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Thirty years of focus on individual variability and the dynamics of processes

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Abstract

We fully endorse Arocha's (2021) thesis about the fundamental importance of studying variability in real, observable processes and agree with his critique of the standard practice of psychological research. However, we regret that Arocha's article does not acknowledge a rich body of research that has been around for almost three decades and that does exactly what Arocha recommends. This research is based on the theory of complex dynamic systems. We discuss its main implications for a research focus on concrete psychological processes, as they occur in individual cases (including real interacting groups). Variability over time is used as a main source of information about the nature of the underlying processes. Various examples of empirical studies, model building, and process-oriented methodology are discussed, and Arocha's examples of perceptual control theory (PCT) and observation-oriented modeling (OOM) are put in the perspective of the complex dynamic systems approach, which is fully compatible with scientific realism as advocated by Arocha.

Keywords

complex dynamic systems, development, methodology, processes, variability

We wholeheartedly endorse Arocha's (2021) main thesis that "variability is a fact of behavior necessary for successful performance, not the result of some unknown variables randomly affecting individual outputs" (p. 375) and his systematic and concise analysis of the problematic way in which the standard psychological and health research practice deals with intra-individual variability of behavior and performance over time. However, we regret that the author does not acknowledge the rich and growing body of nonstandard psychological research that, for almost three decades now, has embraced this main thesis. This work is entirely consistent with Arocha's clear and unequivocal critique of the main tenets of standard psychological research praxis, and

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the recommendations for a new approach based on it. It focuses on intra-individual variability and person-specific processes in a wide variety of psychological research domains, and has explicitly rejected the linear causal model between dependent and independent variables. This research has been inspired by theoretical developments that explicitly focus on processes, and, by doing so, have diverged from the variable-centered approach characteristic of mainstream psychology. The starting point of this research is the assumption that change results from interactions between many temporally varying components (Wallot & Kelty-Stephen, 2018). Processes are real, observable sequences of connected events, with temporal variability as a fundamental and characteristic feature. They take place in real individuals, or in real communities, such as specific families, school classes, parent–child dyads and so forth. The study of psychological processes is based on a number of overlapping theories: dynamic systems theory and complex dynamic systems theory, as well as statistical theories of person-specific processes. In fact, Arocha's (2021) five principles of scientific realism (p. 378) can be effortlessly integrated in standard definitions of complex dynamic systems, and complex systems theories endorse critical scientific realism and vice versa (e.g., Pratten, 2013).

Concisely stated, what these theoretical approaches have in common is the way they explain how a particular state of the system develops into another state over the course of time. A state is defined by the state space, which is basically the space of dimensions that we use to describe a particular system, such as a particular individual, a dyad, or a group of individuals, in a context. The dimensions of the state space correspond with components or features that interact with one another over time. A complex system or complex dynamic system is defined as a system consisting of many such features or components, the interactions of which generate order and structure through self-organization and novel properties through the process of emergence. In such a dynamic system, variability is a fundamental property, and it is through the study of such variability that dynamic systems can be understood. In line with Arocha's (2021) critique of aggregated data (p. 382), the nonergodicity thesis (Molenaar & Campbell, 2009) states that models for individual processes cannot be inferred from population data, in spite of the (erroneous) claim that population data yield general models, of which individual processes are specific cases. Much of complex dynamic systems-oriented research is based on high-frequency observation of authentic behavior, in which the observational facts are done full justice and are not smoothed out by reductive statistical techniques.

The theoretical ideas described above have been around in the study of human development from the early 1990s onwards, first in the domain of infant motor co-ordination and action-perception (e.g., Thelen & Ulrich, 1991), followed by cognitive and language development (e.g., Fischer & Bidell, 1998; van Geert, 1991, 1998), and emotional/social development (e.g., Fogel, 1999).[1] In developmental psychology, various researchers (e.g., de Ruiter et al., 2017; Fogel, 1999; Lewis & Granic, 2000; Schöner & Spencer, 2016; Thelen & Smith, 1994; van Dijk & van Geert, 2014; van Geert & van Dijk, 2002) have explicitly investigated intra-individual variability in developmental phenomena, such as motor, cognitive, language, social, personality, and identity development. This type of variability is an important indicator and a genuine causal factor of development. Thelen and Smith (1994), for instance, demonstrated how intra-individual variability resulted from the very dynamics of behavior and performance itself, and showed how particular

performance or behavior is a soft-assembled temporal pattern that emerges out of the interactions between a great many internal and external components. They have also shown that variability changes in the vicinity of a transition. Van Geert and van Dijk (2002), for instance, showed how variability occurs on a variety of interacting timescales, more particularly the short-term timescale of actual behavior—for instance in a particular child–parent conversation—and the long-term timescale of (language) development.

Schöner, Spencer, van Geert, and others have built models based on dynamic systems principles and have demonstrated that these models generate interindividual variability in processes, that is, characteristic patterns of intra-individual variability in a wide variety of performance domains. Perceptual control theory (PCT; Arocha, 2021, p. 385) implies feedback loops and circular causality, which are typical features of dynamic systems models predicting individual process properties. Other researchers, such as van der Maas and Molenaar (1992) and Guastello (1984) have used catastrophe theory, which is a general mathematical theory of continuous and discontinuous change in performance, to explain patterns of change, characterized by typical, qualitatively different patterns of intra-individual variability that go far beyond the standard model of symmetrical distribution due to independent random influences. Catastrophe theory shows how changes in variability can be used as predictors and indicators of (imminent) transitions and discontinuities in a wide variety of developmental, clinical, and educational processes. It has inspired a wide variety of studies on the temporal structure of variability. A wide range of processes, such as reaction times or variations in self-esteem, display variability in the form of "pink noise," where the frequency of random fluctuations (from small to large ones) is inversely related to their magnitude. Recurrence quantification studies, which focus on how events repeat over the course of a particular, individual process, have demonstrated how performance can self-organize from unordered chaotic to regular but still flexible patterns in reading performance, problem-solving, and so forth (Guevara et al., 2017; Wijnants et al., 2012).

Recent work in clinical psychology has moved from a focus on latent variables (e.g., "depression") to an approach that views clinical disorders as person-specific processes of mutually influencing, concrete, and observable symptoms that typically vary over time (Cramer et al., 2016). Instead of treating them as unexplained variance or measurement error, the typical ways in which the symptoms vary over time in individuals provide fundamental information about the underlying psychopathological processes (Fisher et al., 2018; Schiepek et al., 2017).

Theoretical, empirical, and methodological developments go hand in hand. First, various techniques display intra-individual variability (Xu et al., 2020). State space grid (Hollenstein, 2007) and other qualitative dynamic methods are similar to Arocha's (2021, p. 388) observation-oriented modeling (OOM), in their focus on finding temporal relationships between observable categorical properties of processes (e.g., Steenbeek et al., 2012). State space grids are widely applied in developmental and educational psychology as well as in applied linguistics. Advances in research methodology (Nesselroade & Molenaar, 2010), have provided statistical techniques for quantifying or testing patterns of behavioral variability in individuals, for example, dynamic factor analysis.

We agree that it is of fundamental importance to explain why the study of variability in real, individual processes is of utmost importance for psychology, as Arocha (2021)

did in his article in a concise and insightful way. However, it should be noted that the necessary theoretical and methodological advances, as well as empirical proof of why variability is a crucial element of processes of change has already been given in psychology, covering virtually all domains of psychological research and beyond.

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Note

1. The current references cover only a minute part of the extensive literature on variability in, and dynamics of, real individual psychological processes; where possible we refer to early, seminal papers that have inspired later work.

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