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The Intrinsic Dynamics of Psychological Process

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Abstract
Psychological processes unfold on various timescales in accord with internally generated patterns. The intrinsic dynamism of psychological process is difficult to investigate using traditional methods emphasizing cause–effect relations, however, and therefore is rarely incorporated into social psychological theory. Methods associated with nonlinear dynamical systems can assess temporal patterns in thought and behavior, reveal the emergence of global properties in mental and social systems due to self-organization of system elements, and investigate the relation between external influences and intrinsic dynamics. The dynamical perspective preserves the insights that inspired the field's early theorists while connecting social psychology to other areas of science.

Keywords
psychological process, intrinsic dynamics, self-organization, attractor, time series, computational modeling, dynamical systems

Psychology would be much easier if people simply responded to events and situations and then remained static until the next external force triggered another reaction. A person is insulted and gets angry, for example. But framing psychological process in terms of simple cause–effect relations misses what is arguably the signature feature of human experience. In the absence of external influence, a process can evolve because of internal mechanisms of a psychological system. Once a mental or behavioral event is initiated, it generates a sequence of subsequent events, resulting in a pattern of changes in mental or behavioral experience. The person's initial anger in response to an insult, for example, may intensify, diminish, promote self-affirmation, or give way to self-criticism. Internally generated patterns of change represent the *intrinsic dynamics* of psychological process.

The intrinsic dynamism of psychological process is rarely acknowledged in mainstream approaches. In recent years, though, the principles and methods of nonlinear dynamical systems have been adapted to topics in developmental, personality, and social psychology (Lewis & Granic, 2000; Vallacher & Nowak, 2007; Van Geert, 1998). Our aim is to outline this approach and suggest its added value for theory and research.

The Significance of Intrinsic Dynamics

The intrinsic dynamics of psychological process is not a new idea. To the contrary, the pioneers of social psychology in the early 20th century emphasized this feature of human experience. James (1890) theorized about the dynamic nature of mental process, emphasizing the continuous and ever-changing stream of thought. Cooley (1902) discussed the constant press for action that people experience without being triggered by incentives and external forces. Lewin (1936) conceptualized psychological process as the intersection of motivational forces, both within the person and arising from external influences, that promote variability as well as stability in behavior. And in one of the earliest social psychology texts, Krech and Crutchfield (1948) framed personal processes as the constant reconfiguration of thoughts and feelings in an attempt to achieve a coherent perspective on one's experience.

The temporal nature of psychological process is sometimes recognized in contemporary theory and research.

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For instance, social judgments become more polarized in evaluations when people focus on them without outside influences (Tesser, 1978), persuasive appeals that have little immediate impact sometimes grow stronger over time (Hovland & Weiss, 1951), and emotions decay rapidly despite the intensity of an initial affective reaction (Gilbert & Wilson, 2000). Developmental processes (e.g., language acquisition), meanwhile, are defined in terms of change on various timescales.[1]

These processes represent an increase or decrease on some dimension (e.g., evaluation, affect, vocabulary). Linear change, however, hardly exhausts the possible dynamic patterns. A person's thoughts may vacillate between approach and avoidance when contemplating a course of action, for example, and a romantic couple's affection can alternate between warm and cold. Some social and developmental processes, meanwhile, reflect threshold dynamics, with periods of stability punctuated by qualitative changes in thought and behavior. Even dynamics that appear irregular or random may be governed by a few nonlinear rules (e.g., deterministic chaos).

Temporal patterns can be highly informative. Mood variability, for example, may be more informative about a person's self-regulatory tendencies than is his or her average mood (Kuppens, Oravecz, & Tuerlinckz, 2010)—a state he or she may never experience. The pattern of variability in a couple's mutual affect, meanwhile, may signify more about the relationship than does the mean level of affect. The members of the couple may oscillate between passion and resentment, for example, never experiencing the average of these opposing sentiments—a temporal pattern that bodes poorly for the relationship (Gottman, Swanson, & Swanson, 2002).

Even if a process stabilizes on a fixed value, knowing the sequence of states through which the process evolved is important. Two individuals may ultimately be swayed by a persuasive message, for example, but whereas one reaches this final state by incrementally adjusting his or her initial position, the other may experience sizable swings in opinion before settling on the new attitude. Each person's trajectory may provide insight into his or her cognitive structure: Incremental adjustment is indicative of a moderately strong viewpoint that accommodates to new information, whereas large swings in attitude indicate the coexistence of very strong but mutually inconsistent viewpoints that cannot be easily reconciled (Latané & Nowak, 1994).

The Sources of Intrinsic Dynamics

Intrinsic dynamics are inherent in dynamical systems. A dynamical system is a set (system) of interconnected elements that undergoes change as a result of the interelement connections. Elements can represent everything from neurons (in neural systems) and thoughts (in cognitive-affective systems) to individuals (in relationships or groups). Through their connections, the elements may change their state in service of mutual coherence. As the elements adjust to one another, the system as a whole may become increasingly coherent with respect to a global property. In the context of several positive thoughts, for example, a negative event can be reinterpreted as positive in order to promote evaluative coherence. In social-cognitive systems, coherence is commonly manifest as higher-order judgments (e.g., attitudes) that provide evaluative integration for specific thoughts regarding a person, event, or topic. In social systems, coherence is manifest as shared reality, with individuals adopting common norms and values.

Self-organization, emergence, and attractors

Because a coherent higher-order state may be achieved in a bottom-up as opposed to top-down fashion as individual elements adjust to one another, the process is referred to as *self-organization*. Self-organization is rarely a one-step process, but rather typically involves many iterations of mutual adjustment among elements before they are sufficiently organized to promote a system-level property. Self-organization provides an explanation for the emergence of higher-order patterns of thought and behavior (e.g., social judgment, skilled action) from the interaction of simple elements (e.g., information, limb movements).

Once a system-level state emerges, it stabilizes the system by constraining subsequent thought and behavior. New input to the system evolves toward this state, even if the input is initially discrepant. In social judgment, for example, new information that someone is "critical" is interpreted as a virtue ("constructive") rather than a vice ("mean") if the judgment system is governed by a coherent state representing positive evaluation. The state to which a system evolves over time and to which it returns after being perturbed is referred to as a *fixed-point attractor*. To date, this dynamic tendency has proven to be the most relevant to the processes of interest in social psychology (Vallacher & Nowak, 2007), although more complex dynamic tendencies have been shown to be inherent in developmental processes (e.g., Lewis & Granic, 2000; Thelen & Smith, 1996; Van Geert, 1998).

Metaphorically, an attractor can be depicted as a valley in a hilly landscape. As illustrated in Figure 1, a new element entering the system, represented by a ball, will roll down the hill and come to rest in the valley. Even if the new element is initially inconsistent with the value of the attractor (e.g., critical behavior), its meaning will converge on the attractor (positive evaluation).

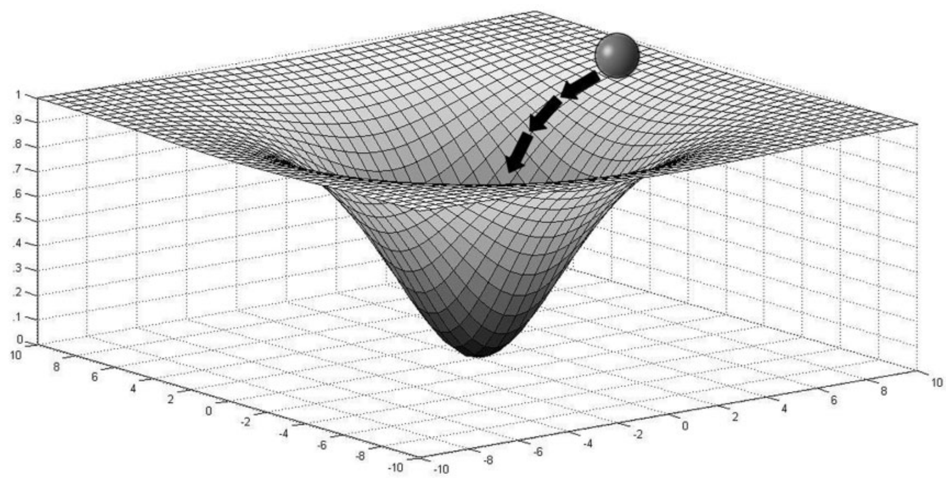

Fig. 1. The landscape for a fixed-point attractor. Individual elements (e.g., thoughts or behaviors) converge toward the bottom of the valley, which marks the location of the attractor. The wider the basin of attraction (the width of the valley), the greater the range of states that will converge on the attractor. The depth of the valley represents the strength of the attractor—its resistance to disruptive external influences. The horizontal axes represent independent dimensions (e.g., warmth and competence in social judgment).

Attractors are self-sustaining, but they are not necessarily desirable states. A person might display a pattern of antagonistic behavior, for example, despite efforts to avoid interacting in this manner. People with low self-esteem, meanwhile, may initially embrace flattering social feedback, but over time they may discount or reinterpret this feedback, with their thoughts converging on a negative self-evaluative state (Swann, 1992). And in intergroup relations, warring factions may act in a conciliatory fashion when induced to do so but revert to a pattern of antagonistic thought and behavior when outside interventions are relaxed (Vallacher, Coleman, Nowak, & Bui-Wrzosinska, 2010).

Systems may have two (or more) attractors and thus demonstrate *multi-stability*. Multi-stability captures the intuition that people can have mutually contradictory attitudes, self-concepts, goals, and patterns of behavior. A romantic couple, for example, may have a strong attractor for positive feelings and a weaker attractor for negative feelings. If the positive attractor has a wider basin of attraction, a broader range of initial affective states (e.g., neutral to very positive) will promote a communication trajectory converging on the exchange of warm sentiments. However, the two partners will converge on negative feelings if they begin an interaction within a different (more restricted) range of affective states (e.g., moderately to highly negative). The couple could have a wider basin of attraction for negative feelings, of course, with anything short of a highly positive initial state evolving toward unpleasant exchanges (Gottman et al., 2002).

External influences

External forces affect thought and behavior by interacting with an individual's or group's intrinsic dynamics. If the system lacks an attractor, outside influences may have a strong impact on the system's behavior. This is likely for unfamiliar behavior that lacks higher-order meaning (Vallacher & Wegner, 1987). It is not surprising that the "power of the situation" is demonstrated in novel settings, such as psychology labs, that elicit unfamiliar actions (e.g., pushing buttons), particularly if the influence is very strong (e.g., deriving from a legitimate authority figure). In a system governed by an attractor, however, external influences inconsistent with the system's attractor (but within the basin of attraction) may have an immediate impact that is dampened over time as the system returns to its attractor. A couple whose predominant mutual feelings are positive, for example, may experience anger in response to each other's insensitive behavior, but this reaction will be short-lived as the behavior converges on a more benign meaning in line with the couple's positivity.

In a multi-stable system, external influences can appear paradoxical. If the influence is incongruent with one of the attractors but within its basin of attraction, the impact will be minimal and temporary. But if the influence is slightly more incongruent, falling just outside the basin of attraction, it can converge on an alternative attractor. A romantic couple, for example, may have two attractors for their mutual feelings—love and resentment—each with its own strength and basin of attraction.

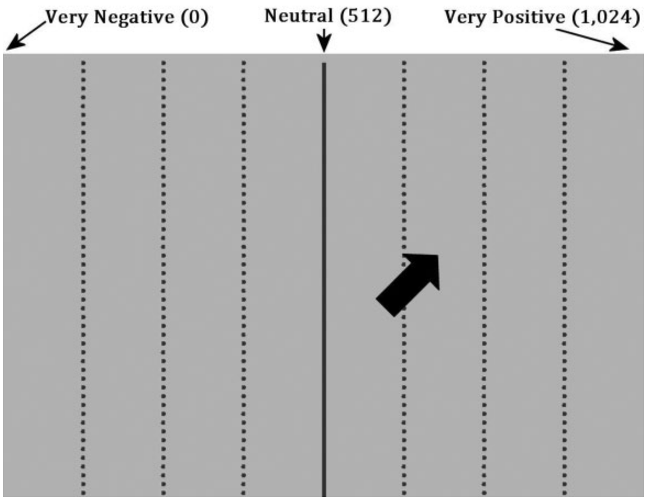

Fig. 2. A screen shot illustrating the computer-mouse procedure for tracking the intrinsic dynamics of self-evaluative thought (Vallacher, Nowak, Froehlich, & Rockloff, 2002). Participants used the mouse to position the cursor to express the moment-to-moment self-evaluation conveyed in a brief (2- to 3-min) recording of their verbalized self-narrative. The far left and far right of the screen represent "very negative" (0 pixels) and "very positive" (1,024 pixels) evaluations, respectively. This approach can be employed to assess the intrinsic dynamics regarding any object of thought (self, acquaintance, relationship partner, etc.).

If the positive attractor is stronger and has a wider basin, the couple may express mutual support despite difficult circumstances and troubling information. But love can turn to resentment in response to an event or a piece of new information that falls just outside the basin of attraction for love and within the basin for negative feelings.

Some influences can transform a system's dynamics. As the value of these *control parameters* change, the system may switch from a single attractor to multi-stability or vice versa, from fixed-point attractors to a pattern of change between attractors (periodic evolution), or from any of these tendencies to deterministic chaos (complex and unpredictable patterns of change). So although social psychological processes largely conform to fixed-point attractors, some influences could conceivably reconfigure a person's or a group's dynamic tendencies. A couple with stable attractors for love and resentment, for example, could become destabilized by a radical change in circumstances and develop a chaotic trajectory of mutual feelings.

The dynamical perspective thus allows for both stability and flexibility in thought and behavior. If behavior were solely under the control of external factors, people would demonstrate no consistency from one situation to the next, responding instead to the most recent force they experience. But if behavior were solely an expression of attractors, people's behavior would be rigid, reflecting persistent internal forces that do not accommodate changing circumstances. Because of the self-organizing nature of dynamical systems, however, a person or group that appears resistant to external influence may undergo dramatic change when the influence reaches a critical value that promotes a state of *self-organized criticality* (Bak, 1996). In this state, a relevant input from the environment can cause a rapid shift to an alternative attractor or a change in the system's dynamic tendencies.

The Assessment of Intrinsic Dynamics

Time series

Intrinsic dynamics can be assessed directly by tracking the sequence of states as they unfold in real time. Processes involving short timescales can be tracked using computer-mouse procedures (e.g., Freeman & Ambady, 2010; Spivey & Dale, 2006; Vallacher, Nowak, & Kaufman, 1994). For example, participants can privately verbalize their thoughts about themselves, then use the mouse-controlled cursor to indicate the moment-to-moment evaluation expressed in the recorded narrative (Vallacher, Nowak, Froehlich, & Rockloff, 2002). Tracking cursor positions with high temporal resolution (e.g., every second) produces a time series of self-evaluation (Fig. 2).

Time-series data can be analyzed in several ways. In the self-evaluation procedure, for example, fixed-point attractors are assessed by computing how frequently each cursor position is visited. Figure 3 illustrates a bistable system with two predominant self-evaluative states (very negative and very positive). Simply asking the participant to report his or her overall level of self-evaluation using a paper-and-pencil measure would provide a far different—and misleading—conclusion regarding the participant's self-concept.

Other techniques are available for characterizing the structure underlying temporal trajectories. *GridWare* (Lamey, Hollenstein, Lewis, & Granic, 2004) identifies how frequently the possible states in a system are experienced and tracks the transitions between these states. In dyadic interaction, for example, each state might represent a combination of the individuals' expressed emotions. In an interaction governed by an attractor, a small subset of states is frequently visited (e.g., mutual positivity) and there is rapid return to this subset after a deviation from it. This approach is scalable, enabling characterization of processes ranging from momentary interaction to social development (Hollenstein, 2013). *Recurrence quantification analysis* looks for repetitive patterns in the data stream, which can be used to identify the number of dimensions underlying the surface variability—the fewer the dimensions, the stronger the connections among the system's elements (e.g., Shockley, Santana, & Fowler, 2003). Temporal patterns may also have a fractal structure, such that variability on a long

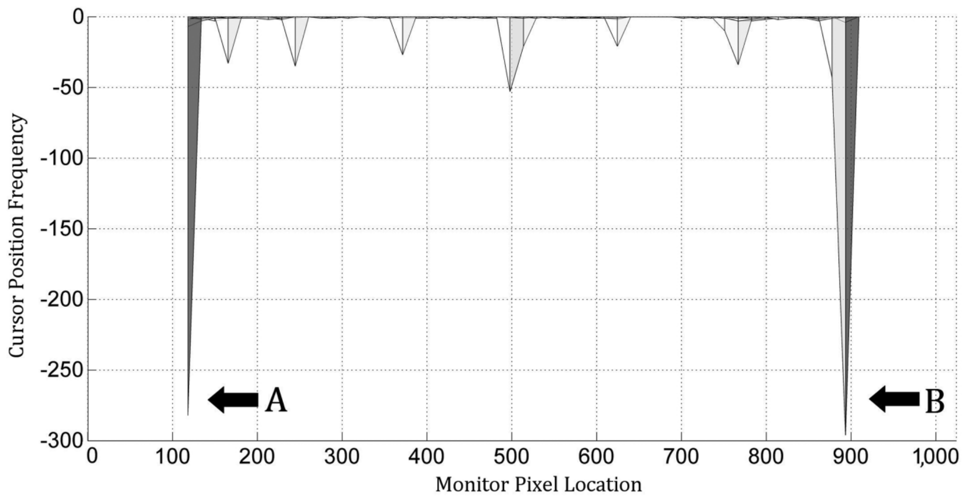

Fig. 3. A bi-stable attractor landscape generated from a participant's self-evaluation. There are two attractors, one in the negative domain (A) and one in the positive domain (B), indicating that the participants' momentary self-evaluation moved between two coherent but mutually inconsistent states. The histograms are inverted to convey the metaphor of attractors as basins. Reprinted from "Mental Dynamism and Its Constraints: Finding Patterns in the Stream of Consciousness," by R. R. Vallacher, J. L. Michaels, S. L. Wiese, U. Strawinska, and A. Nowak, 2013, in *Personality Dynamics: Embodiment, Meaning Construction, and the Social World* (p. 176). Copyright 2013 by Eliot Werner Publications. Reprinted with permission.

timescale resembles the variability over shorter timescales (e.g., Delignières, Fortes, & Ninot, 2004). The presence of fractal structure signifies that the connections among system elements are reflected in every aspect of the system's behavior.

Computational modeling

Computational modeling has become a primary tool for investigating intrinsic dynamics and the emergence of system-level properties in complex systems (Gilbert & Troitzsch, 2011; Nowak, 2004). For social psychological processes, this commonly takes the form of agent-based modeling (Smith & Conrey, 2007). Individuals are represented as interacting agents, and a model of a process is implemented as assumptions concerning the agents and the rules of interaction among them. Computer simulations of the process reveal how the system changes over time and what system-level properties emerge via self-organization.

This approach has proven useful in investigating group- and societal-level phenomena, such as the emergence of public opinion through social interaction (Nowak, Szamrej, & Latané, 1990) and the emergence of social norms that reconcile competing evolutionary mandates (e.g., Kenrick, Li, & Butner, 2003). Because elements can represent different levels of psychological reality (e.g., thoughts, individuals, groups), however, phenomena ranging from intrapersonal (e.g., self-concept) to societal (e.g., social change) can be understood using common formalisms (e.g., Nowak, Vallacher, Tesser, & Borkowski, 2000).[2]

Dynamic networks

In recent years, dynamic networks have emerged as a primary formalism for modeling complex social phenomena (e.g., Westaby, Pfaff, & Redding, 2014). The nodes in a network represent system elements, which are connected by links corresponding to relations. Mutual influence of elements across links promotes change in both the elements and their relations, resulting in changes in the overall configuration of the network. Dynamic networks can also be used to investigate networks of interacting cognitive and emotional variables (Fischer & Van Geert, 2014).

Intrinsic Dynamics in Perspective

Psychological processes unfold over time, and investigating this defining feature of human experience has added value for theory construction. People respond to external forces and events, of course, but the effect of these factors depends on the dynamic properties of the psychological system that is engaged. Focusing only on the immediate or delayed effect of a causal factor thus provides an incomplete and potentially misleading portrait of the process under investigation. Characterizing thought, emotion, and behavior in terms of a single value (e.g., a response on a 7-point scale), moreover, is problematic because of the potential for multi-stability and other attractor landscapes in psychological systems.

With the ascendance of nonlinear dynamical systems, methods (time series, computational models) are now available to identify patterns of temporal variation and link these patterns to properties of the underlying system. And because these methods can be adapted to different timescales (seconds, years), they can identify dynamic properties common to processes at different levels of psychological reality. The dynamical approach thus holds promise as an integrative paradigm for the diverse topical landscape of psychology. Perhaps most important, a focus on intrinsic dynamics recaptures the seminal insights concerning human experience that launched social psychology over a century ago, while providing the concepts and tools with which the field can advance as a precise science.

Recommended Reading

Nowak, A. (2004). (See References). A description of how computer simulations can identify the few variables essential to the emergence of complex properties in phenomena at different levels of psychological reality.

Nowak, A., & Vallacher, R. R. (1998). *Dynamical social psychology*. New York, NY: Guilford. A graduate-level text that reframes the topics of social psychology in terms of the principles and methods of nonlinear dynamical systems.

Vallacher, R. R., & Nowak, A. (Eds.). (1994). *Dynamical systems in social psychology*. San Diego, CA: Academic Press. An edited volume, consisting of original chapters by psychologists, mathematicians, and physicists, that describes the principles, methods, and early applications of nonlinear dynamical systems to social processes.

Vallacher, R. R., Read, S. J., & Nowak, A. (2002). The dynamical perspective in personality and social psychology. *Personality and Social Psychology Review*, *6*, 264–273. A special issue consisting of 12 articles illustrating the theoretical and methodological relevance of nonlinear dynamical systems for a wide range of personal, interpersonal, and collective processes.

Van Geert, P., & Steenbeek, H. (2005). Explaining after by before: Basic aspects of a dynamic systems approach to the study of development. *Developmental Review*, *25*, 408–442. An accessible account of how the principles and methods of dynamical systems can be used to model transitions in cognitive and language development.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Notes

1. Although developmental psychology often emphasizes sequences of stages that result from social influence (e.g., imitation) or maturation, classical developmentalists such as Piaget (1954) and Vygotsky (1934/1962) focused on internal mechanisms (e.g., assimilation and accommodation, the principle of the zone of proximal development) responsible for change across many domains (Van Geert, 1998). Language acquisition, for example, is conceived of as a process of construction rather than imitation or simple transmission.

2. Computer simulations have also been used to investigate important developmental processes, including the socially embedded processes of learning and teaching during math lessons (Steenbeek & Van Geert, 2013) and the emergence of personality through behavioral synchronization (Nowak, Vallacher, & Zochowski, 2005).

References

Bak, P. (1996). *How nature works: The science of self-organized criticality*. New York, NY: Springer-Verlag.

Cooley, C. H. (1902). *Human nature and the social order*. New York, NY: Scribner.

Delignières, D., Fortes, M., & Ninot, G. (2004). The fractal dynamics of self-esteem and physical self. *Nonlinear Dynamics, Psychology, and Life Sciences*, *8*, 479–510.

Fischer, K. W., & Van Geert, P. (2014). Dynamic development of brain and behavior. In P. M. Molenaar, R. M. Lerner, & K. M. Newell (Eds.), *Handbook of developmental systems theory and methodology* (pp. 287–315). New York, NY: Guilford Press.

Freeman, J. B., & Ambady, N. (2010). MouseTracker: Software for studying real-time mental processing using a computer mouse-tracking method. *Behavior Research Methods*, *42*, 226–241.

Gilbert, D. T., & Wilson, T. D. (2000). Miswanting: Some problems in the forecasting of future affective states. In J. Forgas (Ed.), *Feeling and thinking: The role of affect in social cognition* (pp. 178–200). Cambridge, England: Cambridge University Press.

Gilbert, N., & Troitzsch, K. G. (2011). *Simulation for the social scientist* (2nd ed.). New York, NY: Open University Press.

Gottman, J., Swanson, C., & Swanson, K. (2002). A general systems theory of marriage: Nonlinear difference equation modeling of marital interaction. *Personality and Social Psychology Review*, *6*, 326–340.

Hollenstein, T. (2013). *State space grids: Depicting dynamics across development*. New York, NY: Springer.

Hovland, C., & Weiss, R. (1951). The influence of source credibility on communication effectiveness. *Public Opinion Quarterly*, *15*, 635–650.

James, W. (1890). *Principles of psychology*. New York, NY: Holt.

Kenrick, D. T., Li, N. P., & Butner, J. (2003). Dynamical evolutionary psychology: Individual decision rules and emergent social norms. *Psychological Review*, *110*, 3–28.

Krech, D., & Crutchfield, R. S. (1948). *Theory and problems of social psychology*. New York, NY: McGraw-Hill.

Kuppens, P., Oravecz, Z., & Tuerlinckz, F. (2010). Feelings change: Accounting for individual differences in the temporal dynamics of affect. *Journal of Personality and Social Psychology*, *99*, 1042–1060.

Lamey, A. V., Hollenstein, T., Lewis, M. D., & Granic, I. (2004). GridWare (Version 1.1) [Computer software]. Available from http://statespacegrids.org

Latané, B., & Nowak, A. (1994). Attitudes as catastrophes: From dimensions to categories with increasing involvement. In R. R. Vallacher & A. Nowak (Eds.), *Dynamical systems in social psychology* (pp. 219–249). San Diego, CA: Academic Press.

Lewin, K. (1936). *Principles of topological psychology*. New York, NY: McGraw-Hill.

Lewis, M. D., & Granic, I. (Eds.). (2000). *Emotion, development, and self-organization: Dynamic systems approaches to emotional development*. Cambridge, England: Cambridge University Press.

Nowak, A. (2004). Dynamical minimalism: Why less is more in psychology. *Personality and Social Psychology Review*, *8*, 183–192.

Nowak, A., Szamrej, J., & Latané, B. (1990). From private attitude to public opinion: A dynamic theory of social impact. *Psychological Review*, *97*, 362–376.

Nowak, A., Vallacher, R. R., Tesser, A., & Borkowski, W. (2000). Society of self: The emergence of collective properties in self-structure. *Psychological Review*, *107*, 39–61.

Nowak, A., Vallacher, R. R., & Zochowski, M. (2005). The emergence of personality: Dynamic foundations of individual variation. *Developmental Review*, *25*, 351–385.

Piaget, J. (1954). *The construction of reality in the child*. New York, NY: Basic Books.

Shockley, K., Santana, M., & Fowler, C. A. (2003). Mutual interpersonal postural constraints are involved in cooperative conversation. *Journal of Experimental Psychology: Human Perception and Performance*, *29*, 326–332.

Smith, E. R., & Conrey, F. R. (2007). Agent-based modeling: A new approach for theory building in social psychology. *Personality and Social Psychology Review*, *11*, 87–104.

Spivey, M. J., & Dale, R. (2006). Continuous dynamics in realtime cognition. *Current Directions in Psychological Science*, *15*, 207–211.

Steenbeek, H., & Van Geert, P. (2013). The emergence of learning-teaching trajectories in education: A complex dynamic systems approach. *Nonlinear Dynamics, Psychology, and the Life Sciences*, *17*, 233–267.

Swann, W. B., Jr. (1992). Seeking "truth," finding despair: Some unhappy consequences of a negative self-concept. *Psychological Science*, *1*, 15–17.

Tesser, A. (1978). Self-generated attitude change. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 11, pp. 85–117). New York, NY: Academic Press.

Thelen, E., & Smith, L. B. (Eds.). (1996). *A dynamic systems approach to the development of cognition and action*. Cambridge, MA: MIT Press/Bradford Books.

Vallacher, R. R., Coleman, P. T., Nowak, A., & Bui-Wrzosinska, L. (2010). Rethinking intractable conflict: The perspective of dynamical systems. *American Psychologist*, *65*, 262–278.

Vallacher, R. R., Michaels, J. L., Wiese, S. L., Strawinska, U., & Nowak, A. (2013). Mental dynamism and its constraints: Finding patterns in the stream of consciousness. In D. Cervone, M. Fajkowska, M. W. Eysenck, & T. Maruszewski (Eds.), *Personality dynamics: Embodiment, meaning construction, and the social world* (Vol. 3, pp. 159–181). Clinton Corners, NY: Eliot Werner Publications.

Vallacher, R. R., & Nowak, A. (2007). Dynamical social psychology: Finding order in the flow of human experience. In A. W. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of basic principles* (2nd ed., pp. 734–758). New York, NY: Guilford Press.

Vallacher, R. R., Nowak, A., Froehlich, M., & Rockloff, M. (2002). The dynamics of self-evaluation. *Personality and Social Psychology Review*, *6*, 370–379.

Vallacher, R. R., Nowak, A., & Kaufman, J. (1994). Intrinsic dynamics of social judgment. *Journal of Personality and Social Psychology*, *67*, 20–34.

Vallacher, R. R., & Wegner, D. M. (1987). What do people think they're doing? Action identification and human behavior. *Psychological Review*, *94*, 3–15.

Van Geert, P. (1998). A dynamic systems model of basic developmental mechanisms: Piaget, Vygotsky and beyond. *Psychological Review*, *105*, 634–677.

Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: MIT Press. (Original work published in 1934)

Westaby, J. D., Pfaff, D. L., & Redding, N. (2014). Psychology and social networks: A dynamic network theory perspective. *American Psychologist*, *69*, 260–284.