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**Eye-Tracking as a Method
for Legal Research**

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Abstract

Legal research is a repeat offender – in the best sense of the term – when it comes to making use of empirical and experimental methods borrowed from other disciplines. We anticipate that the field’s response to developments in eye-tracking research will be no different. Our aim is to aid legal researchers in the uptake of eye-tracking as a method to address questions related to cognitive processes involved in matters of law abidance, legal intervention, and the generation of new legal rules. We discuss methodological challenges of empirically studying thinking and reasoning as the mechanisms underlying behavior, and introduce eye-tracking as our method of choice for obtaining high-resolution traces of visual attention. We delineate advantages and challenges of this methodological approach, and outline which concepts legal researchers can hope to measure with a toy example. We conclude by outlining some of the various research avenues in legal research for which we predict a benefit from adopting eye-tracking to their methodological toolbox.

Keywords: methods, eye-tracking, cognition, process tracing

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I. Introduction

The law is a methodological omnivore. Whatever theoretical or empirical approach is out there, there will be a legal scholar employing it. There is the old tradition of law and philosophy (see only Dworkin 1977), or law and history (see e.g. Baker 2019), or the more recent fields of law and society (read sociology, Friedman 1986), law and economics (Posner 2014), law and political science (for instance adopting an international relations perspective on public international law (Dunoff and Pollack 2013)). Same on the empirical side: there is the empirical legal movement (Eisenberg 2011, in particular borrowing from the focus of the social sciences on identification problems (see e.g. Frakes and Jena 2016)), law and computer science (in particular capitalizing on the power of machine learning to discern patterns in large datasets (e.g. Choi 2022)), and the experimental traditions building a bridge to experimental economics (e.g. Engel 2015) and psychology (e.g. Simon 2004).

The willingness of the law to embrace a broad spectrum of paradigms and methods as they become available and accessible should not come as a surprise. Much like engineering or medicine, at its core the law is an applied field (Engel 2007). Even the most abstract contribution to the legal discourse is motivated by understanding, and often improving, the law as a technology for governing society. If this technology is put in action, sovereign powers are called upon. For the most part, these powers are only there as a potential. But all involved know that they can be activated. Society acts “in the shadow of the law” (Mnookin and Kornhauser 1979). As there is the potential of adjudication and enforcement, those applying the law engage not only moral, but legal authority. The individuals acting on behalf of the legal system must take on personal responsibility (Engel 2009).

The law is meant to address a set of problems of life that is not only rich. Very often these problems cut across conceptual paradigms (Engel 2009). Often, this means that there is no empirical method in sight that would perfectly match the research question. The law must content itself with partial insights from various conceptual or empirical vantage points, triangulating (parts of) answers to the questions at hand. If an additional method becomes available, it therefore almost necessarily promises valuable new insights and additional evidence for parts of the legal enterprise that, hitherto, had to be handled intuitively (Glöckner and Engel 2013), as no better option seemed to exist.

Eye-tracking is one such novel methodology, with a strong pedigree in cognitive psychology. It promises insights into the cognition and mental processes taking place to prepare or justify behaviors, and has pertinent applications to research projects related to the law. What do the subjects of the law think, while they decide how to behave? How do those enforcing the law come to their decision whether and how to intervene? Better understanding the nature of these mental processes would inform the legal debate around them. Given empirical and experimental groundwork, attempts to act on mental processes in the legal context could be based on tailored and empirically tested interventions. At the same time, the availability of eye-tracking data may give rise to a regulatory need.

While the method has clear appeal for legal research, it only very rarely has been embraced by the legal community. Among the research we have been able to locate, the contributions can loosely be clustered into four overarching categories:

A. Identifying differential patterns of eye-gaze as indicators of criminally relevant cognition

Eye-tracking has been used to observe if the accused's gaze patterns match those of patients with schizophrenia, to assess the validity of an insanity defense (Ales, Giromini et al. 2021). In another example, eye-tracking was used to observe preferential attention to sexualized stimuli to identify pedophile intentions in sexual offenders (Godet and Niveau 2021). Finally, eye-tracking has been employed in an exploratory study to make the decision-making process of 39 active shop-lifters visible (Jacques, Lasky et al. 2015).

B. Assessing the processes of cognitive errors relevant to the law

With eye-tracking, a small (N = 42) study showed that experts who viewed crime scene photos and could correctly identify the course of action took less time until they first fixated the critical stimulus than those who came to the wrong conclusion (Chang and Tsai 2022). Further, eye-tracking evidence suggested that there were no systematic differences in the gaze data of mock witnesses who correctly or falsely identified alleged perpetrators in police line-ups (Mansour and Flowe 2010).

C. Demonstrating the role of expertise in assessing material relevant to the law

Eye-tracking has been used to show that law enforcement experts are systematically more effective than students in spotting a lying witness (Bond 2008). Other eye-tracking evidence suggests that law students become experts in reading case reports (Cameron 2017), and that, with experience on the job, police officers get better at spotting visual cues of critical situations (Huhta, Di Nota et al. 2022).

D. Discussing matters of legal policy

Policy papers have used eye-tracking to assess if court-room television has detrimental effects on the conduct of justice (Lambert 2011). Other policy-relevant publications have called for legal protection against the commercial collection of eye-tracking data (Logan 2018).

Albeit an intriguing start for leveraging the promise of eye-tracking for legal research, much of the appeal of eye-tracking as an advanced methodology to illuminate cognitive processes remains unexplored by the legal community. On the one hand, where highly externally valid materials are used, this often is at the expense of the unambiguity with which insights about the mental processes can be generated. On the other hand, much of this research takes place without much reception or integration of formal theories of mental processes.

To aid the adoption of eye-tracking into the canon of methods at legal researchers' disposal, in this paper, we first explain what the method is able to make visible, and compare it to alter-

native methods. Essentially eye-tracking is a window into the mental process leading to judgment and decision-making. More specifically, eye-tracking generates precise, unobtrusive, and manipulation proof evidence about information retrieval and information processing. Thereafter, we offer hands-on advice on designing eye-tracking experiments for questions of experimental jurisprudence. In the fourth part of the paper, we sketch legal research questions that could benefit from such evidence. The potential for productive, eye-opening legal research using eye-tracking is substantial. First attempts at tapping into this potential look promising. The prospect for the emerging field of eye-tracking for law is bright.

II. Eye-Tracking and Its Methodological Siblings

To study mental processes involved in behavior related to the law, legal scholars can reach into the quiver of methods established in other areas of research aiming to uncover cognitive mechanisms. Deploying these methods requires keeping in mind the fit between the method, the research question and the boundary conditions of the empirical investigation, as well as methodological prerequisites and limitations.

A. Simply Asking: Introspective Reports as Data

A straight-forward and face-valid approach to learning about cognitive processes is to rely on retrospective introspective reports. Empirical legal scholars could ask the participants in their studies what they thought about while preparing a target behavior, or if they found a particular argument important, convincing or surprising. For instance, suppose we were interested in finding out why people commit petty theft. We may simply ask participants – say, a convenience sample of shoppers in a local grocery store – to rate a number of arguments in favor of or against stealing a particular item from the supermarket (e.g., “Stealing would help me save money” or “The shop owner would lose revenue”). On 7-point Likert scales (1 (not at all) to 7 (extremely so)), participants would indicate how much weight each of the arguments should have for the decision to steal or not to steal, how difficult they found it to understand the argument, to which degree the argument was ambiguous, and to which degree the argument was in conflict with other arguments.

Despite the obvious appeal of such an easy-to-implement way to measure cognitive processes, there are notable drawbacks to this method, which may render convincing interpretations of the responses difficult or even impossible. First, in particular in the legal context, strong normative or social expectations exist for what one *ought* to think (see Carbonara 2017). If respondents deviate from these expectations, they may be unwilling to reveal their actual cognitions and cognitive processes. For instance, in our example on motivations behind petty theft, we may ask participants to express how important it is to them that the store owner would suffer a financial loss because of the theft. Responding that the outcomes of the victim of the crime are irrelevant would contradict socio-normative expectations, such that respondents may overstate the importance they assign to this argument for the decision, to maintain a positive self- and social image.

Second, even if participants wanted to give accurate responses, it is possible that they may lack insight into their own cognitive processes (see Nisbett and Wilson 1977). This is particularly problematic when introspective reports are elicited post-hoc, after the target behavior has taken place, because respondents may reconstruct their cognitive processes based on their previous behavior. For instance, in our example on petty theft, suppose that we asked participants who had just committed petty theft to tell us about their reasoning steps while doing so. We may find participants only able to explain how they think *now* that they have made their decision already, unwittingly increasing the importance ratings of arguments supporting their decision.

Attempting to avoid measuring mere post-hoc reconstruction of cognitive processes leads empiricists towards a methodological fork in the road. Down one path lie attempts to draw inferences on cognition from behavioral outcomes, relying on as-if models of cognition and behavior. Down the other path lies process tracing, a portfolio of methods aiming to make the mental steps of reaching a behavioral outcome visible.

B. As-If Models: Inferring Cognition from Overt Behavior

Taking the route of as-if models, empiricists experimentally create conditions that produce distinguishable behavioral outcomes from which they attempt to construct which cognitive mechanisms may have been at play. In our example about petty theft, we may aim to study the importance of potential repercussions on the decision to commit petty theft. We could randomly assign participants to one of two experimental conditions inducing different perceived probabilities that a theft would be detected: Either participants shop in a store where clerks work on restocking the shelves, reflecting a low detection probability, or additional security staff is posted to increase the detection probability. We may observe that participants are more likely to steal in the low detection scenario, suggesting that petty thieves behave *as if* they believed it less likely to get caught. We may further observe that participants take longer to decide to steal in the high surveillance scenario, and reach the conclusion that they behaved *as if* they had to overcome the threat of detection before they could make their choice.

Such as-if models of the relation of cognition and behavior, however, are limited in the degree of detail with which they supply insights about the mental process. In our example above, the assumption that more stealing in the low detection scenario indicates that it is easier to steal when the threat of repercussions is mild may have merit. Yet it is but one of several possible explanations of the data: Other cognitive processes may similarly affect choices and decision times. For instance, shoppers may actually find increased surveillance indicative of higher-valued items in the store, which they may wish to locate rather than to simply grab a lower-valued item. Another plausible interpretation of the data might be that decisions under low threat of detection were quicker because shoppers were less uncertain about the decision situation, held fewer pieces of information in their working memory, were processing the information more intuitively, etc. In other words, a multitude of different cognitive mechanisms could drive response time differences, such that the meaningfulness of conclusions about cognition from behavioral outcomes is limited (see Berg and Gigerenzer 2010; Krajbich, Bartling et al. 2015).

To avoid such ambiguity, the cognitive process itself could be manipulated, for example by experimentally inducing variation in the importance participants assign to specific arguments in favor or against the target behavior. Regarding our example on petty theft, to manipulate the importance of the potential repercussions after getting caught stealing, we could ask one group of shoppers to list reasons why getting caught red-handed would be bad for them, while the other group of shoppers is cued to think about enjoying the spoils of their misdeeds. If we observe that theft differs between these conditions, we might conclude that this result is driven by differences in the importance assigned to negative vs. positive outcomes of theft.

However, by manipulating the cognitive process itself, we no longer observe the “pure” reasoning process behind deciding to steal in a scenario with low vs. high detection probability. Instead, we observe the reasoning process behind deciding to steal in a scenario with low vs. high detection probability, when shoppers are also cued to think about negative or positive outcomes of their misdeed. The manipulation of the cognitive process itself does not give us insight into the unperturbed cognitive mechanisms producing judgment (uncertainty principle, Heisenberg 1927). In some cases, the perturbations of the process may be acceptable and still yield interesting research results. Often, however, these perturbations again limit the interpretability and generalizability of the results.

C. Process Tracing Methods: Delivering Ex-Interim Evidence of the Cognitive Process

Taking the process tracing route aims to observe not only summary indicators of cognition, such as decision time, but to collect data about the cognitive process as it unfolds, while leaving the process largely unperturbed. The theoretical basis of this approach lies in general process models of choice formation, which often consider choice tasks with binary options. Sequential sampling models, which are increasingly used to describe decision processes and are preferred due to their ability to capture speed-accuracy trade-offs, depict the process of making a decision as the continuous acquisition of information about the choice options, until sufficient evidence supporting one option has been found (for an overview, see Ratcliff and Smith 2004). Other models of information acquisition processes, such as the attentional drift diffusion model (Cavanagh, Wiecki et al. 2014; Krajbich, Armel et al. 2010; Krajbich, Lu et al. 2012; Krajbich and Smith 2015), assume that attention to information increases its decision value. In several different types of decision situations, such models have been paired with utility theory, describing how individuals cross a threshold to making a decision, depending on their prior weighting of the alternatives.

A number of different techniques belonging to the broader category of process tracing methods are available to reveal this continuous weighting of available information (for a detailed overview, see Schulte-Mecklenbeck, Kuehberger et al. 2019). Below, we introduce their working mechanisms, advantages and drawbacks, while again entertaining our example on petty theft.

1. *Think-Aloud Protocols: Ex-Interim Introspection*

Applying a process-tracing twist on introspective reports, introduced and critiqued above, leads us to think-aloud protocols (Svenson 1974). This method asks respondents to verbalize their thoughts while they complete the target behavior. For example, in a study on petty theft, participants could be prompted to verbalize their thoughts about their shopping trip, while deliberating about their decision which items to buy, which ones to disregard, and which ones to steal.

Although the completeness and accuracy of such verbal reports may still be lacking, this method offers distinct advantages by eliciting responses at multiple points in time while the target behavior is prepared or takes place. First, because information about participants' cognitions is available at several points in time, it becomes possible to *trace* the cognitive process as it evolves. At any given point in time during the decision process, we know the current thought verbalization and can draw inferences about the cognitive process from them, giving us ex-interim evidence about the mental process (albeit at a relatively low resolution, capped by participants' speed of verbalizing). Second, respondents may find it more difficult to mask their actual thoughts, because of the concurrent effort required to continuously verbalize. This, however, also constitutes perhaps the most important drawback of think-aloud protocols: instead of only completing the target behavior, participants continuously interrupt the process of preparing and completing the target behavior by *also* completing their task to verbalize their thoughts. These interruptions, and possible alterations of the cognitive and behavioral processes in question, may therefore distort the processes themselves and the data obtained from them.

2. *Information Boards and MouseLab: Assessing Information Acquisition*

Techniques measuring the timing and sequence of information acquisition or revisiting by recording when hidden information is unveiled run into a similar problem. Such techniques hide information relevant to the target behavior behind covers that respondents can remove, either manually by lifting up sticky notes on so-called information boards (Payne 1976), or in computerized tasks (Payne, Bettman et al. 1988) via mouse-clicks (or mouse-overs) using software such as MouselabWEB (Willemsen and Johnson 2011). In our petty theft example, we may present shoppers with a computerized task where multiple grocery items, as well as defining attributes such as price, caloric value, resale value and product weight are made available, albeit hidden behind clickable boxes. The timing and count of their mouse clicks to reveal the hidden arguments could be recorded, indicating which information participants use (and re-use) in the process of deciding whether to buy or steal (or disregard) a product. Although these techniques remove the concurrent effort of verbalizing one's thoughts because cognitive processes are inferred from which piece of information is "revealed" when, the process itself is perturbed. By forcing the respondent to sequentially access information relevant to their decision at a cost (i.e., the metabolic cost of revealing the information of interest) and by forcing the respondent to explicitly decide which information to uncover (and which not), the decision

process deviates from how respondents would have behaved in a neutral situation (Glöckner and Betsch 2008).

3. *Mouse-Tracking: Attraction Revealed through Movement*

To study cognitive processes while keeping the perturbations to the cognitions in question at bay, more unobtrusive methods can be used, capitalizing on process indicators that occur while the target behavior is prepared or carried out (Dale, Kehoe et al. 2007; Spivey, Grosjean et al. 2005). Mouse-tracking makes it possible to draw inferences from participants' use of the computer-mouse. In our example on petty theft, participants could be presented with the options to steal or purchase grocery items on the computer screen. From the curvature of the mouse trajectory as it approaches the option participants choose, process tracers can infer how "attractive" the competing option was: the more participants considered choosing the other option, the more the mouse trajectory will be leaning towards it. At each point during the decision process, by assessing the mouse cursor position, the acceleration of movement and its directionality, inferences can be drawn about the current valuation of the decision options and the temporal dynamics of the decision process (see Hehman, Stoller et al. 2015). However, not all concepts of interest can be captured via mouse-tracking in a straight-forward manner. Some concepts, such as the importance assigned to attributes of the alternatives between which participants choose, are not routinely observable. Further, it is easily possible for participants to dissimulate, because moving their computer mouse is not directly part of the cognitive process itself: A participant who does not wish to reveal their deliberation may choose to pause their mouse until they have made a choice, and to then move it to its destination in a straight line.

4. *Eye-Tracking: Gaze as a Window to Information Processing*

Eye-tracking relies on capturing eye-movements as an essential part of and prerequisite for cognition (Just and Carpenter 1980). Where information relevant for the decision is presented visually, there is often no way around for participants to gaze at it, unless they relinquish the opportunity for obtaining the information in question. Eye-movements position the eye such that the stimulus of interest is captured in the foveal region of the eye, the place of sharpest vision. During fixations, occurrences where the eye is held stable for a certain amount of time (typically about 200ms-300ms, Holmqvist, Nyström et al. 2011), this information is acquired and can subsequently be processed. When the eye rapidly moves to a different point of regard, this motion is referred to as a saccade. During these transitions, information that is passed over cannot be acquired (Matin 1974).

As such, eye-tracking capitalizes on the pivotal role of visual information search and acquisition for human cognition, leveraging the potential of observing gaze behavior for inferring cognitive processes. The underlying assumption is captured by the eye-mind-hypothesis: "There is no appreciable lag between what is fixated and what is processed." (Just and Carpenter 1980, p. 331). Although information acquisition is the pivotal function of eye gaze, it does not necessarily follow that information that is gazed at will be fully processed. When gazing at a

visual scene, we may be taking in stimuli without them seeping into our awareness (Lamme 2003). Vice versa, we may also process information that we do not (or no longer) gaze at, looking at one stimulus but thinking about another (Posner 1980). To accommodate such phenomena, a reformulation of the eye-mind hypothesis has been proposed, the relative eye-mind hypothesis: “The most active location in working memory will eventually determine the most likely direction of the eye movement at a given point in time.” (Huettig, Olivers et al. 2011, p. 141).

Similarly to the debate about the relation of visual attention and information processing, the question of directionality in the relationship between gaze and cognition is a matter of perspective (Corbetta and Shulman 2002; Orquin and Mueller Loose 2013; Theeuwes 2010). The rubber-band metaphor captures the essential dependency between the two: where the eyes go, the mind will follow; and where the mind goes, the eyes will follow. Exogenous stimuli may capture visual attention (e.g., when they are large, centrally positioned or positioned where one would begin reading, colorful, bright or moving) and therefore hold the potential to bias cognition. At the same rate, humans can purposefully move their eyes to stimuli they wish to explore and away from stimuli they wish to avoid, determining endogenously where visual attention will be directed.

III. Gauging the Methodological Fit of Eye-Tracking to Legal Research

Eye-tracking leverages goal-oriented, purposefully directed visual attention allocation for process tracing. Although deliberate ignorance, signal detection misses and covert attention do occur and may weaken the link between visual attention and the cognitive steps taken to form a decision, for the most part, they can be avoided or leveraged in good research designs (for a discussion, see Rahal and Fiedler 2019). Again using the previous example of decisions to commit petty theft, in the following, we describe prerequisites and challenges of eye-tracking experiments in the scope of legal research, and define constructs of interest.

A. Sacrificing Some External Validity to Gain Interpretability

A central challenge for putting the might of eye-tracking technology to good use is tied to reflecting on external validity of the research design. Ideally, eye gaze could be tracked with lightweight glasses or even contact lenses, leaving the wearer free to explore their reality while seamlessly transmitting high-resolution data. In our example about petty theft, we could obtain rich data about whether shoppers keep an eye out for store detectives as they meander through the aisles of their usual grocery stores. The clear advantage of such a set-up would be its ability to capture a close-up of the participant’s reality. Currently, although it is possible to use head-mounted eye-tracking devices that allow the viewer to move through (real or virtual) space while their visual attention is tracked, such set-ups bring with them a central problem: the field of vision, and with it the stimuli to which the view could attend, vary as the viewer moves (Meißner, Pfeiffer et al. 2019). This renders data processing difficult and cumbersome.

Each recorded frame would have to be coded with regard to the presence or absence of (confounding) stimuli, the perceived size of stimuli, etc., to standardize the data for subsequent analyses.

While we may hope for advances in automatic image recognition to solve such data processing needs, we can often rely on computerized set-ups, in which the participant gazes at a computer screen while an eye-tracking device is mounted on or near the display. These devices can triangulate where participants' gaze is directed by relying on corneal reflections of infrared light rays (Duchowski 2007). Because the display positions of stimuli on the computer screen are under the experimenter's full control, data processing is vastly simplified, at the expense of external validity. For our grocery store example, we may choose to present a photo of a shelf with various grocery items to participants, and observe which items (and which features thereof) they consider while preparing their decision to steal or to buy.

Yet, engaging in eye-tracking research may even require further adaptations so that meaningful conclusions can be drawn from the recorded eye gazes. To ensure that gazes can be understood as expressions of purposeful, goal-directed attention, eye-tracking studies should be designed to control or exclude exogenous attention capture. Attention can "get caught" by various features of visual stimuli, such as their color, positioning, movement or size (for an overview, see Orquin and Mueller Loose 2013). In our petty theft example, for instance, we would have to consider that grocery shelves are in fact designed to capitalize on bottom-up capture of attention. Shoppers' (or petty thieves') attention is drawn to items placed on eye-level (or centrally), with item packaging screaming for attention with elaborate color schemes and symbols. However, it is difficult to distinguish between gazes that get "caught" by grocery items designed to do just that, and gazes directed at items to gauge whether one should buy (or steal) them. To give each item the same chance of catching participants' attention, and allowing conclusions about the meaning of gazes to them, adaptations to the stimuli are necessary (e.g., counterbalancing locations in the visual display between participants, using small stimuli and placing them far apart to avoid peripheral vision, balancing stimuli sizes, color, etc.). For simplicity and experimental control, many eye-tracking designs rely on displaying stimuli as words (where word length and difficulty may still be a confounding factor), numbers or symbols (see Figure 1).

Sample Set-Up For Eye-Tracking Study

Item 1		Item 2
8.20	Retail Price	4.40
1	Security Tag	0
10	Item Size	2

Figure 1. Sample set-up for an eye-tracking study on petty theft, with two items described by three attributes each.

Further, a clear interpretation of what information participants obtain from viewing the stimuli is possible only when they are presented unambiguously. For example, if an image of a store detective is presented, it may be straightforward to assume that participants think about store detectives. Yet, what exactly they think about when presented with this image is unclear. They may be thinking about the store detective’s choice of footwear, about their favorite movie involving a store detective, or about a number of other things that have to do with store detectives. To avoid this issue, process tracers can introduce the target image to participants as a symbol for a specific meaning (e.g., store detective means there is increased surveillance, while struck-through store detective means no surveillance in the aisles, etc.). When participants are initially instructed where to later find which type of information on the computer screen, their fixations to these stimuli, at each moment during the process of preparing behavior, can be used to reveal insights about their cognition.

B. Concepts of Interest: Measuring Cognition

As we discuss below, legal scholars may be interested in a variety of aspects of human cognition and their relation to the law. Here, we describe a selection of concepts that eye-tracking can provide insights about: information acquisition, information weighting, search strategy, processing difficulty, and arousal (Figure 2).

Leclerc 1994; Armel, Beaumel et al. 2008). Assessing the proportion of attention allocated to one stimulus type relative to another (e.g., to one option vs. another), in terms of relative fixation counts or dwell times, can also yield insights into their importance. In the example about petty theft, efficiency-minded would-be thieves might gaze more frequently and for longer durations at information about retail price, while thieves assigning greater importance to not getting caught than to obtaining the most valuable item may dedicate more attention to the presence or absence of a security tag.

Similarly, information that participants find important tends to be gazed at first (Gwinn, Leber, and Krajbich 2019). In the petty theft example, we could assess if would-be thieves' gazes first dart to item price, revealing a priority of this over other item attributes (such as item size, presence of security tags, etc.). Importantly, increased assigned weight can only be inferred from the allocation of initial gaze if the location of relevant information is known – if participants gaze at an unknown display, initial gazes serve the purpose of orienting.

Information that is gazed at last, right when participants clear the threshold to initiate the behavior they decided on, is thought to be of decisive value in the cognitive process (Krajbich and Smith 2015). During the petty theft decision, for instance, as decision makers consider various items, their eyes will likely last (and more briefly, as predicted by the attentional drift diffusion model, Krajbich, Armel et al. 2010) rest on the item they will subsequently choose.

3. *Search Strategy*

The order in which information is assessed reveals insights about search strategies. The frequency of transitions between different attribute types can reveal which kinds of comparisons decision makers make more frequently (Payne 1976). For instance, in the petty theft example, we could find that decision makers compare the items by attributes, first considering the retail price of both items, then considering if a security tag is attached. However, it would also be possible that decision makers first consider one item, both in terms of price and protection, and then consider the other item.

More complex analyses, such as transition probability matrices or scan path analyses (Noton and Stark 1971; Shi, Wedel et al. 2013) can be used to assess various aspects of search strategies, such as the directionality, repetition or duration of (sections of) the search process. To validate insights about search strategies, comparing free viewing patterns with gazes when instructed to make a certain choice helps avoid the danger of reverse inference problems (Schulte-Mecklenbeck, Kühberger et al. 2017). In our petty theft example, therefore, relevant treatment variations to substantiate conclusions could be to instruct participants to choose the item that is easiest to steal, as compared to the item that is the most valuable.

4. *Processing Difficulty and Arousal*

Some stimuli are easier to process than others, which is often accompanied by shorter durations of individual fixations, shorter dwell times on the stimuli, and lower fixation counts and look-up rates throughout (Just and Carpenter 1980, Rayner 1998; Vlaskamp and Hooge 2006).

When the decision is easy to make, like stealing candy from a newborn, it takes only few gazes to get it done. However, would-be thieves facing a heavily surveilled display of potential loot will likely require more gazes to decide how to get around the security systems.

When pupils increase (and no confounding variables such as differing lighting or luminance conditions are at play), it may be due to increased cognitive processing requirements (Beatty 1982). Most eye-trackers seamlessly capture not only information about where participants are looking, but also about the size of the pupils as they do so, making it appealing to leverage this data for assessing how difficult it is for participants to engage with the stimuli. However, pupil sizes are also known to increase in response to rising arousal (Stanners, Coulter et al. 1979; Janisse 1974). In our petty theft example, for instance, we might observe that choices to steal are made with more dilated pupils than choices to buy; or that taking the risk to steal under surveillance takes place with larger pupil sizes than deciding to steal when no mall cop is in sight. Consequently, whether we can conclude which behavior is more arousing, or which information is more difficult to process, requires an experimental design capable of excluding alternative influences on pupil sizes.

IV. The Potential of Eye-Tracking for Legal Research

Legal research is concerned with three big questions: why is there reason for legal intervention in the first place? Which is the most effective legal intervention, and what can be said about the proper functioning of the institutions for the generation of new legal rules? How does the apparatus work that is tasked with applying the existing legal rules? To each of these three big questions, eye-tracking can make valuable contributions.

A. The Law's Subjects

The law does normally not care what people think. It cares what they do. In the language of cognitive psychology, the law is thus chiefly interested in decision-making, and less so in judgement (for an overview see Ayton 2005). What people do can also be characterized as an action (which, in pertinent situations, could also be a non-action, i.e. an omission). Why would the law want to dig deeper and not only understand and investigate the outcome, i.e. the implementation of the decision? There are multiple reasons why.

1. Mental Process as a Precondition for Legal Intervention

In multiple contexts, the law does not exclusively consider outcomes. This is most prominently the case in criminal law. It does not suffice that the harm captured by the respective provision of the criminal code has been done. It does also not suffice that the harm has been caused by an action that can be attributed to the defendant. Criminal law all over the world additionally requires that the defendant is proven guilty. For most crimes this means that the defendant must have planned to inflict harm on the victim. Maybe the law distinguishes between cases where inflicting harm was the goal of the action, as opposed to cases where the goal was a

different one, but the defendant has accepted harm as an inevitable side-effect. For some crimes, the law goes even further. Most legal orders criminalize the infliction of bodily harm even if the defendant has only knowingly exposed the victim to the risk of harm, maybe hoping that the risk would not materialize.¹

In criminal law, the standard tends to be strictly subjective. Intent, or negligence for that matter, of the defendant, in the criminal act with which she has been charged, must be proven to the requisite standard. In legal jargon, *mens rea* is required.² If this is the standard, eye-tracking is of little practical help. In principle, the method could deliver. One could for instance show whether the defendant has taken the risk of harm for the victim into consideration. Within the limits described above one might even be able to infer how the defendant has traded the risk of harm against the desired benefit from committing the crime. But criminal jurisprudence always comes after the fact, often even with substantial delay. The object of discovery is what happened on the crime scene. Replicating the situation, in the courtroom or with an expert witness, is not the same. Possibly in the future cyber crime might be the exception that proves the rule, provided eye tracking evidence of individuals using online services is collected – and any legal order makes this collection of evidence legal.

Outside cyber crime, eye-tracking evidence might at most be used to probe the defendant on proclivity towards certain mental processes. The eye-tracking studies with convicted sexual offenders reported in the introduction go into that direction (Godet and Niveau 2021). But in criminal law there is the presumption of innocence.³ It also holds for defendants who have previously been convicted for the same or other crimes. The defendant may not be convicted for being a "criminal person". She must be convicted for having committed the crime with which she has presently been charged. Hence ex post eye-tracking with the defendant can at most be utilized for follow-up decisions that the law permits to be based on predicting the risk of recidivism. Jurisdictions differ in their willingness to consider such evidence. It might be used at the level of sentencing, in particular for supplementary precautionary measures directed towards exceptionally dangerous convicts (Monahan and Skeem 2016).

At face value, the civil law of damages, and torts in particular, look very similar to criminal offenses. Yet both parts of the law serve very different functions. It is the purpose of criminal law to sanction particularly egregious, often also particularly harmful behaviour. By contrast the civil law of damages serves a distributive function. It allots the pecuniary consequences of a harmful act to either the tortfeasor or the victim. One may also argue that the law of damages serves a forward-looking purpose. Anticipating the obligation to compensate the victim should give the would-be tortfeasor an incentive to abstain from inflicting harm (Geistfeld 2011). Hence the philosophy of civil law is much more pragmatic. Tort law is not meant as the legal order expressing disdain, but making sure that the pecuniary effects of the action lie with the normatively appropriate actor. This difference in philosophy translates into a different standard for the subjective component. Unless there is strict liability (so that mere causation

1 See, e.g., 18 U.S.Code § 1112 (a), defining involuntary manslaughter as a crime.

2 See, for federal US law, *Rehaif v. United States*, 139 S. Ct. 2191, 2195 (2019).

3 For the US, see *Coffin v. United States*, 156 U.S. 432 (1895).

suffices), there is a subjective component (Shavell 1980). But intent or negligence are interpreted differently. In order to find for plaintiff, the court does not have to infer the mental process of this specific defendant in this specific situation. It suffices if there are sufficient indications that a typical defendant, in a stylized situation as the one before the court, would have had intent, or would at least have been negligent.

If such a more objectivized standard is in place, there is considerably more scope for eye-tracking. The court could call upon an eye-tracking expert and ask her to test a sufficiently large sample from a sufficiently comparable part of society. If there is a strong correlation between a certain eye-tracking pattern and the decision to commit the tort in question, this might be used as evidence. Probably the evidence would not be conclusive, but would have the character of prima facie evidence: unless the defendant is able to specify and, if contested, to prove elements that distinguish the case at hand from the typical case for which the sample has been tested, the subjective part of the legal rule would be taken as proven.

In other contexts, the law also conditions its intervention on a specific mental process. It for instance requires that the buyer has acted in good faith for him to become the owner of the property of a third party (Levmore 1987). In other contexts, the law protects trust (Birks and Pretto-Sakmann 2002), or it gives a person a remedy who has been the victim of misrepresentation (Hill 1973). In all such situations, eye-tracking evidence could help the law understand which features of the situation are likely to trigger a false representation that the law may want to protect.

2. *Mental Process as a Source of Concern*

Not so rarely, the law cares about mental process for a different reason. On some mental path, the risk is aggravated that the decision-maker takes a normatively undesirable decision. Caring about mental process is a way of containing this risk. There are many illustrations. The law requires a specific form, for instance seeing the notary public, if a decision is particularly important, like selling a house.⁴ Eye-tracking evidence can help the law gauge the importance of the risk. Are participants likely to neglect important pieces of information, for instance about likely long-term effects, if they are allowed to decide on the spot?

On the opposite end, the law may oblige individuals to train themselves such that they can react adequately if a rare, but not impossible, risk materializes. The classic illustration is driving school. It is meant to prepare drivers to properly handle multiple pieces of information that arrive continuously. To that end drivers must routinize their behavior such that they are mentally free to focus on the traffic situation, rather than technically handling their cars, or worrying about standard precautions (Björklund 2018). The example can also be interpreted as the law aiming at inducing individuals to shift from one decision mode (deliberate action) to another (subconscious reaction to environmental cues) (Engel and Weber 2007). Eye-tracking may help the law check whether these expectations about the choice of decision mode, and about its ordinary performance, are well founded.

4 As famously in § 311b German Civil Code.

Not everybody is the same. This also holds true when it comes to the choice of decision mode, and to mental process more broadly (Chan, Mestelman et al. 1999, Burlando and Guala 2005, Angelovski, Di Cagno et al. 2018, Engel 2020). Yet even if potential addressees of regulatory intervention come in cognizable types, often times the regulator must still choose a uniform intervention. This may be for practical reasons: the regulator has no chance to previously sort addressees into types. Even if such sorting would technically be feasible, it may not be legal. The constitution of the land may require that all addressees are treated equally. Or the regulator could only get information about individual addressees' types by exploiting unacceptably intrusive methods, like inferring types from personality sensitive information that is protected by data protection legislation. If sorting is out of the question, the legislator needs an estimate about the composition of the type space. It ultimately may be most important to get the socially most disruptive type under control, even if its fraction in the population is small. But if this fraction is tiny, or if different types are only marginally riskier for society than others, it may be important information that the more dangerous types are infrequent. If the regulator suspects such patterned heterogeneity, it may want to sample the relevant part of population and find markers for the type with the help of eye-tracking.

Sticking with traffic, distraction is another normative concern (Wright 1974). Some distractions (like a pedestrian crossing the street unexpectedly) are beyond normative control. But others are susceptible to regulatory intervention, like the proverbial prohibition to use the cell phone while driving.⁵ Eye-tracking evidence can help the legislator understand the degree of the risk, and the acceptability of substitutes, like a hands-free kit.

Interested parties may have an incentive to manipulate on which information others focus. The typical cookie pop-up makes it difficult to find the "no cookies" option.⁶ Information overload may be an effective technique for disguising problematic information (Bawden and Robinson 2020). Detrimental information may be verbally or visually presented in ways that makes it difficult to get the message (Langevoort 1997). Third parties may try to channel the attention to information that is favorable to their cause. They may give the information an emotional overtone meant to mask their true intention (Goldie 2018). Whether or not such techniques are effective, either for the majority of the users, or at least for a sufficiently large vulnerable minority, could be made visible with the help of eye-tracking.

Traditional attempts at motivating regulatory intervention start from the observation that, absent the intervention, an individual might exploit an opportunity to her personal benefit, and to the detriment of someone else or society at large. In this perspective, intervention has the purpose of realigning individual and social rationality, by threatening individuals with a sufficiently probable and sufficiently severe sanction in case they break the rule. In other words this perspective interprets regulation as deterrence (Becker 1968, Nagin 1998).

There are certainly instances in which deterrence is effective, and hard to replace by less intrusive interventions. Yet arguably most of the time most individuals perceive themselves as good-natured. For this majority of the population, outright deterrence is not only an overkill. It

5 https://en.wikipedia.org/wiki/Restrictions_on_cell_phone_use_while_driving_in_the_United_States.

6 For regulatory background, see <https://gdpr.eu/cookies/>.

may even be counter-productive. Otherwise good-natured individuals may read legal deterrence as a signal of public distrust, and as information about the erosion of normative standards in society (Feldman 2018).

This is, however, not to say that mere regulatory abstention is likely to suffice. Unfortunately, most situations of life are complex. The richer the elements of the situation, the easier it becomes for an individual to get both for the price of one: they can advance their individual, selfish well-being while maintaining the self-image of being a good citizen. This is made possible by the powerful mental ability of reinterpreting the situation such that the perceived conflict between individual and social well-being disappears. The mechanism is well understood as motivated reasoning (Kunda 1990). This is where eye-tracking can become instrumental. To the extent that typical additional features of the context can be isolated, with eye-tracking it can be checked in which ways individuals reinterpret the situation to their favor. To the extent this has been shown, deterrence might be supplemented by, possibly even replaced by, cognitive governance closing tempting ways of reconciling personal interest with social harm (Lindenberg 2003).

Another concern features prominently in the debate over classic, and even more social media (Cinelli, De Francisci Morales et al. 2021). The way information is presented may increase its political impact, and thereby change the political process. Eye-tracking may make the potential for manipulation visible. Eye-tracking may also help understand the biasing effect of free information retrieval. Unfortunately, what sounds like a desirable property of a free society may have a detrimental effect on the social fabric. If it becomes easy for individuals to observe the political environment selectively, they may increasingly end up in their personal echo chamber, and construct themselves a picture of the social environment that is completely at odds with how others see it, and possibly even at odds with hard facts. Eye-tracking may demonstrate how far this process is advanced, if participants systematically pay little or no attention to evidence that conflicts with their world view.

3. *Manipulation Free Evidence of a Social Concern*

For some normative concerns, it is difficult to only check outcomes. The classic illustration is discrimination. Few people would openly admit that they decide to the detriment of people of colour, females or migrants. But the law may not be happy with lip service (Braman and Nelson 2007). It may want to affect actual choices. Now in many contexts the mere fact that a person from a protected category of society has not been selected need not say that this person has been discriminated against. There could have been other, legitimate reasons for the decision. Ideally, the law would therefore want to see which importance the protected criterion is actually played in the process of coming to a conclusion. For the same reasons as with the subjective element, eye-tracking will not be helpful for the individual decision. At the point in time when the law has to decide, this decision has long been made. But if the law wants to react to this problem of observability by some alternative protective measure, it may be important evidence of relevant the protected criterion is in the decision of a typical decision-maker. Such evidence can be generated with the help of eye-tracking.

4. *Eye-tracking as a Threat to Privacy*

The very fact that eye-tracking is unobtrusive and almost perfectly manipulation proof does not only make the technology powerful for regulatory purposes. The regulator may also worry that third parties exploit this power for purposes that are normatively problematic (Logan 2018)<. This is obviously true if some company capitalizes on machine learning to manipulate the uses of online services based on personality characteristics retrieved with the help of eye-tracking. Providers might even adjust the presentation of a website on the fly in reaction to eye-tracking information about the way how the individual user responds. But even if nefarious intentions or effects cannot be proven, users may still feel threatened by the mere possibility that third parties generate personality profiles and have access to information about their character that they themselves have never possessed. This is why the legislator may want to regulate the commercial use of eye-tracking.

B. Regulatory Intervention

As a rule, regulation is not performed by isolated individuals. New legal rules are the result of a complex, highly institutionalized process. Of course, all these institutions are manned by humans. In contributing to the process, these human agents go through mental processes. In principle, each and every element of these mental processes could be investigated with the help of eye-tracking. Yet at this point, interactive eye-tracking is still in its infancy. This is why, for the time being, eye-tracking research is unlikely to be of considerable help in understanding and ultimately improving political process.

However, eye-tracking is able to help the regulator in a different respect. Very often, if the regulator has come to the conclusion that a sovereign intervention is in order, there is more than one option. Hence the regulator face is a problem of institutional choice. Not so rarely, there is the additional option of fine-tuning previously developed interventions. This fine-tuning can also be referred to as institutional design.

No ultimately, whatever the law achieves, it must do so through affecting the behavior of individual addressees. This action by an addressee results from a mental process. Understanding in which ways a proposed intervention is mentally processed by the addressees is therefore of direct instrumental value for the regulator. The regulator will first and foremost want to know whether the intervention is at all effective. Moreover, when comparing alternative interventions, the regulator may want to know how robust alternative interventions are to disturbance. While some signal, resulting from the intervention, may be processed with high reliability, an alternative intervention may require a much more elaborate mental process, which is more likely to be disrupted. To illustrate: the regulator not so rarely has the choice between a bright line rule (simply for bidding a certain course of action) and an intervention that tries to convince the addressee that she should adopt one, rather than an alternative action (Smith 1989). In the law and economics literature, this distinction is often labelled rules vs. standards (Kaplow 1992, Agoglia, Doupnik et al. 2011, Girvan 2016). While the bright line intervention is easy to process, this intervention does not invite the addressee to mentally process the normative concern that led to the adoption of the intervention. With a slight change in context, a

brightline intervention may therefore prove ineffective: the addressee interprets the context such that it does no longer call for abiding by the rule. If, by contrast, the intervention makes the addressee elaborate on the reason why the legislator requires a change in action, even if context has slightly changed, the addressee may still exhibit the normatively desired conduct as she understands that, in essence, the normative expectation is still the same. Eye-tracking evidence may help the regulator understand whether a more involved intervention lives up to its promise.

Eye-tracking could be particularly helpful if the regulator considers replacing hard intervention with a nudge (Thaler and Sunstein 2008, Sunstein and Reisch 2017, Engel and Kurschilgen 2020). The definition of a nudge is a bit fluid. But usually the term refers to a regulatory impulse short of command and control or changing incentives. At its face, the impulse leaves it to the addressee whether and how to respond. But the intervention is such that the regulator expects the majority of addressees, most of the time, to react in the normatively expected way. The choice of a nudge thus critically hinges on the expectations of the regulator about the typical reaction by the addressees. This is where eye-tracking may prove instrumental. The relevance of eye-tracking is straightforward if the nudge consists of presenting a visual cue, like the proverbial mosquito in a urinal. Eye-tracking evidence can demonstrate in which ways the cue directs attention to the element that the regulator means to highlight. More broadly, eye-tracking may be used to probe the robustness of the nudge: must it be a mosquito, or would a colored dot do the trick? Does the cue still work if alternative elements of the presentation might draw the attention? Does the cue only work initially, as individuals are surprised by it, and loses effectivity with habituation?

Another application that could benefit from eye-tracking evidence is regulatory rules for the presentation of information. A classic is a Miranda warning: do individuals apprehended on the crime scene understand their rights, and the potential implications of waving one of them (Rogers, Harrison et al. 2007, Rogers, Hazelwood et al. 2008)? With the help of eye-tracking, one might investigate how they process the rather complicated wording of the warning. In similar ways, eye-tracking might be used to check how effective regulatory rules about the presentation of decision relevant information in finance is at directing individuals attention at critical elements (Glaser, Iliewa et al. 2019).

Another illustration is defaults. In multiple contexts, it has been demonstrated how big a difference it makes whether individuals have to opt into some scheme, or whether they are free to opt out of it. From a rational choice perspective, both designs of the rule are equivalent: the individual is free what to do. But empirical evidence shows that defaults tend to be sticky. If individuals have to opt in, many will not, and stay with the status quo. If, by contrast, they have to opt out, not many individuals go for this active change of the situation (Johnson and Goldstein 2003). While the effect is well documented, it is much less clear why defaults are so sticky. One possibility is that individuals simply refrain from making a decision in the first place. Alternatively, the default might be interpreted as information about desirable behavior. In the latter perspective, individuals would still consider the full choice problem. But the fact that one decision is the default would change how they weigh the alternatives. Understanding the process may be important for estimating the resilience of the default once context

changes, or the normative assessment in the population has changed. If the default has essentially led to an unquestioned routine, behavior can be expected to stay stable over a long time, even after circumstances or normative valuations in the population have changed.

C. Authoritative Rule Application

Ideally, expectations expressed in a legal rule are fulfilled simply because they are the legal rules. Actually, this expectation holds true to a surprising extent: In the lab, the majority of participants is willing to abide even by an arbitrary rule, and even if rule abiding is costly and there is neither audit nor sanction (Desmet and Engel 2021). Normativity has a fairly pronounced motivating effect. Still not all legal rules are followed by everybody all of the time. If infractions are too frequent, or if harm resulting from rule violation is too pronounced, government may want to rely on sovereign powers for rule implementation and, if needs be, enforcement. This is when administrative authorities or the courts become active.

Administrative agencies sometimes decide in complex procedural arrangements, involving multiple agents. The courts frequently decide in benches. The more the process of collective decision making is involved, the less eye-tracking as it is available at this point is helpful in understanding and possibly improving the decision making process. But not so rarely a single agent decides. And in a bench of three or five, the analysis may still go a long way if one has a good understanding of how individuals participating in collective decision-making process the information. This is why there is scope for gaining new insights with the help of eye-tracking.

The mental ability to re-interpret facts such that they match preferences has already been discussed (Kunda 1990). Conceptually the proclivity towards motivated reasoning is, however, only the downside of an otherwise highly adaptive mental process. Very often, humans have to navigate an environment that they know or suspect to only partly understand. Many human decisions have to be taken under uncertainty. Often this uncertainty is profound. Decision makers not only face well defined risks. The uncertainty is of a qualitative nature. Decision-makers know that they do not know (enough), but cannot avoid deciding regardless. In judicial decision-making, this is the rule, rather than the exception. Very often, even at the end of the judicial procedure, critical facts remain contested. Judicial procedure is essentially an exercise in reconstructing past events. There is always the risk that the decision maker misunderstands, or misses relevant elements of the situation. As judges are normally not allowed to refuse deciding the case, procedural law offers a decision based on the burden of proof as a way out. Then the judge refrains from herself assessing the facts, and decides against the party whose responsibility it would have been to convince the court of her interpretation of the facts. Yet decisions by burden of proof are not standard in court. This is chiefly due to legal rules about the standard of proof. In criminal procedure, this standard is normally strict. If prosecution cannot prove the charge “beyond a reasonable doubt”, the presumption of innocence kicks in and the defendant is acquitted (in some jurisdictions “by want of evidence”). But even this strict standard does not require that any theoretically possible alternative interpretation is ruled out. It suffices if no “reasonable” doubt remains. In some jurisdictions, most notably in the US, in civil law disputes the standard of proof is much more lenient. It suffices if the “preponderance of the evidence” supports the claim (Glöckner and Engel 2013).

This explains why legal decision-making is not a mechanical, mathematical exercise. Legal decision making is a true choice. The judge must make up her mind. Ultimately all legal and decision making is subjective. The judge must ask herself whether she is personally convinced (Engel 2009). The mental mechanism that makes it possible to decide although one suspects that one's understanding of the decision problem is incomplete is relatively well understood. In a subconscious, nonlinear process, the factual inputs are gradually reinterpreted until a consistent story emerges, or the process is terminated as consistency cannot be achieved. It has not only been shown that this process of "parallel constraint satisfaction" is at work (Holyoak and Simon 1999, Simon, Pham et al. 2001, Simon, Krawczyk et al. 2004). This process has also been demonstrated specifically for judicial decision-making (Simon 1998, Simon 2004, Engel, Timme et al. 2020). As this process consists of mentally manipulating information inputs, it lends itself to the analysis with the help of eye-tracking.

Judicial decision-making is institutionally contained. Jurisdictions differ in these institutional choices. While the common law jurisdictions trust in the adversarial process, on the European continent and its daughter legal orders, the philosophy is more inquisitorial. But even if the regulative idea is truthfinding, the parties have an interest in biasing the outcome in their favor (Engel and Glöckner 2013). Eye-tracking can help understand how the interested perspective of a party induces her to construct the case in a specific way. This helps, for instance, understand why settlement is much rarer than in the objective interest of the parties (Farnsworth 1999). And eye-tracking can help understand in which ways judges and jury members process contested information.

Jurisdictions draw different lines between legal professionals and laypersons. Shall the question whether the defendant is guilty as charged be decided by the jury or by a professional judge? Should professional lawyers be excluded from decisions made by laypersons (as in the jury system), or shall both of them interact on the same bench (as in German criminal procedure)? The decision might depend on the implications for the decision making process, and mental processes in particular. Eye-tracking might compare how the typical layperson integrates proven facts when directly interacting with professional judges, and when not.

V. Conclusion

Eye-tracking is not a tried and tested arrow in the quiver of empirical legal studies. This paper could therefore not be an extensive review of a rich literature. But we hope we could achieve two things: introducing the potential of the method, also in comparison with alternative process measures, and sketching avenues for putting this method to productive use in legal scholarship. The list of potential research questions is of course not meant to be exhaustive. It illustrates the substantial potential of the method, and will hopefully trigger many more interesting applications. The next paper reviewing eye-tracking from the vantage point of the law will hopefully be rife with interesting findings.

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