Causal Inference	Manuel Völkle, Humboldt-Universität zu Berlin

UCL MPG Computational Psychiatry Talks (weekly virtual lectures and discussion)

Max Planck Society and UCL scientists and guests from other universities

COMP2PSYCH Colloquium
(monthly virtual talks and discussion)

COMP2PSYCH students and faculty

Winter 2021/22

Workshop on Research Data Management

Maike Kleemeyer, MPI for Human Development

UCL MPS Computational Psychiatry Talks (weekly virtual lectures and discussion)

Max Planck Society and UCL scientists and guests from other universities

COMP2PSYCH Colloquium
(monthly virtual talks and discussion)

COMP2PSYCH students and faculty

Summer 2022

UCL MPG Computational Psychiatry talks (weekly virtual lectures and discussion)

Max Planck Society and UCL scientists and guests from other universities

COMP2PSYCH Colloquium
(monthly virtual talks and discussion)

COMP2PSYCH students and faculty

Winter 2022/23

Symposium and Advanced Course on Computational Psychiatry and Ageing Research, Schloss Marbach

COMP2PSYCH students and faculty and guests

Note. The Berlin students were able to participate in lectures held at UCL via video-conferencing; they were also invited to participate in all LIFE activities (see https://www.imprs-life.mpg.de/life-program/curriculum/seminars).

COMP2PSYCH Faculty

Dominik Bach, University College London

Andreas M. Brandmaier, MPI for Human Development

Christian Doeller, MPI for Human Cognitive and Brain Sciences, Leipzig

Raymond J. Dolan, University College London

Stephen Fleming, University College London

Douglas D. Garrett, MPI for Human Development

Tobias Hauser, University College London

Ralph Hertwig, MPI for Human Development

Quentin Huys, University College London

Ylva Köhncke, MPI for Human Development

Simone Kühn, MPI for Human Development

Ulman Lindenberger, MPI for Human Development

Janaina Mourao-Miranda, University College London

Nicolas W. Schuck, MPI for Human Development

Tali Sharot, University College London

Bernhard Spitzer, MPI for Human Development

Stephanie Theves, MPI for Human Cognitive and Brain Sciences, Leipzig

Arno Villringer, MPI for Human Cognitive and Brain Sciences, Leipzig

Manuel C. Völkle, Humboldt-Universität zu Berlin

Timo von Oertzen, Universität der Bundeswehr München & MPI for Human Development

Markus Werkle-Bergner, MPI for Human Development

G. Elliott Wimmer, University College London

International Max Planck Research School on the Life Course (LIFE)

www.imprs-life.mpg.de/

Studying the development of human behavior from infancy to old age is at the heart of the LIFE graduate program. LIFE takes an integrative and interdisciplinary approach to identifying, understanding, and improving the mechanisms and conditions that shape the human life course. It actively promotes international networking and communication as an integral part of graduate training. The Berlin-based fellows are recruited from all over the world (e.g., Iran, India, Italy, Lebanon, Turkey, etc.). In addition, four LIFE sites in three countries (Germany, the United States, Switzerland) located on either side of the Atlantic guarantee a graduate education with a strong emphasis on international exchange and collaboration.

Co-Speakers: Ulman Lindenberger, MPI for Human Development; Clemens Tesch-Römer, German Centre of Gerontology (Associate Co-Speaker); Toni C. Antonucci, University of Michigan; Jacqui Smith, University of Michigan (Associate Co-Speaker); Steven M. Boker, University of Virginia; Angeline M. Lillard, University of Virginia (Associate Co-Speaker); Moritz Daum, University of Zurich; Alexandra M. Freund, University of Zurich (Associate Co-Speaker)
Program Manager: Imke Kruse, MPI for Human Development
Coordinators: Silke Schäfer, MPI for Human Development; Karen Johnson, University of Virginia
Newsletter Editor: Julia A. M. Delius, MPI for Human Development

LIFE is all about the development of human behavior from infancy to old age. LIFE is a joint international PhD program of the MPI for Human Development, Freie Universität Berlin, Humboldt-Universität zu Berlin, the University of Michigan, the University of Virginia, and the University of Zurich. LIFE was established in 2002 and reached the nominal maximum period of 18 years of funding by the Max Planck Society in 2019. Upon positive review, a new six-year funding period started in 2020, with continued involvement of all four sites.

LIFE takes an integrative and interdisciplinary approach to identifying, understanding, and possibly ameliorating the mechanisms and conditions that shape the human life course. LIFE unifies a wide range of disciplines from the behavioral, computational, social, and neurosciences. The research of individual fellows is anchored within specific disciplines and their training is enriched by exposure to an international and interdisciplinary context that actively promotes the lifespan perspective.

The target groups of LIFE are graduate students who have completed their M.A. or a comparable degree, share an interest in the human life course, and intend to pursue a doctorate in one of the disciplines represented in LIFE (computer science, economics, educational science, neuroscience, psychology, and sociology). As a collaborative research school, LIFE offers students a unique educational experience: academic training in their area of specialization that is enriched by interdisciplinary and international perspectives.

Collaboration among the participating institutions has been close and extensive since the program's inception. The semiannual academies, in which fellows and faculty from the four LIFE sites participate, are the beating heart of the international LIFE program. About 40 fellows typically attend the academies, and most of them present their dissertation research either as a poster or in a talk, with ample time for discussion with faculty and co-fellows. In addition, roughly 35 faculty members from all sites and a few local alumni, as well as one or two guest speakers from other institutions, participate in each academy. Each time, the graduating alumni also join the group to celebrate their LIFE Commencement. Each fellow participates in four academies.

The COVID-19 pandemic necessitated several adaptations of the standard LIFE curriculum; four academies were carried out virtually and one semi-virtually before a fully in-person event could be held again in Berlin in October 2022. The opportunity was taken to celebrate the 20th LIFE Anniversary with fellows and faculty as well as members of the first LIFE cohort, who started the program in 2002 (see Figures 1 & 2).

Figure 1. The first in-person LIFE event after the pandemic: Fall Academy 2022 at the Harnack House, Berlin.
Image: MPI for Human Development

Figure 2. The 20th LIFE Anniversary celebration involved the alumni of the first LIFE cohort. From left to right: Andreas Wilke, Rui Mata, Oliver Huxhold, Nicole Hess, Christina Limbird, Christina Röcke, Sabine Schäfer, Kate Fiori.
Image: Steven Boker

The LIFE exchanges, or research stays at a LIFE site abroad, are usually the other core element of international collaboration. Over the years, these exchanges have triggered an impressive number of collaborative research projects among fellows as well as fellows and faculty members from different sites and institutions. In the reporting period, the pandemic obviously limited the opportunities for exchanges, but three fellows were able to visit another LIFE site.

LIFE fellows in Berlin normally participate in a special program of weekly seminars each semester. On a rotational basis, the topics are designed to give a broad overview of research and theory in the biology, psychology, sociology, and education of the life course. The seminars are usually held at the MPI for Human Development, taught throughout the academic year by a varying team of faculty from the three Berlin institutions, and also include invited lectures by external faculty. Again, several seminars needed to be held online, and a new format was established, namely the LIFE Theory Lab, an open lecture series on contemporary theorizing, methodological advancements, and future challenges for lifespan developmental science. The lectures were given by invited international experts and were open to a wide audience across the academic community.

Table 1. LIFE Academies 2020–2022

►

Spring Academy 2020, 27.05 2020
University of Virginia
Virtual event
Fall Academy 2020, 08.–09.10.2020
MPI for Human Development
Virtual event
Spring Academy 2021, 25.05.–27.05.2020
University of Michigan
Virtual event
Fall Academy 2021, 11.10.–13.10.2021
University of Zurich
In-person and virtual event
Spring Academy 2022, 09.05.–11.05.2022
University of Virginia
Virtual event
Fall Academy 2022 and 20th LIFE Anniversary Celebration 13.10.–16.10.2022
MPI for Human Development
In-person event

Table 2. International LIFE Community (as of 03/2023)

	Berlin	Michigan	Virginia	Zurich
Faculty	34	26	25	26
Fellows	25	6	7	15
Alumni	117	65	50	49

Table 3. LIFE Seminars and Workshops 2020–2023, Berlin

Semester	Topic	Instructor(s)
Summer 2023	Introductory Workshop on the Foundations of Lifespan Research	Berlin LIFE faculty and guests
Summer 2020	The LIFE Theory Lab: Open Lecture Series*	Ulman Lindenberger (MPIB) and guests
Winter 2020/21	Seminar: Education Across the Lifespan*	Martin Brunner (University of Potsdam) and guests
Winter 2020/21	Presentation Training*	Steve Weir (FU)
Winter 2020/21	*Lectures on Multivariate Methods**	Timo von Oertzen (MPIB/Universität der Bundeswehr)
Summer 2021	Seminar: Fellows' Project Presentations*	Chaired by Berlin LIFE alumni
Summer 2021	*Git Workshop**	Antonio Amaddio (FU)
Summer 2021	*Workshop on Good Scientific Practice**	Uwe Czienskowski (MPIB)
Summer 2021		

*Workshop: From Data to Causes**

Manuel Voelkle (HU) and guests

Winter 2021/22

Introductory Workshop on the Foundations of Lifespan Research

Markus Werkle-Bergner (MPIB)

Winter 2021/22

Seminar: Decision Making

Nicolas Schuck (MPIB) and guests

Winter 2021/22

Workshop on Academic Writing

Ulman Lindenberger

Winter 2021/22

*Lectures on Data Mining**

Timo von Oertzen (MPIB/Universität der Bundeswehr)

Winter 2021/22

Workshop on Research Data Management

Maike Kleemeyer (MPIB)

Summer 2022

The LIFE Theory Lab: Open Lecture Series*

Wiebke Bleidorn (UZH) and guests

Winter 2022/23

Seminar: Methods in Research on Human Development

Ulman Lindenberger (MPIB) and guests

Winter 2022/23

Presentation Training

Steve Weir (FU)

Winter 2022/23

*Class on Dynamical Systems Analysis**

Steven Boker (UVA)

Summer 2023
Introductory Workshop on the Foundations of Lifespan Research
Berlin LIFE faculty and guests

Freie Universität Berlin (FU), MPI for Human Development (MPIB), University of Virginia (UVA), University of Zurich (UZH). Events in italics were optional.
* Virtual events

Table 4. Berlin LIFE Fellows' Dissertation Projects (as of 03/2023)

►

Name	Institution	Dissertation Project
Muna Aikins	MPIB	Biosocial pathways of racialized inequalities in children’s and adolescents‘ mental health
Warsha Barde	DZNE	The role of learning in the emergence of individuality
Elisa Buchberger	MPIB	The process architecture of memory in early to middle childhood
Laura Buchinger	DIW	The interplay of life goals, personality, and well-being: A lifespan perspective
Hannes Diemerling	MPIB	Machine learning methods to determine the correlation between partially or completely missing variables
Michael Geers	MPIB	Rebalancing human and algorithmic decision making
Urmimala Ghose	HU	Contextual effects on adaptation to major life events
Andrea Hasl	University of Potsdam	Time matters: Adopting a lifespan developmental perspective on individual differences in skills, cumulative advantages, and the role of dynamic modeling approaches

Marlene Hecht	
MPIB	
Social sampling from online and offline contacts: Information search, adaptive use and developmental differences	
Maike Hille	
MPIB	
Training-induced brain changes during motor skill learning in humans and mice	
Neda Khosravani	
MPIB	
The effects of task-switching training in childhood: Individual differences in performance change	
Michael D. Krämer	
DIW	
Social relationships, personality, and subjective well-being: Investigating social processes across different methods and temporal resolutions	
Toni Muffel	
HU	
Modulating and assessing plasticity after stroke and across the lifespan	
Jannik Orzek	
HU	
Statistical learning in psychological research: Methods and applications	
Eleftheria Papadaki	
MPIB	
Experience-dependent plasticity in the auditory domain: Effects of expertise and training on functional brain organization	
Claire Pauley	
MPIB	
Age differences in memory representations	
Sina A. Schwarze	
MPIB	

Mechanisms of cognitive control plasticity during childhood
Alexander Skowron
MPIB
The role of neural and behavioral variability in learning and decision-making across the lifespan
Sophie Stallasch
University of Potsdam
Multilevel design parameters and effect size benchmarks for students' competencies
Sonja Sudimac
MPIB
Neural correlates of beneficial effects of a one-hour walk in natural vs. urban environments
Sarah Swanke
MPIB
On the origin of risk preferences
Nour Tawil
MPIB
Affective and behavioral mechanisms underlying the response to architectural stimuli
Anna Thoma
MPIB
Ecological rationality of repeated choice under uncertainty: A developmental perspective
Luianta Verra
MPIB
Mechanisms of aversive generalization and replay and its relationship to transdiagnostic psychiatric measures
Dilara Zorbek
MPIB
Task-dependent representational dynamics of working memory

German Institute for Economic Research (DIW), Deutsches Zentrum für Neurodegenerative

Erkrankungen, Dresden (DZNE), Humboldt-Universität zu Berlin (HU), MPI for Human Development (MPIB).

Table 5. LIFE Faculty Members at the MPIB or With MPIB Affiliation (as of 02/2023)

▶

Name	Center/Research Group	Position
Douglas D. Garrett	Lifespan Neural Dynamics Group & Lifespan Psychology	Senior Research Scientist
Ralph Hertwig	Adaptive Rationality	Director
Simone Kühn	Lise Meitner Group for Environmental Neuroscience	Group Leader
Ulman Lindenberger	Lifespan Psychology	Director
Laurel Raffington	Max Planck Research Group Biosocial	Group Leader
Iyad Rahwan	Humans and Machines	Director
Naftali Raz	Lifespan Psychology	Research Scientist
Azzurra Ruggeri	Max Planck Research Group iSearch	Group Leader
Myriam C. Sander		

Minerva Group, Lifespan Psychology

Group Leader

Nicolas W. Schuck

Max Planck Research Group NeuroCode

Group Leader

Christin Schulze

Adaptive Rationality

Senior Research Scientist

Bernhard Spitzer

Research Group Adaptive Memory and Decision Making

Group Leader

Timo von Oertzen

Lifespan Psychology

Associate Research Scientist

Gert G. Wagner

Max Planck Fellow

Markus Werkle-Bergner

Lifespan Psychology

Senior Research Scientist

Annie E. Wertz

MPRG Naturalistic Social Cognition

Group Leader

Dirk Wulff

Adaptive Rationality

Senior Research Scientist

Note that Nicolas W. Schuck and Markus Werkle-Bergner are LIFE alumni, that is, they completed their graduate training within LIFE.

Max Planck School of Cognition

In Germany, the best researchers in a specific field are often working at different universities and non-university research organizations spread throughout the country. The Max Planck Schools serve as hubs gathering this distributed knowledge. Here, the brightest minds in their respective fields come together from within the scientific community to interconnect in faculties.

The MPI for Human Development is participating in one of the three existing Max Planck Schools, namely the Max Planck School of Cognition (MPSCog). The school is coordinated by the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, and has its Berlin hub at the MPI for Human Development's Max Planck Dahlem Campus of Cognition. Ralph Hertwig, Ulman Lindenberger, and Iyad Rahwan are faculty members of the school. It offers an international 4-year doctoral program starting each September, with a 1-year orientation phase followed by 3 years of research for the doctorate. Students can enter the program with a bachelor's (fast-track) or a master's degree.

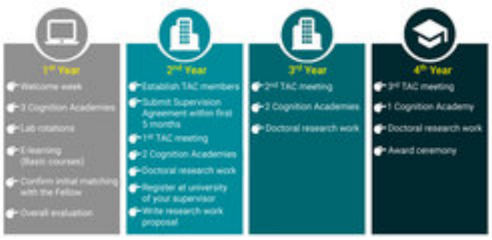


Figure 1. Schedule of the 4 years of doctoral training at the Max Planck School of Cognition. Note: TAC: Thesis Advisory Committee. Source:
https://cognition.maxplanckschools.org/en/program

Year 1

Figure 1 shows the general schedule of the 4 years of MPSCog doctoral training. During the 1st year (the orientation phase), emphasis is put on teaching and prolonged laboratory rotations, usually in three different labs of MPSCog faculty members. An important goal of the orientation period is that doctoral candidates acquire interdisciplinary or multidisciplinary perspectives on a selected common research theme (e.g., by combining artificial intelligence and cognitive neuroscience or psychology and basic anatomy). Lab rotations allow 1st-year doctoral candidates to explore several different research groups associated with the MPSCog's program. Students further define their individual research interests and eventually choose a laboratory where they will conduct their doctoral research work in the following 3 years. At the MPI for Human Development, we regularly have students doing their lab rotations with the participating Centers or research groups (see Table 1).

Table 1. Laboratory Rotations at the MPIB

►

Name	Cohort	Laboratory Visited
Tamer Ajaj	2020	Iyad Rahwan
Maria Badanova	2020	Ulman Lindenberger, Douglas Garrett
Clara Bersch	2020	Ralph Hertwig
Surabhi S. Nath	2020	Ralph Hertwig
Rena Bayramova	2021	Nicolas Schuck
Max A. B. Hinrichs	2021	Nicolas Schuck
Thomas Graham	2022	Ralph Hertwig, Bernhard Spitzer
Tiantian Li	2022	Ulman Lindenberger, Martin Dahl

Doctoral candidates are expected to attend basic scientific units presented in two categories: e-learning courses that cover the essentials in a specific area, and cognition academies (classroom weeks) in which doctoral candidates meet in person. The first cognition academy, to introduce the MPISCog's program, takes place as a welcome week at the beginning of the 1st academic year. It is followed by three academies each year.

Although the academic program is conducted in English, being able to learn the German language benefits all doctoral candidates. Thus the MPSCog offers a German course to all its international candidates to reduce language barriers and improve their daily life.

The 1st year is completed with an evaluation of the performance of each doctoral candidate before they advance to the doctoral research phase (years 2–4). Only after successful evaluation can doctoral students select a faculty member for their supervisory team. Table 2 shows the students carrying out their doctoral research at the MPI for Human Development.

Table 2. MPSCog Students' Dissertation Projects at MPIB

►

Name	Advisor(s)	Cohort	Dissertation Title
Pietro Nickl	Ralph Hertwig, Iyad Rahwan	2019	The social dynamics of cultural evolution online
Caedyn Stinson	Ralph Hertwig	2019	Cognitive mechanisms of social sampling from memory
Clara Bersch	Iyad Rahwan	2020	The psychological and societal impacts of AI advisory systems and their implications for AI design
Fabian Renz	Nicolas Schuck	2020	Replay induced representation changes
Fabian Kamp	Ulman Lindenberger, Douglas Garrett	2021	Neural dynamics of adaptive cognition
Konstantin Offer	Ralph Hertwig	2021	Deliberate ignorance as a strategic device in social interactions

Years 2 and 3

At the beginning of the 2nd year, doctoral candidates work together with their selected supervisor to develop a feasible and relevant project proposal, which is then presented to a thesis advisory committee (TAC). After approval of the research plan, doctoral candidates start their individual project. Furthermore, doctoral candidates attend two academies per year, each of which lasts 2 weeks. Each academy involves 1 week of courses on advanced topics and 1 week of presentations on select research topics by doctoral candidates, faculty, and guest speakers.

Year 4

Students are expected to finalize their dissertation by the end of the 4th year. In addition, they attend one cognition academy involving presentations on respective research topics by faculty, students, and guest speakers. At the end of the 4th year, the doctoral degrees will be awarded by the university to which the supervisor of the respective candidate is affiliated.

Introduction: Support Services at the Institute

Support services play a vital role in the smooth running of the Institute. The four non-scientific service units—Administration, Central Services, Press and Public Relations, and Technical Services—are led by the Head of Administration. The scientific service units—previously comprising Central IT and Library and Research Information—report to the Managing Director.

Collaboration and collective impact is becoming increasingly important for all service units. In recent years, the units have joined forces to advance several Institute-wide projects that benefit all Centers and Groups.

Library and Research Information Unit

One initiative centers around the development and professionalization of the Institute's Research Data Management (RDM) services, which have been incorporated into the portfolio of the Library and Research Information Unit. This process began with a working group on RDM set up by the directors in 2018, leading to the appointment of an RDM Coordinator in March 2021. In 2022, the RDM team success fully integrated the Castellum project as an Institute-wide tool, including the development of a data protection-compliant participant database. In 2023, the RDM team launched an Institute-wide study registration tool.

Recognizing the growing importance of Open Science, the RDM Coordinator has engaged in various activities to facilitate easy and open access to research results (e.g., publications, data, software) and to promote transparency within the research process as a whole.

Scientific Service Unit and Third-Party Funding

In March 2022, the Scientific Service Unit was established, headed by the newly appointed Institute Research Coordinator. This development reflects the management's commitment to centralizing infrastructure, meeting the demands of an increasingly interdisciplinary workplace, and enhancing the professionalization of the services provided.

Central IT Unit

The Central IT Unit plays a critical role at the Institute by ensuring that all IT operations run smoothly. The Unit consists of two teams: Infrastructure and Service Desk. The Infrastructure team is responsible for constructing and maintaining crucial elements of the Institute's IT systems, including the Internet infrastructure, WiFi, networks, and data storage. The Service Desk team provides indispensable support to the Institute staff in their day-to-day work, serving as a one-stop point of contact for any IT issues, including troubleshooting, technical support, and service requests. In 2022, the Institute established an IT Advisory Board to facilitate the exchange of expertise and knowhow across all Centers and Groups. The Board brings together scientific IT staff from throughout the Institute to discuss and make important decisions in consultation with Central IT. All IT staff members benefit from better insights into developments in other areas of the Institute and from the opportunity to identify and leverage synergies.

Max Planck Dahlem Campus of Cognition (MPDCC)

A further area of major Institute-wide change is the establishment of the Max Planck Dahlem Campus of Cognition (MPDCC) as a core facility in Dillenburger Straße. Over the past decade, the Institute has transitioned from a predominantly humanities-focused research institution to one that emphasizes experimental approaches. This shift has fueled a growing demand for laboratory infrastructure and innovative imaging techniques. In 2017 and 2018, the Max Planck Society approved the construction of a wave field synthesis audio lab, as well as the purchase of a second 3T MRI scanner and a 7T MRI scanner. With the recent acquisition of the Dillenburger Straße building, the Institute is now in a position to set up a core facility with the necessary laboratories. The Max Planck Dahlem Campus of Cognition was launched in 2021 as the organizational umbrella for this core facility.

The heads of the service units regularly meet to provide updates on their respective areas and address shared concerns, ensuring a coordinated approach throughout the Institute. This practice allows for diverse perspectives to contribute to discussions and enables efficient planning of overarching projects. By fostering open communication and collaboration among the units, we leverage expertise and work towards effective solutions that benefit the entire Institute.
Image: MPI for Human Development

Library and Research Information Unit

Last update: July 2023

Head: Sebastian Nix
Academic Librarian: Nicole Engelhardt
Research Data Management Coordinator: Maike Kleemeyer

The Library and Research Information Unit is a central service facility for the support of scientific work in the Institute. It is responsible for the analog and digital supply of information to researchers and research support staff, for whom it also provides services in the areas of research data management (RDM), information research, scientific publishing, and impact optimization. In this way, the team supports research with custom-tailored services throughout the entire research cycle.

Intranet presence of the Library and Research Information Unit
Image: MPI for Human Development

Since 2019, taking into account the dynamic changes at the Institute, the unit has been implementing a strategic work program for the demand-oriented further development of its service portfolio. Significant progress has been made in this area.

In 2020, the permanent position of a research data management coordinator was created and filled by a developmental psychologist with a PhD. Since then, research data-related services have been continuously expanded. They range from comprehensive information and training offers to the further development of a software-based platform for the systematic registration of data-based studies and Castellum, a privacy-compliant subject management tool for scientific research. In this context, 1.6 temporary full-time positions for research data-related software development and processes were established in the Library and Research Information Unit in summer 2022.

The generally growing importance of Open Science was recognized with the implementation of a workshop offer within the framework of the in-house RDM and Open Science working group. A second focus was the significant expansion of services for publishing in Open Access (OA).

At the same time, the intranet site was extensively relaunched in terms of structure and content, including a differentiated FAQ section on scientific publishing, copyright, and OA. The COVID-19 pandemic also caused the acceleration of the demand-oriented expansion of the e-book portfolio, both through the purchase of and temporary subscription to e-books. New evidence-based acquisition models for e-books are also being tested, based on an analysis of the book collection development in recent years. With the goal of optimizing the use of existing staff resources, proactive acquisition activities have been scaled back in favor of a model in which researchers are informed about potentially relevant new publications on the national and international scholarly book market, based on automated data extraction from various bookstore sources, and can then seamlessly order titles of interest electronically via interlibrary loan, document delivery services, or for purchase. By implementing the LibKey Link service, it was possible to improve access to information resources subject to licensing from search platforms such as Google Scholar or the Web of Science. The monthly (E-)Books Selection service, available as a push service, provides information about 25 intellectually selected, particularly interesting new book acquisitions (e-books and printed books). Another new service, Thematic Alerts, offers researchers the opportunity to receive targeted information by email about new publications that are particularly relevant to their ongoing research, based on thematically tailored search profiles in renowned subject databases from a wide range of disciplines.

For the structural further development of the library space into an “Information, Communication & Concentration Space,” including coworking space elements, a comprehensive concept was submitted to the Administrative Headquarters of the Max Planck Society at the end of 2021, which is to be implemented as part of a dedicated construction measure. Even if a timely realization is not foreseeable due to generally uncertain framework conditions, new space utilization scenarios have already been implemented within the scope of the given possibilities, e.g. the setting up of a video conference area with modern technical equipment in the journal reading room that can be booked house-wide, and the addition of two provisional reading booths.

Digital Libraries Connected (DLC) is a freely accessible platform for the publication of digitized

documents and collections from, at present, four libraries of the Max Planck Society.
https://dlc.mpg.de/index/

Finally, the team also cooperated closely with other Max Planck Society institutions to implement new services and promote professional exchange: In February 2021, the relaunch of Digital Libraries Connected (DLC), a publication platform for digital documents and collections, was successfully completed in cooperation with three other Max Planck Institutes. In addition, together with 11 other institutes, a Max Planck Society internal application for project funding was successfully submitted for MPG.Discovery, a powerful, institute-specific, customizable search engine for research-relevant resources from a wide variety of data sources from within and outside the Max Planck Society. Collaboration in various working groups within the Max Planck Society on topics such as OA was also successfully continued.

In 2023, the team will continue to work actively on the strategic realignment of its services, also in the context of an institute-wide strategy process. For example, from the results of a qualitative in-depth analysis of the service needs of researchers—this is a cooperative project with the Institute for Library and Information Science at Humboldt-Universität zu Berlin—new directions for the service portfolio and job assignments will be derived.

Research Data Management

Last update: June 2023

Research Data Management Coordinator: Maike Kleemeyer

Given the increasing amount of (digital) research data as well as the endeavor for openness and transparency, professional research data management (RDM) has become both an essential factor in excellent and sustainable research and a cornerstone of good and open scientific practice. The corresponding activities were initially coordinated by a working group set up by the Institute's Board of Directors in 2018 (see Table 1). One major achievement of this working group was the establishment of RDM as a central service unit, located in the Library and Research Information Unit, with a new permanent position for an RDM coordinator. This position was filled in March 2021 and since then has been coordinating RDM & Open Science-related activities, together with a cross-divisional in-house working group. The coordinator was furthermore the main driver of developing an institutional approach to RDM, involving stakeholders across the Institute in relation to questions of superior strategical significance. To support the implementation of necessary RDM-related software, a project employee was hired in July 2022.

The Research Data Management Team (from left to right): Maike Kleemeyer, Tobias Bengfort, Karolina Mader, and Sebastian Nix.
Image: MPI for Human Development

As participant management and recruitment are essential aspects of RDM for human sciences, the team responsible for the development and deployment of the Castellum software was also allocated organizationally to the new RDM unit in May 2022. Castellum has become a powerful tool for participant management that is compliant with the General Data Protection Regulation (GDPR). It is actively used in multiple Institutes within the Max Planck Society (including the MPI for Human Development) and interest has recently been expressed by external research institutions (e.g., Universität Hamburg).

With the growing pressure of funding agencies, journals, and research organizations including the German Research Council (DFG) regarding (raw) data and analysis code sharing, it is increasingly important to educate, in particular, young scientists accordingly. If projects including research data and code are well named, structured, and documented right from the start, the effort needed to openly share them at the end is negligible. A major focus of the RDM & Open Science activities was therefore the organization of a workshop series covering relevant topics, for example, a workshop on the Brain Imaging Data Structure (BIDS). Specifically, the RDM team developed a half-day workshop tailored to the Institute's needs that is regularly offered as part of the workshop series and contains information on all important aspects of RDM, such as data organization, documentation, and storage, as well as final publication and related challenges (e.g., anonymization, licenses). A succinct version of the workshop's contents was also compiled into a comprehensive RDM subpage that has been added to the Library and Research Information Unit's intranet presence.

Another focus was the provision of general advice and support for researchers wishing to publish their research data, in order to increase the number of high-quality, openly shared data sets. In the reporting period, two large data sets were systematically organized and documented to make them openly available in the near future: In close collaboration with the Leibniz Institute for Psychology (ZPID), data from the Berlin Aging Study (BASE) will be available on ZPID's Research Data Center, and data from the AKTIV study are about to be published on E-Brains. Provision of access to data from the COGITO Study was transferred to the RDM unit as a first step toward managing access to open data centrally.

Overview of the COGITO Study – www.mpib-berlin.mpg.de/cogito

In the COGITO study, 101 younger adults (20–31 years of age) and 103 older adults (65–80 years of age) participated in 100 daily sessions in which they worked on cognitive tasks measuring perceptual speed, episodic memory, and working memory, as well as various self-report measures (see Schmiedek et al., 2010, 2020). All participants completed pretests and posttests with baseline measures of cognitive abilities and transfer tasks for the practiced abilities. Brain-related measures were taken from subsamples of the group, including structural magnetic resonance imaging (MRI), functional MRI, and electroencephalographic (EEG) recordings. A central goal of the COGITO study was the comparison of between-person and within-person structures of cognitive abilities. Further, the COGITO study qualifies as a cognitive training study of unusually high dosage and long duration because of its 100 sessions of challenging cognitive tasks.

A particular challenge of managing research data at the MPI for Human Development is the multidisciplinarity of research that requires handling highly diverse data from a range of study designs and instruments, which a rather generic workshop cannot possibly cover. The RDM team thus also developed a software tool in cooperation with all Research Centers, conceptually building upon an existing software tool from the Center for Adaptive Rationality. With this study registration tool, a set of meta-information on studies acquiring data is collected, which will allow the provision of customized RDM support throughout the data life cycle. The tool furthermore gives an overview of studies conducted at the Institute, including badges for openness (referring to preregistration, open data, and open materials) to promote scientific exchange between researchers and also the reuse of existing data, especially between researchers from different Centers and Research Groups. The tool was successfully launched in April 2023.

Another important goal of the RDM unit was a more efficient and sustainable way of managing storage space. Together with the Central IT Unit, we linked storage on institutional servers with the new registration tool such that a study folder including predefined subfolders is created when a study is entered. This harmonizes storage across Centers/groups and allows us to closely monitor the allocation of storage on a rather fine-grained level. Furthermore, a procedure was established to ensure responsible data handling when researchers leave the Institute and at the same time adhering to the Max Planck Society's rules of conduct for good scientific practice. Similarly, another aim was to avoid, whenever possible, the arrival of raw DICOM data from the MR scanner on institutional servers. Given that BIDS provides a standardized way of organizing MR data, we developed a systematic workflow that takes the DICOM data from the scanner's storage, directly converts them into BIDS format, and only then stores them on institutional servers. The workflow has been implemented in close collaboration with the Research IT and is now in its final testing phase.

The new RDM services were presented in various contexts, including the 46th Annual Meeting of the Max Planck Libraries (2022) and the discussion series Human Research Data in Practice organized by the Max Planck Digital Library in 2021/22, and BiblioCon 2023, the most important conference for information professionals from German-speaking countries.

►

***Table 1.* Research Data Management & Open Science Working Group**

Tobias Bengfort, Library and Research Information Unit
Josefine Blunk, Library and Research Information Unit
Levin Brinkmann, Center for Humans and Machines
Uwe Czienskowksi, Central IT Unit
Nicole Engelhardt, Library and Research Information Unit
Thomas Feg, Center for Lifespan Psychology
Lou Haux, Center for Adaptive Rationality
Stefan Herzog, Center for Adaptive Rationaliy
Maike Hille, Center for Lifespan Psychology & Lise Meitner Group for Environmental Neuroscience
Daniela Kefer, Library and Research Information Unit
Maike Kleemeyer, Library and Research Information Unit
Nils Köbis, Center for Humans and Machines
Imke Kruse, Scientific Service Unit
Sebastian Nix, Library and Research Information Unit
Aaron Peikert, Center for Lifespan Psychology
Sebastian Schröder, Center for Lifespan Psychology
Sina Schwarze, Center for Lifespan Psychology
Anna Thoma, Center for Adaptive Rationality
Gert G. Wagner, Max Planck Fellow

The members of the Research Data Management & Open Science Working Group come from different fields (Central IT Unit, Library and Research Information Unit, Centers, and Research Groups).

The Institute's Research Data Management Group

The Research Data Management Working Group at the MPI for Human Development has been accepted as a member of the German Reproducibility Network. In order to facilitate networking and to benefit from each other's expertise, every initiative was asked to introduce itself with a short video clip. Curious who we are and what we do? Watch our video!

Open Science

Last update: July 2023

The importance of Open Science continues to grow. During the reporting period, the MPI for Human Development engaged in various activities to make research outputs freely and easily accessible and to increase the transparency of the research process as a whole. These activities primarily targeted Open Access, open data, open materials, and open source software. A working group set up by the Institute's Board of Directors in 2018 coordinated these activities.

One focus of the Open Science activities has been providing an extensive range of information and workshops. These included workshops on data documentation with the codebook package developed by Ruben Arslan, researcher at the Institute (Arslan, 2019), on software version control with Git, on computational reproducibility, and on the Brain Imaging Data Structure (BIDS). Due to COVID-19, most of these workshops took place online; their contents, in the form of video recordings and slides, have been made permanently available for current and future Institute members on the Institute’s intranet.

Science-led development of tools to support Open Science practices also continued; these include the establishment of best practices for reproducible research (Peikert et al., 2021; Peikert & Brandmaier, 2021; Van Lissa et al., 2021) and the development and publication of the accompanying R packages repro (Peikert et al., 2021) and WORCS (Van Lissa et al., 2021). In this context, scientists also actively contributed to the debate about implementing Open Science practices, such as preregistration (Peikert & Brandmaier, 2023). Data as well as materials were made openly available for others to reuse, with particular attention to computer code. These were sometimes a byproduct of the project (e.g., Buchberger et al., 2022; Ernst et al., 2022; Kosciessa et al., 2020; Moneta et al., 2023; Sommer et al., 2022; Wittkuhn & Schuck, 2021) aimed at increasing transparency, reuse, and replicability of empirical findings, and at other times they were the key outcome of the research, for example the proposal of new statistical or computational tools (e.g., Arnold, Voelkle, & Brandmaier, 2021; Ernst & Peikert, 2023).

In order to quantify the publication of data, a workflow that is applicable to research activities across the Institute was created with colleagues from the Library and Research Information Unit. The workflow enables the monitoring of whether a given publication includes open data as well as information about the storage site.

The trend towards publishing research results as preprints using various preprint servers (in particular PsyArXiv, BioRxiv, and arXiv), which had already been apparent for some time, continued impressively.

The increase in the proportion of institutional publications available in Open Access (OA), namely journal articles, is also highly visible. An overview of the development from 2020 to 2022 will be provided by 31 August 2023. Here, a distinction is made between the proportion of articles in original OA journals ("gold OA"), articles in journals subject to subscription ("hybrid OA"), and articles that were initially published in "closed access" but were then republished in an OA version ("green OA") on the basis of corresponding legal regulations.

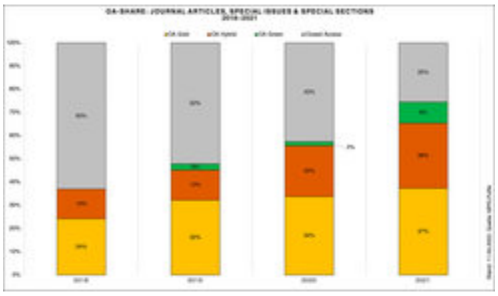
The steady increase in OA publications was possible due not only to centrally funded Max Planck Society publication contracts, but also to newly established Library and Research Information services at the Institute. Through the partial reallocation of literature acquisition funds, in May 2020 a local fund was established for the criteria-based funding of OA articles and books for which no or only partial funding is available from central Max Planck Society funds or from third-party funds. As a result, four major OA book projects were funded at the Institute for the first time until 31 August 2023, as well as eleven journal articles. In addition, a workflow for systematic, legally secure OA secondary publication of articles that were originally only accessible in "closed access" was successfully implemented in September 2021. If permitted by legal or contractual requirements, this ensures that such content is made freely available as early as possible and in a form that is as citable as possible. The authors of the corresponding articles merely have to authorize the Institute to carry out a secondary publication on their behalf and have no extra burden of work.

Due to the COVID-19 pandemic, the development of an Open Science policy for the MPI for Human Development had to be postponed, but this process is set to continue. Independently of this, starting in 2023 the Institute will offer an annual Open Science Innovation Award for one individual and one group. This is intended to promote innovative Open Science projects and at the same time present them as part of an in-house event, in order to anchor Open Science even more firmly at the Institute across Centers and Research Groups.

Since Open Science thrives on exchange, the Institute is actively involved in various networks and working groups related to it. Since spring 2020, the MPI for Human Development has been a member of ENABLE!, a network of various stakeholders (e.g., libraries, publishers) for the realization of OA publication projects. In addition, the Institute, represented by the Library and Research Information Unit's OA team, participates in a Max Planck Society cross-institution OA working group, which was founded at the end of 2020. Finally, in the summer of 2021, the Institute joined the German Reproducibility Network (GRN), an interdisciplinary consortium of various research institutions in Germany that aims to increase the trustworthiness and transparency of scientific research through joint initiatives. In a regional context, the Institute participated in the organization and implementation of the first virtual Open Access Week for Berlin-Brandenburg, with five online events between November 2021 and March 2022. Two members of the Institute are also involved in the

Open Science Panel recently established by the Max Planck Society, which is to help develop an Open Science strategy for the Max Planck Society in the medium term.

Data will be updated by 31 August 2023.



OA share: Journal articles, special issues, and special sections published by authors at the MPI for Human Development 2018–2021. Stand: 11.04.2022
Source: MPG.PuRe

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Scientific Service and Third-Party Funding

Last update: July 2023

Head: Imke Kruse

Taking into account the increased demand for coordinated science management, the directors created the position of Institute Research Coordinator in 2021. Under the leadership of Imke Kruse, the newly-established Scientific Service Unit offers a range of services to all researchers at the Institute. It seeks to create synergies throughout the Institute to save resources and professionalize available services. Service offers include support for international colleagues by the International Office, management of third-party funding, support for PhD students in our structured graduate programs, access to the Institute's core facility at the Max Planck Dahlem Campus of Cognition, scientific editing, and the Office of the Research Groups. In addition, the Office of the Managing Director was established as part of the Scientific Service Unit in response to the challenge of rotating management among directors. Its purpose is to ensure continuity and preservation of knowledge of cross-institutional operations.

One of the Scientific Service Unit's central tasks concerns third-party funding. The team supports the Institute's staff in the application, administration, and accounting of third-party funds. Third-party funding is of great importance for the Institute's research. In the period 2020–2022, researchers at the Institute newly acquired 11.4 million € in third-party funds. The years 2020 and 2021 were unusual years, also in terms of the expenditure of third-party funds, due to the COVID-19 pandemic, which delayed data collection at the Institute. In 2020 and 2021, research was third-party funded amounting to about 2 million € each year. In 2022, third-party funds rose to about 3 million €.

During the reporting period, the German Research Foundation (DFG) was the Institute's major external funder: Almost 40% of third-party funding came from the DFG. In second place were German federal agencies such as Federal Ministry of Education and Research with a share of 18%. The European Union (EU) followed in third place with 12%. Indeed, the EU is becoming increasingly important for the external funding of the Institute's research. Nicolas Schuck, head of MPRG NeuroCode, received an European Research Council (ERC) Starting Grant on "The Function of Hippocampal and Cortical Memory Replay in Humans" in 2020, followed by Bernhard Spitzer, former member of the Center for Adaptive Rationality (ARC), who won an ERC Consolidator Grant to finance his new group on "Adaptive Memory and Decision Making," which started in 2022.

Within the EU's Horizon 2020 program, ARC research scientists Stefan Herzog and Ralf Kurvers received a grant for the Hybrid Human Artificial Collective Intelligence in Open-Ended Decision Making (HACID) project in 2022 in which they collaborate with colleagues from Ireland, Italy, and the UK. They are developing a novel hybrid collective intelligence for decision support for professionals facing complex open-ended problems, promoting engagement, fairness, and trust. Furthermore, towards the end of the current reporting period, a group of researchers from ARC were granted a project in collaboration with the Max Planck Institute for Mathematics in the Sciences and other European partners, such as Sciences Po in Paris and the University of Venice. The project "Understanding the causal mechanisms of digital citizenship" proposes to take the diagnosis of a structural change through the large-scale adoption of social media seriously and seeks to develop solutions that help make it work for, rather than against democracy.

The Institute has also been successful in the context of the EU Marie Skłodowska-Curie Action during the reporting period. Marwa El Zein (ARC) started her research under this EU-funded program in 2021 and is working on social individual's decisions and how they are shaped by group affiliation during collective decisions. Another researcher, Shweta Suran, will join the Institute in 2024 with funding from the Marie Skłodowska-Curie Action.

In the last round of calls (2022), the Institute was able to acquire two additional ERC Consolidator Grants, which will start in July 2023 and January 2024, respectively. Simone Kühn, head of the Lise Meitner Group for Environmental Neuroscience, received funding for the project BrainScape, in which she intends to study how the physical environment shapes the human brain, well-being, and mental health. BrainScape aims to spearhead the emerging field of Environmental Neuroscience and will make an impact by building a knowledge base for evidence-based urban planning to promote healthy living environments with significant practical implications. Siawoosh Mohammadi, who very recently started as head of the newly-established MPRG MR Physics, received an ERC Consolidator Grant to study non-invasive staining of tissue microstructure in temporal lobe epilepsy using in-vivo MRI (MRStain). MRStain will exploit the sensitivity of the MRI signal to estimate aggregated histological metrics in the human brain non-invasively. Like established histology staining methods (e.g., myelin-basic protein), MRStain will be sensitive to changes in cellular populations, axons, myelin, and iron.

Given the increasing importance of third-party funding for the Institute's research activities, the professionalization of the third-party funding position, which the Institute began in 2022, was of great importance. As part of the Scientific Service Unit, the Institute's Third-Party Funding Officer, Claudia Vinent, a position existing in this form since March 2022, advises the Institute's researchers on potential national and international third-party funding lines. She offers individual consulting and active assistance in the application for, and during the use of, granted external funds. She coordinates with third-party funders, checks the project budgets of the Institute's third-party funds, prepares budget plans and allocations, and monitors project costs and compliance with contractual terms and conditions. During the funding periods, the third-party funding officer also prepares data for reports, statistics, and analyses. Where necessary, she coordinates with the Max Planck Society's Administrative Headquarters. Towards the end of a project, the officer provides advice on the reporting and documentation obligations and takes care of audit documents and cooperation with reviewers.

Taken together, the Scientific Service Unit fills a major gap in the support offered to researchers at the MPI for Human Development so far and represents a significant infrastructural improvement.

Central IT Unit

Heads:
Moataz Elmasry (as of 12/2021)
Joachim Schmitz (06/2020–12/2020)
Sebastian Lau (until 06/2020)

The Central IT Unit is a critical component of the Institute, responsible for ensuring that all IT operations run smoothly. It consists of two key units: the Infrastructure Unit and the Servicedesk Unit. The Infrastructure Unit is responsible for building and maintaining crucial IT components—such as the internet infrastructure, WiFi, networks, and storage—within the data center. This plays a pivotal role in ensuring that the entire IT system runs efficiently and effectively, which is essential for the Institute to meet its goals and objectives. The Servicedesk Unit provides much-needed support to the Institute's users in their daily work, acting as a single point of contact for any IT-related issues users may have, including troubleshooting, technical support, and service requests. By providing this support, the Servicedesk enables the Institute's users to focus on their core responsibilities, thus increasing productivity and enhancing overall performance. Together, the Infrastructure and Servicedesk Units form the vital backbone of the Institute's IT operations, ensuring that the organization remains at the cutting edge of technology and can meet the challenges of a rapidly evolving digital landscape.

Image: MPI for Human Development

The years 2020–2022 were truly the years of the user. When lockdown began in early 2020, IT was not in a position to support users working from home. During that time, we procured and configured a significant number of laptops to support mobile work, as well as web cameras and other equipment to support users in the unusual circumstances. Furthermore, we overhauled our whole VPN infrastructure by purchasing new software and licenses, as the VPN infrastructure was designed to sustain all the Institute's users simultaneously.

During the COVID-19 pandemic, we also upgraded the Servicedesk significantly, starting with the move to a new Servicedesk software (Atlassian Servicedesk) and working on documentation, processing automation, and building different request types so that users could get assistance as fast as possible. In total, during the COVID-19 years, we resolved over 6,000 support tickets and wrote more than 100 internal and external help pages.

Furthermore, we installed several new hardware components, for example a new Dell Isilon storage cluster with about 800 Terabyte storage capacity to meet users' increasing need for more storage, as well as a state of the art WiFi controller and a new firewall. We also renovated our internet gateways together with our colleagues from the Gemeinsames Netzwerkzentrum (GNZ). The installation of these new components led to a better network infrastructure within the Institute and with our internet connectivity in general.

In the Infrastructure Unit, one event clearly stands out: the decommissioning of the outdated Citrix environment and the building of a comparable setup in the Microsoft Azure Cloud, called Azure Virtual Desktop. The new Azure solution proved to be around 70% cheaper than the previous solution.

Moreover, we introduced several new software programs for the Central IT Unit that help us manage the whole IT landscape. For example, we introduced Baramundi and JAMF, which are mobile device management software programs that simplify the orchestrating and managing of over 600 personal devices at the Institute, while also increasing our ability to push important security updates and enabling us to offer more software programs that aid research. We also introduced Macmon, a network segmentation software program that helps us to compartmentalize our network—this is an important measure to minimize the damage when a network breach or cyberattacks occur.

We also finished our IT audit successfully. This was a joint effort of all IT colleagues at the Institute and is considered a very important exam that shows we uphold high security standards.

Max Planck Dahlem Campus of Cognition (MPDCC)

The Max Planck Dahlem Campus of Cognition (MPDCC) offers a high-end laboratory infrastructure for cognitive behavioral and neuroscience research conducted at the MPI for Human Development. Over the past 15 years, the spectrum of empirical methods used at the Institute has expanded and shifted fundamentally. Today, it is strongly oriented towards experimental research and can no longer be regarded as purely rooted in the humanities.

In order to meet the growing demand for laboratory space, more and more parts of the building on the neighboring property Dillenburger Straße 53 have been rented over the last 10 years. To enable the Institute to operate these laboratory spaces sustainably and develop them innovatively for the future, the Max Planck Society was finally able to purchase the entire building in March 2023 after protracted negotiations (see Figures 1 and 2).

Figure 1. Aerial view of the newly purchased building in Dillenburger Straße (top left).
Image: Thomas Rehmann

Figure 2. Entrance of the Max Planck Dahlem Campus of Cognition.

Image: Jordis Antonia Schlösser

At present, the MPDCC houses a magnetic resonance imaging lab (MRI Lab), a lab for electroencephalography (EEG) including mobile EEG that can be integrated with virtual reality (VR), a dedicated VR lab, and several labs for behavioral testing, as well as a high-performance computing cluster. The capacities of the current magnetic resonance tomograph (MRI, 3-Tesla field strength, Siemens Trio) no longer meet the increased demand, as several Centers and junior research groups now rely on neuroscientific methods. In addition, the multiband sequences required for state-of-the-art quantitative imaging can rarely be run on the existing scanner, necessitating the acquisition of a modern 3-Tesla device.

The topic of plasticity across the lifespan is of central importance for both the Center for Lifespan Psychology and the Lise Meitner Group for Environmental Neuroscience. The Institute occupies an internationally leading position in the field. In order to maintain this position, the acquisition of a 7-Tesla MR device is required. Over the past few years, the MPI for Human Development has increasingly been working on closing the gap between plasticity research on animal models and the corresponding research in the human field through the concerted use of structural, spectroscopic, and functional MRI methods. The acquisition of a 7-Tesla device will greatly propel these efforts, as the increased signal yield of the device provides improved spatial resolution in both structural and functional imaging. For metabolic imaging and for single-voxel spectroscopy, the signal gain and the smaller spectral linewidth are also an enormous advantage. Taken together, an MRI scanner with 7-Tesla field strength is the first choice for studies in which the relationships among changes in the brain on a structural, functional, and neurochemical level and changes in behavior are to be explored. In sum, by expanding its neuroimaging facilities, the Institute underscores its leading role in research on the causes and consequences of neural plasticity in humans.

The acquisition of a 3-Tesla and a 7-Tesla MR scanner was already granted to the Institute by the Max Planck Society in 2018. Through the purchase of the building at Dillenburger Straße 53, the large equipment will now find a suitable home. Additional labs for extended reality (XR), robotics, science of intelligence research, near-infrared spectroscopy (NIRS), and wave-field audio synthesis are being planned. The construction planning and the tenders for the procurement of the equipment have begun, so this unique laboratory infrastructure will hopefully be completed within the next 2 to 3 years.

Beyond pure laboratory infrastructure, we launched the MPDCC in 2021 in order to create a hub for scientific collaboration and exchange in the field of cognitive neuroscience. The MPDCC provides office space and laboratory facilities for MPI for Human Development researchers and integrated Campus research groups. Current research groups at MPDCC include the Lise Meitner Group for Environmental Neuroscience (Simone Kühn), the ERC-funded Adaptive Memory and Decision Making Group (Bernhard Spitzer), and the ↗ Mind-Body-Emotion Group at the MPI for Human Cognitive and Brain Sciences (Michael Gaebler). Collaborators from partner institutions in Berlin and beyond as well as international guests are also welcome to work at the MPDCC.

The Humboldt-Universität zu Berlin (HU) and the Freie Universität Berlin are involved in the MPDCC development, e.g., via the shared International Max Planck Research Schools (IMPRS) on Computational Psychiatry and Ageing Research (COMP2PSYCH) and on the Life Course (LIFE) (see below). In addition, by appointing Roberto Cabeza from Duke University, USA, as an Einstein Profile Professor for Cognitive Neuroscience of Aging and Memory at HU, the Einstein Foundation has brought an internationally renowned neuroscientist to Berlin who is collaborating with the MPDCC. The Berlin site of the Max Planck UCL Centre for Computational Psychiatry and Ageing Research, under the leadership of Ulman Lindenberger and Ray Dolan, is also interlinked with the MPDCC. It is a central research location for London and Berlin Fellows of the Max Planck UCL Centre, providing a unique research infrastructure in the near future. Overall, the MPDCC is designed to promote high-level scientific cooperation in Berlin and beyond.

Research at the MPDCC is facilitated by an experienced lab team supporting neurocognitive study organization, recruitment, and data collection. We have introduced mandatory guidelines for conducting research at our labs. Study participants are recruited through our participant data base (Castellum), and all employees who require access to data from Castellum must complete both Castellum training and data protection training via our data protection awareness platform. To make efficient use of limited office space and laboratory infrastructure and to secure the high standards of scientific practice and excellence of the Max Planck Society, the Institute's Board of Directors introduced regular Campus User Meetings for research conducted under the MPDCC umbrella in September 2022. Every study planning to use MPDCC laboratory or staff resources is required to seek approval from the Campus User Meeting Committee. To be considered for approval by the Committee, researchers will need to register their study plans with the Institute's newly established Study Registration Tool. The Campus User Meeting Committee, consisting of the directors, the Institute's research coordinator, the heads of labs, the head of lab technology, and the main research assistant, decides on the general suitability of a given study to be run at the MPDCC based on the research design, intended methods, and available resources. Should several studies require access to the same laboratory or support resources (e.g., telephone studio), the Campus User Meeting Committee decides the priority of resource allocation among the studies.

Figure 3. Presentation during PhD Day at the Max Planck Dahlem Campus of Cognition.
Image: Daniel Sax / MPI for Human Development

The MPDCC is also set to provide an excellent environment for educating and promoting the next generations of leading researchers in cognitive neuroscience and developmental psychology. Hence, it is the Berlin home base for three international PhD programs: the IMPRS LIFE, the IMPRS COMP2PSYCH, and the Max Planck School of Cognition (MPSCog). The Berlin headquarters of MPSCog is located at Dillenburger Straße and thus forms a crucial part of the MPDCC. The graduate schools at the MPDCC organize curricula and training together to create synergies between schools and strengthen graduate education, particularly with regard to (computational) methods training. We regularly organize a PhD Day, where PhD fellows from the various Campus groups and schools get the chance to meet and exchange ideas (see Figure 3). Furthermore, we offer a colloquium series, talks, and workshops at the MPDCC, forming the basis for a vibrant scientific community with a focus on exchange and collaboration.

Overview

Our goal is to understand how people develop in their setting, act in it, and are influenced by it. We explore the foundations of human behavior, our development and competencies in the context of our history, environment, society, and technology. For example, we study how people learn to make good decisions; how their emotions change throughout history and differ across cultures; how they manage to interact with artificial intelligence in a self-determined way; how everyone can realize their potential; what environments promote health, well-being, and cognitive performance; and how individuals and collectives alike can contribute to designing them. We want to make findings accessible and create knowledge to enable our society to shape the lifeworld effectively. Interdisciplinarity, cutting-edge research, and great intellectual freedom characterize our work.

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Institute Structure

Board of Directors

Ute Frevert

Ralph Hertwig (Managing Director since July 2023)

Ulman Lindenberger

Iyad Rahwan

Scientific Advisory Board

List of members 2020–2022/23

Research Centers

Center for Adaptive Rationality
Director: Ralph Hertwig

Center for the History of Emotions
Director: Ute Frevert

Center for Humans and Machines
Director: Iyad Rahwan

Center for Lifespan Psychology
Director: Ulman Lindenberger

Lise Meitner Group

Lise Meitner Group for Environmental Neuroscience
Head: Simone Kühn

Emmy Noether Group

Lifespan Neural Dynamics Group (LNDG)
Head: Douglas Garrett

ERC-Funded Research Group

Adaptive Memory and Decision Making Group
Head: Bernhard Spitzer

Max Planck Research Groups

Biosocial | Biology, Social Disparities, and Development
Head: Laurel Raffington

iSearch | Information Search, Ecological and Active Learning Research with Children
Head: Azzurra Ruggeri

Naturalistic Social Cognition
Head: Annie E. Wertz

NeuroCode | Neural and Computational Basis of Learning, Memory and Decision Making
Head: Nicolas W. Schuck

Structured Graduate Education

International Max Planck Research School on the Life Course (LIFE)

International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH)

Max Planck School of Cognition (MPSCog)

Max Planck Dahlem Campus of Cognition (MPDCC)

Core lab facilities

Open Space

Flexible office space

Service Units

Administration

Cafeteria

Central IT Unit

Central Services

Library and Research Information Unit

Press and Public Relations

Scientific Service

Technical Services

Academic Degrees 2020–2022/23

Last update: August 2023

Thesis - PhD (34)

2023

Thesis - PhD

Buchberger, E. S. (2023). *The process architecture of memory in early to middle childhood* [PhD Thesis, Ruhr-Universität Bochum].

MPG.PuRe

Thesis - PhD

Jöchner, A.-K. (2023). *Sleep-associated memory consolidation across child and adolescent development: Different yet the same?* [PhD Thesis, Ruhr-Universität Bochum].

MPG.PuRe

Thesis - PhD

Koch, C. (2023). *How aging shapes neural representations of continuous spaces* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-39372
(published online 2023: http://dx.doi.org/10.17169/refubium-39372).

MPG.PuRe DOI Full

Thesis - PhD

Lieth, J. (2023). *Lieben als Lebensprojekt: Der Pfarrer, Gefühle und Moral in der württembergischen Erweckungsbewegung des 19. Jahrhunderts* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - PhD

Papadaki, E. (2023). *Experience-dependent plasticity in the auditory domain: Effects of expertise and training on functional brain organization* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

2022

Thesis - PhD

Appelhoff, S. (2022). *Researching neural correlates of human decisions from experience using electroencephalography* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169

/refubium-35218

MPG.PuRe DOI Full

Thesis - PhD

Karlsson, A. E. (2022). *Neural oscillations shape the quality and content of episodic memories in young adulthood and older age* [PhD Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Thesis - PhD

Polk, S. E. (2022). *Aerobic exercise for the promotion of healthy aging: Changes in brain structure assessed with new methods* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - PhD

Rahwan, Z. (2022). *Dishonesty: The role of rewards, professional identity and experimenter purpose disclosures* [PhD Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe Full

Thesis - PhD

Rudeck, L. M. (2022). *Vergnügung im Besatzungsalltag: Begegnungen in westalliierten Offiziers- und Soldatenclubs in Deutschland, 1945-1955* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - PhD

Russell, C. J. S. (2022). *Error management in learning and generalisation: The domain of food* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-36992

MPG.PuRe DOI Full

Thesis - PhD

Tiede, K. E. (2022). *An ecological perspective on decisions under risk: How the structure of the environment shapes information processing* [PhD Thesis, Universität Konstanz].

MPG.PuRe Full

Thesis - PhD

Wittkuhn, J. L. (2022). *Investigating neural replay of task representations in the human brain using fMRI* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-34672

MPG.PuRe DOI Full

2021

Thesis - PhD

Arnold, M. (2021). *Score-based approaches to heterogeneity in psychological models* [PhD Thesis, Humboldt-Universität zu Berlin]. https://doi.org/10.18452/24146 (published online 2022: https://doi.org/10.18452/24146) .

MPG.PuRe DOI Full

Thesis - PhD

Borrero, A. T. (2021). *Moral education: Soldiers, war, and the U.S. military in U.S. history textbooks (1964-2000)* [PhD Thesis, Technische Universität Berlin]. https://doi.org/10.14279/depositonce-11765

MPG.PuRe DOI Full

Thesis - PhD

Ciranka, S. (2021). *Computational mechanisms of social influence during adolescence* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-33128
(published online 2022: https://doi.org/10.17169/refubium-33128).

MPG.PuRe DOI Full

Thesis - PhD

Danilina, A. (2021). *Ethiken der Essenz: Eine Emotions- und Körpergeschichte der Rasse in inneren Kolonien (1890-1933)* [PhD Thesis, Technische Universität Berlin].

MPG.PuRe

Thesis - PhD

De Simone, C. (2021). *Active and ecological learning to navigate the social world* [PhD Thesis, TUM School of Social Sciences and Technology].

MPG.PuRe Full

Thesis - PhD

Jacobs, P. (2021). *On the significance of information* [PhD Thesis, Humboldt-Universität zu Berlin]. https://doi.org/10.18452/22919

MPG.PuRe DOI Full

Thesis - PhD

Jones, A. (2021). *Active learning strategies in child- and adulthood: An interdisciplinary perspective* [PhD Thesis, Technische Universität München].

MPG.PuRe Full

Thesis - PhD

Lindner, T. (2021). *Transnational networks of anti-imperialism: Mexico City in the 1920s* [PhD Thesis, Technische Universität Berlin].

MPG.PuRe

Thesis - PhD

Schlegelmilch, K. (2021). *Grass or gravel? Influences on the visual categorization of naturalistic structures in infancy and early childhood* [PhD Thesis, Universität Potsdam]. https://doi.org/10.25932

/publishup-52637

MPG.PuRe DOI Full

Thesis - PhD

Schlünz, B. (2021). *Pastoral und Politik: Katholische Frömmigkeit im spanischen Liberalismus, 1833-1868* [PhD Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Thesis - PhD

Wodzicki, L. (2021). *The virtuous: Political communication between the Italian states and the Ottoman Empire in the age of Mehmet II (1453-1481)* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

2020

Thesis - PhD

Bähr, M. (2020). *Grassroots veterans: The American legion and conservative change in California, 1945-2000* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - PhD

Dahl, M. J. (2020). *Neuromodulation and rhythmic neural activity shape cognition across the adult lifespan* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - PhD

Kosciessa, J. Q. (2020). *Measurement and relevance of rhythmic and aperiodic human brain dynamics* [PhD Thesis, Humboldt-Universität zu Berlin]. https://doi.org/10.18452/22040

MPG.PuRe DOI

Thesis - PhD

Mühlroth, B. E. (2020). *Sleep-associated consolidation of episodic memories in old age: The challenge of studying cognitive and cerebral aging* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-27290

MPG.PuRe DOI Full

Thesis - PhD

Schröer, F. (2020). *Reassembling the feeling community: Space, time, and morality in the Tibetan diaspora in India, c. 1959-1979* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - PhD

Sommer, V. R. (2020). *The fidelity of neural representations shapes episodic memory across the human* *lifespan* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-28640

MPG.PuRe DOI Full

Thesis - PhD

Süsler-Rohringer, T. (2020). *Die Transformation der Sozialpolitik in Cisleithanien und die moralische Ökonomie der Re-Integration Kriegsversehrter 1880-1918* [PhD Thesis, Technische Universität Berlin].

MPG.PuRe

Thesis - PhD

Tump, A. N. (2020). *How social learning strategies boost or undermine decision making in groups* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-27728

MPG.PuRe DOI Full

Thesis - PhD

Yahosseini, K. S. (2020). *Experimental study and modeling of three classes of collective problem-solving methods* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-27367

MPG.PuRe DOI Full

Thesis - PhD

Zilker, V. (2020). *Measuring and modeling the construction of preferences in decision making under risk* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe Full

Thesis – Habilitation (1)

2021

Thesis - Habilitation

Moine, C. (2021). *Pour une histoire culturelle transnationale de l'Europe après 1945* [Habilitation Thesis, University of Paris 1 Panthéon-Sorbonne].

MPG.PuRe

Thesis – Master (34)

2023

Thesis - Master

Kaisheva, M. (2023). *Pupil-indexed neuromodulation is parametrically associated with trial-by-trial alpha oscillations* [Master's Thesis, Eberhard-Karls-Universität Tübingen].

MPG.PuRe

2022

Thesis - Master

Billenstein, H. (2022). *Morality at odds: Probability as a moral factor in sacrificial dilemmas* [Master's Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Thesis - Master

Düben, M. (2022). *3-4-year-old children's behavior in binary repeated choice from description* [Master's Thesis, Universität Potsdam].

MPG.PuRe

Thesis - Master

Hebisch, J. (2022). *Neural correlates for adolescent risk-taking in the learning context* [Master's Thesis, Westfälische Wilhelms Universität Münster].

MPG.PuRe

Thesis - Master

Kohler, M. (2022). *#Drosten: Analyzing predictors of the spread of Covid-19 risk communication on Twitter* [Master's Thesis, Universität Basel].

MPG.PuRe

Thesis - Master

McClary, T. M. (2022). *Age differences in memory generalization across childhood* [Master's Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - Master

Mooraj, Z. (2022). *Metamemory judgements in aging: Differences in behavioral influences, neural activation, and connectivity patterns between younger and older adults* [Master's Thesis, Humboldt Universität zu Berlin].

MPG.PuRe

Thesis - Master

Özince, D. D. (2022). *Exercise, cognitive, multimodal training and white matter hyperintensities in the aging brain: No effects after six months of intervention* [Master's Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - Master

Picó Cabiró, M. (2022). *Urbanicity is associated with perceptual style* [Master's Thesis, University of Amsterdam].

MPG.PuRe

Thesis - Master

Poppa, C. (2022). *Dynamics of markers for neuronal plasticity (BDNF, IGF-1, IGFBP-3) and general fitness during a six-month intervention study in healthy older adults (AKTIV study)* [Master's Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - Master

Schmidt, M. K. (2022). *Associations of non-invasive correlates of noradrenergic neuromodulation and learning across the adult lifespan* [Master's Thesis, Humboldt Universität zu Berlin / Berlin School of Mind and Brain].

MPG.PuRe

Thesis - Master

Verra, L. (2022). *Behavioural evidence for state dependent uncertainty* [Master's Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

2021

Thesis - Master

Daschowski, Y. (2021). *When is waiting worth it? The trade-off between decreasing forecast uncertainty and increasing cost of action over time* [Master's Thesis, Universität Potsdam].

MPG.PuRe

Thesis - Master

Firnrohr, J. (2021). *In nature we trust: Der Einfluss der Naturverbundenheit auf die wahrgenommene Restaurativität natürlicher und urbaner Umgebungen* [Master's Thesis, Freie Universität Berlin].

MPG.PuRe

Thesis - Master

Gubernath, J. (2021). *Spatial uncertainty in probabilistic forecasts lowers perceived risk and likelihood of precautionary action* [Master's Thesis, Maastricht University].

MPG.PuRe

Thesis - Master

Hecht, M. (2021). *Is what you know who you know online? Social sampling in online social networks* [Master's Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Thesis - Master

Hedrich, N. (2021). *The role of the temporal coherence prior in reinforcement learning* [Master's Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Thesis - Master

Kaiser, C. (2021). *Mentale Gesundheit während des ersten Lockdowns der COVID-19-Pandemie in Deutschland* [Master's Thesis, MSB Medical School Berlin].

MPG.PuRe

Thesis - Master

Moultrie, J. (2021). *Performance on a flanker task in matched real and virtual conditions* [Master's Thesis, Universiteit van Amsterdam].

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Popielarz, O. (2021). *Combined intervention and the brain: Effects of combining language learning training with physical exercise on structure of ageing brains* [Master's Thesis, Freie Universität Berlin].

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Schakowski, A. (2021). *Pooling judgments in homogenous and heterogenous groups: Accounting for interindividual differences in confidence calibration improves collective performance* [Master's Thesis, Universität Heidelberg].

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Sultan, M. (2021). *The impact of time-scarcity on discrimination ability and response bias during misinformation identification* [Master's Thesis, University of Amsterdam].

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Thesis - Master

Fox, T. (2020). *Second-hand smoking and the human brain: An MRI study linking second-hand smoking, brain structure and cognition* [Master's Thesis, Freie Universität Berlin].

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Krause, M.-T. (2020). *Analysis of information in leaflets on ovarian cancer screening* [Master's Thesis, Jade University for Applied Science].

MPG.PuRe

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Löwe, A. (2020). *Trial-wise feedback leading to uninstructed spontaneous strategy switches* [Master's

Thesis, Freie Universität Berlin].

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Pauley, C. (2020). *Age differences in the effects of contextualisation on the similarity of memory representations* [Master's Thesis, Carl von Ossietzky Universität Oldenburg].

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MPG.PuRe

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Sale, V. (2020). *Stress and the city: Behavioural, cognitive and physiological correlates of a one-hour exposure to a natural or urban environment* [Master's Thesis, Radboud University Nijmegen].

MPG.PuRe

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Schwarze, S. A. (2020). *Differences in effective connectivity between children and adults during task switching* [Master's Thesis, Freie Universität Berlin].

MPG.PuRe

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Vidal Orga, B. (2020). *The role of social information in non-human great apes' behavioral responses to plants* [Master's Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Thesis - Master

Wollny-Huttarsch, D. (2020). *First come, first serve: Early social influence exerts higher influence on individuals' judgments* [Master's Thesis, Maastricht University].

MPG.PuRe

Habilitations 2020-2022/23

Last update: August 2023

2021

Moine, C. (2021). *Pour une histoire culturelle transnationale de l'Europe après 1945* [Habilitation Thesis, University of Paris 1 Panthéon-Sorbonne].

MPG.PuRe

Doctoral Dissertations 2020–2022/23

Last update: August 2023

2023

Buchberger, E. S. (2023). *The process architecture of memory in early to middle childhood* [PhD Thesis, Ruhr-Universität Bochum].

MPG.PuRe

Jöchner, A.-K. (2023). *Sleep-associated memory consolidation across child and adolescent development: Different yet the same?* [PhD Thesis, Ruhr-Universität Bochum].

MPG.PuRe

Koch, C. (2023). *How aging shapes neural representations of continuous spaces* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-39372 (published online 2023: http://dx.doi.org/10.17169/refubium-39372).

MPG.PuRe DOI Full

Lieth, J. (2023). *Lieben als Lebensprojekt: Der Pfarrer, Gefühle und Moral in der württembergischen Erweckungsbewegung des 19. Jahrhunderts* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Papadaki, E. (2023). *Experience-dependent plasticity in the auditory domain: Effects of expertise and training on functional brain organization* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

2022

Appelhoff, S. (2022). *Researching neural correlates of human decisions from experience using electroencephalography* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-35218

MPG.PuRe DOI Full

Karlsson, A. E. (2022). *Neural oscillations shape the quality and content of episodic memories in young adulthood and older age* [PhD Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Polk, S. E. (2022). *Aerobic exercise for the promotion of healthy aging: Changes in brain structure assessed with new methods* [PhD Thesis, Freie Universität Berlin].
MPG.PuRe

Rahwan, Z. (2022). *Dishonesty: The role of rewards, professional identity and experimenter purpose disclosures* [PhD Thesis, Humboldt-Universität zu Berlin].
MPG.PuRe Full

Rudeck, L. M. (2022). *Vergnügung im Besatzungsalltag: Begegnungen in westalliierten Offiziers- und Soldatenclubs in Deutschland, 1945-1955* [PhD Thesis, Freie Universität Berlin].
MPG.PuRe

Russell, C. J. S. (2022). *Error management in learning and generalisation: The domain of food* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-36992
MPG.PuRe DOI Full

Tiede, K. E. (2022). *An ecological perspective on decisions under risk: How the structure of the environment shapes information processing* [PhD Thesis, Universität Konstanz].
MPG.PuRe Full

Wittkuhn, J. L. (2022). *Investigating neural replay of task representations in the human brain using fMRI* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-34672
MPG.PuRe DOI Full

2021

Arnold, M. (2021). *Score-based approaches to heterogeneity in psychological models* [PhD Thesis, Humboldt-Universität zu Berlin]. https://doi.org/10.18452/24146
(published online 2022: https://doi.org/10.18452/24146) .
MPG.PuRe DOI Full

Borrero, A. T. (2021). *Moral education: Soldiers, war, and the U.S. military in U.S. history textbooks (1964-2000)* [PhD Thesis, Technische Universität Berlin]. https://doi.org/10.14279/depositonce-11765
MPG.PuRe DOI Full

Ciranka, S. (2021). *Computational mechanisms of social influence during adolescence* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-33128
(published online 2022: https://doi.org/10.17169/refubium-33128).
MPG.PuRe DOI Full

Danilina, A. (2021). *Ethiken der Essenz: Eine Emotions- und Körpergeschichte der Rasse in inneren Kolonien (1890-1933)* [PhD Thesis, Technische Universität Berlin].
MPG.PuRe

De Simone, C. (2021). *Active and ecological learning to navigate the social world* [PhD Thesis, TUM School of Social Sciences and Technology].

MPG.PuRe Full

Jacobs, P. (2021). *On the significance of information* [PhD Thesis, Humboldt-Universität zu Berlin]. https://doi.org/10.18452/22919

MPG.PuRe DOI Full

Jones, A. (2021). *Active learning strategies in child- and adulthood: An interdisciplinary perspective* [PhD Thesis, Technische Universität München].

MPG.PuRe Full

Lindner, T. (2021). *Transnational networks of anti-imperialism: Mexico City in the 1920s* [PhD Thesis, Technische Universität Berlin].

MPG.PuRe

Schlegelmilch, K. (2021). *Grass or gravel? Influences on the visual categorization of naturalistic structures in infancy and early childhood* [PhD Thesis, Universität Potsdam]. https://doi.org/10.25932/publishup-52637

MPG.PuRe DOI Full

Schlünz, B. (2021). *Pastoral und Politik: Katholische Frömmigkeit im spanischen Liberalismus, 1833-1868* [PhD Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Wodzicki, L. (2021). *The virtuous: Political communication between the Italian states and the Ottoman Empire in the age of Mehmet II (1453-1481)* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

2020

Bähr, M. (2020). *Grassroots veterans: The American legion and conservative change in California, 1945-2000* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Dahl, M. J. (2020). *Neuromodulation and rhythmic neural activity shape cognition across the adult lifespan* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Kosciessa, J. Q. (2020). *Measurement and relevance of rhythmic and aperiodic human brain dynamics* [PhD Thesis, Humboldt-Universität zu Berlin]. https://doi.org/10.18452/22040

MPG.PuRe DOI

Mühlroth, B. E. (2020). *Sleep-associated consolidation of episodic memories in old age: The* *challenge of studying cognitive and cerebral aging* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-27290

MPG.PuRe DOI Full

Schröer, F. (2020). *Reassembling the feeling community: Space, time, and morality in the Tibetan diaspora in India, c. 1959-1979* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe

Sommer, V. R. (2020). *The fidelity of neural representations shapes episodic memory across the human lifespan* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-28640

MPG.PuRe DOI Full

Süsler-Rohringer, T. (2020). *Die Transformation der Sozialpolitik in Cisleithanien und die moralische Ökonomie der Re-Integration Kriegsversehrter 1880-1918* [PhD Thesis, Technische Universität Berlin].

MPG.PuRe

Tump, A. N. (2020). *How social learning strategies boost or undermine decision making in groups* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-27728

MPG.PuRe DOI Full

Yahosseini, K. S. (2020). *Experimental study and modeling of three classes of collective problem-solving methods* [PhD Thesis, Freie Universität Berlin]. https://doi.org/10.17169/refubium-27367

MPG.PuRe DOI Full

Zilker, V. (2020). *Measuring and modeling the construction of preferences in decision making under risk* [PhD Thesis, Freie Universität Berlin].

MPG.PuRe Full

Master's Theses 2020-2022/23

Last update: August 2023

2023

Kaisheva, M. (2023). *Pupil-indexed neuromodulation is parametrically associated with trial-by-trial alpha oscillations* [Master's Thesis, Eberhard-Karls-Universität Tübingen].

MPG.PuRe

2022

Billenstein, H. (2022). *Morality at odds: Probability as a moral factor in sacrificial dilemmas* [Master's Thesis, Humboldt-Universität zu Berlin].

MPG.PuRe

Düben, M. (2022). *3-4-year-old children's behavior in binary repeated choice from description* [Master's Thesis, Universität Potsdam].

MPG.PuRe

Hebisch, J. (2022). *Neural correlates for adolescent risk-taking in the learning context* [Master's Thesis, Westfälische Wilhelms Universität Münster].

MPG.PuRe

Kohler, M. (2022). *#Drosten: Analyzing predictors of the spread of Covid-19 risk communication on Twitter* [Master's Thesis, Universität Basel].

MPG.PuRe

McClary, T. M. (2022). *Age differences in memory generalization across childhood* [Master's Thesis, Freie Universität Berlin].

MPG.PuRe

Mooraj, Z. (2022). *Metamemory judgements in aging: Differences in behavioral influences, neural activation, and connectivity patterns between younger and older adults* [Master's Thesis, Humboldt Universität zu Berlin].

MPG.PuRe

Özince, D. D. (2022). *Exercise, cognitive, multimodal training and white matter hyperintensities in*

the aging brain: No effects after six months of intervention [Master's Thesis, Freie Universität Berlin].
MPG.PuRe

Picó Cabiró, M. (2022). *Urbanicity is associated with perceptual style* [Master's Thesis, University of Amsterdam].
MPG.PuRe

Poppa, C. (2022). *Dynamics of markers for neuronal plasticity (BDNF, IGF-1, IGFBP-3) and general fitness during a six-month intervention study in healthy older adults (AKTIV study)* [Master's Thesis, Freie Universität Berlin].
MPG.PuRe

Schmidt, M. K. (2022). *Associations of non-invasive correlates of noradrenergic neuromodulation and learning across the adult lifespan* [Master's Thesis, Humboldt Universität zu Berlin / Berlin School of Mind and Brain].
MPG.PuRe

Verra, L. (2022). *Behavioural evidence for state dependent uncertainty* [Master's Thesis, Humboldt-Universität zu Berlin].
MPG.PuRe

2021

Daschowski, Y. (2021). *When is waiting worth it? The trade-off between decreasing forecast uncertainty and increasing cost of action over time* [Master's Thesis, Universität Potsdam].
MPG.PuRe

Firnrohr, J. (2021). *In nature we trust: Der Einfluss der Naturverbundenheit auf die wahrgenommene Restaurativität natürlicher und urbaner Umgebungen* [Master's Thesis, Freie Universität Berlin].
MPG.PuRe

Gubernath, J. (2021). *Spatial uncertainty in probabilistic forecasts lowers perceived risk and likelihood of precautionary action* [Master's Thesis, Maastricht University].
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Hecht, M. (2021). *Is what you know who you know online? Social sampling in online social networks* [Master's Thesis, Humboldt-Universität zu Berlin].
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Wollny-Huttarsch, D. (2020). *First come, first serve: Early social influence exerts higher influence on individuals' judgments* [Master's Thesis, Maastricht University].
MPG.PuRe

Honors and Awards 2020–2022/23

Last update: August 2023

Ahner, Helen Sign Up! Career Building Program 2023 "For Your Career" for Female Postdocs, Max Planck Society, 2022.

Dahl, Martin Margret and Paul Baltes Award, Developmental Psychology Section of the German Psychological Society (DGPs), 2021; Otto Hahn Medal, Max Planck Society, 2021; Junior Researcher Award 2021 (2nd place), Gesellschaft für Neuropsychologie (GNP), 2021.

El Zein, Marwa Marie Skłodowska-Curie Individual Fellowship 2021–2023, European Commission, 2020.

Frevert, Ute Appointed President, Max Weber Foundation, 2023; Sigmund-Freud-Preis für wissenschaftliche Prosa (Prize for Academic Prose), German Academy for Language and Literature, 2020; Ernst Hellmut Vits Prize, University of Münster, Germany, 2020; Book Award for *Kapitalismus, Märkte und Moral,* Friedrich-Ebert-Stiftung, 2020; Appointed Member of the Council of the Berlin-Brandenburg Academy of Sciences and Humanities (BBAW), 2020; Appointed Member of the Presidium, German National Academy of Sciences Leopoldina, 2020.

Geers, Michael Add-on Fellowship for Interdisciplinary Business Administration, Joachim Herz Foundation, 2022; Graduate Travel Award, Society for Personality and Social Psychology, 2022; Graduate Student Conference Award, Psychonomic Society, 2022.

Gigerenzer, Gerd Science Communication Medal 2022, Max Planck Institutes Göttingen, 2022; Distinguished Educator Award, Society for Risk Analysis, 2021; Appointed Member of the German National Academy of Sciences Leopoldina (Section Global Health), 2021; Appointed Member, Scientific Council of the European Research Council, 2020; Best TED talk 2020 (2nd place), awarded by Duke University Annual Hindsight Awards, 2020; Appointed Honorary Professor of the University of Potsdam, 2020.

Grossmann, Tobias Friedrich Wilhelm Bessel Award for collaboration with the Center for Lifespan Psychology, Humboldt Foundation, 2022.

Grüneisen, Sebastian ERC Starting Grant 2020, European Research Council, 2020.

Hall-McMaster, Sam Fellow, Humboldt Foundation, 2021.

Hertwig, Ralph Appointed Member of the Berlin-Brandenburg Academy of Sciences and Humanities (BBAW), 2022; Appointed Member of the German National Academy of Science and Engineering (acatech), 2021; Appointed Member to the Corona expert panel of the German Federal Government, 2021.

Hitzer, Bettina Leipzig Book Fair Prize 2020 for the Best Non-fiction Book *Krebs fühlen: Eine Emotionsgeschichte des 20. Jahrhunderts* (*The history of cancer and emotions in twentieth-century Germany*); Heisenberg Program, German Research Foundation (DFG), 2020.

Hong, Inho Young Statistical Physicist Award, The Korean Physical Society, 2021.

Köbis, Nils Best Presentation, Berlin Science Week, 2022; Finalist for the AI Newcomer of the Year, German Informatics Society, 2021.

Kosciessa, Julian Otto Hahn Medal 2022, Max Planck Society, 2022; Brain Products Young Scientist Award 2021, Deutsche Gesellschaft für Psychophysiologie und ihre Anwendung (DGPA), 2021.

Kozyreva, Anastasia / Wineburg, Sam / **Lewandowsky, Stephan** / **Hertwig, Ralph** Critical ignoring as a core competence for digital citizens designated as one of the 10 most impactful articles in 2022, Association for Psychological Research, 2023.

Kühn, Simone ERC Consolidator Grant 2022, European Research Council (ERC), 2023; Appointed Member of the German National Academy of Sciences Leopoldina, 2022; Research Grant, Strategic Innovation Fund, Max Planck Society, 2021.

Lämmert, Stephanie Research Grant, Volkswagen Foundation, 2022.

Linde-Domingo, Juan Ramón y Cajal Fellowship, Spanish State Research Agency and University of Granada, 2022.

Lindenberger, Ulman Appointed Foreign Member (Class for Social Sciences) of the Royal Swedish Academy of Sciences, 2023; Appointed Vice President of the Max Planck Society, 2020.

Lorenz-Spreen, Philipp Leopoldina Prize for Young Scientists, German National Academy of Sciences Leopoldina, 2021.

Månsson, Kristoffer N.T. Best Oral Presentation, Alpine Brain Imaging Meeting, Champéry, Switzerland, 2020.

Månsson, Kristoffer N. T. / **Waschke, Leonhard** / Manzouri, Amirhossein / Furmark, Tomas / Fischer, Håkan / **Garrett, Douglas D.** ↗ Moment-to-moment brain signal variability reliably predicts psychiatric treatment outcome was a top-15 finalist for the Somerfeld-Ziskind Research Award from the Society of Biological Psychiatry and received an Honorable Mention, 2022.

Mayer, Karl Ulrich University Medal, University of Mannheim, 2021; Honorary Doctorate, European University Institute, Florence, 2021.

Mohammadi, Siawoosh ERC Consolidator Grant 2022, European Research Council (ERC), 2023.

Mühlroth, Beate Doctoral Dissertation Award 'Becker-Carus', German Sleep Society (DGSM), 2020.

Ngo, Chi (Zoe) Sign Up! Career Building Program 2023 "For Your Career" for Female Postdocs, Max Planck Society, 2022; Cermak-Corkin Postdoctoral Award, Memory Disorders Research Society, 2021; Jacobs Foundation Research Fellowship, Jacobs Foundation, 2021.

Pahl, Kerstin Maria Member of the presidium of the "Die Junge Akademie," Berlin Brandenburg Academy of Sciendes and Humanities, 2023; Fulbright Fellowship, Harvard University, 2023; Sign Up! Career Building Program 2022 "For Your Career" for Female Postdocs, Max Planck Society, 2021.

Pauley, Claire Poster Prize at "Psychologie & Gehirn" Annual Conference, Deutsche Gesellschaft für Psychophysiologie und ihre Anwendung (DGPA), 2021.

Pernau, Margrit Research Fellow, International Centre of Advanced Studies: Metamorphoses of the Political (ICAS: MP), Delhi, 2020; Appointed Chair of the Advisory Committee of the India Branch Office, Max Weber Stiftung Delhi, 2020.

Petzka, Marit Brain Products Young Scientist Award 2022, Deutsche Gesellschaft für Psychophysiologie und ihre Anwendung (DGPA), 2022.

Rahwan, Iyad Listed as one of the most distinguished Arab AI experts, MIT Technology Review, 2022; Best Poster Presentation, International Conference on Computational Social Science (IC2S2), 2020; One of 30 thinkers to watch, Thinkers50 Radar, 2020.

Sarıoğlu, Esra Best Book Award 2023 for ↗ *The body unburdened. Violence, emotions, and the New Woman in Turkey*, ASA Section on Sociology of Body & Embodiment, American Sociological

Association, 2023.

Schakowski, Alexander Presentation Award (best student talk), Early-Career Social Learning Researchers, 2022.

Spitzer, Bernhard Heisenberg Program, German Research Foundation (DFG), 2021; ERC Consolidator Grant 2020, European Research Council (ERC), 2020.

Stille, Max Walter Witzenmann Prize 2020, Heidelberg Academy of Sciences, 2020.

Thoma, Anna Isabel Graduate Conference Award, Psychonomic Society, 2020.

Turner, Tamara Early Career Prize 2022, British Forum for Ethnomusicology, 2022.

Vaish, Amrisha Max Planck Sabbatical Award for collaboration with the Center for Lifespan Psychology, Max Planck Society, 2021.

Wagner, Gert G. Appointed APS Fellow, Association for Psychological Science, 2023; Reelected Member, German Federal Government's Social Advisory Council (Sozialbeirat der Bundesregierung), 2022; Appointed Fellow of the Federal Institute for Population Research (BiB), 2022.

Wittkuhn, Lennart ReproNim/INCF Training Fellowship Program 2020–2021, ReproNim & International Neuroinformatics Coordinating Facility (INCF), 2020.

Wegwarth, Odette Heisenberg Professorship for Medical Risk Literacy & Evidence-Based Decisions, German Research Foundation (DFG), 2020.

Wertz, Annie E. Don Symons Award for best paper of last 3 years, *How plants shape the mind*, Human Behavior and Evolution Society, 2023.

Wertz, Annie E. / **Gerdemann, Stella** Margo Wilson Award for *18-month-olds use different cues to categorize plants and artifacts*, Human Behavior and Evolution Society, 2022.

Zilker, Veronika Q. Heinz Heckhausen Prize, German Psychological Society (DGPs), 2022; Gender Research Award, Department of Education and Psychology at Freie Universität Berlin, 2021.

Scientific Events

Research Colloquia

The Centers and Groups regularly invite interesting and renowned guests to talk in their Research Colloquia. The talks are open to all members of the Institute, and occasionally also to the interested public. In recent years, hybrid formats have also become increasingly established.

> more

Conferences, Workshops, and Seminars

Numerous conferences, workshops and seminars also took place during the reporting period, providing scientific exchange and encouraging cross-group collaboration.

> more

Research Colloquia

Last update: August 2023

Acerbi, Alberto
Brunel University London, UK
Cultural evolution in the digital age
30.08.2022

Ait Si Abbou, Kenza
International Business Machines Coporation, Berlin, Germany
AI Renaissance? Reflecting on a new era of societal transformation
29.08.2023

Al-Qassemi, Sultan S.
Bard College Berlin, Germany
Scientific thought in modern Arab art
28.03.2023

Almaatouq, Abdullah
Massachusetts Institute of Technology, Cambridge, USA
When social influence promotes the wisdom of crowds
27.08.2020

Amir, Dorsa
University of California, Berkely, USA
The development of decision-making across diverse cultural contexts
27.07.2023

Analytis, Pantelis P.
University of Southern Denmark, Odense, Denmark
The structure of social influence in recommender networks
22.09.2020

Anand, Shayla
MCI Management Center Innsbruck, Austria
Informed decision making in clinical practice

16.02.2023

Arend, Jan

University of Tübingen, Germany

Stress and the long transformation in Czechoslovakia/Czech Republic, 1960–2000

18.04.2023

Atanasov, Pavel

Phyto, Brooklyn, NY, USA

Skill spotting and elicitation systems in crowd prediction

31.03.2022

Bailkin, Jordanna

University of Washington, Seattle, USA

Love in the time of welfare

10.05.2022

Bakker, Michiel

DeepMind, London, UK

Fine-tuning language models to find agreement among humans with diverse preferences

18.04.2023

Ballard, Timothy

The University of Queensland, Brisbane, Australia

Dynamic self-regulation across timescales: From milliseconds to decades

08.12.2022

Banerjee, Sanchayan

Vrije Universiteit Amsterdam, Netherlands

Choice architecture 2.0 using nudge plus: Embedding reflection in behavioural cues to promote low-carbon diets

25.11.2021

Baranyi, Gergő

University of Edinburgh, UK

Healthy aging in place: Integrating the life-course perspective in neighbourhood effects research

24.08.2022

Bassam, Hassan

Max Planck School of Cognition (MPSCog), Leipzig, Germany

Does visual working memory really directly alter perception?

20.01.2020

Bassett, Danielle

University of Pennsylvania, Philadelphia, USA

Network architectures supporting learnability
16.07.2020

Baum, Julia
Humboldt-Universität zu Berlin, Germany
The neurocognition of emotional misinformation
13.01.2022

Beach, Lee R.
The University of Arizona, Tucson, USA
The rise and fall of subjective probability
08.04.2021

Becker, Felicitas
Ghent University, Ghent, Belgium
The politics of 'shame' in the aftermath of slavery in East Africa, ca. 1920–2022
14.6.2022

Becker, Joshua
University College London, UK
Structuring communication process to optimize belief accuracy in groups and networks
27.05.2021

Bell, David
Princeton University, New Jersey, USA
Loving your leader: emotions and the charismatic bond in the age of revolution
04.05.2021

Bellani, Elvita
Hasanuddin University, Makassar, Indonesia
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Hochschule für Musik [Dresden], Germany
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University of Zurich, Switzerland
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The Pennsylvania State University, State College, USA

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Institute of Cognitive Neuroscience at University College London, UK

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Yale University, New Haven, USA

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University of Warwick, UK

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Copenhagen Business School (CBS), Denmark
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Copenhagen Business School (CBS), Denmark
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Korea Advanced Institute of Science and Technology (KAIST), Daejeon, South Korea
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ETH Zurich, Switzerland
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Stockholm Resilience Centre, Sweden
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Stanford University, USA
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MPI for the Study of Crime, Security and Law, Freiburg, Germany
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The Graduate Institute [Geneva], Italy

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Freie Universität Berlin, Germany

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Birkbeck, University of London, UK
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WZB Berlin Social Science Center, Germany
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University of Bristol, UK
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Freie Universität Berlin, Germany
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MPI for Intelligent Systems, Stuttgart, Germany
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Kingston University, London, UK
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Georgetown University, Washington, USA
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University of Bonn, Germany
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Sciences Po Paris, France
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The University of Edinburgh, UK
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New York University, USA
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University of the Witwatersrand, Johannesburg, South Africa
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“Tkuma” Ukrainian Institute for Holocaust Studies (Wissenschaftskolleg zu Berlin), Dnipro, Ukraine
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University of Freiburg, Germany
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Harvard University, Cambridge, USA
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University of New South Wales, Sydney, Australia
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Wissenschaftskolleg zu Berlin, Germany
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Umå University, Sweden
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Duke University, Durham, USA
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University of Paris Nanterre, France
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University of Cambridge, UK
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German Centre for Higher Education Research and Science Studies (DZHW), Berlin, Germany
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Deutsches Institut für Ernährungsforschung, Potsdam, Germany

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MPI for Social Anthropology, Germany; Martin Luther University Halle-Wittenberg, Germany
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Zhang, Ying
Ohio State University, Columbus, USA
Should anger be managed? Bureaucratic culture in Ming China (1368–1644)
13.12.2022

Zhang, Yunhao
Massachusetts Institute of Technology, Cambridge, USA
Identify experts through revealed confidence: Application to wisdom of crowds
05.05.2021

Zhou, Xun
University of Essex, Colchester, UK
Pandemics, xenophobia and fear: Who is to blame for COVID-19?
07.06.2022

Zmigrod, Leor
University of Cambridge, UK
A cognitive science of the ideological mind
01.10.2020

Conferences, Workshops, and Seminars

Last update: August 2023

Feeling DIS/EASE: New Perspectives on Modern History
HoE concluding conference of the Minerva Research Focus "Emotions and Illness: Histories of an Intricate Relation"
29.01.20–31.01.20

A Reproducible Data Analysis Workflow with R Markdown, Git, Make, and Docker
IMPRS COMP2PSYCH workshop
20.02.20

LIFE Introductory Workshop: Foundations of Lifespan Research
IMPRS LIFE workshop
27.04.20–05.05.20

Writing Workshop
ARC workshop
14.05.20

LIFE Spring Academy 2020
Virtual IMPRS LIFE international academy , hosted by LIFE Virginia
26.05.20–29.05.20

COMP2PSYCH Colloquium
IMPRS COMP2PSYCH talk and discussion rounds (monthly virtual talk and discussion), jointly organized with Max Planck UCL Center for Computational Psychiatry and Ageing Research
03.06.20–06.01.21

LIFE Theory Lab 2020: Contemporary Theorizing, Methodological Advancements, and Future Challenges for Lifespan Developmental Science
IMPRS LIFE weekly virtual lecture series
04.06.20–30.07.20

VW AI
ARC workshop
16.06.20

Effective Presentations
COMP2PSYCH workshop (online webinar)
30.06.20

ARC´s Online Unconference
ARC conference
15.07.20–17.07.20

Writing Workshop
ARC workshop
03.08.20

The Tidyverse Approach to R
Research Data Management & Open Science working group workshop
15.09.20–16.09.20

UCL MPS Computational Psychiatry Talks
IMPRS COMP2PSYCH lecture series (weekly virtual lectures and discussion), jointly organized with MP UCL Centre for Computational Psychiatry and Ageing Research
17.09.20–25.03.21

Solidarity and Humanitarianism in the Global South between Decolonization and the Cold War (1960s-1980s)
HoE workshop, jointly organized with Centre Marc Bloch at Humboldt-Universität zu Berlin
28.09.20–29.09.20

Effective Presentations
IMPRS LIFE workshop (online webinar)
28.09.20–29.09.20

Effective Presentations
IMPRS LIFE workshop (online webinar)
06.10.20–07.10.20

LIFE Fall Academy 2020
Virtual IMPRS LIFE international academy, hosted by LIFE Berlin
08.10.20–09.10.20

TRIOS Workshop
ARC workshop
08.10.20–09.10.20

Emotion, Symbol, Space: the AKP'S never ending Conquest of Istanbul
HoE seminar
10.10.20

Decision Making in Online Environments

ARC workshop

11.11.20

Writing a Reproducible Paper in R with WORCS

Research Data Management & Open Science working group workshop

11.11.20

Education across the Lifespan

IMPRS LIFE weekly virtual seminar

12.11.20–21.02.21

Data Management Workshop with DataLAd

Research Data Management & Open Science working group workshop

18.11.20

SCIoI Project Meeting

ARC meeting

19.11.20

Thesis Defence Workshop for PhD Students of the IMPRS "Moral Economies in Modern Societies"

HoE professional development seminar

02.12.20

An Introduction to the Basics of Deep Learning Methods

IMPRS COMP2PSYCH workshop

08.12.20

The Emotional Consequences of the Peace

HoE hybrid workshop, jointly organized with MPI for Social Anthropology

10.12.20–11.12.20

Karl Barth im Radio. Karl Barth 'on Air'

HoE seminar (Studientag) in cooperation with Zentrum für evangelische Gottesdienst- und Predigtkultur

20.01.21

Introduction to Excetuable Research Articles (ERAs)

Research Data Management & Open Science working group talk

21.01.21

Development of Ecological Rationality

ARC meeting

02.02.21

Moral Dilemmas Project Meeting

ARC meeting
10.02.21

Deliberate Ignorance Project Meeting
ARC meeting
15.02.21–19.02.21

Reclaiming Autonomy Online
ARC kick off workshop
17.02.21–18.02.21

Documenting your Data with the Codebook Package
Research Data Management & Open Science working group workshop
03.03.21

Writing Retreat
ARC retreat
05.03.21

Collective Intelligence in Medical Diagnostics
ARC meeting
16.03.21

A Reproducible Data Analysis Workflow with RMarkdown, Git, Make, and Docker
Research Data Management & Open Science working group workshop
18.03.21

From Data to Causes – Advancing Research and Education on the Missing Link of Causal Inference
IMPRS COMP2PSYCH workshop
30.03.21

From Data to Causes
IMPRS LIFE workshop
31.03.21

Fellows' Project Presentations
IMPRS LIFE weekly seminar
15.04.21–15.07.21

Prozesse Filmen: Ein soziales Thema
HoE online workshop, jointly organized with Centre Marc Bloch at Humboldt-Universität zu Berlin
20.05.21

Emotions of Inclusion and Exclusion in Transnational Spaces
HoE workshop, jointly organized with McGill University, University of Copenhagen

20.05.21–21.05.21

LIFE Spring Academy 2021

Virtual IMPRS LIFE international academy hosted by LIFE Michigan

25.05.21–27.05.21

Social Minds

ARC meeting

02.06.21

Fatal Attraction: Germany, Poland and the Jews after the Holocaust

HoE online workshop, jointly organized with University of Sussex & Ludwig-Maximilians-Universität München

09.06.21–10.06.21

Rethinking Behavioral Economics

19th Summer Institute on Bounded Rationality, hosted by Gerd Gigerenzer and ARC funded by the Joachim Herz Stiftung

15.06.21–24.06.21

Git Workshop

IMPRS LIFE workshop

21.06.21–22.06.21

COMP2PSYCH Colloquium

IMPRS COMP2PSYCH talk and discussion rounds (monthly virtual talk and discussion), jointly organized with MP UCL Centre for Computational Psychiatry and Ageing Research

07.07.21–01.06.22

Twitter Sharing Project Meeting

ARC meeting

13.07.21

Ensuring Good (Better: Best!) Scientific Practice in the Research Process

Research Data Management & Open Science working group workshop

08.09.21–23.09.21

UCL MPS Computational Psychiatry Talks

IMPRS COMP2PSYCH lecture series (weekly virtual lectures and discussion), jointly organized with Max Planck UCL Centre for Computational Psychiatry and Ageing Research

17.09.21–01.07.22

Herbstschule "Eine Anthropologie der Emotionen: Epistemologische Fragen"

HoE autumn school, jointly organized with École des hautes études en sciences sociales (EHSS, Paris), CNRS (UMR Passages - Institut ARI, Bayonne)

04.10.21–09.10.21

Academic Writing

IMPRS LIFE workshop

04.10.21

LIFE Fall Academy 2021

Hybrid LIFE international academy, hosted by LIFE Zurich

11.10.21–13.10.21

Behavioural Interventions for Promoting Truth and Democratic Discourse in Online Environments

ARC workshop

12.10.21–13.10.21

Decision Making

IMPRS LIFE weekly virtual/hybrid seminar

21.10.21–18.01.22

Decision Making Colloquium

ARC colloquium

28.10.21

LIFE Introductory Session on Developmental Theory

IMPRS LIFE seminar

28.10.21

Academic Writing

IMPRS LIFE workshop

02.11.21

The Decade of Disenchantment? The Global 1970s

HoE online workshop

04.11.21–05.11.21

Spectacle and the Spectacular in the Contemporary Era

HoE summer school, jointly organized with University of Lausanne

08.11.21–11.11.21

Starting to Version Control using Git

Research Data Management & Open Science working group workshop

09.11.21–10.11.21

Research Data Management

IMPRS COMP2PSYCH workshop

19.11.21

Cartooning AI Anxiety

CHM salon, jointly organized with Amy Kurzweil

07.12.21

Multi-level Modeling in R

Research Data Management & Open Science working group Workshop

15.12.21

Newsfeed Project

ARC kick off workshop

25.01.22

Ethics Workshop: How to Apply

ARC workshop

31.01.22

ERC The healthy Self as Body Capital: Final Conference

HoE final conference (ERC project), jointly organized with University of Strasbourg

02.02.22–04.02.22

Running Experiments Workshop

ARC workshop

08.02.22

IMPETUM

MPRG iSearch conference, jointly organized with Technical University of Munich [TUM], Imperial College London

01.03.22

Development of Ecological Rationality

ARC meeting

02.03.22

AI, Us, and our Dreams of the Future

CHM salon, jointly organized with Beth Singler and William Powers

15.03.22

Reimar Lüst Memorial Lecture 2022 - Kepler in Relation: Emotion & Science in a New Age of Knowledge

Commemoration, jointly organized with University of Cambridge

15.03.22

Research Data Management

Research Data Management & Open Science working group workshop

06.04.22

1st Twin Registry

LMG EnvNeuro seminar, jointly organized with Bielefeld University, Saarland University, University of

Bremen, MPI for Psychiatry, MSH Medical School Hamburg
03.05.22

LIFE Spring Academy 2022
Virtual LIFE international academy, hosted by LIFE Virginia
09.05.22–11.05.22

NFTs, Artificial Intelligence and Culture
CHM salon, jointly organized with Johann König
24.05.22

Neuropointillist: Using R to Foster Innovation Modeling of MRI Data
Research Data Management & Open Science working group workshop
02.06.22

LIFE Theory Lab 2022
IMPRS LIFE weekly virtual lecture series
02.06.22–07.07.22

Search & Learning in an Uncertain World
20th Summer Institute on Bounded Rationality, hosted by ARC funded by the Joachim Herz Stiftung
14.06.22–23.06.22

Jürgen Baumert Festive Symposium on the Occasion of his 80th Birthday
Emeritus Group Educational Research symposium, jointly organized with Jacobs Foundation, Leibniz Institute for Science and Mathematics Education
17.06.22

Advanced Multi-level Modeling using R v
Research Data Management & Open Science working group workshop
20.06.22

Tracking the Public Mind: Can Online Discourse be a Force for good?
CHM salon, jointly organized with William Powers
21.06.22

Wolfgang Edelstein Memorial Lecture - Educational Research: Analysis and Criticism, Reflection and Action
Commemoration
24.06.22

Long Night of the Sciences
Public event
02.07.22

5th Max Planck UCL Centre Symposium and Advanced Course on Computational Psychiatry and

Ageing Research

LIP, IMPRS COMP2PSYCH, MP UCL Centre symposium, jointly organized with MP UCL Centre for Computational Psychiatry and Ageing Research, Jacobs Foundation

28.08.22–03.09.22

Understanding Neural Plasticity: From Animal Models to Human Individuality

LMG EnvNeuro and LIP conference, jointly organized with MPI for Biological Intelligence

04.09.22–10.09.22

BIDS (ify your data)

Research Data Management & Open Science working group workshop

07.09.22

Serendipity, Radical Uncertainty and Economic Progress

Keynote lecture on the Occation of Gerd Gigerenzer`s 75th birthday by Lord Mervyn King, Former Governor of the Bank of England, London

15.09.22

10th anniversary of ARC

ARC colloquium

16.09.22

Modern Bayesian Analysis

Research Data Management & Open Science working group workshop

29.09.22

Herbstschule "Situierte Emotionen: Anthropologie und Geschichte im Gespräch"

HoE autumn school, jointly organized with École des hautes études en sciences sociales (EHSS, Paris), CNRS (UMR Passages - Institut ARI, Bayonne)

03.10.22–08.10.22

International Association for the Evaluation of Educational Achievement (IEA) General Assembly

Emeritus Group Educational Research conference, jointly organized with Johannes Gutenberg University Mainz

04.10.22–07.10.22

AI and Future of Societies

ARC workshop

10.10.22–11.10.22

The Tidyverse Way of Working with Data in R

Research Data Management & Open Science working group workshop

11.10.22

LIFE Fall Academy 2022

In-person LIFE international academy hosted by LIFE Berlin

13.10.22–16.10.22

rs-fMRI Workshop

LMG EnvNeuro workshop, jointly organized with University Medical Center Hamburg-Eppendorf (UKE)

17.10.22–19.10.22

ACM Collective Intelligence Conference 2022

CHM conference, in cooperation with Association for Computing Machinery (ACM) and Special Interest Group on Computer–Human Interaction (SIGCHI)

20.10.22–21.10.22

Methods in Research on Human Development

IMPRS LIFE weekly seminar

21.10.22–22.12.22

Generating Reports with Quarto

Research Data Management & Open Science working group workshop

26.10.22

Max Planck-Humboldt Research Awards and Medals 2021 & 2022

Meeting the scientists, event as part of the Berlin Science week

03.11.22

Cartooning your Research

CHM workshop, jointly organized with Amy Kurzweil

17.11.22

2nd Twin Registry

LMG EnvNeuro seminar in cooperation with Bielefeld University, Saarland University, University of Bremen, MPI for Psychiatry, Medical School Hamburg

23.11.22

Lonely Death and Contact-less Socialities

HoE hybrid workshop, jointly organized with University of Amsterdam

24.11.22–25.11.22

COMP2PSYCH Colloquium

IMPRS COMP2PSYCH talk and discussion rounds (monthly virtual talk and discussion), jointly organized with MP UCL Centre for Computational Psychiatry and Ageing Research

04.01.23–05.03.23

LIFE Introductory Workshop: Foundations of Lifespan Research

IMPRS LIFE e-learning videos and discussion rounds (online)

19.01.23–09.03.23

QGIS Workshop
LMG EnvNeuro workshop, jointly organized with University Medical Center Hamburg-Eppendorf (UKE)
09.02.23

Structure your Data
Research Data Management & Open Science working group workshop
14.02.23

Research Data Management
Research Data Management & Open Science working group workshop
15.02.23

Structure your Data
Research Data Management & Open Science working group workshop
16.02.23

AciBeh Workshop: Collectively Intelligent Science Communication-Lessons Learned for a post-COVID Era
ARC workshop
01.03.23–02.03-23

How to Move beyond Impact Factors and H-Index: Responsible Research Assessment and its Implementation
Research Data Management & Open Science working group talk
15.03.23

Starting to Version Control using Git
Research Data Management & Open Science working group workshop
28.03.23–29.03.23

Dying Alone and its Afterlives in Contact-less Sociality
HoE conference, jointly organized with University of Amsterdam
17.04.23–19.04.23

Associations of Self-Control with DNA-Methylation Measures of Aging-Related Health
European Social Science Genetics conference, Bologna, jointly organized with University of Bologna
10.05.23–13.05.23

Measuring the Long Arm of Childhood in Real-Time: Epigenetic Predictors of BMI and Social Determinants of Health across Childhood and Adolescence
European Social Science Genetics conference, Bologna, jointly organized with University of Bologna
10.05.23–13.05.23

LIFE Spring Academy 2023
LIFE international academy, hosted by LIFE Michigan

16.05.23–18.05.23

Critical Ignoring

ARC workshop

05.06.23–08.06.23

Lateral Reading

ARC workshop

07.06.23

Science of Boosting: How to Empower Citizens

21th Summer Institute on Bounded Rationality hosted by Gerd Gigerenzer and ARC, funded by the Joachim Herz Stiftung

13.06.23–21.06.23

CERN for the Information Environment

ARC workshop

15.06.23

Measuring the Long Arm of Childhood in Real-Time: Epigenetic Predictors of BMI and Social Determinants of Health across Childhood and Adolescence

talk at the Behavioral Genetics Association annual conference, jointly organized with University of Murcia

21.06.23–25.06.23

6th ESLR Workshop – Social Learning in Complex Systems

ARC workshop

03.07.23–05.07.23

Meeting of the BR50 Press Departments

Networking event

04.07.23

Feeling Competitive - Sport as Affective Practice

HoE workshop

12.07.23–14.07.23

Max Planck Symposium on AI and Ethics

CHM symposium in cooperation with MPG zur Förderung der Wissenschaften e.V.

02.08.23–03.08.23

Panel Convention Developmental Psychology 2023

LIP convention jointly organized with German Psychological Society (DGPs)

03.09.23–05.09.23

Grants and Stipends

Last update: August 2023

Abdel Rahman, Rasha / Ammon, Sabine / Brock, Oliver / Hafner, Verena / Haynes, John-Dylan / Hellwich, Olaf / **Hertwig, Ralph** / **Kurvers, Ralf** / Krause, Jens / Kyselo, Miriam / Lazarides, Rebecca / Lewejohann, Lars / Maertens, Marianne / Obermayer, Klaus / Pachur, Thorsten / Pauen, Michael / Raisch, Jörg / Rolfs, Martin / Romanczuk, Pawel / Schulz-Schaeffer, Ingo / Sprekeler, Henning / Thöne-Reineke, Christa – Funding for the Cluster of Excellence "Science of Intelligence" (EXC 2002), a cooperation between Technische Universität Berlin, Humboldt-Universität zu Berlin, Charité Universitätsmedizin Berlin, Freie Universität Berlin, MPI for Human Development, and Universität Potsdam, German Research Foundation (DFG), 01/2019–12/2025.

Berger, Julian – PhD Stipend, Stiftung der deutschen Wirtschaft, 11/2021–10/2024.

Buchberger, Elisa S. – Exposé Stipend, Studienstiftung des Deutschen Volkes, 12/2019–05/2020.

Burton, Jason William – Humboldt Research Fellowship, Humboldt Foundation, 01/2023–06/2023.

Dahl, Martin – Research Grant, G. A.-Lienert-Stiftung, 2020.

Deserno, Marie K. – Rubicon Fellowship, The Netherlands Organization for Scientific Research, 12/2019– 09/2021.

Düzel, Sandra – Boost!-Programme, Max Planck Society, 11/2019–03/2022.

Düzel, Sandra / **Drewelies, Johanna** – Funding for Project "Dynamics of daily-life adaptation in the Corona crisis among older adults," Volkswagen Foundation, 03/2021–07/2023.

El Zein, Marwa – Sir Henry Wellcome Postdoctoral Fellowship, "An adaptive role of collective decisions: Shared responsibility in the human brain," University College London, 01/2017–04 /2021; Marie Skłodowska-Curie European Postdoctoral Fellowship "The social individual's decisions: How are they shaped by group affiliation during collective decisions?," European Commision Union, 07/2021–07/2023.

Fandakova, Yana – Funding for Project "Plasticity of task switching in childhood: Mechanisms and sequential progression," German Research Foundation (DFG), 10/2018–09/2021.

Fandakova, Yana / Bunge, Silvia A. – Funding for Project "How do students learn new concepts? Identifying factors that promote students' understanding of physical science concepts," Jacobs

Foundation, 06/2019– 05/2021.

Fecher, Benedikt / Hornbostel, Stefan / Sokolovska, Nataliia / **Wagner, Gert G.** – Funding for Project "Indikatorik, Messung und Performanz der Qualitätssicherung: Third-Mission-Tätigkeiten in den Gesellschaftswis- senschaften (IMPaQT), BMBF-Programm "Qualitätsentwicklungen in der Wissenschaft," Federal Ministry of Education and Research, 07/2019–06/2022.

Garrett, Douglas D. – Emmy Noether Programme, "Toward a structural and functional basis for changes in brain signal variability with age," German Research Foundation (DFG), 01/2017–02/2023.

Geers, Michael – SSRC/Summer Institutes in Computational Social Sciences Research Grant, Social Science Research Council, 08/2021.

Gigerenzer, Gerd – Funding of the Harding Center, Winton Capital Management & Claudia and David Harding Foundation, 01/2007–12/2019; the Center will be continuously funded at the University of Potsdam from 2020–2024.

Grossman, Shany – Postdoctoral Fellowship of Zuckerman Israeli Postdoctoral Scholars Program, 01/2022–01/2024.

Grüneisen, Sebastian – Marie Skłodowska-Curie Individual Global Fellowship, "The psychological origins of trust-based cooperation (ORIGINSOFTRUST), in cooperation with University of Michigan, European Commission, 04/2018–03/2021.

Gumenik, Ksenija – Stipend, Ernst Ludwig Ehrlich Studienwerk (ELES), 10/2019–09/2021.

Hall-McMaster, Sam – Postdoctoral Fellowship, Humboldt Foundation, 03/2021–02/2023.

Haux, Lou M. – Stipend, Studienstiftung des Deutschen Volkes, 01/2019–01/2021.

Hecht, Marlene – Doctoral Stipend, Stiftung der deutschen Wirtschaft, 06/2021–10/2023.

Hechtlinger, Shahar – Research Grants—Doctoral Programs in Germany, German Academic Exchange Service, 10/2019–09/2021; 10/2022–09/2023.

Hedrich, Noa – PhD Fellowship, Einstein Center of Neurosciences, 10/2021–09/2024.

Hertwig, Ralph – External cooperation partner of the Cluster of Excellence "Centre for the Advanced Study of Collective Behaviour" (EXC 2117), a cooperation between University of Konstanz and MPI of Animal Behavior, German Research Foundation (DFG), 01/2019–12/2025; Gottfried Wilhelm Leibniz Prize 2017, German Research Foundation (DFG), 01/2018–12/2025; Funding for Summer Institute for Bounded Rationality 2020–2023, Joachim Herz Foundation.

Hertwig, Ralph / **Lewandowsky, Stephan** / Eliassi-Rad, Tina / Herzog, Stefan M. / Rashid, Awais – Planning Grant "Controlling the Jekyll and Hyde of artificial-intelligence assisted information architectures: Accepting customization while resisting micro-targeted manipulation," Volkswagen Foundation, 03/2019–10/2020.

Hertwig, Ralph / **Wagner, Gert G.** – Funding for Project "Origins and determinants of malleable risk preferences," Max Planck Society, 04/2017–04/2022.

Herzog, Stefan M. / **Hertwig, Ralph** / **Lewandowsky, Stephan** / Eliassi-Rad, Tina / Rashid, Awais – Funding for Project "Reclaiming individual autonomy and democratic discourse online: How to rebalance human and algorithmic decision making," Volkswagen Foundation, 02/2021–01/2025.

Herzog, Stefan M. / Hahn, Ulrike / **Lewandowsky, Stephan** / Porciello, Jaron – Funding for Project „Unterstützung von Verhaltensforschung und evidenzbasierter Politikgestaltung durch maschinelle Online-Tools," German Research Foundation (DFG), 01/2022–12/2024.

Herzog, Stefan M. / **Kurvers, Ralf H. J. M** / Berditchevskaia, Aleks / Fung, Fai / Lin, Irving / Trianni, Vito – Funding for Project "Hybrid Human Artificial Collective Intelligence in Open-Ended Decision Making (HACID)," European Union, 09/2022–08/2025.

Jenny, Mirjam A. / **Rebitschek, Felix** – Funding for Project "Comprehending drone risks," Federal Ministry of Transport and Digital Infrastructure, 10/2018–06/2020.

Köbis, Nils – EU HORIZON Grant RESPOND, European Research Council, 07/2023–07/2028.

Kühn, Simone – ERC Starting Grant, "Take control! Towards novel training regimes enhancing inhibition and impulse control in health and psychiatric disease," European Research Council, 08/2016–08/2021; Funding for Project "The Baltic game industry—Empowering a booster for regional development; Interreg Baltic Sea Region, European Union, 08/2017–09/2020; ERC Consolidator Grant, "How the physical environment shapes the human brain (BrainScape)", European Research Council, (07/2023–06/2028).

Kurvers, Ralf H. J. M. – DFG Fellowship, "The role of individual differences in collective behaviour," in cooperation with Leibniz-Institute of Freshwater Ecology and Inland Fisheries, German Research Foundation (DFG), 07/2016–09/2020; Funding for Project "Icefishing. Individuelle, kollektive und umgebungsbedingte Triebkräfte der Dynamik menschlicher Nahrungssuche," German Research Foundation (DFG), 12/2021–11/2024.

Kurvers, Ralf H. J. M. / Trianni, Vito – (ISTC-CNR) "CROME: Harnessing the wisdom of crowds in medical diagnostics," Nesta Collective Intelligence Grant, 02/2020–05/2021.

Lämmert, Stephanie – Funding for Project "African Studies in Germany through the lens of Critical Race Theory," Volkswagen Foundation, 04/2023–09/2024.

Li, Weihua – Postdoctoral Fellowship, Humboldt Foundation, 02/2020–07/2021.

Lindenberger, Ulman / Dolan, Raymond J. – Max Planck UCL Centre for Computational Psychiatry and Ageing Research in cooperation with University College London & Humboldt-Universität zu Berlin, Max Planck Society, 04/2014–03/2024.

Lindenberger, Ulman / Düzel, Emrah / Sendtner, Michael / Kreutz, Michael – Collaborative Research Project "Energizing the hippocampus in aging individuals (EnergI)," in cooperation with the German Center for Neuro- degenerative Diseases (DZNE), Universitätsklinikum Würzburg, & Leibniz Institute for Neurobiology, Federal Ministry of Education and Research (BMBF), 07/2015–06/2021.

Lindenberger, Ulman / **Kühn, Simone** / **Brandmaier, Andreas M.** – Funding for Lifebrain consortium Project "Healthy minds 0–100 years: Optimising the use of European brain imaging cohorts ("Lifebrain")," EU Horizon 2020, European Commission, 01/2017–12/2022.

Lindenberger, Ulman / Lövdén, Martin / Pedersen, Nancy / Ullén, Fredrik / Zatorre, Roberto – Funding for Project „How does plasticity differ across people, and why? Probing age differences in gene–environment interplay during musical skill learning," Max Planck Society, 09/2019–08/2024.

Lorenz-Spreen, Philipp / **Hertwig, Ralph** / **Herzog, Stefan** / **Kozyreva, Anastasia** – Funding for Project "Social Media for Democracy (SOME4DEM), Understanding the causal mechanisms of digital citizenship," EU Horizon Europe, 03/2023–02/2026.

Mohammadi, Siawoosh – ERC Consolidator Grant, "Non-invasive staining of tissue microstructure in temporal lobe epilepsy using in-vivo MRI (MRStain)," European Research Council, 01/2024–12/2028.

Moneta, Nir – PhD Fellowship, Einstein Center for Neurosciences Berlin, 10/2019–09/2022.

Mousavi, Shabnam / **Gigerenzer, Gerd** / Sunder, Shyam – Think Forward Initiative Long-Term Research Grant, ING Bank, 05/2019–12/2020.

Mousavi, Shabnam – Funding for Project "Lost and found emotions in the history of economic modeling," Volkswagen Foundation, 10/2020–12/2022.

Ngo, Chi (Zoe) – Funding for Project "Bestimmung der neuronalen Grundlagen der episodischen Spezifität und Generalisierung in der Entwicklung," German Research Foundation (DFG), 08/2021–07/2024; Jacobs Foundation Research Fellowship, Jacobs Foundation, 01/2022–12/2024; Seed Funding for Project „Hippocampal streams for rule learning (HIPSTER)", CIFAR and Jacobs Foundation, 09/2022–08/2024.

Pahl, Kerstin Maria – Boost!-Programme, Max Planck Society, 11/2019–04/2021.

Power, Sarah / **Buchberger, Elisa** / **Jöchner, Ann-Kathrin** / **Ngo, Chi (Zoe)** / Stewart, Erika / **Waschke, Leonhard** – Funding for Project "Memory availability versus accessibility in early ontogeny across species," Jacobs Foundation, 01/2023–12/2025.

Rahwan, Iyad – Funding for Project "Transcription of the dictionary of occupational titles," MIT Task Force on Work of the Future, 03/2019–06/2020.

Rioux, Camille – Postdoctoral Fellowship, Humboldt Foundation, 02/2018–01/2020.

Ruggeri, Azzurra – Funding for Project "Center for Active Learning in Museums (CALM)," Museum für Naturkunde—Leibniz Institute for Evolution and Biodiversity Science, 01/2020–12/2020; Subcontract Award for Project "The development of intellectual humility," Templeton Foundation/Duke University, 05/2021–11/2022.

Ruggeri, Azzurra / Raab, Markus – Funding for Project "Kletternd zum Selbst: Eine Embodied

Cognition Perspektive der Entwicklung zum Zusammenhang zwischen dem Minimalen Selbst und sensomotorischen sowie kognitiven Fertigkeiten," German Research Foundation (DFG), 02/2020–01/2023.

Ruggeri, Azzurra / Martius, Georg / Schulz, Eric – Funding for Project "Towards a science of curiosity," Volkswagen Foundation, 05/2021–04/2025. Funding for Project "Curiosity Research Exhibition on Wheels," Volkswagen Foundation, 10/2022–09/2024.

Rust, Henning / Ulbrich, Uwe / **Hertwig, Ralph** / **Fleischhut, Nadine** / Kox, Thomas / Gerhold, Lars / Schiller, Jochen / Voss, Martin / Raupp, Juliana – Funding for Project "WEXICOM—Weather warnings: From EXtreme event Information to COMunication and action," in cooperation with Freie Universität Berlin, Hans Ertle Center for Weather Research, Germany, funded by Deutscher Wetterdienst (DWD), 01/2019–09/2023.

Sarıoğlu, Esra – Max Planck Diversity Excellence Fund for Project "Earthquake Relief Working Group", Max Planck Society, 09/2023–09/2025.

Schröer, Frederik – Travel Grant "Gerald D. Feldman-Reisebeihilfen," Max Weber Foundation, 01/2023–12/2023.

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Schulze, Christin – Boost!-Programme, Max Planck Society, 11/2019–10/2025; Exchange Program Australia, DAAD, 07/2021–12/2022.

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Wagner, Gert G. – Conference grant, “Boosting - ein neues Konzept der Verbraucherwissenschaften, ein neues Instrument der Verbraucherpolitik?,“ Federal Ministry of Justice/Federal Office of Administration, 07/2020–12/2021.

Wegwarth, Odette – EU Horizon 2020 Research and Innovation Project, “Female cancer prediction using cervical omics to individualise screening and prevention (FORECEE),” in cooperation, amongst others, with University College London, Erasmus Medical Center Rotterdam, & Karolinska Institutet, European Commission, 09/2015–02/2020; Funding for Project “ERONA; Experiencing the Risks of Overutilizing Opioids Among Patients With Non-Tumor Chronic Pain in Ambulant Care,” Federal Ministry of Health/Federal Office of Administration, 06/2019–11/2021; Funding for Project “Stärkung der Gesundheitskompetenz von Sepsis-Risikogruppen zur Verbesserung der Sepsis-Früherkennung und -prävention”, G-BA Innovationsausschuss & Sepsis-Stiftung, 08/2020–07/2023; Funding for Project “Evaluation of an interactive information tool for vaccine-hesitant individuals using the example of COVID-19 vaccination (iWILL),” Innovation Fund of the Federal Joint Committee (G-BA), 01/2022–10/2023.

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These publications are the result of Institute-wide cooperations among members of different Centers or Research Groups.

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Journal Article

Scheunemann, J., Jelinek, L., Biedermann, S. V., Lipp, M., Yassari, A. H., Kühn, S., Gallinat, J., & Moritz, S. (2023). Can you trust this source? Advice taking in borderline personality disorder. *European Archives of Psychiatry and Clinical Neuroscience*, *273*, 875–885. https://doi.org/10.1007/s00406-022-01539-w

MPG.PuRe DOI publisher-version

Journal Article

Schlegelmilch, K., & Wertz, A. E. (2023). Grass and gravel: Investigating visual properties preschool children and adults use when distinguishing naturalistic images. *Cognitive Development*, *66*, Article 101324. https://doi.org/10.1016/j.cogdev.2023.101324

MPG.PuRe DOI

Journal Article

Schmauder, C., Karpus, J., Moll, M., Bahrami, B., & Deroy, O. (2023). Algorithmic nudging: The need for an interdisciplinary oversight. *Topoi*, *42*, 799–807. https://doi.org/10.1007/s11245-023-09907-4

MPG.PuRe DOI publisher-version

Journal Article

Schmiedek, F., Lövdén, M., Ratcliff, R., & Lindenberger, U. (2023). Practice-related changes in perceptual evidence accumulation correlate with changes in working memory. *Journal of Experimental Psychology: General*, *152*(3), 763–779. https://doi.org/10.1037/xge0001290

MPG.PuRe DOI

Journal Article

Schwarze, S. A., Laube, C., Khosravani, N., Lindenberger, U., Bunge, S. A., & Fandakova, Y. (2023). Does prefrontal connectivity during task switching help or hinder children's performance? *Developmental Cognitive Neuroscience*, *60*, Article 101217. https://doi.org/10.1016/j.dcn.2023.101217

MPG.PuRe DOI publisher-version

Journal Article

Senkowski, D., Ziegler, T., Singh, M., Heinz, A., He, J., Silk, T., & Lorenz, R. C. (2023). Assessing inhibitory control deficits in adult ADHD: A systematic review and meta-analysis of the stop-signal task. *Neuropsychology Review*. Advance online publication. https://doi.org/10.1007/s11065-023-09592-5

MPG.PuRe DOI

Journal Article

Shamsrizi, P., Jenny, M. A., Sprengholz, P., Geiger, M., Jäger, C. B., & Betsch, C. (2023). Heatwaves and their health risks: Knowledge, risk perceptions and behaviours of the German population in summer 2022. *European Journal of Public Health*. Advance online publication. https://doi.org/10.1093/eurpub/ckad109

MPG.PuRe DOI

Journal Article

Shvadron, S., Snir, A., Maimon, A., Yizhar, O., Harel, S., Poradosu, K., & Amedi, A. (2023). Shape detection beyond the visual field using a visual-to-auditory sensory augmentation device. *Frontiers in Human Neuroscience*, *17*, Article 1058617. https://doi.org/10.3389/fnhum.2023.1058617

MPG.PuRe DOI publisher-version

Career Paths 2020–2022/23

Other Professional Activities

Our researchers are involved both inside and outside the Max Planck Society—be it in terms of editorships, participation in renowned boards and committees.

> more

Professorship Offers

Our researchers regularly receive professorship offers from universities in Germany and abroad. The following list is labeled in accordance with the US system.

> more

Where Have Our Researchers Gone?

During the reporting period, we said goodbye to valued colleagues. The following list shows the career paths of the researchers, post-, and predoctoral fellows who have left the Institute.

> more

Other Professional Activities 2020–2022/23

Last update: August 2023

Ahner, Helen S.

– INSIST – Interdisciplinary Network for Studies Investigating Science and Technology (Speaker)

– Sustainability at Work Committee of the MPI for Human Development (Co-chair), 2023–

Arndt, Agnes A.

– Deputy Ombudsperson for the Max Planck Institute for Human Development

– German Historical Association (Member)

Arslan, Ruben C.

– Research Data Management Group of the MPI for Human Development (Member), 2018–2021

Baumert, Jürgen

– European Research Council (ERC) (Panel Member for the 2017 Consolidator Grant call)

– LEAD (Learning, Educational Achievement, and Life Course Development), Graduate School & Research Network, Tübingen (Advisory Board)

– Waxmann Verlag's series on educational psychology and developmental psychology (Advisory Board)

– Psychologie in Erziehung und Unterricht (Advisory Board)

– Schweizerische Zeitschrift für Bildungswissenschaften (Advisory Board)

– Zeitschrift für Erziehungswissenschaft (Co-Editor)

Brandmaier, Andreas M.

– International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH) (Faculty Member)

– Max Planck UCL Centre for Computational Psychiatry and Ageing Research (Fellow)

– Ombudsperson of the MPI for Human Development to secure the Max Planck Society's guidelines on "Good scientific practice and procedures for handling misconduct and fraud in science, 2018–2021
– Research Data Management Group of the MPI for Human Development (Member), 2018–2021
– Journal of Quantitative and Computational Methods in Behavioral Sciences (Editor)

Cebrian, Manuel
– National Advisory Board for Artificial Intelligence of the Spanish Government (Board Member), 2020–
– OECD-UNESCO Global Partnership on Artificial Intelligence (Member of the Expert Group), 2021–
– UNICEF Frontier Data (Adviser to the Chief Scientist
– WHO COVID-19 Contact Tracing Guideline Development Group (Member), 2021–2022
– WHO Public Health Surveillance for COVID-19 (Member), 2022
– WHO Infection Prevention and Control Guidance Development Group (Observer), 2022

Chien, Samson
– Ethics Committee of the MPI for Human Development (Member)

Ciranka, Simon
– Max Planck UCL Centre for Computational Psychiatry and Ageing Research (Fellow)

Cummins, Stephen
– Scientific Staff Committee of the MPI for Human Development (Member), 2019–2023

Czienskowski, Uwe
– Ethics Committee of the MPI for Human Development (Member)

Dahl, Martin J.
– The Alzheimer's Association International Society to Advance Alzheimer's Research and Treatment (ISTAART) (Representative), 2020–
– Ethics Committee of the MPI for Human Development (Member), 2020–

Deffner, Dominik

– Association of Early-career Social Learning Researchers (ESLR), 2018–2022
Domberg, Andreas
– Ethics Committee of the MPI for Human Development (Member)

Domberg, Andreas
– Ethics Committee of the MPI for Human Development (Member)

Einhorn, Maria
– Equal Opportunities Representative of the MPI for Human Development, 2022–
– Content Marketing Forum (Jury Member), 2020–

Engelhardt, Nicole
– Research Data Management Group of the MPI for Human Development (Member), 2018–

Fandakova, Yana
– Ethics Committee of the MPI for Human Development (Member), 2017–2020
– Gender Equality Officer of the MPI for Human Development, 2020–2022
– Mind, Brain, and Education (Associate Editor), 2021–
– Developmental Science (Editorial Board Member), 2022–

Fleischhut, Nadine
– Ethics Committee of the MPI for Human Development (Member)

Frevert, Ute
– Berlin-Brandenburg Academy of Sciences and Humanities (Member of the Council)
– British Academy for the Humanities and Social Sciences, London (Corresponding Fellow)
– Einstein Forum, Potsdam (Advisory Board)
– Forum Transregionale Studien (Board of Trustees)
– Foundation German-Israeli Future Forum (Board of Trustees)
– German National Academy of Sciences Leopoldina (Member of the Presidium)
– Historisches Kolleg (Board of Trustees)
– Institute for Human Sciences, Vienna (Advisory Board)
– International Max Planck Research School for Moral Economies of Modern Societies (Principal

Investigator and Spokesperson), 2013–2020
– Körber Foundation (Board of Trustees)
– Leopoldina Centre for Science Studies (Member of the Scientific Advisory Board)
– Leuphana University of Lüneburg, Bachelor Program Liberal Education/Studium Individuale (Advisory Board)
– Max Weber Foundation (President)
– Research Initiative "ConTrust: Trust in Conflict – Political Life under Conditions of Uncertainty", Goethe University Frankfurt am Main (Advisory Board)
– Society for the History of Emotions (Council Member)
– University Council Konstanz (Chairperson)
– Van Leer Jerusalem Institute, Israel (Board of Trustees)
– Working group for Modern Social History (Member)
– Emotions and Society (Editorial Advisory Board)
– Emotions in History, Oxford University Press series (Co-Editor)
– European Studies Review (Advisory Board)
– Geschichte und Gesellschaft. Zeitschrift für Historische Sozialwissenschaft (Co-Editor/Managing Director)
– Historical Journal, Cambridge University Press (Advisory Board)
– Journal of Contemporary History (Advisory Board)
– Journal of Modern History (Advisory Board)
– L'Homme: Zeitschrift für Feministische Gesellschaftswissenschaft (Advisory Board)
– Sensibilités. Histoire, critique & sciences sociales (Advisory Board)

Garrett, Douglas D.
– International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH) (Faculty Member)
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– Max Planck UCL Centre for Computational Psychiatry and Ageing Research (Fellow)
– Scientific Staff Committee of the MPI for Human Development (Member), 2014–2020

Gigerenzer, Gerd
– ALLEA (All European Academies) (Member, Expert Committee, “Democracy in a Digital Society Task Force”)
– American Institute for Behavioral Research and Technology (AIBRT) (Scientific Advisory Board)
– Berlin-Brandenburg Academy of Sciences (Member, “Zukunft der Medizin,” Interdisciplinary Working Group [IAG])
– BERLIN.MINDS (Advisory Board)

– Board of the APS Policies (Advisory Committee of International Scholars)
– Centro de Investigación Avanzada en Educasión, Universidad de Chile, Santiago (International Scientific Committee)
– DVFA (Deutsche Vereinigung für Finanzanalyse und Asset Management) (Member, Ethics Panel)
– European Society for Philosophy and Psychology (ESPP) (Advisory Board)
– European Research Council (Scientific Council), 2020–
– Ethikverband der deutschen Wirtschaft (EDW) (Advisory Board), 2020–
– Federal Ministry of Education and Research, "Recht und Ethik," Lernende Systeme—die Plattform für Künstliche Intelligenz (Member)
– Frankfurt Big Data Lab, Goethe University Frankfurt am Main (Associated Faculty), 2020–
– German National Academy of Sciences Leopoldina, Task Force "Wissenschaft, Öffentlichkeit und Medien" (Member)
– Herbert Simon Society (President)
– International Union of Psychological Science (Member, Jury for the Major Advancement in Psychological Science Award)
– Scientific Council of the European Research Council (Member), 2020–
– Summer Institute on Bounded Rationality, Berlin (Co-Director)
– Technical University of Munich (Advisory Board, "Risk and Security")
– www.unstatistik.de, Unstatistik des Monats (False statistics of the month), with T. K. Bauer & W. Krämer (Co-Author)
– Yidan Prize for Educational Research (Jury Member), 2019–2020
– Decision (Editorial Board)
– Industrial and Corporate Change on Macroeconomics and Development, yearly special issue (Senior Editorial Board), 2020–
– International Journal of Psychology (Editorial Board)
– Journal of Behavioral Decision Making (Editorial Board)
– Psychological Inquiry (Editorial Board)
– Theory & Psychology (Co-Editor)

Grossmann, Shany
– Ethics Committee of the MPI for Human Development (Contributing Member), 2021–2022

Hall-McMaster, Sam
– Max Planck UCL Centre for Computational Psychiatry and Ageing Research (Fellow)
– Ethics Committee of the MPI for Human Development (Contributing Member), 2021–2022

Haux, Lou

– Research Data Management Group of the MPI for Human Development (Member), 2020–

Hedrich, Noa Louise

– Sustainability at Work Committee of the MPI for Human Development (Co-chair), 2023–
– ECN student representative, 2023–

Hertwig, Ralph

– Association for Psychological Science (Fellow)
– Consumer Research Network, Federal Ministry of Justice and Consumer Protection (Member), 2020–
– Excellence Cluster "Science of Intelligence", funded by the German Science Foundation (Principal Investigator)
– German National Academy of Sciences Leopoldina, Ad Hoc Committee on the Corona Virus (Medicine) (Member), 2020–2021
– German National Academy of Sciences Leopoldina, Section 26 "Psychology and Cognitive Sciences" (Member)
– German National Academy of Sciences Leopoldina, Scientific Commission "Individual Action —Societal Consequences" (Individuelles Handeln—Gesellschaftliche Konsequenzen) (Member)
– German National Academy of Sciences Leopoldina, Task Force "Digizitation and Democracy" (Digitalisierung und Demokratie) (Member)
– International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH) (Faculty Member)
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– Leibniz-Science Campus Primate Cognition (Advisory Board)
– Max Planck School of Cognition (Faculty Member)
– Max Wertheimer Minerva Center for Cognitive Processes and Human Performance, Haifa (Advisory Board)
– MobileMed: Mobile Consultation and Learning System (Advisory Board)
– National Academy of Science and Engineering acatech (Member), 2021–
– Steering Committee JRC Report Enlightenment 2.0 (Member)
– Steering Committee of the DFG Priority Program "New Frameworks of Rationality" (Member)
– Summer Institute on Bounded Rationality, Berlin (Co-Director)
– Wilhelm Wundt Society (Elected Member)
– Experimental Psychology (Editorial Board)
– Journal of Behavioral Decision Making (Editorial Board)
– Thinking & Reasoning (Editorial Board)

Herzog, Stefan

– Research Data Management Group of the MPI for Human Development (Member)

Hille, Maike

– Research Data Management Group of the MPI for Human Development (Member), 2021–

– Sustainability at Work Committee of the MPI for Human Development, 2022–

Jayles, Bertrand

– Scientific Staff Committee of the MPI for Human Development (Member), 2018–2020

Jones, Angela

– Max Planck Society PhDnet (Executive Representative of the MPI for Human Development), 2019–2020

Kämmer, Juliane E.

– Working Group “Progress Test Medizin,” Charité Universitätsmedizin Berlin (Head Research Scientist), 2016–2020

Kleemeyer, Maike

– Research Data Management Group of the MPI for Human Development (Member), 2021–

Kloosterman, Niels A.

– Scientific Staff Committee of the MPI for Human Development (Member), 2020–2022

Köbis, Nils C.

– Interdisciplinary Corruption Research Network (Co-founder)

– Kickback – The Global Anti-Corruption Podcast (Co-host)

– Research Data Management Group of the MPI for Human Development (Member), 2020–

Köhncke, Ylva

– International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH) (Faculty Member), 2018–2023

Konovalova, Elizaveta
– Sustainability at Work Committee of the MPI for Human Development (Member), 2019–2020

Kruse, Imke
– Research Data Management Group of the MPI for Human Development (Member)

Kühn, Simone
– Max Planck UCL Centre for Computational Psychiatry and Ageing Research (Fellow)
– German National Academy of Sciences Leopoldina (Member)
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH) (Faculty Member)
– Ombudsperson of the MPI for Human Development to secure the Max Planck Society'sguidelines on "Good scientific practice and procedures for handling misconduct and fraud in science, 2021–

Lau, Sebastian
– Ausbildungsverbund Fachinformatik Berlin—afib (Coordinator), 2016–2020
– Research Data Management Group of the MPI for Human Development (Member), 2018–2020

Laube, Corinna
– Representative of the MPIB in the Human Science Section of the MPG, 2018–2020

Laukötter, Anja
– Internet Portal "History of Emotions—Insights into Research" (Co-Editor)
– Research group "The healthy self as body capital: Individuals, market-based societies, and body politics in visual twentieth century Europe" (Co-Director), 2016–2021

Lindenberger, Ulman
– Advisory Committee of CIFAR Child & Brain Development Research Program, Canadian Institute for

Advanced Research (Member)
– Academia Europaea (Member)
– Alexander von Humboldt Foundation (Fellow)
– American Psychological Association (Fellow, Div. 20)
– Association for Psychological Science (Fellow)
– Behavioral Genetics Association (Fellow)
– Berlin School of Mind and Brain (Faculty Member)
– CARINA Stiftung (Board of Trustees)
– C. L. de Carvalho-Heineken Prize for Cognitive Science (Jury Member), 2016–2020
– Cognitive Neuroscience Society (Fellow)
– German Research Foundation (Member of the Selection Committee for the Gottfried Wilhelm Leibniz Prize), 2017–2022
– German National Academy of Sciences Leopoldina, Section 26 “Psychology and Cognitive Sciences” (Member)
– Gerontological Society of America (Fellow)
– GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry (Editorial Board)
– International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH) (Berlin Speaker)
– International Max Planck Research School on the Life Course (LIFE) (Berlin Speaker)
– International Union of Psychological Science (Jury Member of the Lifetime Career Award), 2017–2022
– International Journal of Behavioral Development (Editorial Board)
– Jacobs Foundation, Zurich (Board of Trustees)
– Margret M. and Paul B. Baltes Foundation for the Advancement of Research in Developmental Psychology and Gerontology (Board Member)
– Max Planck School of Cognition (Faculty Member), 2019–2021
– Max Planck Society, Human Science Section (Vice President), 2020–2023
– Minerva Stiftung (Scientific Managing Director), 2020–
– Royal Swedish Academy of Sciences, Class for Social Sciences (Foreign Member), 2023–
– Wilhelm Wundt Society (Deputy Chair)
– Aging, Neuropsychology, and Cognition (Editorial Board)
– GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry (Editorial Board)
– International Journal of Behavioral Development (Editorial Board)
– Journal of Experimental Psychology: General (Contributing Editor)
– Neuroscience & Biobehavioral Reviews (Editorial Board)
– Psychology and Aging (Editorial Board)
– Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie (Advisory Board)

Lorenz-Spreen, Philipp

– Ethics Committee of the MPI for Human Development (Member), 2020–

Löwe, Anika

– Sustainability at Work Committee of the MPI for Human Development (Member), 2019–2020

– COMP2PSYCH student speaker, 2020–

– PhD representatives of MPI for Human Development, 2021–

Mayer, Karl Ulrich

– Bundesbericht Wissenschaftlicher Nachwuchs (Chair of Advisory Board)

– Einstein Center on Demographic Diversity (Advisory Board), 2020–

– European Research Council, Panel SH 13, 2021–2022

– German National Academy of Sciences Leopoldina, Ad Hoc Committee on the Corona Virus (Societal Impact) (Member), 2020

– German National Academy of Sciences Leopoldina, Scientific Committee on Individual Behavior and Collective Consequences (Member), 2018–

– Graduate School Dynamics of Demography, Democratic Processes and Public Policy, Humboldt-Universität zu Berlin (Member of Advisory Board), 2019–

– German National Academy of Sciences Leopoldina, Scientific Committee on Demographic Change (Member)

– H-ITS-Heidelberg Institute for Theoretical Studies (Member of the Board of Trustees)

– Leibniz Institute for Educational Trajectories (Chair of Scientific Advisory Board), 2019–2022

– Mercator Science-Policy Fellowship-Program, Goethe University Frankfurt am Main, Johannes Gutenberg University Mainz, and Technische Universität Darmstadt (Advisory Board)

– New York University Abu Dhabi (Tenure Committee), 2018, 2020

– NORFACE Research Program on Dynamics of the Life Course (Advisory Board)

– Swedish Academy of Sciences, Evaluation Committee for the Linnaeus Center of Excellence (Member), 2020

– Swedish Research Council, Assessment Committee Centers of Excellence, 2023

– The Emperor Otto Prize, City of Magdeburg (Selection Committee)

– University of Potsdam (Advisory Board Bund-Länder-Programme)

– University of Potsdam (Advisory Board Excellence Initiative)

Mikulová, Soňa

– Sustainability at Work Committee of the MPI for Human Development (Member)

Moine, Caroline
– Le Temps des Médias. Revue d'histoire (Editorial Board)
– Revue d'histoire Culturelle (Editorial Board), 2021–
– SYMPOSIUM. Culture@Kultur (Co-Editor)

Moneta, Nir
– PhD representatives of MPI for Human Development, 2021–

Nix, Sebastian
– German Library Association, commission for customer-oriented services (Member), 2015–2021
– Group of speakers of the MPS information professionals (Member)
– MPDL Advisory Board (Member)
– Research Data Management Group of the MPI for Human Development (Member)

Oberländer, Alexandra
– Kritika: Explorations in Russian and Eurasian History (Associate Editor)

Oña, Linda S.
– Ethics Committee of the MPI for Human Development (Member), 2019–2021

Pachur, Thorsten
– Decision (Editorial Board)
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member), 2022
– International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COMP2PSYCH) (Faculty Member), 2022
– Journal of Behavioral Decision Making (Editorial Board)
– Journal of Experimental Psychology: Applied (Consulting Editor)
– Journal of Experimental Psychology: Learning, Memory, and Cognition (Consulting Editor)

Pahl, Kerstin Maria
– Die Junge Akademie at Berlin-Brandenburg Academy of Science and Humanities and the German National Academy of Sciences Leopoldina (Board Member)

Peikert, Aaron

– Research Data Management Group of the MPI for Human Development (Member), 2020–

Pernau, Margrit

– Berlin Graduate School Muslim Cultures and Societies, Freie Universität Berlin (Principal Investigator)
– Freie Universität Berlin, MA Global History (Faculty Member)
– Freie Universität Berlin (Extraordinary Professor)
– German Historical Institute London (Advisory Board)
– History of Concepts Group (Executive Board Member and Vice Chair)
– India Branch Office of the Max Weber Foundation, Delhi (Chair of the Advisory Board)
– History of Concepts Group (Vice Chair)
– International Advisory Board of the Project "The 20th Century in Basic Concepts. A Dictionary of Socio-Political and Cultural Semantics in Germany", Leibniz-Zentrum für Literatur- und Kulturforschung (Member), 2021–
– International Max Planck Research School for Moral Economies of Modern Societies (Principal Investigator), 2019–2020
– Internet Portal “History of Emotions—Insights into Research” (Co-Editor)
– Series “Globalgeschichte: Theorien, Ansätze, Themen” (Co-Editor)
– Sindhu: An Interdisciplinary Journal of South Asian Studies (Editorial Board)
– The Historian - Research Journal (Government College, Lahore) (Advisory Board)
– The History of Concepts Group (HCG) (Executive Board Member)
– Contributions to the History of Concepts (Co-Editor)
– Geschichte und Gesellschaft. Zeitschrift für Historische Sozialwissenschaft (Editorial Board)

Petzka, Marit

– Ethics Committee of the MPI for Human Development (Contributing Member), 2022–

Raffington, Laurel

– Equal Opportunities Representative of the MPI for Human Development, 2022–
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)

Rahwan, Iyad

– Council on Extended Intelligence, initiative of IEEE & MIT Media Lab (Member), 2018–2020–
Institute for the Development of Internet, Spain (Scientific Advisory Board)

– Artificial Intelligence (Editor), 2017–2020
– MIT Technology Review (Arabic edition) (Advisory Board), 2018–2020

Raz, Naftali
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)

Reiber, Lisa
– Research Data Management Group of the MPI for Human Development (Member), 2018–2020

Rioux, Camille
– Scientific Staff Committee of the MPI for Human Development (Member), 2017–2022
– Sustainability at Work Committee of the MPI for Human Development (Member), 2019–2022

Ruggeri, Azzurra
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– Opportunity Awards Advisory Panel, James S. McDonnell Foundation (Board Member), 2022

Sander, Myriam C.
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– Representative of the Institute’s Scientific Staff for the Scientific Council (Arts and Humanities Section) of the Max Planck Society, 2020–2023

Schröer, Frederik
– Contributions to the History of Concepts (Social Media Editor), 2017–2021
– Contributions to the History of Concepts (Book Review Editor), 2022–
– Sustainability at Work Committee of the MPI for Human Development (Member), 2019–

Schuck, Nicolas W.
– Bernstein Center for Computational Neuroscience Berlin (Member), 2021–
– Einstein Center Neurosciences, Berlin (Faculty Member)
– Ethics Committee of the MPI for Human Development (Member)
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)

– International Max Planck Research School of Computational Psychiatry and Ageing Research (COMP2PSYCH) (Faculty Member)
– Max Planck UCL Centre for Computational Psychiatry and Ageing Research (Fellow), 2021–
– Memory Disorders Research Society (Member), 2022–
– Research Data Management Group of the MPI for Human Development (Member), 2018–2021
– Organising Committee Cognitive Computational Neuroscience Conference (Member), 2023
– Neuropsychologia (Guest Editor), 2019–2020
– Oxford Open Neuroscience (Associate Editor), 2022–

Schulze, Christin
– Equal Opportunities Representative of the MPI for Human Development, 2020–2020
– International Max Planck Research School on the Life Course (Faculty Member)
– Journal of Cognition (Editorial Board Member), 2022–

Schwarze, Sina
– Research Data Management Group of the MPI for Human Development (Member), 2021–

Spitzer, Bernhard
– Berlin School of Mind and Brain (Associated Member)
– Bernstein Center for Computational Neuroscience Berlin (Member), 2023–
– Einstein Center Neurosciences, Berlin (Faculty Member)
– International Max Planck Research School on Computational Methods in Psychiatry and Ageing Research (COM2PSYCH) (Faculty Member)
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– Research Data Management Group of the MPI for Human Development (Member), 2018–

Tiede, Kevin
– PostdocNet (External PhD Representative)

Thoma, Anna
– Research Data Management Group of the MPI for Human Development (Member), 2018–

Toyota, Mika

– Sustainability at Work Committee of the MPI for Human Development (Co-chair), 2023–

Wagner, Gert G.
– Association for Psychological Science (APS) (Member), 2023–
– Advisory Council for Consumer Affairs (Sachverständigenrat für Verbraucherfragen), German Ministry of Justice and Consumer Protection (BMJV) (Member), 2018–2022
– Ethics board of the European Social Survey; a European Research Infrastructure Consortium (ESS-ERIC) (Member)
– Federal Government's Commission on a "Reliable Intergenerational Contract" (Kommission Verlässlicher Generationenvertrag) (Member), 2018–2020
– German Federal Government's Social Advisory Council (Sozialbeirat der Bundesregierung) (Member)
– German Socio-Economic Panel Study (SOEP) (Senior Research Fellow)
– Interdisciplinary working group "Implications of Digitalization for the Quality of Science Communication" of the Berlin–Brandenburg Academy of Sciences and Humanities (BBAW) (Member), 2018–2021
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– IPD-Work Consortium (Member)
– National Academy of Science and Engineering (acatech) (Elected Member)
– Social Science Genetic Association Consortium (SSGAC) (Member)
– The Leibniz Association's Commission for Research Ethics (Member)
– Research Data Management Group of the MPI for Human Development (Member), 2018–
– PLOS ONE (Editorial Board)

Wambach, Julia
– Sustainability at Work Committee of the MPI for Human Development (Member), 2019–

Wegwarth, Odette
– BMBF project "Preference of elderly people presenting with multimorbidity: An evidence map and systematic review," Goethe University Frankfurt am Main, Institute for General Medicine (Scientific Advisory Board), 2018–2021
– G-BA-Innovationsfond–Project "ERIC: Enhanced recovery after intensive care," Charité Universitätsmedizin Berlin, Department of Anesthesiology/Division of Operative Intensive Care Medicine (Scientific Advisory Board), 2019–2022
– World Health Organization (WHO)/Regional Office Europe (Invited Expert for the WHO initiative on improving policy decision-making on screening)

– Scientific Reports (Editorial Board)

Werkle-Bergner, Markus
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– International Max Planck Research School on Computational Psychiatry and Aging Research (COMP2PSYCH) (Faculty Member)
– Representative of the Institute’s Scientific Staff for the Scientific Council (Arts and Humanities Section) of the Max Planck Society, 2023–

Wertz, Annie E.
– APA Handbook of Evolutionary Psychology (Associate Editor), 2021–
– Evolution and Human Behavior (Consulting Editor)
– Human Nature (Consulting Editor), 2020–
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member)
– Leipzig Centre for Early Child Development (LFE) (Affiliate)
– Psychological Inquiry (Editorial Board Member), 2022–

Wittkuhn, Lennart
– Ethics Committee of the MPI for Human Development (Contributing Member), 2022–
– Research Data Management & Open Science Working Group at MPIB (Contributing Member), 2021–

Wulff, Dirk
– International Max Planck Research School on the Life Course (LIFE) (Faculty Member), 2023–

Verra, Luianta
– Sustainability at Work Committee of the MPI for Human Development (Co-chair), 2023–

Yizhar, Or
– Ethics Committee of the MPI for Human Development (Member), 2022–

Zika, Ondrej

– Max Planck UCL Centre for Computational Psychiatry and Ageing Research (Fellow)
– International Journal for Psychophysiology (Guest Editor), 2021–2022

Professorship Offers 2020–2022/23

Last update: August 2023
(Labeled in accordance with the US system)

Alnaes, Dag Full Professor of Psychology, Kristiania University College, Oslo, Norway, 2022 (accepted).

Allan, Jinan N. Assistant Professor of Psychology, Clemson University, USA, 2023 (accepted).

Barua, Rukmini Assistant Professor of South Asian History, York University, Toronto, Canada, 2023 (accepted).

Brandmaier, Andreas M. Associate Professor of Psychology, Leipzig University, Germany, 2020 (declined); Full Professor of Psychology, MSB Medical School Berlin, Germany, 2021 (accepted).

Brauer, Juliane Full Professor of History Didactics, University of Hildesheim, Germany, 2020 (accepted); Full Professor of History and its Didactics, University of Wuppertal, Germany, 2021 (accepted).

Buscemi, Francesco Assistant Professor of History of Government & Politics in Modern Times, University of Groningen, Netherlands, 2021 (accepted).

Deserno, Marie Full Professor of Clinical Psychology, University of Amsterdam, Netherlands, 2021 (accepted).

Fandakova, Yana Assistant Professor of Psychology, Cardiff University, UK, 2021 (declined); Associate Professor of Psychology, Universität Trier, Germany, 2022 (accepted).

Gammerl, Benno Full Professor of History of Gender and Sexuality, European University Institute, Fiesole, Italy, 2020/21 (accepted).

Gollwitzer, Anton Assistant Professor of Psychology, Norwegian Business School (BI), Oslo, Norway, 2022 (accepted).

Grüneisen, Sebastian Assistant Professor, Leipzig University, Germany, 2021 (accepted).

Hong, Inho Assistant Professor of Computational Science, Chonnam National University, Gwangju, South Korea, 2023 (accepted).

Hitzer, Bettina Full Professor of History of Medicine, Julius-Maximilians-Universität Würzburg

(JMU), 2023 (declined).

Hu, Jiejun Assistant Professor of Computer Science, Lancester University in Leipzig, Germany, 2022 (accepted).

Klockmann, Victor Junior Professor of Microeconomics, Julius-Maximilians-Universität Würzburg (JMU), Germany, 2022 (accepted).

Konovalova, Elisaveta Associate Professor of Behavioral Science, Warwick Business School, UK, 2020 (accepted).

Köbis, Nils Full Professor of Engineering, University of Duisburg-Essen, Germany, 2023 (accepted).

Laube, Corinna Full Professor of Psychology, Hochschule Fresenius University of Applied Sciences, Hamburg, Germany, 2020 (accepted).

Laukötter, Anja Full Professor of Cultural History, Friedrich Schiller University Jena, Germany, 2021 (accepted).

Malone, Hannah Assistant Professor of Contemporary History, University of Groningen, Netherlands, 2021 (accepted).

Månsson, Kristoffer N.T. Associate Professor of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden, 2022 (accepted).

Moine, Caroline Full Professor of Cultural and Political History in Modern Times, Université of Paris-Saclay, France, 2022 (accepted).

Pachur, Thorsten Full Professor of Behavioral Research Methods, Technical University of Munich, Germany, 2022 (accepted).

Pahl, Kerstin Maria Visiting Professor of History, Humboldt-Universität zu Berlin, Germany, 2023 (accepted).

Pescetelli, Niccolò Assistant Professor of Cyberpsychology, New Jersey Institute of Technology, USA, 2021 (accepted).

Ruggeri, Azzurra Full Professor of Cognitive Science, Central European University, Vienna, Austria, 2022 (accepted); Full Professor of Cognitive and Developmental Psychology, Technical University of Munich (TUM), Germany, 2023 (accepted).

Sarioğlu, Esra Assistant Professor of Sociology, University of Virginia, USA, 2023 (accepted).

Schuck, Nicolas W. Full Professor of Learning and Change Mechanisms, Universität Hamburg, Germany, 2022 (accepted).

Schulze, Christin Assistant Professor of Computational Cognitive Science, University of New South Wales, Australia, 2022 (accepted).

von Schenk, Alicia Junior Professor of Applied Microeconomics, Julius-Maximilians-Universität

Würzburg (JMU), Germany, 2022 (accepted).

Wegwarth, Odette Full Professor of Medical Risk Literacy & Evidence-Based Decision-Making, Charité Universitätsmedizin Berlin, Germany, 2020 (accepted).

Wenger, Elisabeth Full Professor of Developmental Psychology, HMU Health and Medical University, Potsdam, Germany, 2023 (accepted).

Wertz, Annie E. Associate Professor of Psychology, Brunel University London, UK, 2022 (declined); Assistant Professor of Developmental and Evolutionary Psychology, University of California, Santa Barbara, USA, 2023 (accepted).

Woike, Jan K. Assistant Professor of Psychology, University of Plymouth, UK, 2020 (accepted).

Ying, Li Assistant Professor of Psychology, Chinese Academy of Sciences, Beijing, China, 2022 (accepted).

Where Have Our Researchers Gone? New Positions 2020-2022/23

Last update: August 2023

Researchers/Research Scientists

Alneas, Dag 2022, Kristiania University College, Oslo, Norway, Full Professor

Arslan, Ruben C. 2021, Leipzig University, Germany, Researcher

Barua, Rukmini 2023, York University, Toronto, Canada, Assistant Professor

Brauer, Juliane 2020, University of Hildesheim, Germany, Full Professor; 2021, University of Wuppertal, Germany, Full Professor

Buscemi, Francesco 2021, University of Groningen, Netherlands, Assistant Professor

Cebrian, Manuel 2022, Universidad Carlos III de Madrid, Spain, Distinguished Researcher

Dallacker, Mattea 2022, German Federal Foreign Office, Berlin, Germany, Researcher

Dandekar, Deepra 2020, Leibniz-Zentrum Moderner Orient (ZMO), Berlin, Germany, Postdoctoral Fellow

Debbeler, Luka J. 2021, Charité Universitätsmedizin Berlin, Germany, Research Scientist

Düzel, Sandra 2022, Charité Universitätsmedizin Berlin, Germany, Research Scientist

Driver, Charles 2021, University of Zurich, Switzerland, Research Scientist

Fandakova, Yana 2022, Trier University, Germany, Full Professor

Hitzer, Bettina 2021, Technische Universität Dresden, Germany, Heisenberg Professor; 2022, Otto von Guericke Universität Magdeburg, Heisenberg Professor

Kämmer, Juliane 2020, University of Bern, Switzerland, Research Scientist

Lämmert, Stephanie 2022, Humboldt-Universität zu Berlin, Germany, Substitute Professor

Laukötter, Anja 2021, Friedrich Schiller University Jena, Germany, Full Professor

Malone, Hannah 2021, University of Groningen, Netherlands, Assistant Professor

Moine, Caroline 2022, Université de Versailles Saint-Quentin-en-Yvelines, Germany, Full Professor

Pachur, Thorsten 2022, Technical University of Munich [TUM], Germany, Full Professor

Pescetelli, Niccolò 2021, New Jersey Institute of Technology, USA, Assistant Professor

Schnädelbach, Sandra 2021, Heinrich Heine University Düsseldorf, Germany, Researcher

Schulze, Christin 2023, University of New South Wales, Sydney, Australia, Professor

Wegwarth, Odette 2021, Charité Universitätsmedizin Berlin, Germany, Full Professor

Willems, Yayouk E. 2023, Michigan State University, East Lansing, USA, Research Scientist
Wenger, Elisabeth 2023, HMU Health and Medical University, Potsdam, Germany, Full Professor
Wertz, Annie E. 2024, University of California, Santa Barbara, USA, Assistant Professor
Woike, Jan K. 2020, Plymouth University, UK, Assistant Professor

Postdoctoral Fellows

Allan, Jinan N. 2023, Clemson University, USA, Assistant Professor
Bähr, Marvin 2020, Leibniz Association, Berlin, Germany, Senior Research Manager
Bassett, Jason 2022, Robert Koch Institute, Berlin, Germany, Data Engineer
Beese, Caroline 2021, University of Vienna Austria, Postdoctoral Fellow
De Boer, Lieke 2021, eScience Center Amsterdam, Netherlands, Scientific Community Manager
Deserno, Marie 2021, University of Amsterdam, Netherlands, Assistant Professor
Domberg, Andreas 2022, The Flying Squirrel, Berlin, Germany, Freelance Data Scientist
Ferreira, Leonardo N. 2022, University of Oxford, UK, Senior Postdoctoral Researcher
Hall-McMaster, Sam 2023, Universität Hamburg, Germany, Postdoctoral Fellow
Gollwitzer, Anton 2022, Norwegian Business School (BI), Oslo, Norway, Assistant Professor
Grüneisen, Sebastian 2021, Leipzig University, Germany, Assistant Professor
Hong, Inho 2023, Chonnam National University, Gwangju, South Korea, Assistant Professor
Hu, Jiejun 2021, Lancester University Leipzig, Germany, Assistant Professor
Jayles, Bertrand 2021, EDHEC Business School Singapore Campus, Singapore, Postdoctoral Fellow
Karlsson, Anna 2022, Humboldt-Universität zu Berlin, Germany, Postdoctoral Fellow
Klockmann, Victor 2022, Julius-Maximilians-Universität Würzburg (JMU), Germany, Junior Professor
Kloosterman, Nils 2022, Universität zu Lübeck, Germany, Lecturer
Koch, Christoph 2023, Universität Hamburg, Germany, Postdoctoral Fellow
Konovalova, Elisaveta 2020, Warwick Business School, The University of Warwick, UK, Assistant Professor
Köhncke, Ylva 2022, DGVT Ausbildungsakademie Berlin, Germany, Psychotherapy Trainee
Kosciessa, Julian 2022, Donders Institute for Brain, Cognition and Behaviour at Radboud University, Nijmegen, Netherlands, Postdoctoral Fellow
Laube, Corinna 2020, Hochschule Fresenius, Berlin, Germany, Dean
Leuker, Christina 2020, Robert Koch Institute, Berlin, Germany, Researcher
Lieth, Julia 2022, Aurelia Stiftung, Berlin, Germany, Press and Public Relations Officer
Lin, Ziyong 2021, Amazon Berlin, Germany, Behavioral Scientist
Linde-Domingo, Juan 2023, University of Granada, Spain, Assistant Professor
Lindner, Thomas 2021, University of Rostock, Germany, Researcher
Månsson, Kristoffer N.T. 2020, Karolinska Institutet, Stockholm, Sweden, Associate Professor
Moine, Caroline 2022, Université Paris-Saclay, France, Full Professor

Mühlroth, Beate 2020, Bundespsychotherapeutenkammer (BPtK), Berlin, Germany, Research Scientist

Oña, Linda S. 2023, Universität Leipzig, Germany, Postdoctoral Fellow

Patil, Indrajeet 2021, esqLABS GmbH, Saterland, Germany, Software Engineer and Data Scientist

Perry, Alistair 2020, Cambridge Centre for Frontotemporal Dementia and Related Disorders, UK, Postdoctoral Fellow

Petzka, Marit 2023, Universität Hamburg, Germany, Postdoctoral Fellow

Polk, Sarah 2023, Deutsches Zentrum für Neurodegenerative Erkrankungen, Magdeburg, Germany, Postdoctoral Fellow

Ren, Xiangjuan 2023, Universität Hamburg, Germany, Postdoctoral Fellow

Rioux, Camille 2022, Université Paris Cité, France, Postdoctoral Fellow

Satarifard, Vahid 2023, Yale University, USA, Postdoctoral Fellow

Schlegelmilch, Karola 2023, Leipzig University, Germany, Researcher

Sommer, Verena 2021, LBD-Beratungsgesellschaft, Berlin, Germany, Data Scientist

Teng, Xiangbin 2021, Freie Universität Berlin, Germany, Postdoctoral Fellow

Thomas, Armin 2022, Stanford University, USA, Postdoctoral Fellow

von Schenk, Alicia 2022, Julius-Maximilians-Universität Würzburg (JMU), Germany, Junior Professor

Waschke, Leo 2023, Federal Ministry of Education and Research (BMBF), Berlin, Germany, Consultant

Wittkuhn, Lennart 2023, University of Hamburg, Germany, Postdoctoral Fellow

Ying, Li 2022, Chinese Academy of Sciences, Beijing, China, Assistant Professor

Zhang, Jason S. 2021, ASOS, London, UK, Machine Learning Scientist

Zilker, Veronika 2022, Technical University of Munich [TUM], Germany, Postdoctoral Fellow

Predoctoral Fellows

Kobelt, Malte 2020, Ruhr-Universität Bochum, Germany, Predoctoral Fellow

Reiber, Lisa 2021, Citizens for Europe, Berlin, Germany, Researcher

Russell, Connair J. S. 2022, Queen's University Belfast, UK, Postdoctoral Fellow

Yahosseini, Kyanoush S. 2020, Robert Koch Institute, Berlin, Germany, Software Developer

Scientific Advisory Board 2020-2022/23

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University of Zurich, Switzerland (until 2021)

Jonas Obleser (Chair)

Universität zu Lübeck, Germany (as of 2022)

David C. Parkes

Harvard University, Cambridge, USA

Klaus Rothermund

Friedrich Schiller University Jena, Germany (as of 2022)

Katherine Schofield

King's College London, UK

Michael R. Waldmann

University of Göttingen, Germany

Anita Williams Woolley

Carnegie Mellon University, Pittsburgh, USA