Perspectives on Behavior Science (2019) 42:713–731
https://doi.org/10.1007/s40614-019-00208-z

CULTURAL AND BEHAVIORAL SYSTEMS SCIENCE

Out of the Lab: Shaping an Ecological and Constructional Cultural Systems Science

Mark A. Mattaini [1,2]

Published online: 17 June 2019

Abstract

Contemporary societies face critical, interlocking, "wicked" challenges, including economic inequities and marginalization, personal and collective violence, ethnic and religious conflicts, degradation of "the commons," climate change, and more, and all of these issues clearly are grounded in behavior. An adequate culturo-behavior science could be positioned to advance and leverage research and interventions supporting community well-being, and contribute to overcoming urgent societal and global challenges. The current state of cultural systems science, however, is limited by theory and methodology, and by competition for attention with well-established research and practice opportunities related to individual-level challenges. In this article, the author explores those limitations, and suggests a more expansive perspective drawing on historical and contemporary ecological science and contemporary theories of complex systems. Research guided by established science within those disciplines offers opportunities to move cultural systems science out of the lab, and into a more adequate, environmentally rich stance drawing on ecological strategies, recursively integrating contextual observations, conceptual advances, and in vivo experimentation. Examples of each of those strategies and exploration of developmental programs of research grounded in such integration are explored.

Keywords Cultural systems science · Ecological systems · Culturo-behavior science · Complex systems

Contemporary societies face critical, interlocking, "wicked" challenges, including economic inequities and marginalization, personal and collective violence, ethnic and

A previous version of this article was delivered as the Presidential Address at the 44th Annual Convention of the Association for Behavior Analysis: International in San Diego, California, on May 28, 2018.

✉ Mark A. Mattaini

[1] Jane Addams College of Social Work, University of Illinois at Chicago, Chicago, IL, USA

[2] Paguate, USA

religious conflicts, degradation of "the commons," climate change, and more, all of which involve social and environmental justice dimensions (Mattaini & Aspholm, 2016). Each of these issues is clearly grounded in behavior; an adequate behavioral systems science should therefore be positioned to advance and leverage research and interventions that support community well-being, and contribute to overcoming urgent societal and global challenges. Since B. F. Skinner's *Walden Two* (1948, 1976) and *Science and Human Behavior* (1953), and especially since his 1981 "Selection by Consequences," behavior science has explored the selection of cultural practices and processes, arguing that our science has unique potential for contributing to just, satisfying, and sustainable societies (see, for example, Grant, 2011). An Association for Behavior Analysis International (ABAI) task force on public policy in 1988 established guidelines for contributing to such change in scientifically rigorous and ethical ways (Fawcett et al., 1988). Behavior analysts also have more recent history and experience in influencing public policy (Biglan, 2009), including advocacy for persons living with developmental disabilities (ABAI, 1989, 2010) and for ourselves related to certification and licensure (Moore & Shook, 2001). Such skills could, under supportive conditions, generalize to work in other cultural and community arenas, although such efforts have so far been quite modest.

The collective challenges listed above, however, demonstrate humbling levels of complexity, and are essentially and deeply interlinked. By contrast, current cultural analytic scholarship must be viewed as relatively rudimentary, not yet demonstrating the capacity to capture complex systemic realities thoroughly enough to predictively intervene. Although experimental and conceptual work in this area offers a valuable foundation, a broader view is required to have a meaningful impact on contemporary issues, a view that goes beyond our current knowledge base. In this article, I reflect on the current state of cultural analytic science, and explore a transdisciplinary framework that holds real promise for understanding, predicting, and influencing the complex dimensions of urgent societal and global issues. Skinner (1987) was, I think, largely correct in his analysis of "why we are not acting to save the world," focusing on susceptibilities inherent in selection, but limitations in the current state of behavior science is in my view an additional and powerful limiting factor. Rehfeldt (2011) and Dixon, Delisle, Rehfeldt, and Root (2018) argue that the impact of studies of derived stimulus relations has been limited by their settings in "highly controlled, laboratory-like environments" (p. 247), a critical limitation for cultural science, as explored in detail later.

Cultural Analytic Scholarship

Conceptual Scholarship

Cultural analytic scholarship thus far has been primarily of three types. The first to emerge, conceptual interpretation and analysis, has been a rich stream that has offered and will continue to offer guidance for other forms of scholarship, both in the laboratory and in the field (Skinner, 1987). Although this was not an area he explored in depth, Skinner's work going back at least to 1948 recognized the potential of behavior science for contributing to a rigorous understanding of human culture (1948, 1953, 1987). Sigrid Glenn's seminal 1988 paper "Contingencies and Metacontingencies" and her 1992 presidential address, "Windows on the 21st Century" (Glenn, 1993), integrated previous work and inspired much

more, framing and elaborating basic concepts that have guided the field ever since. Other conceptual contributions included significant work in behavioral community psychology in the 1960s, 1970s, and 1980s (Greene, Winett, Van Houten, Geller, & Iwata, 1987), more recent studies out of the University of Kansas, particularly from Steve Fawcett (e.g., 1991) and his colleagues and students (e.g. Francisco, Paine, & Fawcett, 1993), two books edited by Peter Lamal in the 1990s (Lamal, 1991, 1997), the work of the University of Nevada Reno Group (e.g., Alavosius, Newsome, Houmanfar, & Biglan, 2015), and perhaps some of our own (e.g., Aspholm & Mattaini, 2017; Mattaini, 2013). Jay Moore's 2002 presidential address called out and conceptualized our collective ethical obligations to support social justice (Moore, 2003). Several international thinktanks, organized by Jõao Claudio Todorov, Sigrid Glenn, Maria Malott, and Ingunn Sandaker, among others, have focused on clarifying critical cultural science concepts and processes ("Complexity & selection," 2004; Glenn et al., 2016). Many others have made important contributions, more than I could possibly include here.

Much of the recent conceptual work on cultural systems, however, has focused on developing analogues to operant processes, and efforts to reach consensus on terms. Useful as such work can be for jumpstarting a new area of science, emphasizing expert consensus on core concepts and processes, and widely adopting analogic frameworks that risk limiting the boundaries of relational responding, may blunt innovation and the uncertainty crucial to a just-emerging field. An emerging science must be open to stimulating, welcoming, and encouraging alternative perspectives—and honest challenges.

Basic Laboratory Research

A second stream of cultural scholarship has consisted of basic laboratory research, most of which explores brief structured encounters among subjects who lack common histories or expectations of common futures (e.g., Smith, Houmanfar, and Louis, 2011; Todorov & Vasconcelos, 2015; Vichi, Andery, & Glenn, 2009). As is standard in laboratory science, these studies are intentionally amputated by setting and design from larger contextual and historical influences and variables. Such studies have been and will continue to be valuable in moving behavior science beyond conjecture and in answering some basic questions, in particular so long as (a) the results are genuinely unknown in advance and meet the "so what" criterion, (b) findings reported do not simply apply new labels to existing social psychological observations, and (c) investigators analytically search for implications beyond the lab. *Prioritizing a serious and rigorous emphasis on translational research* that could emerge from such research holds considerable promise for contributing to social change efforts (Dixon et al., 2018). For example, organizational behavior management research conducted in laboratory settings has provided broadly applicable models emphasizing the dynamics of behavioral systems, clearly a crucial direction for elaborating a cultural systems science (Houmanfar & Mattaini, 2017; Malott 2003; Krapfl & Kruja, 2015) Special Issues, 2009).

Behavioral Community Psychology

A third body of work is found in behavioral community psychology, which includes substantial experimental work (e.g., Jason, Braciszewski, Olson, & Ferrari, 2005;

Greene et al., 1987). I will return to this stream of research later, but note here that the behavior analytic community has gradually shifted away from such work, limiting our involvement in large system and community work. Widening differences in acceptable methodologies and costs associated with experiments conducted in community or societal settings account, at least in part, for that shift. Before discussing this further, however, I want to explore the challenges present in taking our work beyond its current state, and suggest that a framework integrating elements of the natural science of ecology, contemporary developments in systems sciences, and related aspects of complexity theories offer possible routes out of the lab and into collective societal challenges that presently appear largely intractable.

Complexity and Systems Science

As emphasized by the National Academy of Science et al. (2005), inter- and transdisciplinary collaborations are essential for realistic intervention in complex arenas. Potential disciplinary partners in large-scale efforts, however, often operate from models of scholarship that seriously oversimplify cultural processes, as is typical with ours. Many public health interventions, for example, primarily target changes in individual behavior, often focusing on macrocontingencies (as defined in Glenn et al., 2016), or on individual health-related behaviors rather than systemic conditions that contribute to those behaviors.

A transdisciplinary, comprehensive, and effective cultural science certainly requires a natural science commitment, grounded in contemporary selectionist processes. Recent research, however, argues that selection by consequences accounts for only some, and in some cases the lesser part, of genetic, behavioral, and cultural evolution (Killeen, 2017; Killeen & Jacobs, 2017). Killeen (2017) argues "before, beneath, and after the cosmically brief but crucial epoch of Darwinian evolution that shaped creatures such as ourselves, non-Darwinian forces prevail, in all three domains" (the evolution of species, response repertoires, and cultures; p. n/a). The evolution of species, as Killeen discusses, depends not only on genetic selection, but also, and perhaps more so, on processes like saltations (quantum jumps in complexity and genetic diversity) and lateral gene transfers that he describes as powerful, communal, evolutionary processes. Likewise, at the behavioral level, although selection by consequences is certainly present, much of behavior appears to be largely responsive to contextual factors, motivational states, errors in attention, and signaling processes, rather than simple reinforcement (Baum, 2012; Killeen, 2017).

Of most interest for us in this article, many cultural practices appear to emerge from lateral transfers of practices and memes rather than from Darwinian selection processes. It appears that most changes in cultural practices do not significantly contribute to cultural survival (Killeen, 2017). In some cases, the most critical factors are relational in nature (Dixon et al., 2018). These reports and other work in related areas (e.g., Baum, 2012; Cowie & Davison, 2016) serve as valuable challenges to behavior science's almost exclusive focus on standard models of selection and analogic analyses (i.e., directly applying principles from the behavioral level to the cultural).

Recent advances in complexity science (Beckage, Kauffman, Gross, Zia, & Koliba, 2013; Grossmann & Haase, 2016; Loehle, 2004; Mitchell, 2009; Rizzo & Galanakis

2015), dynamical systems theory (including study of self-organization and emergent processes, e.g., Granic & Patterson, 2006; Kwakkel & Pruyt, 2015; Valentinov & Chatalova, 2016), general ecology (Hörl & Burton, 2017), and non-Darwinian evolution likely will and should influence our science in the future in ways that open new conceptual options—but behavior scientists have only begun to explore, much less integrate, such advances. The references listed here involve work related to cultural-level challenges that "are by nature complex, have a long time horizon, involve both current and future generations, have a nature that is often contested by the different actors affected by it, have issues that evolve over time, and are wicked problems" (Cagnin, Amanatidou, & Keenan, 2012. p. 140), including "global environment change, societal ageing, and long-term resource availability" (Kwakkel & Pruyt, 2015, p. 358). A willingness to engage in transdisciplinary scholarship with a willingness to both learn and contribute will be essential to benefit from such work.

Complexity within and among Behavioral Systems

The metacontingency as developed by Glenn et al. (Glenn, 1988; Glenn et al., 2016), and the elaborated metacontingency as recast by Houmanfar et al. and the University of Nevada-Reno (Brayko, Houmanfar, and Ghezzi, 2016; Houmanfar, Alavosius, Morford, Reimer, & Herbst, 2015; Houmanfar, Rodrigues, & Ward, 2010) have proved useful in beginning to understand some dimensions of cultural processes, and we need more of this work. In the elaborated metacontingency, the addition of feedback loops between consumer practices and group rule generation by providing a functional account of associated verbal networks (i.e., relational responding) was a critical advance, as much of the earlier work did not convincingly capture *how* the choices/environmental demand of receiving systems/consumers produced changes in the contingency interlocks within the dynamic behavioral systems.

As seen in the listed publications and multiple others, the Reno group has increasingly recognized and integrated contextual variables such as rule generation, cultural milieu (e.g., traditions, cultural values, belief systems) and institutional stimuli (Houmanfar, Rodrigues, & Smith, 2009) in their research—an advance driven in part by the practical, on-site work of scholars and practitioners in organizational behavior management. Also contributing to possible advances is expanding conceptual and experimental work related to leadership within organizations and communities (Houmanfar & Mattaini, 2017). Still, as behavior scientists further explore determinants of complex cultural practices and cultural dynamics, current models and approaches cannot yet adequately capture the complex networks of cultural practices and patterns involved in difficult societal realities. Furthermore, scientists working in the cultural area have a good deal more work to do in integrating what is known about relational responding (Hayes, Barnes-Holmes, & Roche, 2001, Dixon et al., 2018) into cultural-level research, given that such responding can potentiate or limit the impact of interventions (see, for example, Baker et al., 2015).

As a small-scale example of the realities of complexity at community or societal levels, the behavior of neighbors coming together to support green energy practices, as discussed by Nevin (2018), is almost certainly more influenced by media, education, personal histories, and established communal values than by immediate reinforcement, or even in-the-moment patterns of interlocking behavioral contingencies as neighborhood groups

met, present as those may be. Adequately diagramming and integrating even just the most important processes present in such collective action may require concurrent examinations of multiple events and conditions at considerable physical, temporal, and conceptual distances. (I emphasize diagramming because the increased bandwidth offered by graphics enables simultaneous capture of more dimensions than can linear verbal descriptions; Mattaini, 1993; Tufte, 1990, 1997, 2001, 2006). The diagrams in Kwakkel and Pruyt (2015), in particular Figure 1 (p. 366), and Figure 6 in Granic and Patterson (2006, p. 113) are accessible examples of such integrative graphics.

Consider as another example, the complex realities within which a failing school in an impoverished and marginalized community operates (e.g., Rice, 2018). Factors leading to failure typically involve a mix of intrastaff dynamics; marginalized families; trauma histories of children, parents, and in many cases teachers; relational responding emerging from media attention, neighborhood and personal histories; state budget provisions; patterns of community-police relations; actions of teachers' unions; intersections with youth "gangs" (now mostly very small cliques; Aspholm & Mattaini, 2017); local churches; and the list goes on. Within this network, an established but narrow intervention like the Good Behavior Game (Barrish, Saunders, & Wolf, 1969; Embry, 2002; Leflot, van Lier, Onghena, & Colpin, 2010) can be of help, but is unlikely to have major impact or to be sustained unless attention is also directed in a tightly targeted way toward identifying and addressing the most powerful and accessible elements of the larger ecological context, and the interactions among them (Gambrill, 1994; Mattaini, 2002; Mattaini & Holtschneider, 2016). And then consider the situation of a large city with many such schools; factors influencing what happens in a single classroom can include national and even global variables.

Unpredictability in Complex Systems

Complexity theory suggests that in many cases the results of intentional efforts to maintain or shift practices cannot be easily or adequately predicted (Mitchell, 2009; Zenil, 2013). Building on Wolfram's (2002) controversial but defensible irreducibility argument, Beckage et al. (2013) indicate that there is necessarily "a loss of predictability as one moves from physical to biological to human social systems," but that the loss of predictability "also creates a rich and enchanting range of dynamics" (p. 79). Furthermore, Wolfram's claim that complexity emerges from patterns of simple elements is a surprisingly encouraging perspective for behavior and cultural analysis. Identifying optimal points for influence advances with targeted attention to current complex dynamics and those in personal and collective history, with particular attention to coupling, emergence, structure and process, homeostasis, affordances, and dispositions—drawing on elements of general and other systems theories and well as behavior science research (Allen & Hoekstra, 2015; Beckage et al., 2013; Couto & Sandaker, 2016, Hörl & Burton, 2017; Killeen & Jacobs, 2017).

Cultural Systems Analysis: An Ecological Science

The science required to have a meaningful impact on major social issues will largely be, for behavior analysis, "a new kind of science" (apologies to Wolfram) constructed

within the ecological fields where the issues about which we are concerned are embedded. The present article sketches what such a science might look like, providing exemplars from recent field work, our own and that of others, within a strategic ecological research framework. As background, it may be helpful to consider how an ecological strategy differs from our traditions, while noting that elements of this strategy are in fact sometimes found in our literature. The 1974 exchange in *Journal of Applied Behavior Analysis* between Edwin P. Willems and Don Baer on "behavioral technology and behavioral ecology," raised some of the challenges that we are revisiting as we advance toward an adequate cultural science. Willems (1974) indicated that behavioral ecology draws attention to the "system-like interdependencies among environment, organism and behavior" (p. 8), and further noted the "immediate and pervasive need for an expansion of perspective" (p. 12) in behavior analysis, a call repeated here. Don Baer's characteristically brilliant but acerbic response to Willems (with the title "A Note on the Absence of a Santa Claus in Any Known Ecosystem"; Baer, 1974), nonetheless ends with the statement "Willems argument is the proper one for today" (p. 170). Baer's statement appears to be particularly appropriate as behavior science widens its lens.

In 1985, Edmund Fantino published a paper arguing that behavioral ecology (within ethology) and behavior analysis were complementary, each offering valuable information to the other. Fantino provided a series of examples, most from the foraging literature, demonstrating mutual advantages, and producing results that otherwise would not have been discovered. Although the questions under investigation were narrow, Fantino's message reminds behavior science that it arguably is one area of ecological study, within the broader discipline of biology. The essential connections become even clearer as one moves to current work in human ecology (Dyball & Newell, 2015), unified ecology (Allen & Hoekstra, 2015), and general ecology (Hörl & Burton, 2017). All are firmly grounded in systems and complexity theories as they have grown and specialized from the original work of Ludwig von Bertalanffy (1968), Parsons and Smelser (1999), Odum and Odum (1953), Bogdanov (1980), and others across multiple scientific disciplines. Thus, cultural systems science may best be understood as a specialty area within ecological science, offering an expanded framework for behavior science, and in fact also for behavior analytic practice.

A Strategic Framework for Ecological Analysis

Ecological frameworks are increasingly integrated into and across multiple analytic domains in basic sciences, information science, biopolitics, economics, social work, and many others (Allen & Hoekstra, 2015; Hörl & Burton, 2017; Karban, Huntzinger, & Pearse 2014; Mattaini & Holtschneider, 2016; Zenil, 2013). An ecological perspective, I believe, offers a powerful integrative framework for cultural systems science as well. Marston Bates (1906–1974), a zoologist, was among the founders of ecological science. In his 1950 book, *The Nature of Natural History*, he offered an accessible introduction to a highly recursive strategy for ecological study and intervention, a strategy on which ecological systems analyses currently draw. Ecological science has of course advanced enormously since 1950; Bates's heuristic framework, however, offers a robust core for organizing data collection and systems analysis that largely remains characteristic of ecological disciplines. This framework is used here to introduce integrated options for constructing transdisciplinary programs of research in areas that behavior scientists have

not typically pursued ecologically. Bates's methodological strategy encourages and structures multiple transactional and recursive iterations of (a) rigorous observations of the phenomenon of interest within their complex natural contexts, (b) the framing of "conceptual schemes" emerging from those observations, and tested against existing knowledge, and (c) (often modest) experiments conducted under typical conditions in natural settings, designed in response to those observations and conceptual schemes, all (d) facilitated by the development of new measurement and analytic tools as required to collect and process complex data. In particular, it is important to note that this strategic model assertively calls for the integrative programs of research, largely in natural settings. For work with community and other large cultural systems, programs of research strategically integrating observation, conceptual advances, and experimentation within complex, natural conditions, using advanced analytic tools, provides considerable scientific power. Applications of this systematic approach hold promise for elaborating cultural systems analyses that specifically direct attention to the complex dynamics within which societal and global issues are embedded.

Observational Methods

Bates (1950) describes science as "a queer kind of search" (p. 269) in which scientists often cannot be clear in advance about just for what they are searching. Within Bates's strategic model, ecological science typically begins with observation. Such observation may be undertaken in person, or through the study of existing data, and may include interviews (observation of verbal behavior) and other methods often used in qualitative research. Observation is a central tactic for skilled behavior analysts performing functional assessments or exploring schedules of reinforcement under varying conditions, but the value of observations potentially extends much further. Our well-established direct observation repertoires, integrated with simultaneous attention to context across at least the most critical ecological dimensions, have potential to contribute to refining ecological observation methods across disciplines. Willems (1974) emphasized the need to collect "other data," (contextual data) noting that "the more narrow and specific the technological application becomes, the greater the array of phenomena its practitioners tend to disregard" (p. 18). He also notes, echoing Wahler (verbal statement quoted in Willems, 1974), that "there is, at present, no *a priori* basis for choosing behaviors to monitor" (p. 19). Essential to rigorous data collection, then, is an openness to observing contextually and often in new ways,[1] always including rigorous procedures to ensure validity and reliability (Miles, Huberman, and Saldana, 2014). Doing ecological work may require the courage to step into difficult, and perhaps intimidating contexts—often, in the beginning, without knowing quite for what one is looking. (Making sense of what is observed requires moving into conceptual analysis, the second methodology discussed below.)

The dissertation recently completed by Roberto Aspholm (one of my recent PhD graduates), *"This Ain't the Nineties": Chicago's Black Street Gangs in the Twenty-First Century* (2016), offers an examples of both observational research, and conceptual integration. His study participants were young men, in general mid-teens to mid-20s,

[1] There are many established forms of data collection. Jason and Glenwick's 2016 *Handbook of Methodological Approaches to Community-Based Research* offers many approaches from which behavior analysts can learn, and I recommend it both for content, but also as an example of considerable interdisciplinarity.

who were actively involved in violent gang activities on the South Side of Chicago. Aspholm was a known figure in the community, having done paid and volunteer youth work during the years he was completing his graduate studies, and living with his family in the community. (His wife is African American, and he was raised primarily in African American communities.) He conducted extended interviews with his study participants ("subjects" in research terms) exploring their life histories and factors contributing to their continuing involvement on the streets and specifically in acts of violence. This was a rich study that will be published as a book shortly by Columbia University Press (Aspholm, in press). Interview transcripts and Aspholm's extensively documented contextual observations provided the data. Two analyses of these data were performed, the first using standard ethnographic open coding to explore significant contextual variables that might be present, and the second a behavior analytic search for relevant and potentially interlocking contingencies.

The results suggested that violent street cliques offer marginalized young people a mutually reinforcing community, which they often described as "family." The cliques, often named for the blocks or streets on which they lived, offered important—although quite modest—economic opportunities and supports, a measure of mutual protection, and, the data suggest, a means of justifying their violence. Participation also offered a viable means of resistance to psychological trauma associated with poverty, racial denigration, physical insecurity, and economic exclusion (and yes, these conditions and experiences were explicitly and perceptively described by many participants). Despite the potentially severe consequences associated with involvement in violence and street gangs, for many excluded and traumatized young people the reinforcers associated with gang culture were described as outweighing those risks.

But here is the exciting part: These data supported a conceptual model suggesting possibilities for intervention. Contemporary behavior science supports an emphasis on *constructional* approaches to personal and social problems (Goldiamond, 1974/2002; see also Mattaini, 2013; Sidman, 2001)—shaping and sustaining alternative patterns of behavior that produce reinforcers (positive and negative) relatively equivalent to many of those offered by problem behavior, although potentially producing preferred social outcomes. Extensive existing literature demonstrates that enlisting young people in strategic activism and social movements offers a set of reinforcers substantially equivalent to those that gang life and street cultures provide—and some advantages those lifestyles cannot (Aspholm & Mattaini, 2017; Stephan & Thompson, 2018).

In our chapter in Peter Sturmey's 2017 book, *The Wiley Handbook of Violence and Aggression*, Aspholm and I outline reinforcers and conditions often available through participation in nonviolent activism, and the many ways they map onto what gang culture provides. There is substantial history of such shifts among marginalized young people globally, and specifically among Chicago gangs (documented in Aspholm's dissertation, as are the obstacles that Chicago pols placed in the way). Aspholm is now involved in efforts to realize such constructive alternative options for this population, moving from observation to conceptual analysis and soon to experimentation (a program of research).

Conceptual Analysis

The second research option Bates (1950) discusses (always remembering that these options are recursive) is the development of "conceptual schemes" in an effort to make

sense of observations. Bates includes scientific hypotheses, theories, and laws within his definition of conceptual schemes. Although the place of theory in behavior analysis and behavior science has sometimes been controversial (and participating in such controversy evidently can in itself be reinforcing), there really is little question that forming (or identifying) a conceptual frame for study of complex realities is required to bring order out of raw data, explore how those data fit together, and for challenging existing understandings. Recent work in derived stimulus relations and relational responding, controversial as they may be, is one example of an alternative approach that should be mined for possible contributions to cultural-level science (Dixon et al., 2018). Coherent conceptual frameworks may often be the "unknown" for which we are searching in cultural analysis, and typically lead to new questions to be explored. (This is reminiscent of Fred Kerlinger's [1966] emphasis on the search for rigorous theory as central to science).

Examples of conceptual interpretation are quite numerous in the behavior science literature, including much of Skinner's work, many presentations at the 2012 ABAI Theory and Philosophy Conference, and many publications in *The Behavior Analyst* (now *Perspectives on Behavior Science*) and *Behavior and Social Issues*. As an example, Maria Malott's (2013) work on the Mexican muralist movement is an exemplar of conceptual modeling drawing on historical data. (See also Rizzo & Galanakis, 2015, for an example integrating the arts with complexity theory in transdisciplinary work.) There are also many natural experiments available for analysis. Large-scale analyses of past events, for example, nonviolent struggles for democracy and human rights (e.g., Chenoweth & Stephan, 2011) can sometimes be methodologically similar to astrophysics, in which studies of large-scale events (observations) generate hypotheses (conceptual frameworks) that may subsequently be tested in modest ways in natural settings or through natural experiments. An analysis I have been involved with for some time offers a modest example of the development of historico-behavioral conceptual frameworks.

In a paper titled "Constructive Noncooperation: Toward a 21st Century, Science-Based 'Constructive Programme,'" Mattaini (2015) developed a Gandhi-inspired, Goldiamond-shaped constructional framework consistent with significant existing research for addressing crucial societal and global issues. Gandhi (1945) viewed his constructive program as his most important work. The program was a comprehensive strategy for establishing 18+1 interlocking, nationwide cultural practices that he believed in combination would inevitably construct freedom from the British Empire. My preliminary analysis, drawing on that program, focused on human rights expansion, expansion of restorative and transformative justice systems, global expansion of youth activism for social justice and sustainable economic development, expansion of fulfilling and environmentally sustainable lifestyles, and actions to reduce income and wealth disparities. These targets may sound ridiculously expansive, but the purpose of that paper was actually quite limited—integrating a few scientifically defensible and historically documented principles that might redirect activism and advocacy efforts toward modest experiments in the community.

The paper was presented at a peace and justice conference, not a behavior science one, and the ideas were intriguing for and well-received by those attending. This was an activist audience that might immediately find use for the content presented. Behavior scientists clearly need to do much more presenting outside our own intellectual

community, if they are to become players in social change (Eagleman, 2013; Lee, 2016). Attending such conferences can contribute to our own learning about serious societal and global issues, and may offer unfamiliar, yet practical and rigorous intervention possibilities to others. It is said that much of the effort expended in activism is wasted, due to poor strategic and tactical choices (Sharp, 2005; Mattaini, 2013). The goal for the conference presentation was to encourage practices with better chances for success. Table 1 outlines two data-grounded strategic options for one goal area targeted in this project: global expansion of youth activism for social justice concurrent with sustainable economic development (goals that are interlinked). More information on these options is available in *Strategic Nonviolent Power* (Mattaini, 2013). This work preceded and informed Aspholm's dissertation, just discussed—both are components of an ongoing collaborative research program designed according to Bates's strategic model.

Experimentation in Natural Environments

Useful conceptual frames informed by observations often suggest new questions to pursue, directing us to Bates's (1950) third strategic option**.** He notes that experiments, "to be scientific must be organized, codified, directed, repeated, interpreted, fitted into conceptual schemes" (pp. 274–275). From Bates's perspective, to maintain focus in a complex environment, it is generally best to begin with experiments at a modest scale, to test and refine principles suggested conceptually. If one is hoping, at a cultural level,

Table 1 Critical Goals toward which Movements of Constructive Noncooperation Might Reasonably Be Explored and Tested

Goals	Social Movement Strategies (examples)
Broad expansion of restorative and transformative justice approaches in educational and justice settings	• Integration of circle and conferencing approaches as alternatives to school suspension and expulsion (Riestenberg, 2012) • Testing of innovative restorative approaches for intimate partner violence (Ross, 2006; Fulambarker, 2013) • Advocacy supporting integration of community-rounded restorative practices into campaigns to reduce incarceration (Project Nia, 2013)
Global expansion of youth activism for social justice and sustainable economic development	• Construction of networks of support for youth activism within multiple social sectors (e.g., religious institutions, nongovernmental organizations, local community organizations, local community organizations, businesses, media and others (Aspholm & Mattaini, 2017; Mattaini, 2013) • Construction of global electronic and in-person networks of youth activists (e.g., Saleem, 2018 and other AFSC publications) • Development of accessible educational programs for youth emphasizing social justice, consciousness-raising, and the dynamics of advocacy, civil resistance, and movement building (Atkinson, 2012)

to understand and reduce problematic behaviors and practices, or better yet to construct competing and desirable options, laboratory studies can assist with and refine specific component questions, but taking experiments out of the lab, and into the complex world in which violence, trauma, marginalization, economic inequities, and other violations of human rights and many other contextual variables are inescapably present, difficult or impossible to eliminate, and crucial to research results at some point are required. We have long known that in child welfare work, for example, generalization of parenting skills learned in a clinical setting to the home environment is uncommon without targeted attention to the transfer of skills (e.g., Goldstein, Keller, & Erné, 1985; Mattaini, McGowan, & Williams, 1996; Stokes & Baer, 1977). Similar systemic and ecological factors are often crucial to understanding, prediction, and intervention in community and other large-system settings.

A good deal of knowledge about experimentation in natural settings is found in the community psychology literature (e.g., Jason & Glenwick, 2016), but behavior analytic participation in community psychology scholarship and education, once more common, has declined in recent decades. The design of novel experimental methods at community and societal levels consistent with our conceptual models has been limited. There are of course a number of exceptions, including work by Tony Biglan, Dennis Embry, and others, in particular among those active in the prevention science and public health communities (e.g., Biglan, Ary, & Wagenaar, 2000; Watson-Thompson, Woods, Schober, & Schultz, 2013). Nonetheless, behavior scientists clearly need more such work if we are to meet the challenges identified in the beginning of this article. A brief quote from Bates (1950) suggests why experimentation in natural settings can be so valuable:

> We have our total complex, our biotic community, a network of interlocking relationships impossible to completely describe. What happens when some one element is changed? What happens when some element of the community is removed; when a new population of some kind is added; when some environmental factor is modified? Ecology has so far been almost entirely a descriptive science, but this hardly means that it will always remain so. (p. 277)

Note that last sentence: "Ecology has so far been almost entirely a descriptive science, but this hardly means that it will always remain so"—the same is true for cultural analysis at large-system levels. An example is the study conducted by Anderson-Carpenter, Watson-Thompson, Jones, and Chaney (2014), all from the Applied Behavioral Science Department and the Work Group for Community Health and Development at the University of Kansas. This study tested the impact of local and statewide communities of practice (COP) arrangements, supporting implementation of a SAMSA-funded Strategic Prevention Framework. The study included 12 community sectors (e.g., youth, parents, law enforcement, businesses, schools), all working to plan, implement, and evaluate locally relevant and evidence-based prevention activities. Thirty-one evidence-based strategies were chosen and implemented by the 14 participating community coalitions, resulting in 350 documented community changes. Research questions included whether, and if so how many, changes would be made in the target community across sectors, and whether and how many multiple sectors could be engaged; the answers were encouraging. This study can be contrasted

with, for example, with the results of a review by Weible, Sabatier, and McQueen (2009) of 80 community programs that indicated that they were implementing an approach called the Advocacy Coalition Framework (ACF) that claimed to be similar to the COP projects. In contrast with the Anderson-Carpenter study, data collected by the ACF programs, if collected at all, was inconsistent across and probably within settings, and of uncertain quality.

Although the design of the Kansas COP project was modest, it provided a good deal of observational data in addition to demonstrating clear before and after changes, supported the underlying conceptual model, and is clear enough to encourage further replication. If results are evident and as large as in the Kansas COP project, proposals to advance to more complex and expensive experimental designs are easier to support. Over 4 decades, the Kansas program has initiated many excellent demonstrations of the potential for behavior-based intervention within an ongoing program of systemically focused research, conducted in partnership with local communities.

New Analytic Tools

Answering questions different from those we have studied for the last 80+ years will in many cases require different tools, different "scientific instruments"—the final emphasis in Bates's model. Selecting effective analytic tools has recently become a significant issue as behavior scientists increasingly focus on collective and aggregate data in journal submissions, and other research. Under those conditions, it has become somewhat common for authors to submit papers using inappropriate statistics, weak qualitative analyses, and other interpretive errors. This is not surprising, given the limited attention to these analytic strategies in many behavior analysis education programs, which increasingly focus on work with individuals, in particular those within the autism spectrum. With better preparation, behavior science students and graduates could become increasingly competent to design and analyze issues at community and cultural levels, and to collaborate with other disciplines who often rely on such skills.

The development and application of new analytic tools, for our purposes here, includes procedures like multivariate statistics (Ninness, Henderson, Ninness, & Halle, 2015), neural network technology (SOM, self-organizing map; Ninness et al., 2012; Ninness et al., 2013), visual analyses including for the study of dynamical systems (Granic & Patterson, 2006), behavioral economics analyses (Kaplan, Gelino, & Reed, 2018), applications relying on evolutionary computational complexity theory (McDowell & Popa, 2009; McDowell, Calvin, Hackett, & Klapes, 2017), and advanced time-series analyses (Biglan et al., 2000). As behavior science moves increasingly into complex environments, rigorous qualitative methods (like those in the Aspholm study) will also be needed, in particular to identify and explore contextual variables that influence the behaviors and practices we are studying.

An example of the use of new analytic tools consistent with an ecological approach to complex data is the study by Granic and Patterson (2006), mentioned earlier. Many readers are likely familiar with Gerald Patterson, who contributed enormously to our knowledge about coercive family processes and the development of antisocial behavior beginning in the 1950s. Continuing that lifelong commitment to understanding prosocial and antisocial development, in 2006 Granic and Patterson offered a dynamical systems analysis of antisocial development, developing and testing 10

"predictions" (hypotheses) drawn from an extensive literature review. The analysis expanded understanding of the connections between real-time family and contextual sequences and long-term development outcomes by integrating data across dozens of studies. Patterson and colleagues had dedicated years to their research producing many publications, yet by using a different set of analytic methods with their enormous body accumulated data, new, more contextualized models and hypotheses emerged.

Conclusion

In a 2016 article in *The Behavior Analyst*, Mattaini and Aspholm discussed a number of steps our discipline could emphasize in expanding applications within an ecological framework. These included behavioral systems science education as a required area of study; explicit emphasis on transparency and integrity; provision of care for societies' most vulnerable; paid or unpaid service with nongovernmental organizations; the development of new programs, institutes, or centers with missions for specifically applying our science to "wicked" issues; the development of advocacy groups and alternative cultures focused on social justice, human rights, and sustainability; and participation in resistance efforts when scientifically and ethically justified.

Given advances in the development of a truly ecologically integrated cultural analytic science incorporating a strong translational emphasis and extensive participation in transdisciplinary efforts (with a measure of humble behaviorism, Neuringer, 1991), behavior science has unique opportunities to contribute to shaping and sustaining societies committed to social and environmental justice, human rights, and sustainable societies. Several emerging initiatives within ABAI and ABAI special interest groups will support such efforts, as well as integrating cultural level work more integrally into behavior science research and practice. At least a modest disciplinary commitment to this work is, I believe, a moral imperative.

References

Alavosius, M., Newsome, D., Houmanfar, R., & Biglan, A. (2015). A functional contextualist analysis of the behavior and organizational practices relevant to climate change. In R. D. Zettle, S. C. Hayes, D. Barnes-Holmes, & A. Biglan (Eds.), *The Wiley handbook of contextual behavioral science* (pp. 513–530). Hoboken: Wiley-Blackwell.

Allen, T. F. H., & Hoekstra, T. W. (2015). *Toward a unified ecology* (2nd ed.). New York: Columbia University Press.

Anderson-Carpenter, K. D., Watson-Thompson, J., Jones, M., & Chaney, L. (2014). Using communities of practice to support implementation of evidence-based prevention strategies. *Journal of Community Practice, 22*(1&2), 176–188. https://doi.org/10.1080/10705422.2014.901268.

Aspholm, R. R. (2016). *"This ain't the nineties": Chicago's black street gangs in the twenty-first century* (Unpublished doctoral diss.). University of Illinois at Chicago.

Aspholm, R. R. (in press). *"This ain't the nineties": Chicago's black street gangs in the twenty-first century.* New York, NY: Columbia University Press. (note: title may change)

Aspholm, R. R., & Mattaini, M. A. (2017). Youth activism as violence prevention. In P. Sturmey (Ed.), *The Wiley handbook of violence and aggression* (pp. 1–12). Hoboken: Wiley. https://doi.org/10.1002/9781119057574.whbva104.

Association for Behavior Analysis International (ABAI). (1989). Statement on the right to effective behavioral treatment. Retrieved from https://www.abainternational.org/about-us/policies-and-positions/right-to-effective-behavioral-treatment,-1989.aspx. Accessed 30 May 2019.

Association for Behavior Analysis International (ABAI). (2010). Statement on restraint and seclusion. Retrieved from https://www.abainternational.org/about-us/policies-and-positions/restraint-and-seclusion,-2010.aspx. Accessed 30 May 2019.

Atkinson, K. N. (2012). *Education for liberation: A precursor to youth activism for social justice* (Unpublished doctoral diss.). University of Illinois at Chicago.

Baer, D. M. (1974). A note on the absence of a Santa Claus in any known ecosystem: A rejoinder to Willems. *Journal of Applied Behavior Analysis, 7*(1), 167–169. https://doi.org/10.1901/jaba.1974.7-167.

Baker, T., Schwenk, T., Piasecki, M., Smith, G. S., Reimer, D., Jacobs, N., et al. (2015). Cultural change in a medical school: A data-driven management of entropy. *Journal of Organizational Behavior Management, 35*(1–2), 95–122. https://doi.org/10.1080/01608061.2015.1035826.

Barrish, H. H., Saunders, M., & Wolf, M. M. (1969). Good Behavior Game: Effects of individual contingencies for group consequences on disruptive behavior in a classroom. *Journal of Applied Behavior Analysis, 2*(2), 119–124. https://doi.org/10.1901/jaba.1969.2-119.

Bates, M. (1950). *The nature of natural history*. Princeton: Princeton University Press.

Baum, W. M. (2012). Rethinking reinforcement: Allocation, induction, and contingency. *Journal of the Experimental Analysis of Behavior, 97*(1), 101–124. https://doi.org/10.1901/jeab.2012.97-101.

Beckage, B., Kauffman, S., Gross, L. J., Zia, A., & Koliba, C. (2013). More complex complexity: Exploring the nature of computational irreducibility across physical, biological, and human social systems. In H. Zenil (Ed.), *Irreducibility and computational equivalence* (pp. 79–88). Berlin: Springer-Verlag.

"Complexity & selection." (2004). [special issue] *Behavior & Social Issues, 13*(2).

Bertalanffy, L. v. (1968). *General system theory*. New York: George Braziller.

Biglan, A. (2009). The role of advocacy organizations in reducing negative externalities. *Journal of Organizational Behavior Management, 29*(3–4), 215–230. https://doi.org/10.1080/01608060903092086.

Biglan, A., Ary, D., & Wagenaar, A. C. (2000). The value of interrupted time-series experiments for community intervention research. *Prevention Science, 1*(1), 31–49. https://doi.org/10.1023/a:1010024016308.

Bogdanov, A. A. (1980). *Essays in tektology: The general science of organization*. (George Gorelik, trans. Seaside: Intersystems Publications.

Brayko, C., Houmanfar, R., & Ghezzi, E. (2016). Organized cooperation: A behavioral perspective on volunteerism. *Behavior & Social Issues, 25*, 77–98. https://doi.org/10.5210/bsi.v25i0.6739.

Cagnin, C., Amanatidou, E., & Keenan, M. (2012). Orienting European innovation systems towards grand challenges and the roles that FTA can play. *Science & Public Policy, 39*, 140–152. https://doi.org/10.1093/scipol/scs014.

Chenoweth, E., & Stephan, M. J. (2011). *Why civil resistance works: The strategic logic of nonviolent conflict*. New York: Columbia University Press.

Couto, K. C., & Sandaker, I. (2016). Natural, behavioral and cultural selection-analysis: An integrative approach. *Behavior & Social Issues, 25*, 54–60. https://doi.org/10.5210/bsi.v25i0.6891.

Cowie, S., & Davison, M. (2016). Control by reinforcers across time and space: A review of recent choice research. *Journal of the Experimental Analysis of Behavior, 105*(2), 246–269. https://doi.org/10.1002/jeab.200.

Dixon, M. R., Belisle, J., Rehfeldt, R. A., & Root, W. B. (2018). Why we are still not acting to save the world: The upward challenge of a post-Skinnerian behavior science. *Perspectives on Behavior Science, 41*, 241–267. https://doi.org/10.1007/s40614-018-0162-9.

Dyball, R., & Newell, B. (2015). *Understanding human ecology*. New York: Routledge.

Eagleman, D. M. (2013). Why public dissemination of science matters: A manifesto. *Journal of Neuroscience, 33*(30), 12147–12149. https://doi.org/10.1523/jneurosci.2556-13.2013.

Embry, D. D. (2002). The Good Behavior Game: A best practice candidate as a universal behavioral vaccine. *Clinical Child & Family Psychology Review, 5*(4), 273–297. https://doi.org/10.1023/A:1020977107086.

Fantino, E. (1985). Behavior analysis and behavioral ecology: A synergistic coupling. *The Behavior Analyst, 8*(2), 151–157. https://doi.org/10.1007/BF03393147.

Fawcett, S. B. (1991). Some values guiding community research and action. *Journal of Applied Behavior Analysis, 24*(4), 621–636. https://doi.org/10.1901/jaba.1991.24-621.

Fawcett, S. B., Bernstein, G. S., Czyzewski, M. J., Greene, B. F., Hannah, G. T., Iwata, B. A., . . . & Seekins, T. (1988). Behavior analysis and public policy. *The Behavior Analyst*, *11*(1), 11–25. https://doi.org/10.1007/BF03392450

Francisco, V. T., Paine, A. L., & Fawcett, S. B. (1993). A methodology for monitoring and evaluating community health coalitions. *Health Education Research, 8*(3), 403–416. https://doi.org/10.1093/her/8.3.403.

Fulambarker, A. (2013). *Moving forward by going back to our roots: Transformative justness approach to intimate partner violence*. Unpublished manuscript, University of Illinois at Chicago.

Gambrill, E. (1994). What's in a name? Task-centered, empirical, and behavioral practice. *Social Service Review, 68*(4), 578–599. https://doi.org/10.1086/604085.

Gandhi, M. K. (1945). *Constructive programme: Its meaning and place*. India: Navajivan Publishing House.

Glenn, S. S. (1988). Contingencies and metacontingencies: Toward a synthesis of behavior analysis and cultural materialism. *The Behavior Analyst, 11*(2), 161–179. https://doi.org/10.1007/bf03392470.

Glenn, S. S. (1993). Windows on the 21st century. *The Behavior Analyst, 16*(2), 133–151. https://doi.org/10.1007/BF03392619.

Glenn, S. S., Malott, M. E., Andery, M. A. P. A., Benvenuti, M., Houmanfar, R. A., Sandaker, I., . . . & Vasconcelos, L. A. (2016). Toward consistent terminology in a behaviorist approach to cultural analysis. *Behavior & Social Issues*, *25*, 11–27. https://doi.org/10.5210/bsi.v25i0.6634

Goldiamond, I. (2002). Toward a constructional approach to social problems: Ethical and constitutional issues raised by applied behavior analysis. *Behavior & Social Issues, 11*(2), 108–197. (Original work published 1974). https://doi.org/10.5210/bsi.v11i2.92.

Goldstein, A. P., Keller, H., & Erné, D. (1985). *Changing the abusive parent*. Champaign: Research Press.

Granic, I., & Patterson, G. R. (2006). Toward a comprehensive model of antisocial development: A dynamic systems approach. *Psychological Review, 113*(1), 101. https://doi.org/10.1037/0033-295X.113.1.101.

Grant, L. K. (2011). In response: Can we consume our way out of climate change? A call for analysis. *The Behavior Analyst, 34*(2), 245–266. https://doi.org/10.1007/BF03392256.

Greene, B. F., Winett, R. A., Van Houten, R., Geller, E. S., & Iwata, B. A. (1987). *Behavior analysis in the community: Readings from the Journal of Applied Behavior Analysis*. Lawrence: University Press of Kansas.

Grossmann, K., & Haase, A. (2016). Neighborhood change beyond clear storylines: What can assemblage and complexity theories contribute to understandings of seemingly paradoxical neighborhood development? *Urban Geography, 37*(5), 727–747. https://doi.org/10.1080/02723638.2015.1113807.

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (Eds.). (2001). *Relational Frame Theory: A Post-Skinnerian account of human language and cognition*. New York: Plenum Press.

Hörl, E., & Burton, J. (Eds.). (2017). *General ecology: The new ecological paradigm*. New York: Bloomsbury Publishing.

Houmanfar, R., A., Alavosius, M. P., Morford, Z. H., Reimer, D., & Herbst, S. A.(2015). Functions of organizational leaders in cultural change: Financial and social well-being. *Journal of Organizational Behavior Management*, 35, 4–27. https://doi.org/10.1080/01608061.2015.1035827

Houmanfar, R., Rodrigues, N. J., & Ward, T. A. (2010). Emergence & metacontingency: Points of contact and departure. *Behavior & Social Issues, 19*, 53–78. https://doi.org/10.1016/j.beproc.2017.12.024.

Houmanfar, R. A., & Mattaini, M. A. (Eds.). (2017). *Leadership and cultural change: Managing future well-being*. New York: Routledge.

Houmanfar, R. A., Rodrigues, N. J., & Smith, G. S. (2009). Role of communication networks in behavioral systems analysis. *Journal of Organizational Behavior Management, 29*, 257–275. https://doi.org/10.1080/01608060903092102.

Jason, L., & Glenwick, D. (Eds.). (2016). *Handbook of methodological approaches to community-based research: Qualitative, quantitative, and mixed methods*. New York: Oxford University Press.

Jason, L. A., Braciszewski, J., Olson, B. D., & Ferrari, J. R. (2005). Increasing the number of mutual help recovery homes for substance abusers: Effects of government policy and funding assistance. *Behavior & Social Issues, 14*(1), 71–79. https://doi.org/10.5210/bsi.v14i1.121.

Krapfl J. E., & Kruja B. (2015). Leadership and Cultural Change. *Journal of Organizational Behavior Management* (*JOBM*) 2009, 35(1&2), 28–43, Special Issues.

Kaplan, B. A., Gelino, B. W., & Reed, D. D. (2018). A behavioral economic approach to green consumerism: Demand for reusable shopping bags. *Behavior & Social Issues, 27*, 20–30. https://doi.org/10.5210/bsi.v27i0.8003.

Karban, R., Huntzinger, M., & Pearse, I. S. (2014). *How to do ecology: A concise handbook*. Princeton: Princeton University Press.

Kerlinger, F. N. (1966). *Foundations of behavioral research*. New York: Holt, Rinehart & Winston.

Killeen, P. R. (2017). The non-Darwinian evolution of behavers and behaviors. *Behavioural Processes, 161*, 45–53. https://doi.org/10.1016/j.beproc.2017.12.024.

Killeen, P. R., & Jacobs, K. W. (2017). Coal is not black, snow is not white, food is not a reinforcer: The roles of affordances and dispositions in the analysis of behavior. *The Behavior Analyst, 40*(1), 17–38. https://doi.org/10.1007/s40614-016-0080-7.

Kwakkel, J. H., & Pruyt, E. (2015). Using system dynamics for grand challenges: The ESDMA approach. *Systems Research & Behavioral Science, 32*(3), 358–375. https://doi.org/10.1002/sres.2225.

Lamal, P. A. (Ed.). (1991). *Behavioral analysis of societies and cultural practices*. New York: Taylor & Francis.

Lamal, P. A. (Ed.). (1997). *Cultural contingencies: Behavior analytic perspectives on cultural practices*. Westport: Praeger.

Lee, C. M. (2016). Speaking up for science. *Trends in Immunology, 37*(4), 265–268. https://doi.org/10.1016/j.it.2016.02.003.

Leflot, G., van Lier, P. A., Onghena, P., & Colpin, H. (2010). The role of teacher behavior management in the development of disruptive behaviors: An intervention study with the Good Behavior Game. *Journal of Abnormal Child Psychology, 38*(6), 869–882. https://doi.org/10.1007/s10802-010-9411-4.

Loehle, C. (2004). Challenges of ecological complexity. *Ecological Complexity, 1*(1), 3–6. https://doi.org/10.1016/j.ecocom.2003.09.001.

Malott, M. (2013). *Synergy of repertoires and metacontingencies: An account of the Mexican Muralist Movement*. Unpublished paper presented on October 8, 2013, at the Association for Behavior Analysis International conference at Merida, Mexico.

Malott, M. E. (2003). *Paradox of organizational change: Engineering organizations with behavioral systems analysis*. Reno: Context Press.

Mattaini, M. A. (1993). *More than a thousand words: Graphics for clinical practice*. Washington, DC: NASW Press.

Mattaini, M. A. (2002). *Peace power for adolescents: Strategies for a culture of nonviolence*. Washington, DC: NASW Press.

Mattaini, M. A. (2013). *Strategic nonviolent power: The science of Satyagraha*. Edmonton: University Press.

Mattaini, M. A. (2015). Constructive noncooperation: Toward a 21st century, science-based "constructive programme". In R. Amster, L. Finley, E. Pries, & R. McCutcheon (Eds.), *Peace studies between tradition and innovation* (pp. 83–101). Newcastle upon Tyne: Cambridge Scholars.

Mattaini, M. A., & Aspholm, R. (2016). Contributions of behavioral systems science to leadership for a new progressive movement. *The Behavior Analyst, 39*(1), 109–121. https://doi.org/10.1007/s40614-015-0043-4.

Mattaini, M. A., & Holtschneider, C. (Eds.). (2016). *Foundations of social work practice: A graduate text*. Washington, DC: NASW Press.

Mattaini, M. A., McGowan, B. G., & Williams, G. (1996). Child maltreatment. In M. A. Mattaini & B. A. Thyer (Eds.), *Finding solutions to social problems: Behavioral strategies for change* (pp. 223–266). Washington, DC: American Psychological Association.

McDowell, J. J., Calvin, O. L., Hackett, R., & Klapes, B. (2017). Falsification of matching theory and confirmation of an evolutionary theory of behavior dynamics in a critical experiment. *Behavioural Processes, 140*, 61–68. https://doi.org/10.1016/j.beproc.2017.03.025.

McDowell, J. J., & Popa, A. (2009). Beyond continuous mathematics and traditional scientific analysis: Understanding and mining Wolfram's *A new kind of science*. *Behavioural Processes, 81*, 343–352. https://doi.org/10.1016/j.beproc.2009.01.012.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis*. Thousand Oaks: Sage.

Mitchell, M. (2009). *Complexity: A guided tour*. New York: Oxford University Press.

Moore, J. (2003). Behavior analysis, mentalism, and the path to social justice. *The Behavior Analyst, 26*(2), 181–193. https://doi.org/10.1007/BF03392075.

Moore, J., & Shook, F. L. (2001). Certification, accreditation, and quality control in behavior analysis. *The Behavior Analyst, 24*, 45–55. https://doi.org/10.1007/bf03392018.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2005). *Facilitating interdisciplinary research*. Washington, DC: National Academies Press. https://doi.org/10.17226/11153.

Neuringer, A. (1991). Humble behaviorism. *The Behavior Analyst, 14*(1), 1–13. https://doi.org/10.1007/BF03392543.

Nevin, J. A. (2018). Variation, selection, and social action. *Behavior & Social Issues, 27*, AA1–AA3. https://doi.org/10.5210/bsi.v27i0.8275.

Ninness, C., Henderson, R., Ninness, S. K., & Halle, S. (2015). Probability pyramiding revisited: Univariate, multivariate, and neural network analyses of complex data. *Behavior & Social Issues, 24*, 164–186. https://doi.org/10.5210/bsi.v24i0.6048.

Ninness, C., Lauter, J. L., Coffee, M., Clary, L., Kelly, E., Rumph, M., . . . & Ninness, S. K. (2012). Behavioral and physiological neural network analyses: A common pathway toward pattern recognition and prediction. *The Psychological Record*, *62*(4), 579–598. https://doi.org/10.1007/BF03395822

Ninness, C., Rumph, M., Clary, L., Lawson, D., Lacy, J. T., Halle, S., . . . & Forney, D. (2013). Neural network and multivariate analyses: Pattern recognition in academic and social research. *Behavior & Social Issues*, *22*, 49–63. https://doi.org/10.5210/bsi.v22i0.4450

Odum, H. T., & Odum, E. P. (1953). *Fundamentals of ecology*. Philadelphia: Saunders.

Parsons, T., & Smelser, N. J. (1999). *Economy and society: A study in the integration of economic and social theory*. New York: Routledge.

Project Nia. (2013). Building healthy communities. Accessed at http://www.project-nia.org/

Rehfeldt, R. A. (2011). Toward a technology of derived stimulus relations: An analysis of articles published in the *Journal of Applied Behavior Analysis*, 1992–2009. *Journal of Applied Behavior Analysis, 44*, 109–119. https://doi.org/10.1901/jaba.2011.44-109.

Rice, A. J. (2018). Manufacturing failure: Race, revitalization and the takeover of Detroit public schools. SSRN. Available at SSRN: https://ssrn.com/abstract=3286690. Accessed 30 May 2019.

Riestenberg, N. (2012). *Circle in the square: Building community and repairing harm in school*. St. Paul: Living Justice Press.

Rizzo, A., & Galanakis, M. (2015). Transdisciplinary urbanism: Three experiences from Europe and Canada. *Cities, 47*, 35–44. https://doi.org/10.1016/j.cities.2015.01.001.

Ross, R. (2006). *Returning to the teachings: Exploring aboriginal justice*. Toronto: Penguin Books 1996.

Saleem, J. (2018). Young people in St. Louis are taking the lead in working for racial justice in their schools and communities. *Quaker Action.* Accessed at: https://www.afsc.org/document/quaker-action-resistance-to-rebuilding-summer-2018-pdf. Accessed 30 May 2019.

Sharp, G. (2005). *Waging nonviolent struggle: 20th century practice and 21st century potential*. Manchester: Porter Sargent.

Sidman, M. (2001). *Coercion and its fallout* (Rev. ed.). Boston: Authors Cooperative.

Skinner, B. F. (1948). *Walden two*. New York: Macmillan.

Skinner, B. F. (1953). *Science and human behavior*. New York: Free Press.

Skinner, B. F. (1976). *Walden two. (Updated ed.)*. New York: Macmillan.

Skinner, B. F. (1981). Selection by consequences. *Science, 213*, 501–504.

Skinner, B. F. (1987). *Upon further reflection*. Englewood Cliffs: Prentice-Hall.

Smith, G. S., Houmanfar, R., & Louis, S. J. (2011). The participatory role of verbal behavior in an elaborated account of metacontingency: From conceptualization to investigation. *Behavior & Social Issues, 20*, 122–146. https://doi.org/10.5210/bsi.v20i0.3662.

Stephan, M. J., & Thompson, T. P. (2018). Why you should never underestimate a bunch of well-organized teenager protesters. *Washington Post*. Accessed at https://www.washingtonpost.com/news/democracy-post/wp/2018/04/04/why-you-should-never-underestimate-a-bunch-of-well-organized-teenage-protesters/?utm_term=.9cebe5455b61. Accessed 30 May 2019.

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*(2), 349–367. https://doi.org/10.1901/jaba.1977.10-349.

Sturmey, P. (Ed.). (2017). *The Wiley handbook of violence and aggression*. Hoboken: Wiley-Blackwell.

Todorov, J. C., & Vasconcelos, I. (2015). Experimental analysis of the behavior of persons in groups: Selection of an aggregate product in a metacontingency. *Behavior & Social Issues, 24*, 111–125. https://doi.org/10.5210/bsi.v24i0.5424.

Tufte, E. (2001). *The visual display of quantitative information*. Cheshire: Graphics Press.

Tufte, E. (2006). *Beautiful evidence*. Cheshire: Graphics Press.

Tufte, E. R. (1990). *Envisioning information*. Cheshire: Graphics Press.

Tufte, E. R. (1997). *Visual explanation: Images and quantities, evidence and narrative*. Cheshire: Graphics Press.

Valentinov, V., & Chatalova, L. (2016). Institutional economics and social dilemmas: A systems theory perspective. *Systems Research & Behavioral Science, 33*(1), 138–149. https://doi.org/10.1002/sres.2327.

Vichi, C., Andery, M. A. P. A., & Glenn, S. S. (2009). A metacontingency experiment: The effects of contingent consequences on patterns of interlocking contingencies of reinforcement. *Behavior & Social Issues, 18*(1), 41–57. https://doi.org/10.5210/bsi.v18i1.2292.

Watson-Thompson, J., Woods, N. K., Schober, D. J., & Schultz, J. A. (2013). Enhancing the capacity of substance abuse prevention coalitions through training and technical assistance. *Journal of Prevention & Intervention in the Community, 41*(3), 176–187.

Weible, C. M., Sabatier, P. A., & McQueen, K. (2009). Themes and variations: Taking stock of the advocacy coalition framework. *Policy Studies Journal, 37*(1), 121–140. https://doi.org/10.1111/j.1541-0072.2008.00299.x.

Willems, E. P. (1974). Behavioral technology and behavioral ecology. *Journal of Applied Behavior Analysis, 7*(1), 151–165. https://doi.org/10.1901/jaba.1974.7-151.

Wolfram, S. (2002). *A new kind of science*. Champaign: Wolfram Media.

Zenil, H. (Ed.). (2013). *Irreducibility and computational equivalence: 10 years after Wolfram's A new kind of science*. Berlin: Springer-Verlag.