Spring 2-7-2023

When Normal is Not Normal: A Theory of the Non-Linear and Discontinuous Process of Desired Change and its Managerial Implications

Richard Boyatzis Dr.
Case Western Reserve University

Udayan Dhar
ud002@bucknell.edu

Recommended Citation

Boyatzis, R. E., & Dhar, U. (2023). When Normal is Not Normal: A Theory of the Non-Linear and Discontinuous Process of Desired Change and its Managerial Implications. The Journal of Applied Behavioral Science, 00218863231153218.

Original Article

The Journal of Applied Behavioral Science
1–27

DOI: 10.1177/00218863231153218
journals.sagepub.com/home/jab
SAGE

When Normal is Not Normal: A Theory of the Non-Linear and Discontinuous Process of Desired Change and its Managerial Implications

Richard E. Boyatzis[1] and Udayan Dhar[2]

Abstract

Desirable change may appear chaotic, slow, or not sustainable. We may expect linear, continuous change, but it eludes us. Measurement and statistical analysis about behavior change often requires data showing continuity and having normal (i.e., Gaussian) distributions. When we encounter phenomenon that does not fit this expectation, we seek to transform the data to render it compatible with our method of analysis. We move from actual behavior to perception of it through surveys or transformations of the data. We believe this ignores "naturally" occurring data and what it says. Such techniques are convenient for statistics but may hide important features of the real phenomenon. Furthermore, desired behavior change is often nonlinear with a power curve distribution of the data. We explain why this occurs. We suggest how research and practice would be improved by using theories and methods that incorporate properties of non-normal distributions and discontinuous emergence.

Keywords

discontinuity, nonlinearity, complexity, intentional change theory, human change

[1]Department of Organizational Behavior, Case Western Reserve University, Cleveland, OH, USA
[2]Management & Organizations Department, Bucknell University, Lewisburg, PA, USA

Corresponding Author:
Richard E. Boyatzis, Department of Organizational Behavior, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH 44106, USA.
Email: richard.boyatzis@case.edu

Introduction

Change is essential for adaptation and sustainability (Wilson, 2000). We seek desirable change to pursue better performance, a better life, sense of well-being or for helping to build a better society. The changes desired could be at any level of analysis. For example, they might be in our behavior, thoughts, feelings, attitudes, learning, or norms in our social groups and organizations. When individuals change in desired ways, or when we witness desired change in our social systems from teams to organizations or communities, it may appear chaotic or random. We might also make simplistic, post-hoc attributions about change, like, "They completed a training program so they must have learnt something!" The reality could be that a few people have learnt a lot in a short period of time, while a large majority might not have learnt much overall.

Even though there is a long intellectual history of recognizing the prevalence of nonlinearity in social change, for the sake of predictability or comfort, we may expect or even prefer the change process in ourselves and others to be linear and continuous, but it eludes us. Beginning with Lindblom's (1959) influential theories of "muddling through" change in the administrative sciences, to relatively recent studies of emergence (e.g., Amis et al., 2004) in organizational behavior, there is plenty of evidence in the literature for that. However, in our research about behavior change, measurement and statistical analysis typically requires data with normal (i.e., Gaussian) distributions. When we encounter a real phenomenon that does not fit this expectation, we seek to translate or transform the data to render it compatible with our method of analysis (Andriani & McKelvey, 2007, 2020; Golembiewski, 1986; O'Boyle Jr & Aguinis, 2012). For example, a recent review of the literature showed that researchers typically address non-normality in their data by (a) remaining within the linear model, (b) changing the data, or (c) treating normality as informative or as a nuisance (Pek et al., 2018). Clearly, although these issues have been recognized and raised previously, they are still not consistently appreciated and used.

These "unnatural statistical acts" may hide important features of the real phenomenon and hamper insight into change. We call them so because they deliberately ignore what the "naturally"-occurring data might be trying to tell us. Such techniques, though convenient for the sake of mathematical modeling, may hide important features of the real phenomenon and hamper insight into change. The contribution of this paper will be to offer a set of reasons as to why power curves are so prevalent in cross-sectional behavioral data; and non-linearities are so prevalent in longitudinal behavioral data. We are building upon a series of earlier works on non-normal distributions: such as Guastello's (2007) work that showed how leaders emerge from leaderless groups as part of a complex emerging social structure; Andriani and McKelvey's (2007) work that showed how several business studies often gain statistical significance via some assumption device by which extreme events are ignored; and O'Boyle and Aguinis' (2012) work that showed across industries that individual performance is not normally distributed—instead, it follows a Paretan (power law) distribution.

A new appreciation for non-normal distributions and discontinuities in the process of change could help theory development and research. Specifically, this new

appreciation could help researchers to: (1) Collect data about actual behavior or change. For instance, by not ignoring "outliers" in the data that could potentially supply meaningful insights. (2) Collect data with periodicities that allow discontinuities to emerge. For example, through process studies of change that use archival records and ethnographic observations over time. (3) Use visual and segmented statistical analyses to identify bifurcations or other break points and various distributions that maybe embedded within a data set. Examples of such methods include segmented analyses such as a regression discontinuity design.

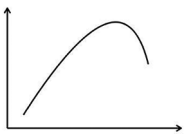
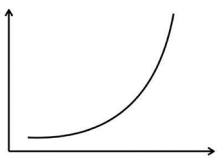
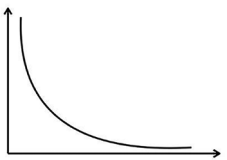
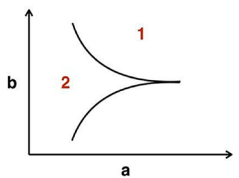
This paper is structured as follows. Firstly, we report on a broad review of the behavioral sciences literature to provide the reasons why longitudinal measurements of behavioral change are often nonlinear and discontinuous; and why cross-sectional data distributions (i.e., the frequency with which each observation occurs) are often non-normal. It is important to understand this because a failure to do so often leads researchers to ignore data points that induce non-normality to the distribution. Instead of studying extreme events, they label them "outliers" and risk losing valuable information. By drawing upon research in evolutionary psychology, we explain how homeostasis leads to defensive and negativity bias and a desire to reduce uncertainty, causing resistance to change. We also draw upon the complexity sciences to explain why ideas of emergence and tipping points are crucial in understanding change at different levels of analyses. Next, distributions of performance in various settings are reviewed to throw light on why this is relevant to management and organizational scholars and practitioners. In the final section, implications for research and practice about individual and group-level change are discussed.

The Various Types of Distributions: A Brief Review and Primer

To help the reader who is not regularly steeped in discussions of distributions of data, the definitions, general formulae, illustrative examples from the behavioral sciences, and sample graphical representation of some common nonlinear functions are provided in Table 1.

Most behavioral researchers and practitioners are familiar with Gaussian or "normal" distributions. The theory of normal distributions is based on the Central Limit Theorem which states that if a random variable, X, is the sum of a large number of small and independent random variables, then almost no matter how the small variables are distributed, X will be approximately normally distributed (Lyon, 2014). Originally considered for distribution of performance in a large sample of professionals, the normality assumption began to be applied to all kinds of performance measures, and in other categories of behavioral distributions regardless of the actual observed distributional properties (O'Boyle & Aguinis, 2012). They are in stark contrast to power law or "Paretian" distributions, which are typified by unstable means, infinite variance, and a greater proportion of extreme events (O'Boyle & Aguinis, 2012). In the context of performance evaluation, consider a situation where a Sales

Table 1. Overview of Nonlinear Relationships and Non-normal Distributions.

Name & definition	General formulae	Illustrative examples from the behavioral sciences	Graphical representation
Curvilinear relationship: An association between variables that does not consistently follow an increasing or decreasing pattern but changes direction after a certain point.	Polynomial functions with the general formula: $y = a_n x^n + a_{n-1} x^{n-1} + \cdots + a_2 x^2 + a_1 x + a_0$	A relationship between anxiety and achievement shows increasing achievement with increasing anxiety to a certain point, where too much anxiety negatively impacts achievement.	A quadratic function with n = 2 
Exponential relationships: A rapidly growing relationship in which the increase is proportional to the size of an x-variable and the slope is equal to the value of the y-variable.	$y = ab^x$	The spread of "viral memes" on social media can show exponential increase as every connection in the social network shares the message with all their network members.	
Power law relationships: A relationship in which the values of one variable varies according to the value of another variable raised to a power	$y = ax^k + \epsilon$	The "80:20" effect observed in performance distribution of researchers in terms of number of publications, etc. (O'Boyle Jr & Aguinis, 2012; Figure 1)	
Bifurcation curves: Represents discontinuous and divergent phenomenon. Can take various forms of "cusp"-like surfaces depending on the number of control dimensions (n) and behavior parameters (b).	$dx/dt = -dV(u,x)/dx$, where V is the potential function, u is a vector or a scalar which parametrizes V	"Swallowtail" model seen in leadership distribution in small teams. In a team with no formal leader, one primary leader and two secondary leaders emerge, which fits a mathematical distribution with one large mode and two small modes.	Cusp shape in parameter space (a,b) showing the contours of discontinuity where region 1 has one stable solution, and region 2 has two stable solutions. ($a=k_1x^2$, $b=k_2x^3$) 

manager might observe a "normal" distribution when most of their sales staff sell about a dozen products per day, a few sell slightly less, and a similar number sell slightly more. On the other hand, when a Sales manager observes that a very large number of their staff sell more or less a similar number of products, but there are just two or three individuals who sell an exceptionally high number of products, it points towards a power law distribution. Figure 1 shows a power law distribution overlaid with a normal curve.

A power law is the mathematical representation or formula that results in the graphic of a "power curve." Mathematically, it can be expressed as: $y = ax^k + \epsilon$.

That is, it is a relationship in which the value of one variable varies according to the value of another variable raised to a power.

Why are Power Curves and Nonlinearity so Ubiquitous in Data About Behavior and Change

The observation that power laws and related distributions are frequent and typical in behavior and behavioral change efforts, whether for individuals or collectives, has been made by scholars in various fields (Andriani & McKelvey, 2007; Gabaix, 2016; Guastello, 2001; O'Boyle & Aguinis, 2012). This has significant implications for not just organizational research, but also for practitioners of organizational development (OD) and change. Change agents assume that every intervention they make for the purpose of change counts incrementally, and that the steady combination of small intervention efforts eventually tips the balance toward successful change. In fact, what these studies imply is that only a few interventions out of the many that are undertaken

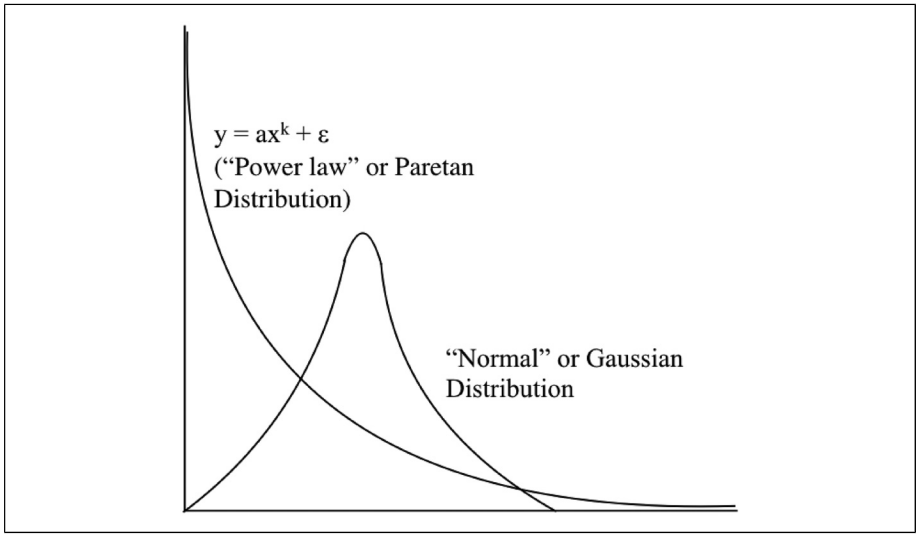


Figure 1. Graphical comparison of normal and Paretan distributions.

really have an impact, and that in some cases, those same interventions used in different settings may have no impact at all.

In the real world of change, the truth is that very few efforts really have desired impact and that many more of the things that OD practitioners do, do not have expected or desired impact except to increase the number of consultants. This is what we mean by a long-tailed distribution. Readers are probably familiar with the 80–20 rule from Pareto analysis. It says that very few things we do in change efforts really matter and that most have no impact at all. If we assume that all interventions are equally important to success, we are not understanding how change happens and we will never be able to study it in a way that allows us to make change either more efficient or more effective.

The reasons for why these power curve and other non- "normal" distributions are encountered in behavioral research maybe found in how people deal with change. Essentially, human behavior is homeostatic around a centroid of preservation (Casti, 1994; Erdi, 2008). It suggests that behavior will be repetitive in the use of energy to survive or seek safety when exposed to threat, including anticipation of disapproval or observed differences from others. Based on our review of the literature and research on this topic, we have identified the following ways in which this phenomenon manifests.

Seeking Safety and Defensive Bias

The human organism has evolved to protect itself and continue functioning (Sapolsky, 2004). Homeostasis plays a key role in this functioning. Homeostasis refers to the fundamental set of operations at the core of life, regulating it within a range that focuses on survival, but also can allow flourishing (Damasio, 2019). The sympathetic nervous system (SNS) (i.e., the human stress response) is activated to defend against threats by preparing the human for "fight or flight." When activated, the SNS moves blood to appropriate muscle groups, and diverts other energy that might otherwise be used in processes not essential to that defense. The result is a set of homeostatic forces, closely and consistently related to feelings or the subjective experiences of preserving life (Damasio, 2019). This reduces unusual behavior that may increase risk. This process seems to extend to social threats of social disapproval or expulsion from a social group not merely physical threats to a human's continued existence.

In addition to an underlying default to survival and defensive postures, as social beings we seek consistency in our behavior to minimize censure, disapproval, or failure (Bowlby, 1969; Crowne & Marlowe, 1964; Parsons, 1937). We want to belong with others (Baumeister & Leary, 1995; Deci & Ryan, 2000; Maslow, 1968; Schutz, 1958). The desire to avoid or minimize possible rejection or even expulsion and censure from such groups is a restraining force on our behavior. As a result, our behavior, and by extension our performance actions become inherently less distinctive. If biologically we show regression to a mean for consistency, we also do that for social conformity and inclusion (Wilson, 2000).

When we seek novelty or change, it is typically a time of uncertainty or transition such as a midlife or midcareer crisis. In social groups, we may seek collective change

akin to a revolution when we experience relative deprivation (Brinton, 1952; Runciman, 1966). But these are experienced as extreme and different states. Such actions are less frequent than acts to reduce distinctiveness.

Negativity Bias: The Other Side of Belonging and Socialization

There is a general bias, based on both innate predispositions and experience to give greater weight to negative entities (e.g., events, objects, personal traits), which manifests in four ways: (a) negative entities are stronger than the equivalent positive entities; (b) the negativity of negative events grows more rapidly with approach to them in space or time than does the positivity of positive events; (c) combinations of negative and positive entities yield evaluations that are more negative than the algebraic sum of individual subjective valences would predict; and (d) negative entities are more varied, yield more complex conceptual representations, and engage a wider response repertoire (Rozin & Royzman, 2001). The desire to belong within a social group and remain in that group is a primate tendency (Wilson, 2000), but can become a restraining force. For example, being committed to a value of humility may act as a homeostatic force. Similarly, in-out group dynamics, such as the fear of people or events that are different from us, may also be restraining forces (Sherif et al., 1961).

This tendency to inhibit changes in actions and be effected by such restraining forces has been labeled a negativity bias (Rozin & Royzman, 2001). A stream of research supports the idea that not only are negative feelings stronger than positive ones (Baumeister et al., 2001), but we tend to be skeptical, hesitant, and negative about ideas, people, and events (Rozin & Royzman, 2001). Such negative views act as a restraining force, and inhibit experimentation with new behavior, or behavior that deviates from expected social norms. The tendency within our brains was described as "Velcro for the negative and Teflon for the positive" experiences by Hanson and Hanson (2018).

In organizations, along with growth and maturity often comes efforts at standardization and increasing bureaucratic processes to ensure consistency of effort, seek more efficiency, or increase control of a limited group of people in powerful positions (Meyer & Zucker, 1989). This also results in a type of arteriosclerosis of organizational norms and squelching of innovation. Even efforts intended to improve organizational performance, like benchmarking other organizations, actually are more likely to result in regression to a performance expectation mean than a breakout new effort or idea. A desire to learn or change may not be sustainable due to these forces.

For example, the popular OD technique of Appreciative Inquiry has often been significantly more effective in sustainable change compared to traditional change management procedures because of its focus on positive lived experiences and its cascading effect on the participants' openness to new ideas (Bushe & Paranjpey, 2015). Maintaining a high degree of positivity by structured interventions such as sharing positive feedback or creating images of a positive future can harness what AI practitioners call the "heliotropic effect" to drive desirable change for the group or organization.

Reducing Uncertainty

When experiencing uncertainty, for instance, during liminal periods (Ibarra & Petriglieri, 2010), people will likely move to reduce the uncertainty (Durrheim & Foster, 1997). When such uncertainty feels threatening, the person responds with a stress reaction and becomes defensive. The exception is for individuals with a trait disposition in which they gravitate toward uncertainty because they find it exciting (Maddi, 1969–2004). At the same time, there are cultures with a low tolerance for uncertainty which limits entrepreneurial ventures and risk taking (Hofstede, 1984).

At the organization level, and sometimes in communities and countries, a person in power will appeal to people's unease with uncertainty (Storr, 1996). Besides reducing the perception of uncertainty, a result is the consolidation of power and personal control of the leader. This centralization of authority is often a restraining force on innovation, or at least innovations not in the mind of the leader. Whether with an explicit purpose of increasing standards of quality, or increasing efficiency, such bureaucratic centralization limits individual initiative (Barnard, 1938).

In organizations, such norms manifest themselves as often stated beliefs that "that is not the way it is done here." If not precluding innovative, distinctive, and disruptive acts, it inhibits the longevity of any such efforts. Such forces have been cited as contributing to "competition neglect" (i.e., not noticing a change in a competitor's behavior (Camerer & Lovallo, 1999). In professions, certification efforts are often proposed for quality reasons, but in reality impose standardization, and limit innovation (Fallows, 1985).

An overall consequence of these restraining forces is less distinctive and less frequent change within an individual's behavior or within social groups. This leads to a situation where only a small minority of individuals are willing to change or innovate. At the collective level, the change process appears as sudden after a long period of inaction, instead of smooth or gradual.

The Perceived Cost of Change

Learning or change pushes against homeostasis. The acts are somewhat stressful arousing the SNS (Dickerson & Kemeny, 2004; Segerstrom & Miller, 2004). Quickly, the regressive effect of stress extinguishes the drive or interest in sustaining learning or change. This can be explained through SNS functioning, ego depletion, or resource depletion theories (Sapolsky, 2004). The switching costs of a behavior change or of espousing new ideas or attitudes learned are more likely to be greater than the perceived costs of remaining the same. This also becomes a regressive force.

For example, the overall impact of treatment adherence in health care (i.e., doing what your physician or nurse tells you to do to speed recovery after an illness or procedure) is woefully low. This continues to baffle professionals given the efforts invested and possible consequences of not following one's physician or nurses' recommendations. It appears to be about 50% for diagnosed Type II diabetics in many countries, the same following orthopedic surgery and even lower for patients after coronary by-pass surgery (Khawaja, 2010).

In an analogous manner, the dramatic drop off of the impact of organizational training programs in three weeks to three months is called the honeymoon effect (Campbell et al., 1970). Again, but with a focus on retained learning within the realm of a required graduate course, Specht and Sandlin (1991) showed the half-life of knowledge was about six and a half weeks. These suggest that sustained, learning or change is a less frequent occurrence regardless of the money and effort expended.

It must be noted, however, that just because such phenomenon is low frequency, it does not imply non-normality. It simply makes the distribution more sensitive to each observation and therefore more likely to skew away from a normal distribution. Crucially, it offers an important insight relevant to our central thesis: that if we continue to practice change management the way we do by focusing on the large population of "normal" or "average" individuals, we will never achieve sustainable change. On the other hand, if we focus on "exceptional" cases, exactly the ones often ignored by statisticians, we will be able to gain insights on the critical factors within a particular context that can drive long-term development and change at the level of both individuals and groups.

Event Dependence, Tipping Points, and Emergence

Gersick (1991) observed that team development is a process of passing through key moments of "punctuated equilibrium." These are moments in the evolving life of a team in which their relationships, interactions, and other signs of change take a sudden break. If the team continues, it is functioning in a dramatically different manner. The reason for this nonlinearity in the change process is that norms are a function of prior behavior, shared values and possibly agreed-upon rules of how to act, and the perspective of the people in powerful positions. Each effort to change the behavior, decisions, or values of the team, organization or community, call for a major culture change. However it begins, each effort is highly dependent on previous behavior, norms, values, and decisions. This interdependency creates conditions for power laws to appear repeatedly.

From a mathematical perspective, power laws do not assume that events or data points are independent (Andriani & McKelvey, 2007). On the other hand, Gaussian distributions assume that data points or events are independent (Erdi, 2008). In other words, when a person seeks to change, it is typically related to something that they are already doing or experiencing that is less desirable. The first act of learning or change is dependent on the experience or perception of the person's initial state.

Once a person begins a change process, such as attempting to lose weight, their actions each day are closely related to their actions the prior day, week, or even month. They fight against habits of snacking or drinking high caloric beverages. When a person attempts to stop smoking, their craving for nicotine is a function of when their body last experienced it and the degree to which they have become physiologically and behaviorally acclimated or addicted. In other words, each act is dependent on previous acts and states. If a person has had a dysfunctional relationship and they desire to have a healthy one with a potential partner, there are many things new

"prospects" may remind the person of their prior, negative relationship and cause the person to back away from exploring a relationship with a new person. In this case, the reactions to others' actions affect a person's next effort at change.

When a person contracts a disease or has a physical accident, like breaking an ankle, comorbidities often occur. That is, some aspect of the disease sets off an inflammation which compromises the immune system resulting in another viral or bacterial infection occurring. When someone breaks an ankle and begins to walk with a cast or crutches, they are likely to experience soreness in muscle groups that are getting uneven loads. Such strains often lead to further muscle problems that must also be addressed.

Another example would be a person's desire to become more effective in working in or leading work teams. To improve a person's effectiveness in a team, a person must consider and become more attentive to each of the other team members. Developing empathy becomes a precursor to developing better team participation or leadership ability. If they fail to develop their empathy sufficiently, the efforts at teamwork will fail sooner rather than later. If they call upon their empathic ability quickly or easily, the new team behavior may emerge more quickly than expected.

The field of complexity science shows us that regardless of the level (i.e., individual, team, organization, community), initiation of a need for change will often occur with a sudden realization. In distribution terms, this means that extreme events are important even at the onset of change efforts. Because of that and the relatively high degree of interdependence, each act has a multiplicative effect on possible future acts (e.g., could even be geometrical or exponential) rather than additive effect. A complex system, such as a person or a team, over time, as a result of the influence of its internal dynamics, evolves into a self-organized critical state (Bak, 1996) or to the "edge of chaos" (Kauffman & Kauffman, 1995). At this stage, a small change in one part of the system can lead to a major systemic change. A single piece of information can lead to a flurry of activity through a cascading of critical thresholds (Dooley, 2004).

Thus, we see that the emergence of structure and behavior in complex systems is possible for non-intuitive reasons. It occurs because of the very nature of the uncertainty, unpredictability, and nonlinearity that characterizes such systems (Marion & Uhl-Bien, 2001). Effective leaders are those who recognize the complex web of interconnections between individuals and groups within an organization, and can create more participative, open, and adaptive organizations by reconciling individual autonomy and organizational control (Wheatley, 1994). Leaders might still be expected to articulate common values that underlie the development process, however they might need to resist the temptation of specifying exactly what the change might look like (Uhl-Bein et al., 2007).

Since desired change occurs within a complex social system, whether the change is within the individual, team, organization, community or even country, the patterns and distributions could be similar (i.e., isomorphic) or the same (i.e., fractal). This is a feature of Boyatzis' intentional change theory (ICT; Boyatzis, 2008), which identifies specific emergent phenomenon at each level of analysis that have the same effects on individual or group motivation and cognition. For example, while a personal vision statement is highly motivating for an individual, a group shared vision can be highly

motivating for a team. In addition, recognition of self-discrepancy can also start the process of intentional change in an individual, a team's recognition that it is operating far from its ideal state can spark a collective desire for change (Boyatzis & Dhar, 2021; Higgins, 1987). Moreover, there are cross-level linkages that can drive change. For example, the stronger the relationship of a team member with the team leader, the greater will be the similarity in the pace and pattern of the desired change.

If sustained, desired change is a fractal, then tipping points should be observable as invoking or preceding moments of emergence of the new thoughts, attitudes, behavior, or norms. Further, Boyatzis (2008) contended that these tipping points would appear as strange or Lorenz attractors (Viana, 2000). Attractors are a region or shape to which points are "pulled" as the result of a process that displays sensitive dependence on initial conditions. In his theory, there are the positive and negative emotional attractors, each defined by three dimensions: perceived affective sensations of positive versus negative; parasympathetic versus SNS arousal; and activation of the empathic (i.e., default mode network) versus analytic (i.e., task positive network) (Boyatzis et al., 2015; Jack et al., 2012).

In this section, we reviewed a number of factors that result in restraining innovative or distinctive behavior. Whether the response to threat, desire to belong, seeking conformity or consensual approval, innovative or different acts are less frequent. When this is added to the nature of behavioral change that each action is highly dependent on previous acts and resulting states, the conditions for long tail distributions, such as power curves are established. When a breakout moment occurs, it seems to result from a tipping point that creates a bifurcation or a two or three dimensional discontinuity. With this theoretical context for the possible ubiquity of power curves and other non-normal distributions and even discontinuous distributions of behavior change, a review of evidence about human performance and change should be more understandable.

Non-normalities and Discontinuities in Behavior and Change: A Review of Evidence in the Literature

Non-normal Data in Individuals, Teams, and Organizations

The behavioral sciences literature has a growing list of examples that show non-normal distributions (Gore, 2022). In five separate studies involving 198 samples including 633,263 researchers, entertainers, politicians, and amateur and professional athletes, O'Boyle Jr and Aguinis (2012) found that 94% follow a power law distribution more closely than a normal distribution. For example, in one of the studies, they tested whether a power law or normal distribution better fit the distribution of performance of researchers who produced publications across several academic disciplines. They found that the average misfit for the power law distribution was lower than the misfit of the normal distribution. To illustrate visually, the histograms in Figure 2 are shown of the observed performance distribution of researchers in terms of number of publications, Emmy Nominees in terms of the number of nominations,

United States Representatives in terms of number of nominations in terms of times elected to US House of Representatives, NBA Career Scorers in terms of career points, and Major League Baseball (MLB) performance in terms of number of career errors (O'Boyle Jr & Aguinis, 2012).

Average problem-solving time in experimental trials among 10 participants also followed a power law distribution (Ritter & Bibby, 1997). Specifically, while the time required to perform a task was relatively high on the first two or three tasks, it reduced dramatically for the several tasks afterwards. By mapping individual subjects' learning on a task over time, the researchers were able to model faster response in certain cases, which they attributed to the role of individual reflection. Donkin and Nosofsky (2012) had also found power law patterns in a memory performance test. They reported the results of their study for each of the four participants individually. The researchers found that the rate at which the participants forgot the items in the memory test modeled a power law curve more closely compared to a normal curve.

To Guastello (2007), who studied emergent leadership in small groups, the phenomenon appeared as a swallowtail distribution, which is marked by a large mode and two small modes, regardless of the context of the team's goals (Guastello, 2007). For

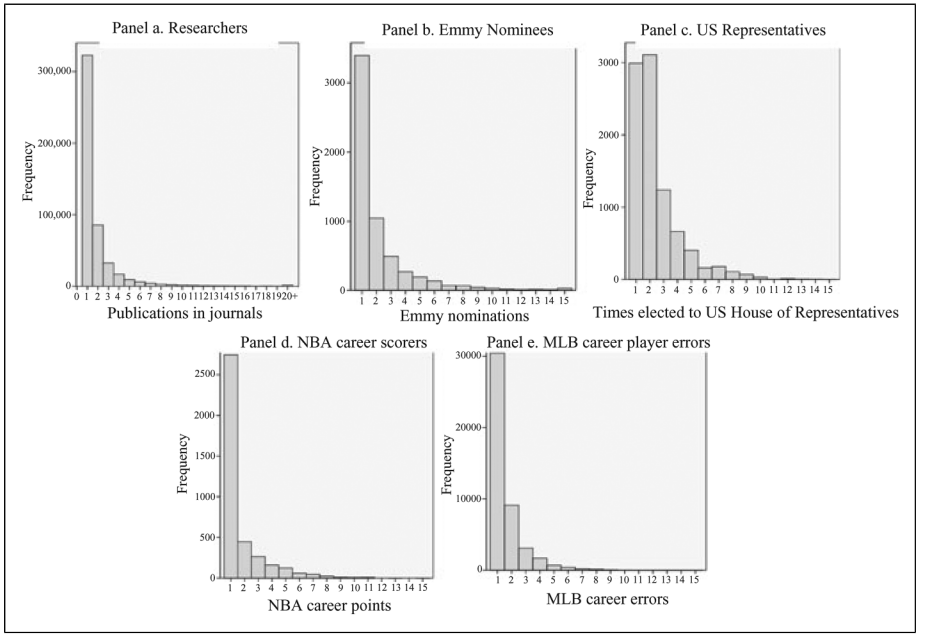


Figure 2. Distribution of individual performance for researchers (N = 490,185), Emmy nominees (N = 5,826), United States representatives (N = 8,976), NBA career scorers (N = 3,932), and Major League Baseball (MLB) career errors (N = 45,885) (O'Boyle Jr & Aguinis, 2012, p. 90). In all cases, the *Y*-axis represents frequency, and the *X*-axis shows the specific performance measure.

example, in one study (Guastello, 2011) 137 undergraduate engineering students self-organized into groups of four to six people to design and test an engineering product. After the end of the task, the students rated other members in their team on specific leadership behaviors such as control of the discussion, facilitation of creativity by others, and contribution of creative ideas. The distribution of leadership ratings fit a swallowtail model as shown in Figure 3. It is likely this occurs because when leaderless groups interact while performing a task, their members become differentiated into primary leaders, secondary leaders, and the majority of the group who remain non-leaders after the differentiation process has occurred (Guastello, 2011). Once again, a departure from the traditional form of data representation allowed the researcher to understand that informal leadership in teams looks different from a hierarchical structure.

When we escalate the level of human groups from teams to organizations, Andriani and McKelvey (2007) offer compelling evidence of the distribution of performance with many examples from strategic decisions to patterns of output. They have argued for decades about the repetitive nature of power laws appearing in organizational studies, as have others (Gabaix, 2016). A 2008 McKinsey Quarterly report titled "Using power curves to assess industry dynamics" showed several examples of power curve phenomenon such as the domestic deposits of the top 30 US banks and savings institutions, the distribution of market values of companies across several industries, and the base of financial assets of the top 30 companies (Zanini, 2008).

Even expanding beyond organizations to industries, economic phenomenon such as financial crashes (Mandelbrot & Hudson, 2008) appear to follow a power law. More recently, Avi Turetsky's (2018) doctoral dissertation showed that the performance of over 5,000 firms in terms of their Internal Rate of Return showed a non-normal distribution. Looking at the histograms across different data cuts gives one a sense of the long tails in the distribution of performance.

False Linearity and Masking Patterns of Desired Behavioral Change

For a long time, organizational research borrowed the metaphor of "evolution" from the biological sciences to describe change, with reference to the notion that change equates to a smooth trajectory of progress (Gersick, 1991). In more recent decades, some social and organizational psychologists have proposed that "emergence" or "metamorphosis" might be a more accurate metaphor to describe much of change that happens in organizational life (Gersick, 1991).

Organizational and team change. One of the first efforts in organizational theory to systematically describe the implications of nonlinear change patterns came from Robert Golembiewski (1986). He pointed out that various techniques of behavioral science, such as randomization of subjects, the use of control groups, and test-retest reliability assume linear change. Other forms of change involve complex and patterned decision-making processes and lead to shift from one psychological state to another. For example, a team moving towards a long-term goal is an example of linear change, but sometimes as part of the development process, the team may redefine for itself

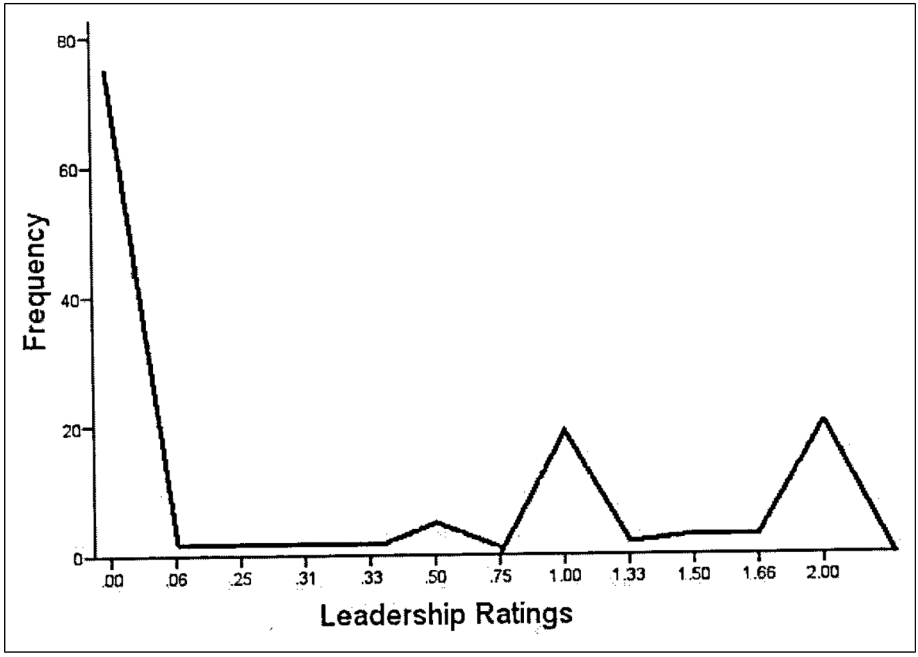


Figure 3. Distribution of leadership ratings for engineering design participants (Guastello, 2011, p. 98).

what is aspirational. It involves a mindset shift and a redefinition of what change involves. Greenwood and Hinings (1988) similarly explained that temporal relationship with structure defines an organization's track of change. Typical tracks include inertia, aborted excursions, reorientations, and unresolved excursions; with nonlinearity being an inherent element of the last three tracks. Intense pressure for change arising from dissatisfaction with accommodation of interests can lead to "radical change," when dissatisfied groups recognize the connection between the prevailing distribution of power and their position of disadvantage (Greenwood & Hinings, 1996).

As an example of micro-behaviors in a team that could lead to radical change is that of the dyadic communications between two members that have no top-down influence from the team leader. These micro-interactions are nonlinear (e.g., the team members interact without a defined time-line), exhibit bottom-up activity (e.g., the ideas generated have an influence on how the whole team acts later), and can create a complex natural teleology (i.e., they can drive the emergence of order) (Marion & Uhl-Bien, 2001). They also exhibit sensitive dependence on initial conditions. For example, if two team members happened to share the same desk on the first day of their jobs, and therefore had the opportunity to interact first, it might have an impact on the end result of their work together several months in the future (Newman, 1996).

"Punctuated equilibrium" models in the social sciences offer a model or theory that consists of relatively long periods of stability or equilibrium, punctuated by compact periods of qualitative, metamorphic change, or revolutionary change (Gersick, 1991). The principal hypothesis of the punctuated equilibrium model is that the pattern of fundamental organizational transformation is one of radical, brief, and pervasive change (Romanelli & Tushman, 1994). To go back to our previous example of individual interactions affecting team functioning, one can imagine similar change happening in an organization where several teams interact over time to enable the emergence of specific organizational forms.

Based on the above discussion, we can conclude that how an individual or a group recognizes the need for change, the direction of desired change, and its eventual trajectory cannot be adequately captured by a simple variance theory. It seems better explained as a long-term discontinuous process theory that is somewhat unpredictable.

Change processes of such nature and the transitional periods associated with them have been studied in the domains of structure (Tushman & Romanelli, 1985) and operations (Ramanujam, 2003) at the organizational level; and group development (Gersick, 1991) and leadership emergence (Guastello, 1998, 2011) at the team level. Amis et al. (2004) examined the trajectory of change in several NGOs and found that there was much less linear change than is initially apparent, particularly when it came to changing the more contentious parts of the organizations. They concluded —"… when we examine changes that took place at the sub-organizational level, we see a tendency for change to be characterized by oscillations and reversals." (Amis et al., 2004, p. 35). In their study, the organizations that completed programs of radical organizational change were characterized by initial bursts of change activity followed by relatively sedate progress toward the desired endpoint. Similarly, Chang and colleagues, who content analyzed data from 25 simulated project teams, offered a nuanced insight of group development as consisting of punctuated equilibrium, while still retaining a limited role for linear progression (Chang et al., 2003).

Individual change. Individual level change also shows similar nonlinear trajectories with emergent behavior. Behavior change, particularly self-directed or intentional change, often does not show a linear progression over time. Instead, if such a behavior change pattern is tracked over time, it will likely show "emergent" behaviors that is better described by an asymptotic curve rather than a straight line. For example, a study that investigated the process of habit formation in everyday life (Lally et al., 2010) asked participants to record whether they carried out a new behavior, such as eating a piece of fruit for lunch, for 12 weeks, and more specifically, how automatic that behavior seemed to them. The graphs for most participants (62 out of 82 volunteers) who submitted data fitted an asymptotic curve. As an example, one of the participant's automaticity score during the course of the study is shown in Figure 4 which can be described as an inverse power distribution. Automaticity is a good indicator of whether the new behavior has been incorporated, and the findings suggest that intentional behavior change can be more accurately described as an emergent phenomenon.

Perhaps the most studied efforts at individual behavior change have been in the fields of addiction research and treatment. Recidivism has been elusive and consistently

appears to follow a power curve. Hunt et al. (1971) made the point that regardless of personality types of different types of addiction (i.e., alcohol, heroin, and cigarettes), relapse rates appear amazingly similar, as shown in Figure 5. More recently, Hughes et al. (2004) profiled a series of studies of smokers attempting to quit and again found power curves, as shown in Figure 6. In another study of 1,689 adolescents aged 11 to 17, Byrne et al. (2001) showed that daily cigarette consumption following efforts to change it followed more closely a power curve than any other type of distribution.

Qualitative research in psychology has shown that major decisions are taken as a result of "crystallization" of desire or discontent (Bauer et al., 2005), and these studies throw light on the mechanisms behind such emergence. The desire for change builds up over time and articulates itself as a discontinuous movement in a new direction. For example, Bauer et al.'s (2005) study used narrative methods to show that some people arrive at a decision to change their lives by realizing what it is that they want to do in the future. One of the subjects who had made a career change from being a paramedic to attending medical school and eventually practicing medicine said: "My realization was that it is possible to have a career that I was passionate about … I had always fantasized about one day becoming a physician. Watching [physicians work together] in action catapulted me to the decision to go for it—I knew my passion lay in doing healing work." (Bauer et al., 2005, p. 1,193). The term "catapulted" vividly captures the discontinuous nature of the change, the potential for which had been building up over several years.

Miller and C'de Baca (2001) described several instances of what they called "quantum change" based on detailed interviews with 55 people who experienced major personality transformation and sudden extensive cognitive and behavior changes. According to them, one of the ways in which such changes occur is through conceptual insights that alter one's sense of self and reality. They are accompanied by an intense emotional release. One of the stories profiled by them is about a subject who had been going through a particularly low period in his life. However, three powerful incidents over a span of few days allowed him to "wake up." One of those incidents related to a friend calling him "fat." The subject described the experience in the following way: "… no one had ever told me that before and it was not my self-image at all … it was like someone was telling me something about myself that I didn't know. It felt very significant because it meant that I didn't even know who I was!" (Miller & C'de Baca, 2001, p. 58). As a result of these incidents, he decided to bring about significant changes in his life. He stopped drinking heavily, began exercising regularly, eating healthy, feeling more confident, and taking initiatives at work. Therefore, the intentional change was nonlinear, discontinuous, and the result of an intrinsic motivation that emerged suddenly and powerfully.

Discussion: Implications for Research and Practice

Future Research

Based on the theoretical insights provided above, there are several ways research on change at both the individual and group levels can be improved.

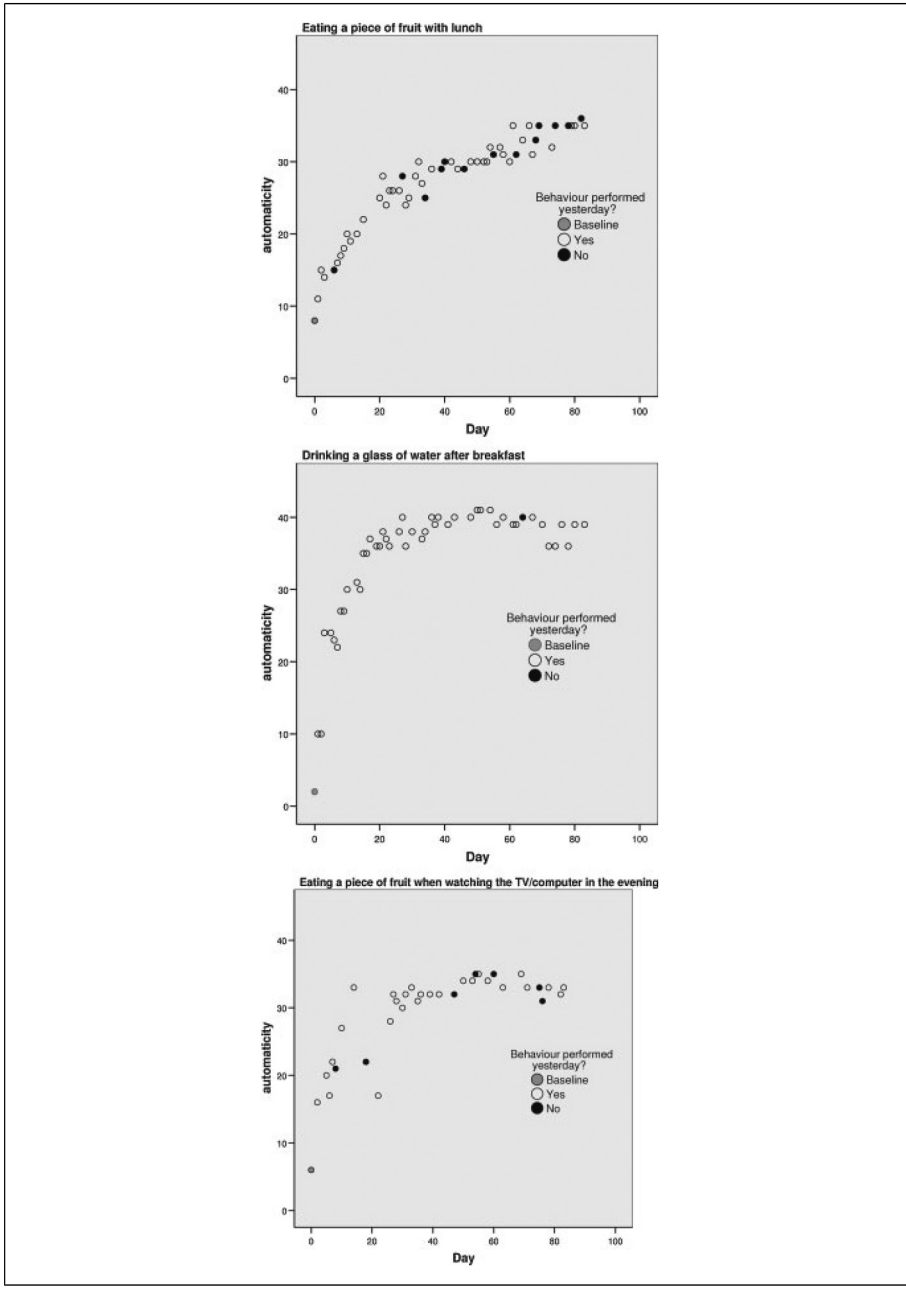


Figure 4. Example of increases in automaticity score during the 84 days of the study, showing on which days each participant had performed their chosen behavior the previous day (Lally et al., 2010, p. 103).

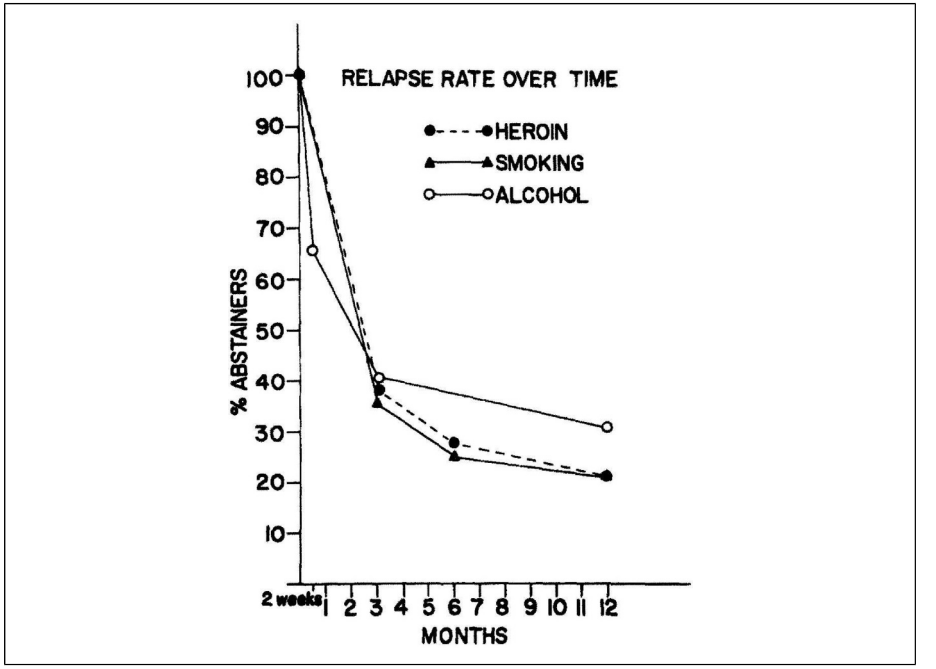


Figure 5. Relapse from heroin, smoking, and alcohol addiction (Hunt et al., 1971, p. 456).

Consider non-normal distributions for the data. Researchers should not assume normal distributions in their data, and be open to alternative curves that better fit the data. For example, Turetsky (2018) had used the maximum likelihood estimation empirical distribution fitting (MLE EDF) technique to identify specific, recognizable shapes that were good fits to theoretically driven models of portfolio growth data, ultimately enabling better theoretical insights. MLE EDF parameterizes the data assuming each candidate theoretical distribution individually, using maximum likelihood estimation in each case, and then produces a variety of fit statistics that can be used to compare the fits between these candidates. Turetsky's analysis shows that by finding the distribution that best fits the data, and then parameterizing it according to its characteristics, researchers can both obtain a more accurate understanding of the predictors of performance for non-outliers, and also important tools towards identifying the predictors of the differentiated performance of outliers. This helps to preclude false security of robustness tests in statistics (Andriani & McKelvey, 2007). For example, statistics often focus on averages when in fact the extremes may hold the most important information (Andriani & McKelvey, 2007).

Use robust non-parametric methods to adjust for non-normality and non-linearity. We do not recommend a blanket avoidance of transformations, but a more mindful application

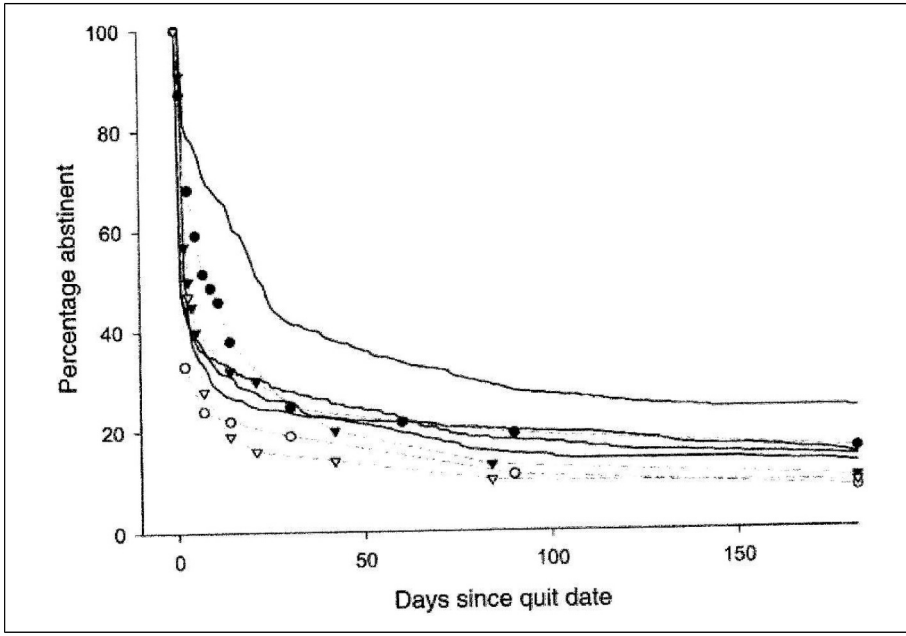


Figure 6. Abstinence over time of addicted smokers (Hughes et al., 2004, p. 33).

of them. Rönkkö et al. (2022) have pointed out in a recent article on this subject, transformations should not be chosen based on the nature or distribution of the individual variables but based on the functional form of the relationship between two or more variables that is expected from theory or discovered empirically. Explaining these methods are beyond the scope of this article. However, we would like to direct interested readers to some recent publications that have focused on modeling nonlinear effects (e.g., Edwards & Parry, 2018; Guastello, 1998; 2001; Rönkkö et al., 2022; Sieweke & Santoni, 2020; Turetsky, 2018; Zeeman, 1979).

Simulate change in a complex adaptive system through agent-based models. Another way of modeling complex behavior represented by ICT involves examining regularity that emerges from interaction of individual elements connected together in a complex adaptive system (CAS). Researchers can model actual human systems. They can define agents with schemata based on theory, build connections among them to foster self-organizing networks through feedback loops, allow them to coevolve within the context of their constantly shifting adaptive landscape, and ultimately lead to recombinations and system evolution (Anderson, 1999). The approach of agent-based modeling (ABM) can offer insights into the dynamics of emergence, and shows how simple and predictable local interactions can generate familiar but enigmatic global patterns (Macy & Willer, 2002). Organizational research has used ABMs so far to explain

emergent group-level phenomenon. Goertzel (2007) showed that ABM can create simulations of cognition based on the hypothesized integration of different components of the human psyche. Therefore, ABMs are relevant for studying desired change at the individual level as well. However, the use of this approach is limited by the need to create universal rules. Moreover, while an ABM can replicate the behavior of human systems, it is not possible to make definite conclusions about causality.

Use qualitative methods to capture emergence. Within the realm of qualitative research, narrative approaches that collect rich, in-depth interviews and other data such as diary entries can reveal instances of emergence and its perceived qualities (e.g., Lichtenstein, 2018). Process studies of change can help researchers in unveiling temporality, activity, and flow by mapping out emergence and discontinuous change over time. For example, Gehman et al. (2013) collected data from a variety of sources, including archival records, ethnographic observations, and stakeholder interviews. The resulting database included about 300 events stretching over ten years, which was then used to map out how organizational values practices emerged during that time.

Video recordings of conversations, such as that with a career coach, can be transcribed (e.g., Schindler et al., 2021), and analyzed inductively, or even be coded and statistical techniques can be used to reveal the long-term trajectory of the variables. For example, hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002) can be used to test linear, quadratic, and cubic patterns of change. It considers both within-subject and between-subject variance in outcome and can be used to provide an overall picture of the change. Hayes and Smith (2005) study, in which the researchers coded essays written weekly over a period of 24 weeks to measure levels of depression, and then used a HLM technique to map out the trajectories of recovery, provides a useful example of how qualitative data could be converted for use in latent growth models and what employing them would look like.

This is particularly relevant to research on sustained, desired change because the long-term pattern of change among subjects can be very different from one another. Traditional statistical approaches such as a t-test that look for average change in a group across a time span can blur out the diversity of patterns of change at the individual level. HLM on the other hand can highlight the fluctuations in relevant variables such as motivation levels, if data are collected at multiple time points during the transition period.

Applying these approaches to studies of retained learning. Research on outcome assessment in higher education became a norm beyond program evaluation and then was required by certification agencies in the 1990s. It asked a basic question, "What are our students learning?" By extension, how much of what they learn "sticks" or is sustained beyond the honeymoon period of 3 weeks to 3 months. In a study of MBAs (about 28–30 year olds) at a top 20 ranked MBA program in the United States, repeated assessment of the students in their first required accounting course with the same test revealed something all too many of us fear as professors (Specht & Sandlin, 1991). The half-life of knowledge was about 6 ½ weeks. The students could only produce about half of what they had earlier on the same final 6 ½ weeks earlier. The science of

learning could benefit from the approaches briefly described above to not merely tolerate but accept and integrate into their research assumptions of non-linear distributions like power curves, and the possibilities of discontinuities in retention of learning.

Future Practice

The practical implications of understanding change from the perspective of power curves or at least non-linear and discontinuous distributions would be significant as well. Ignoring the nonlinear dynamics involved in change can frustrate the person or group attempting change, as well as the change agent. Inappropriate expectations can lead to less than efficacious implications and interpretation of how to help facilitate change.

Re-evaluate the role of leadership in effecting change. While the popular press has emphasized the charismatic role of leaders such as Jack Welch and Steve Jobs in effecting change in their businesses, some empirical studies have shown that their role has probably been overstated (Khurana & Nohria, 2008). Instead, a model of leadership that acknowledges the role of contextual conditions that a perceptive leader taps into can be a better predictor of major changes in organizations (Marion, 1999). Leadership effectiveness in enabling change cannot be built exclusively around controlling the future. It depends on patiently fostering interactive conditions that ultimately enable a productive future (Marion & Uhl-Bien, 2001). It involves assumptions about non-linear and possibly discontinuous progress of any change effort.

Specifically, they can do this by delegation, or by simply not interfering in network construction, and organize their work environment to enable and encourage interaction among workers (Marion & Uhl-Bien, 2001). In some cases, a leader may be someone who rallies unifying behavior, serves as a symbol of a cause, and enables large numbers of followers to come together as a potent force for change (Marion, 1999).

The implication for organizations is that they should focus on establishing a dynamic system which allows bottom-up structuration to emerge, thereby increasing the long-term viability of the system (Osborn & Hunt, 2007). They can do this by formalizing informal networks in the workplace, having more open spaces in the office instead of just cubicles, and through the use of internal social media platforms. A popular OD method for facilitating such large group interactions is an Appreciative Inquiry summit as part of an overall process guided by ICT (Van Oosten, 2006). A leading transportation provider of industrial and commercial goods throughout North America embarked on a cultural transformation using this approach. It illustrated how sustainable change happens when leadership does not impose change top-down, but enables the right conditions over time, so that intentional change can emerge bottom-up.

This aspect of leadership also emphasizes the role of positive and trusting relationships that leaders can foster at all levels of the organization. It recognizes that the development of such relationships and their maintenance will likely follow a power curve. Another case study relates to the success of community transformation projects in rural East Pakistan in the late 1950s, and in the impoverished neighborhoods of Karachi in the 1980s and 1990s (Boyatzis & Khawaja, 2014) which revealed the role of positive and trusting relationships in effecting sustainable intentional change at the community level. Trusting relationships

were found to be not only central to the change process, as predicted by ICT, but they were also found to be providing cross-level linkages. For example, the villager organizers of Comilla became a teacher coach for others when bringing back learning to pass on to others. In this way, relationships developed not just within the village, but they created cross-level linkages between the village and the multi-village coop of which it was a part. The spread of the relationships and building of a social network followed a reverse power curve.

Recognize and leverage the critical forces that can enable transformation. The McKinsey report mentioned earlier (Zanini, 2008) had concluded that the fact that industry structures and outcomes appear to be distributed around 'natural' values opens up an intriguing new field of research into the strategic implications. Notably, the extreme outcomes that characterize power curves suggest that strategic thrusts rather than incremental strategies are required to improve a company's position significantly (Gabaix, 2016). O'Boyle Jr and Aguinis (2012) had also similarly concluded that since most performance outcomes are attributable to a small group of elite performers, then both theory and practice must adjust to the substantial role played by these individuals. That is, sustainable change happens by identifying and leveraging the most critical strategy or idea or person(s) in any specific context.

The focus is on first finding the tipping points and then using them to flip out of the current state and into the next. An example of this is the role of microcredit in helping people escape the poverty trap. The success of the Grameen Bank project in Bangladesh has been the result of ensuring that poor people had just the little bit of money needed to invest in a tiny business of their own and start making more out of it (Scheffer, 2009). In other words, having that extra few dollars can encourage the poor to set up their own business because inaction suddenly becomes less potent an attractor than action.

Another factor that could be used is intentional, guided emotional contagion and swarming. Hazy and Boyatzis (2015) described how positive emotional contagion can propel re-organizing around desired programs, values, or norms. "Going viral" through social media is another example of such a force. Aspects of percolation theory (Stauffer & Aharony, 1994) provide details on how to conceptualize using emotional contagion to access and activate nodes within networks (in this application it would be social networks within organizations or communities). They also explain how such possible access points would decay according to power laws if not activated.

Conclusion

Consideration of non-normal distributions of cross-sectional data and nonlinearity of longitudinal data is not a new request for behavioral research or practical applications. Popular statistical methods and typical practices have allowed us to often drift from this call and use various techniques to impose a particular structure to the data or a top-down approach to change efforts that have the effect of inhibiting desired change. Studying human behavior and performance as well as human desired change would require careful examination of the actual distributions of data and patterns of development. Looking for discontinuities, such as bifurcations, and power law distributions could help extract more insight from the data and

make applications more efficacious. Understanding the nonlinear nature of desired change will allow for more effective change management in individuals, teams, and organizations.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iDs

Richard E. Boyatzis https://orcid.org/0000-0002-3834-8171
Udayan Dhar https://orcid.org/0000-0001-6039-3713

References

Amis, J., Slack, T., & Hiunings, C. R. (2004). The pace, sequence, and linearity of radical change. *Academy of Management Journal*, *47*(1), 15-39. https://doi.org/10.2307/20159558

Anderson, P. (1999). Perspective: Complexity theory and organization science. *Organization Science*, *10*(3), 216-232. https://doi.org/10.1287/orsc.10.3.216

Andriani, P., & McKelvey, B. (2007). Beyond Gaussian averages: Redirecting international business and management research toward extreme events and power laws. *Journal of International Business Studies*, *38*, 1-19. https://doi.org/10.1057/PALGRAVE.JIBS.8400324

Andriani, P., & McKelvey, B. (2020). Perspective- from Gaussian to Paretian thinking: Cause and implications of power laws in organizations. *Organization Science*, *20*(6), 1053-1071. https://doi.org/10.1287/orsc.1090.0481

Bak, P. (1996). Complexity and criticality. In *How nature works* (pp. 1-32). Copernicus.

Barnard, C. I. (1938). *The functions of the executive*. Harvard University Press.

Bauer, J. J., McAdams, D. P., & Sakaeda, A. R. (2005). Crystallization of desire and crystallization of discontent in narratives of life-changing decisions. *Journal of Personality*, *73*(5), 1181-1214. https://doi.org/10.1111/j.1467-6494.2005.00346.x

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology*, *5*(4), 323-370. https://doi.org/10.1037/1089-2680.5.4.323

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3), 497-529. https://doi.org/10.1037/0033-2909.117.3.497

Bowlby, J. (1969). *Attachment: Volume 1*. Basic Books.

Boyatzis, R., & Dhar, U. (2021). Dynamics of the ideal self. *Journal of Management Development*, *41*(1), 99. https://doi.org/10.1108/JMD-09-2021-0247

Boyatzis, R. E. (2008). Leadership development from a complexity perspective. *Consulting Psychology Journal: Practice and Research*, *60*(4), 298. https://doi.org/10.1037/1065-9293.60.4.298

Boyatzis, R. E., & Khawaja, M. (2014). How Dr. Akhtar Hameed Khan led a change process that started a movement. *The Journal of Applied Behavioral Science*, *50*(3), 284-306. https://doi.org/10.1177/0021886313518965

Boyatzis, R. E., Rochford, K., & Taylor, S. N. (2015). The role of the positive emotional attractor in vision and shared vision: Toward effective leadership, relationships, and engagement. *Frontiers in Psychology*, *6*, 670. https://doi.org/10.3389/fpsyg.2015.00670

Brinton, C. (1952). *Anatomy of a revolution* (2nd ed.). Vintage Books.

Bushe, G. R., & Paranjpey, N. (2015). Comparing the generativity of problem solving and appreciative inquiry: A field experiment. *The Journal of Applied Behavioral Science*, *51*(3), 309-335. https://doi.org/10.1177/0021886314562001

Byrne, D. G., Mazanov, J., & Gregson, R. A. M. (2001). A cusp catastrophe analysis of changes to adolescent smoking behavior in response to smoking prevention programs. *Nonlinear Dynamics, Psychology, and Life Sciences*, *5*(2), 115-137. https://doi.org/10.1023/A:1026467401041

Camerer, C., & Lovallo, D. (1999). Overconfidence and excess entry: An experimental approach. *The American Economic Review*, *89*(1), 306-318. https://doi.org/10.1257/aer.89.1.306

Campbell, J. P., Dunnette, M. D., Lawler, E. E.III, & Weick, K. E. (1970). *Managerial behavior, performance, and effectiveness*. McGraw Hill.

Casti, J. L. (1994). *Complexification: Explaining a paradoxical world through the science of surprise*. Harper Collins.

Chang, A., Bordia, P., & Duck, J. (2003). Punctuated equilibrium and linear progression: Toward a new understanding of group development. *Academy of Management Journal*, *46*(1), 106-117.

Crowne, D. P., & Marlowe, D. (1964). *The approval motive*. John Wiley & Sons.

Damasio, A. (2019). *The strange order of things: Life, feeling, and the making of cultures*. Vintage.

Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin*, *130*, 355-391. https://doi.org/10.1037/0033-2909.130.3.355

Donkin, C., & Nosofsky, R. M. (2012). A power-law model of psychological memory strength in short-and long-term recognition. *Psychological Science*, *23*(6), 625-634. https://doi.org/10.3758/s13423-012-0236-8

Dooley, K. J. (2004). Complexity science models of organizational change and innovation. In *Handbook of organizational change and innovation* (pp. 354-373).

Durrheim, K., & Foster, D. (1997). Tolerance of ambiguity as a content specific construct. *Personality and Individual Differences*, *22*(5), 741-750. https://doi.org/10.1016/S0191-8869(96)00207-3

Edwards, J. R., & Parry, M. E. (2018). On the use of spline regression in the study of congruence in organizational research. *Organizational Research Methods*, *21*(1), 68-110. https://doi.org/10.1177/1094428117715067

Erdi, P. (2008). *Complexity explained*. Springer Verlang.

Fallows, J. (1985). The case against credentialism. *The Atlantic Monthly*.

Gabaix, X. (2016). Power laws in economics: An introduction. *Journal of Economic Perspectives*, *30*(1), 185-206. https://doi.org/10.1257/jep.30.1.185

Gehman, J., Trevino, L. K., & Garud, R. (2013). Values work: A process study of the emergence and performance of organizational values practices. *Academy of Management Journal*, *56*(1), 84-112. https://doi.org/10.5465/amj.2010.0628

Gersick, C. J. (1991). Revolutionary change theories: A multilevel exploration of the punctuated equilibrium paradigm. *Academy of Management Review*, *16*(1), 10-36.

Goertzel, B. (2007). *From complexity to creativity: Explorations in evolutionary, autopoietic, and cognitive dynamics* (Vol. 11). Springer Science & Business Media.

Golembiewski, R. T. (1986). Contours in social change: Elemental graphics and a surrogate variable for gamma change. *Academy of Management Review*, *11*(3), 550-566. https://doi.org/10.5465/amr.1986.4306218

Gore, A. (2022). We need to let go of the bell curve, *Harvard Business Review*. January 14, 2022 Digital article.

Greenwood, R., & Hinings, C. R. (1988). Organizational design types, tracks and the dynamics of strategic change. *Organization Studies*, *9*(3), 293-316. https://doi.org/10.2307/258616

Greenwood, R., & Hinings, C. R. (1996). Understanding radical organizational change: Bringing together the old and the new institutionalism. *Academy of Management Review*, *21*(4), 1022-1054. https://doi.org/10.2307/259163

Guastello, D. D. (1998). Origins of coordination and team effectiveness: A perspective from game theory and nonlinear dynamics. *Journal of Applied Psychology*, *83*(3), 423-437.

Guastello, S. J. (2001). Nonlinear dynamics in psychology. *Discrete Dynamics in Nature and Society*, *6*(1), 11-29.

Guastello, S. J. (2007). Non-linear dynamics and leadership emergence. *The Leadership Quarterly*, *18*(4), 357-369. https://doi.org/10.1037/0003-066X62.6.606

Guastello, S. J. (2011). Leadership emergence in engineering design teams. *Nonlinear Dynamics, Psychology, and Life Sciences*, *15*(1).

Hanson, R., & Hanson, F. (2018). *Resilient: How to grow an unshakable core of calm, strength, and happiness*. Harmony Press.

Hayes, S. C., & Smith, S. (2005). *Get out of your mind and into your life: The new acceptance and commitment therapy*. New Harbinger Publications.

Hazy, J. K., & Boyatzis, R. E. (2015). Emotional contagion and proto-organizing in human interaction dynamics. *Frontiers in Psychology*, *6*, 806. https://doi.org/10.3389/fpsyg.2015.00806

Higgins, E. T. (1987). Self-discrepancy: A theory relating self and affect. *Psychological Review*, *94*(3), 319–340.

Hofstede, G. (1984). *Culture's consequences: International differences in work-related values* (2nd ed.). Sage Publications.

Hughes, J. R., Keely, J., & Naud, S. (2004). Shape of the relapse curve and ling-term abstinence among untreated smokers. *Addiction*, *99*, 29-38.

Hunt, W. A., Barnett, L. W., Walker, J., & Branch, I. G. (1971). Relapse rates in addiction programs. *Journal of Clinical Psychology*, *27*(4), 455-456. https://doi.org/10.1002/1097-4679

Ibarra, H., & Petriglieri, J. L. (2010). Identity work and play. *Journal of Organizational Change Management*, *23*(1), 10-25. https://doi.org/10.1108/09534811011017180

Jack, A. I., Dawson, A. J., Begany, K. L., Leckie, R. L., Barry, K. P., Ciccia, A. H., & Snyder, A. Z. (2012). fMRI reveals reciprocal inhibition between social and physical cognitive domains. *NeuroImage*, *66C*, 385-401. https://doi.org/10.1016/j.neuroimage.2012.10.061

Kauffman, S., & Kauffman, S. A. (1995). *At home in the universe: The search for laws of self-organization and complexity*. Oxford University Press.

Khawaja, M. (2010). *The mediating role of positive and negative emotional attractors between psychosocial correlates of doctor-patient relationship and treatment of Type II diabetes* [Doctoral Dissertation]. Case Western Reserve University, Cleveland, Ohio.

Khurana, R., & Nohria, N. (2008). It's time to make management a true profession. *Harvard Business Review*, *86*(10), 70-77.

Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology*, *40*(6), 998-1009. https://doi.org/10.1002/ejsp.674

Lichtenstein, B. (2018). Applying the 15 complexity sciences: Methods for studying emergence in organizations. In *Handbook of research methods in complexity science*. Edward Elgar Publishing.

Lindblom, C. E. (1959). The science of 'muddling through'. *Public Administration Review*, *19*, 79-88. https://www.jstor.org/stable/i331399

Lyon, A. (2014). Why are normal distributions normal? *The British Journal for the Philosophy of Science*, *65*(3), 621-649.

Macy, M. W., & Willer, R. (2002). From factors to actors: Computational sociology and agent-based modeling. *Annual Review of Sociology*, *28*(1), 143-166.

Maddi, S. R. (1969–2004). *Personality theories: A comparative analysis* (1st–6th ed.). Dorsey Press.

Mandelbrot, B. B., & Hudson, R. L. (2008). *A fractal view of risk, ruin, and reward*.

Marion, R. (1999). *The edge of organization: Chaos and complexity theories of formal social systems*. Sage.

Marion, R., & Uhl-Bien, M. (2001). Leadership in complex organizations. *The Leadership Quarterly*, *12*(4), 389-418. https://doi.org/10.1016/S1048- 9843(01)00092-3

Maslow, A. H. (1968). *Toward a psychology of being*. D. Van Nostrand.

Meyer, M. W., & Zucker, L. G. (1989). *Permanently failing organizations*. Sage.

Miller, W. R., & C'de Baca, J. (2001). *Quantum change: When epiphanies and sudden insights transform ordinary lives*. Guilford Press.

Newman, D. V. (1996). Emergence and strange attractors. *Philosophy of Science*, *63*(2), 245-261.

O'Boyle, E. Jr., & Aguinis, H. (2012). The best and the rest: Revisiting the norm of normality of individual performance. *Personnel Psychology*, *65*(1), 79-119. https://doi.org/10.1111/j.1744-6570.2011.01239.x

Osborn, R. N., & Hunt, J. G. J. (2007). Leadership and the choice of order: Complexity and hierarchical perspectives near the edge of chaos. *The Leadership Quarterly*, *18*(4), 319-340. https://doi.org/10.2307/2393892

Parsons, T. (1937). *The structure of social action*. McGraw-Hill.

Pek, J., Wong, O., & Wong, A. (2018). How to address non-normality: A taxonomy of approaches, reviewed, and illustrated. *Frontiers in Psychology*, *9*, 2104. http://dx.doi.org/10.1136/emermed-2018-207857

Ramanujam, R. (2003). The effects of discontinuous change on latent errors in organizations: The moderating role of risk. *Academy of Management Journal*, *46*(5), 608-617. https://www.jstor.org/stable/4093756

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (Vol. 1). Sage.

Ritter, F. E., & Bibby, P. A. (1997). *Modelling learning as it happens in a diagrammatic reasoning task*. In ESRC Centre for Research in Development, Instruction, and Training.

Romanelli, E., & Tushman, M. L. (1994). Organizational transformation as punctuated equilibrium: An empirical test. *Academy of Management Journal*, *37*(5), 1141-1166. https://doi.org/10.2307/256669

Rönkkö, M., Aalto, E., Tenhunen, H., & Aguirre-Urreta, M. I. (2022). Eight simple guidelines for improved understanding of transformations and nonlinear effects. *Organizational Research Methods*, *25*(1), 48–87. https://doi.org/10.1177/1094428121991907

Rozin, P., & Royzman, E. B. (2001). Negativity bias, negativity dominance and contagion. *Personality and Social Psychology Review*, *5*(4), 296-320. https://doi.org/10.1207/S15327957PSPR0504_2

Runciman, W. G. (1966). *Relative deprivation and social justice: A study of attitudes to social inequality in twentieth-century England*. University of California Press.

Sapolsky, R. M. (2004). *Why zebras don't get ulcers: The acclaimed guide to stress, stress-related diseases, and coping* (3rd ed.). Holt Paperbacks.

Scheffer, M. (2009). *Critical transitions in nature and society* (Vol. 16). Princeton University Press.

Schindler, S., Höhner, A., Moeck, R., Bruchmann, M., & Straube, T. (2021). Let's talk about each other: Neural responses to dissenting personality evaluations based on real dyadic interactions. *Psychological Science On Line First*. https://doi.org/10.1177/0956797621995197

Schutz, W. C. (1958). *FIRO: A three dimensional theory of interpersonal behavior*. Holt, Rinehart, and Winston.

Segerstrom, S. C., & Miller, G. E. (2004). Psychological stress and the human immune system: A meta-analytic study of 30 years of inquiry. *Psychological Bulletin*, *130*, 601-630. https://doi.org/10.1037/0033-2909.130.4.601

Sherif, M., Harvey, O. J., White, B. J., Hood, W. R., & Sherif, C. W. (1961). *Intergroup conflict and cooperation: The Robbers Cave experiment* (Vol. 10). University Book Exchange.

Sieweke, J., & Santoni, S. (2020). Natural experiments in leadership research: An introduction, review, and guidelines. *Leadership Quarterly*, *31*, 1-25. https://doi.org/10.1016/j.leaqua.2019.101338

Specht, L., & Sandlin, P. (1991). The differential effects of experiential learning activities and traditional lecture classes in accounting. *Simulations and Gaming*, *22*(2), 196-210. https://doi.org/10.1177/1046878191222003

Stauffer, D., & Aharony, A. (1994). *Introduction to percolation theory: Revised second edition*. CRC Press.

Storr, A. (1996). *Feet of clay: Saints, sinners, and madmen: A study of genius*. Free Press.

Turetsky, A. I. (2018). *Making heads and tails of distributional patterns: A value-creation- type and sector-based analysis among private-equity-owned companies* [Doctoral Dissertation]. Case Western Reserve University.

Tushman, M. L., & Romanelli, E. (1985). Organizational evolution: A metamorphosis model of convergence and reorientation. *Research in Organizational Behavior*, *7*, 171-222.

Uhl-Bien, M., Marion, R., & Mckelvey, B. (2007). Complexity leadership theory: Shifting leadership from the industrial age to the knowledge era. *The Leadership Quarterly*, *18*, 298-318. https://doi.org/10.1016/J.LEAQUA.2007.04.002

Van Oosten, E. B. (2006). Intentional change theory at the organizational level: A case study. *Journal of Management Development*, *25*(7), 707-717. https://doi.org/10.1108/02621710610678508

Viana, M. (2000). What's new on Lorenz strange attractors? *The Mathematical Intelligencer*, *22*(3), 6-19.

Wheatley, M. J. (1994). *Leadership and the new science: Learning about organization from an orderly universe*. Berrett-Koehler Publishers, Inc.

Wilson, E. O. (2000). *Sociobiology: The new synthesis, twenty-fifth anniversary edition*. Harvard University Press.

Zanini, M. (2008). Using power curves to assess industry dynamics. *McKinsey Quarterly*, *1*, 1-6.

Zeeman, E. C. (1979). Catastrophe theory. In *Structural stability in physics* (pp. 12-22). Springer.