

Introduction to the Special Section on Intraindividual Variability and Aging

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This preface introduces articles that appear in the special section on intraindividual variability and aging and illustrate what intraindividual variability might contribute to the study of development. These articles exemplify the variety of conceptual perspectives, analytical methods, and types of data that are being used to study intraindividual variability and illustrate what the study of intraindividual variability might contribute to the study of development.

Across disciplines, scientific inquiry has been moving from relatively static representations of entities and phenomena to more dynamic ones (West, 1985). In our field, the objects of study—people—are conceptualized as dynamic entities that respond to, move in, and interact with endogenous and exogenous contexts that are themselves constantly changing. The result is the complexity and beauty of human behavior—occasionally predictable, but also filled with as yet unexplainable events and transformations.

Developmental psychologists seek to describe, predict, explain, and modify or optimize our own, our families', our friends' and acquaintances', and our species' behaviors (thoughts, feelings, and actions) and how these behaviors change over time. As the articulation of psychological and developmental theory has progressed, researchers have demanded more and more powerful research designs, measurement procedures, and analytical techniques to examine how and when individuals change over time or age (Baltes, Reese, & Nesselroade, 1988; Collins & Horn, 1991; Collins & Sayer, 2001; Hertzog & Nesselroade, 2003; Nesselroade, 1990). In recent decades, a growing number of researchers have begun using methods focused on *intraindividual variability* (for overviews, see e.g., Hultsch & MacDonald, 2004; Linden-

berger & von Oertzen, 2006; MacDonald, Nyberg, & Bäckman, 2006; Martin & Hofer, 2004; Moskowitz & Hershberger, 2001; Nesselroade & Ram, 2004; Walls & Schafer, 2006). The general idea, whether applied to the stream of images obtained via functional magnetic resonance imaging (fMRI) or narrative histories obtained via life-reconstruction methods, is that the dynamics (progression) of behavioral processes manifest themselves within persons as *systematic patterns* over time. Those engaged in research on intraindividual variability seek to locate, extract, and understand those patterns.

In summer 2008, a group of researchers¹ came together to discuss the current theoretical, methodological, and empirical issues facing the study of intraindividual variability. During 3 days of intense discussions, the interdisciplinary group reviewed the current literature base on intraindividual variability in aging, provided empirical illustrations of how intraindividual variability concepts are being used to understand aging-related constructs and processes, highlighted some of the theoretical and methodological challenges faced in the study of intraindividual variability, and identified some general challenges for the future. Energized by the work and discussions about what the study of intraindividual

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¹ The idea for a special section emerged from a meeting of a group of intraindividual variability researchers, the Intravarnet-2008 Working Group Meeting, held July 17–20 in Dölln, Germany. Contributing to the meeting were David Almeida, Fredda Blanchard-Fields, Steve Boker, Annette Brose, Christian Chicherio, Bruno Dauvier, Denis Gerstorff, Shu-Chen Li, Ulman Lindenberger, Stuart MacDonald, Mike Martin, Peter Molenaar, Karl Newell, Nilam Ram, Christina Röcke, Sabine Schäfer, Florian Schmiedek, Yee Lee Shing, Martin Sliwinski, and Marjorie Wool-lacott. Monetary support was provided by the Center for Lifespan Psychology at the Max Planck Institute for Human Development and by the Pennsylvania State University's Social Science Research Institute, College of Health & Human Development, and Departments of Human Development & Family Studies and Kinesiology; organization was by Helena Maravilla. We very much thank all the participants for their many contributions to this special section. It would not have come to fruition without their drive, ideas, and encouragement.

variability might contribute to the study of development, we approached potential authors about the possibility of submitting their manuscripts to *Psychology and Aging*. The outcome is this special section—a collection we hope captures the variety of perspectives that can be brought to bear on intraindividual variability and conveys the sense of optimism that emerged at the meeting.

Intraindividual variability means different things in different areas. Following the basic (methodological) definition, intraindividual variability is, across fields, simply the variation in scores over repeated measurements of a single individual. In the empirical literature, quantification of such variability has been used to “measure” many different constructs—including supposedly basic neural noise (as in reaction time [RT] variability) and personality traits (as in daily or weekly variability in affect). Although identified as intraindividual variability, the underlying processes may differ widely. In some ways, intraindividual variability is what we each make of it. One goal of this collection of articles is to bring different instantiations of intraindividual variability together—setting them side by side so that the variety of theoretical perspectives, analytical methods, and empirical findings might inform and “dance” with one another.

In the art world, John Cage, Merce Cunningham, Jasper Johns, Robert Rauschenberg, and their collaborators crafted a dialogic relationship among dance, music, and visual décor. In rethinking how sounds, movement, and sights could be organized, they invented a new lexicon (Cunningham, 2004). Inspired by these artists and their creations, we have tried to orchestrate conversations among developmental theory, analytical methods, and longitudinal data—“events” where each element sometimes leads and each sometimes follows (Wohlwill, 1991). Theorists are posing new questions, methodologists are developing new techniques that can reveal answers to questions that have yet to be asked, and data technologists are accelerating the pace at which the behavioral realities to be represented and explained are recorded. Each of the seven articles in the collection contributes to these conversations.

Ram and Gerstorff (2009) start us off with an overview of intraindividual variability concepts and analytical methods. They carve out a heuristic framework that might be used to tether specific theoretical constructs to particular types of intraindividual variability measures and models. Wrestling with construct definitions and statistical assumptions, they highlight how theory and method can engage with dynamic constructs. Building on this framework, they then outline the rationale for using intensive measurement and multitime scale “measurement-burst” study designs to simultaneously investigate aging and intraindividual variability.

MacDonald, Li, and Bäckman (2009) provide a comprehensive review of the literature on relatively rapid and transient intraindividual variability in cognitive performance (e.g., trial-to-trial fluctuations in reaction time). Placing this literature within a life-span framework, they summarize the evidence linking age-related increases in cognitive intraindividual variability to neural correlates at anatomical, functional, neuromodulatory, and genetic levels. Key are the theoretical and empirical connections drawn between processes occurring at very fast time scales (dopaminergic neurotransmission) and the changes that manifest over much longer time scales (cognitive development and aging).

Newell, Mayer-Kress, and Liu (2009) bring self-organization and dynamic systems theory to the investigation of intraindividual

variability and aging. The movement community has for a long time had the rich data needed for the study of dynamic processes. Coming from this tradition, these authors lay down a framework for inquiry and dynamic analysis that has implications for many areas of study. Specifically, they describe how the structure of variability might be further unpacked into different types of noise (e.g., white, pink, brown, 1/f noise) and review evidence suggesting that the noise that manifests at shorter time scales may be of particular importance as a sensitive marker of aging and disease. More generally, this article illustrates how intensive data and dynamic systems models are leading theory in new directions.

Almeida, Piazza, and Stawski (2009) examine intraindividual variability in biophysical manifestations of stress. Using a national sample of adults, they examine age and gender differences in the day-to-day noise in cortisol awakening response. The variable of interest is a measure of change (rate of change in cortisol levels across ~30 min)—an explicit step past the examination of static markers of hypothalamic–pituitary–adrenal cortical (HPA) axis function toward more dynamic ones. Connecting a multitime scale study design (daily diaries embedded within an age-heterogeneous sample) with analytical models that explicitly allow for variance heterogeneity, these authors illustrate how systematic patterns can be identified and extracted from data that are often treated as measurement error, raising new questions about how many change processes may be embedded within the concept of allostatic load.

Sliwinski, Almeida, Smyth, and Stawski (2009) examine within-person changes in the intraindividual covariation (i.e., coupling) of daily stress and negative affect. Using data from two measurement-burst studies and a multilevel modeling analytic framework, they illustrate how multitime scale study designs and analytic procedures can be used to effectively target and extract another change-based construct, *emotional reactivity*, and examine how that change-based construct changes within person over time and in relation to within-person changes in global stress. Emphasized are the new possibilities that such conceptualizations and techniques have for the simultaneous examination of psychosocial and developmental processes that operate at different time-scales.

Schmiedek, Lövdén, and Lindenberger (2009) investigate within-person associations between intraindividual mean (iM) levels and intraindividual standard deviations (iSD) of RT performance. Making use of intensive longitudinal data from a laboratory-based study spanning over 100 days, they highlight the heterogeneity of within-person relations and illustrate how a theoretically based analytic model (EZ-diffusion) can be used to represent the processes that give rise to these relations. Their empirical results and discussion of reliability highlight the need for careful consideration of how we conceptualize and simultaneously examine mean level and variability of behavior and question some of the theoretical assumptions on which many findings are based. The move toward process models and theories is made explicit.

Boker, Molenaar, and Nesselroade (2009) provide a critical and forward-looking commentary. Using the collection of articles as a backdrop, they open three methodological issues (each with theoretical and data-oriented counterparts) still in need of much attention: the selection of time scale, the multilayered simultaneity of within-person change processes, and the possibility of idiosyncratic measurement models. Thankfully, they also point the ways toward possible solutions.

Together, the articles display the intensity with which our field is considering within-person processes of change. The data are intense—multiple repeated measures collected simultaneously at multiple time scales—milliseconds and days, seconds and minutes, days and months and years. The analytical models are intense—multitiered, with lots of Greek letters, variance heterogeneity, and time-varying parameters. By intention, the collection takes risks, presenting ideas and analyses that might be considered “edgy” conceptually and methodologically. As you read them, we encourage you to converse with them—exploring if and how their perspectives on intraindividual variability might complement or contribute to the study of development. We look forward to hearing what emerges!

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