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Evolving the Future: Toward a Science of Intentional Change

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Abstract

Humans possess great capacity for behavioral and cultural change, but our ability to manage change is still limited. This article has two major objectives: First, to sketch a basic science of intentional change that is centered on evolution; the second, to provide examples of intentional behavioral and cultural change from the applied behavioral sciences, which are largely unknown to the basic scientific community.

All species have evolved mechanisms of phenotypic plasticity that enable them to respond adaptively to their environments. Some mechanisms of phenotypic plasticity count as evolutionary processes in their own right. The human capacity for symbolic thought provides an inheritance system with the same kind of combinatorial diversity as genetic recombination and antibody formation. Taking these propositions seriously allows an integration of major traditions within the basic behavioral sciences, such as behaviorism, cognitive psychology, and evolutionary psychology, which are often conceptualized as opposed to each other.

The applied behavioral sciences include well-validated examples of successfully managing behavioral and cultural change at scales ranging from individuals, to small groups, to large populations. These examples are largely unknown beyond their disciplinary boundaries, however, for lack of a unifying theoretical framework. Viewed from an evolutionary perspective, they can be seen as examples of managing evolved mechanisms of phenotypic plasticity, including open-ended processes of variation and selection.

Once the many branches of the basic and applied behavioral sciences become conceptually unified, we are closer to a science of intentional change than one might think.

1. Introduction

Change is the mantra of modern life. We embrace change as a virtue but are desperate to escape from undesired changes that appear beyond our control. We crave positive change at all levels, from individuals seeking to improve themselves, to neighborhoods seeking a greater sense of community, to nations attempting to function as corporate units, to the entire planet attempting to manage the global economy and the environment.

Science should be an important agent of change, and it is, but it is responsible for as many unwanted changes as for those we desire. Even the changes we want can be like wishes granted in folk tales, which we end up regretting in retrospect. Our ability to change our behavioral and cultural practices lags far behind our ability to manipulate the physical environment. No examples of scientifically guided social change can compare to putting a man on the moon.

In this article, we ask what a science of positive behavioral and cultural change would look like and what steps might be required to achieve it. We begin with the elementary observation that evolution must be at the center of a science of change. After all, evolution is the study of how organisms change in relation to their environments, not only by genetic evolution, but also by mechanisms of phenotypic plasticity that evolved by genetic evolution, including some that count as evolutionary processes in their own right (Calvin 1987; Jablonka & Lamb 2006; Richerson & Boyd 2005). A solid foundation in evolutionary theory can also help us understand why some changes we desire, which count as adaptations in the evolutionary sense of the word, can turn out to be bad for long-term

human welfare. Left unmanaged, evolutionary processes often take us where we don't want to go. The only solution to this problem is to become wise managers of evolutionary processes (Wilson 2011a).

The first step—appreciating the central importance of evolution—reveals how many steps remain to achieve a mature science of behavioral and cultural change. The study of evolution in relation to human affairs has a long and tortuous history that led many to abandon and even oppose the enterprise altogether (Ehrenreich & McIntosh 1997; Sahlins 1976). Using evolution to inform public policy earned such a bad reputation that “Social Darwinism” came to signify the justification of social inequality (Hofstadter 1959/1992; Leonard 2009). Evolution became a pariah concept and was avoided as a conceptual foundation for the study of human behavior and culture for most of the 20th century. The implicit assumption was that evolution explained the rest of life, our physical bodies, and a few basic instincts such as the urge to eat and have sex, but had nothing to say about our rich behavioral and cultural diversity.

The reception to E.O. Wilson's book, *Sociobiology*, published in 1975, provides an example of this intellectual apartheid. The purpose of *Sociobiology* was to show that there could be a single science of social behavior that applies to all species, from microbes, to insects, to primates. It was celebrated as a triumph except for the final chapter on humans, which created a storm of controversy (Seegerstrale 2001). Only during the late 1980s did terms such as “evolutionary psychology” and “evolutionary anthropology” start to be used,

signifying a renewed attempt to place the study of human behavior and culture on an evolutionary foundation.

As a result, an enormous amount of integration must occur before a science of human behavioral and cultural change can center on evolution. This integration needs to be a two-way street, involving not only contributions of evolutionary theory to the human-related disciplines, but also the reverse. For example, core evolutionary theory will have to expand beyond genetics to include other inheritance systems, such as environmentally induced changes in gene expression (epigenetics), mechanisms of social learning found in many species, and the human capacity for symbolic thought that results in an almost unlimited variety of mental representations, each motivating a suite of behaviors subject to selection (Jablonka & Lamb 2006; Penn et al. 2008).

We will argue that the first steps toward integration, represented by a configuration of ideas that most people associate with the term *evolutionary psychology* (EP), was only the beginning and in some ways led in the wrong direction. In particular, the distinction between EP and the *standard social science model* (SSSM; Pinker 1997; 2002; Tooby & Cosmides 1992) was a wrong turn we must correct. A mature EP needs to include elements of the SSSM, such as the domain generality tradition of the functional contextual wing of behaviorism associated with B. F. Skinner. Only when we depolarize the distinction between EP and the SSSM can a science of change occur (Bolhuis et al. 2011; Buller 2005; Scher & Rauscher 2002; Wilson 2002a).

In the first part of this article, we will attempt to accomplish this depolarization to provide a broader evolutionary foundation for the human behavioral and social sciences. In the second part, we will review examples of scientifically designed and validated programs that accomplish change on three scales: individuals, small groups, and large populations. We draw these examples from branches of the applied behavioral sciences that, like diamonds in the sand, have largely remained hidden from view as far as both evolutionary science and the basic human behavioral sciences are concerned. When viewed from an evolutionary perspective, they emerge as examples of wisely managing evolutionary processes to accomplish significant improvement in human wellbeing. We are closer to a science of intentional change than one might think.

2. Toward a Basic Science of Change

The ability to change behavioral and cultural practices in practical terms must emanate from a basic scientific understanding of behavioral and cultural change. The basic sciences are currently in disarray on the subject of change but rapid integration in the future is possible, as we will attempt to show.

2.1. Reconciling elaborate innateness with an elaborate capacity for open-ended change.

In the summary of his influential article, "Selection by Consequences," B.F. Skinner (1981, p. 501) framed his version of behaviorism in terms of evolution:

Selection by consequences is a causal mode found only in living things or in machines made by living things. It was first recognized in natural selection, but it also accounts for the shaping and maintenance of the behavior of the

individual and evolution of cultures. In all three of these fields, it replaces explanations based on the causal modes of classical mechanics. The replacement is strongly resisted. Natural selection has now made its case, but similar delays in recognizing the role of selection in the other fields could deprive us of valuable help in solving the problems that confront us.

Although the term “evolutionary psychology” had not yet been coined, Skinner’s passage leaves no doubt that he regarded the open-ended capacity for behavioral and cultural change as both a product of genetic evolution and as an evolutionary process in its own right. It is therefore ironic that, when Tooby and Cosmides (1992) formulated their version of EP, they set it apart from the SSSM that included the Skinnerian tradition (see also Pinker 2002).

Long before Tooby and Cosmides’ version of evolutionary psychology made the scene, the so-called cognitive revolution had displaced behaviorism in basic psychology. Cognitive theorists stressed that the enormous complexity of the mind must be studied directly, in contrast to Skinner’s insistence on focusing on the functional relations of environment and behavior (Brewer 1974; Bruner 1973). The central metaphor of the cognitive revolution was that the mind is like a computer that we must understand in mechanistic detail to know how it works. Those who study computers would never restrict themselves to input-output relationships; they would study the machinery and the software. Psychologists were advised to follow the same path.

One of the seeds of the cognitive revolution, which took root in Tooby and Cosmides' version of evolutionary psychology, was a challenge to what was perceived to be the extreme domain generality of behavioral approaches. An example is Martin Seligman's (1970) influential article on the "generality of the laws of learning." Seligman reviewed a body of evidence showing that the parameters of learning processes had to be viewed in light of the evolutionary preparedness of organisms to associate particular events. For example, taste aversion (Garcia et al. 1966) challenged the idea that immediacy per se is key in stimulus pairings in classical conditioning, since illness could follow by tens of hours and still induce aversion to ecologically sensible food-related cues. Seligman recognized that this kind of specialized learning could evolve by altering the parameters of classical conditioning (p. 417), but his preferred interpretation was that general learning processes themselves were not useful: "we have reason to suspect that the laws of learning discovered using lever pressing and salivation may not hold" (p. 417).

Even more important was the conclusion that no general process account was possible in the area of human language and cognition. Pointing to evidence that seemed to show that human language requires no elaborate training for its production, Seligman concluded, "instrumental and classical conditioning are not adequate for an analysis of language" (p. 414). What interests us in this context is how these concerns quickly led to abandoning the idea that general learning process accounts were possible. For example, in an influential chapter that helped launch the "cognitive revolution," William Brewer (1974) concluded, "*all* the results of the traditional conditioning literature are due to the operation of higher mental processes, as assumed in cognitive theory, and. . . there is not and never has been

any convincing evidence for unconscious, automatic mechanisms in the conditioning of adult human beings” (p. 27, italics added).

The concern over the limits of domain generality in cognitive psychology was redoubled as evolutionary psychology arrived as a self-described discipline, including the influential volume *The Adapted Mind: Evolutionary Psychology and the Generation of Culture* (Barkow et al. 1992; see also Pinker 1997; 2002). According to self-described evolutionary psychologists, the mind is neither a blank slate nor a general-purpose computer. The mind is a collection of many special-purpose computers that evolved genetically to solve specific problems pertaining to survival and reproduction in ancestral environments. This claim became known as “massive modularity” (Buller 2005; Buller & Hardcastle 2000; Carruthers 2006; Fodor 1983, 2000).

Tooby and Cosmides’ chapter in *The Adapted Mind*, “The psychological foundations of culture” (1992), which did much to define the field of evolutionary psychology, described domain-general learning (the applicability of general cognitive processes, whether viewed behaviorally or cognitively) as a theoretical impossibility. Too many environmental inputs can be processed in too many ways for a domain-general learning machine to work, whether designed by humans or by natural selection. The most intelligent machines humans have designed are highly task-specific. Tax preparation software provides a good example. It requires exactly the right environmental input, which it processes in exactly the right way to calculate one’s taxes accurately. It is impressively flexible at the task for which it is designed but utterly incapable of doing anything else. According to Tooby and

Cosmides, natural selection is constrained just as human engineers are in creating complex machines or programming software, leaving massive modularity as the only theoretical possibility for the design of the mind.

In discussing cultural evolution, Tooby and Cosmides observed that behavioral differences among human populations do not necessarily signify the cultural transmission of learned information. Instead, they can reflect massively modular minds responding to different environmental cues without any learning or social transmission whatsoever. They called this instinctive response to the environment “invoked” culture, in contrast to the social transmission of learned information, or “transmitted culture.” They did not deny the existence of transmitted culture, but had very little to say about it.

In this fashion, the concept of *elaborate innateness* that became associated with the self-described discipline of evolutionary psychology (EP) was placed in opposition to the *open-ended capacity for change* that became associated with what Tooby and Cosmides branded the SSSM. In our opinion, this was a profound mistake that needs correction before the disciplines in the biological and behavioral sciences can integrate and achieve a coherent science of intentional change.

2.2 Evolution as a domain general process

Ironically, Tooby and Cosmides’ argument against domain generality ignored evolution as a domain-general process. Evolution can adapt organisms to virtually any environment, to the degree that there is heritable phenotypic variation from which to select. Any

mechanism of inheritance, not just genetic, will suffice. Many authors in the past have pointed out that the immune system, learning, culture, science, and various computer algorithms employ guided and random variation-and-selection processes that allow adaptation to current environments (e.g., Boyd & Richerson 1985; Calvin 1987; Campbell 1960; Edelman 1988; Edelman & Tonomi 2001; Farmer & Packard 1987; Plotkin 1994; 2003; 2007; Richerson & Boyd 2005; Wilson 1990; 1995). When Tooby and Cosmides declared that domain-general learning was impossible, they ignored important research traditions within evolutionary biology and the human behavioral sciences.

Evolutionary processes that rely on non-genetic inheritance mechanisms either evolved genetically or were created by humans. The term “Darwin Machine” aptly describes an evolutionary process built by evolution (Calvin 1987; Plotkin 1994). The word “Darwin” signifies that an open-ended process of variation and selection is at work, capable of producing adaptations to current environments that might never have previously existed. The word “Machine” is used here only in the limited sense that complex but systematic processes are required to create heritable phenotypic variation and to select traits that are genetically adaptive on average. It is important to understand the use of the word “Machine” in context to avoid other connotations of the word that do not capture the open-ended nature of Darwin Machines. Properly understood, these two words reconcile open-ended change with elaborate innateness, which Tooby and Cosmides placed in opposition to each other.

2.3. Learning from the immune system about evolutionary psychology

By far, the best understood Darwin Machine is the vertebrate immune system. It is a fabulously complex set of adaptations that evolved genetically to protect organisms against disease. It has many hallmarks of massive modularity, but it also has the open-ended capacity to rapidly evolve new defenses in the form of antibodies. If we can think about the human capacity for behavioral and cultural change as we do the immune system, we can begin to provide an appropriately broad foundation for a science of intentional change.

Immunologists distinguish between the innate and adaptive components of the immune system (see Sompayrac 2008 for an excellent tutorial). The innate component is massively modular, much as Tooby and Cosmides describe for human psychology. Macrophages are designed to sense and engulf foreign particles, for example, but they have no capacity to change their sensory abilities. The innate component of the immune system protects us from most disease organisms but it is helpless against those that manage to evade its automated defenses.

The adaptive component of the immune system includes the ability to create roughly 100 million different antibodies. Each antibody is like a highly specialized hand that can grab onto a narrow range of molecular shapes. Collectively, the 100 million antibodies can grab onto nearly any conceivable organic surface. When a given antibody grabs onto an invading disease organism, it signals the innate component of the immune system to attack; the antibody itself acts only as a tag. Simultaneously, the B-cells producing the antibody are

stimulated to reproduce and to ramp up their production. A single B-cell in full production mode can produce about 2,000 unattached antibody molecules every second.

The variation-and-selection process employed by the adaptive component of the immune system enables the organism to adapt rapidly to diseases that have evaded the innate component of the immune system. In this sense, it is impressively domain general. Yet, not only does the adaptive component rely upon the innate component, it too is elaborately innate. One-hundred million antibodies are not produced by a happy accident, but by an orchestrated process that creates combinations of genes from highly polymorphic regions of the chromosomes. Other genetically evolved processes are required for the antibodies that bind to antigens to signal the innate component of the immune system, for the B-cells producing the antibodies to reproduce and ramp up production, to keep the antibody circulating after the disease organism has been eliminated, and so on. The “machine” part of this Darwin Machine is very complex indeed!

Against this background, we can begin to identify the valid and invalid elements of both EP and the SSSM in their polarized forms. The massive modularity thesis of Tooby and Cosmides is like a description of the innate component of the immune system without the adaptive component. On the other hand, Skinner’s effort to explain as much as possible in terms of operant conditioning was like a description of the adaptive component of the immune system without the innate component. Combining the valid elements of both positions enables us to reconcile the concepts of elaborate innateness and an open-ended capacity for change.

The immune system offers an additional insight into the distinctively human capacity for behavioral and cultural change. The immune system is inherently *a multi-agent cooperative system*. Dozens of specialized cell types coordinate their activities through a chemical signaling system to achieve the common goal of protecting the organism. Individuals with immune systems that don't exhibit teamwork fail to survive and reproduce.

The capacity for open-ended learning at the individual level is found in many species, as Skinner showed for pigeons and rats. The capacity for cultural transmission also exists in many species—more than one might imagine, since it is a relatively new topic in animal behavior research (Hill 2010; Laland & Galef 2009; Laland & Hoppitt 2003; Page & Ryan 2006). However, the human capacity for behavioral and cultural change is so distinctive that it borders on unique (Deacon 1998; Jablonka & Lamb 2006; Penn et al. 2008). This might be because the human capacity requires a degree of teamwork among group members that most other vertebrate species lack. Human evolution increasingly is seen as a major transition, similar to the evolution of eukaryotic cells, multicellular organisms, and eusocial insect colonies, whereby selection within groups is suppressed and between-group selection becomes the dominant evolutionary force (Boehm 1999; Maynard Smith & Szathmary 1995; Sober & Wilson 1998; Wilson 2011b). A major transition might have been required to evolve a multi-agent cooperative system for behavioral and cultural change comparable to the immune system.

2.4. The Human Symbolic Inheritance System

Humans are most distinctive in their capacity for symbolic thought. The rudiments of symbolic thought might exist in other species, but in humans it is a full-blown inheritance system with combinatorial possibilities to rival genetic inheritance (Deacon 1998; Jablonka & Lamb 2005).

When a rat learns to associate an object in the environment (such as food) with an arbitrary signal (such as a bell), the mental relation persists only as long as the environmental association persists. This is clearly adaptive, since it would not benefit the rat to continue expecting food at the sound of a bell when food is no longer forthcoming. With symbolic thought, mental relations become decoupled from environmental ones. The word “cheese” can be uttered to a person a million times in the absence of cheese, and the relation will remain intact.

Mental relations that are decoupled from environmental ones might seem maladaptive, but they remain coupled to the environment in another way. Every set of symbolic relations leads to a suite of behaviors that potentially influences survival and reproduction. In this sense, a set of symbolic relations is like a genotype that produces a phenotype. We will call it a *symbotype* to stress the comparison. Like genotypes, symbotypes evolve based on what they cause the organism to do, regardless of the direct correspondence between the mental and environmental relations. As an example, religious and superstitious beliefs might not correspond directly to anything that exists in the real world, but might still be favored by natural selection, based on the behaviors they motivate in the real world.

Genotypes, symbotypes, and antibodies share something else—almost infinite variety, based on the recombination of their elements. For symbotypes, this begins with the simple mutual entailment or reversibility of human symbols and the events to which they refer. In non-human populations, both speakers and listeners communicate in an interlocking system but “listeners acquire information from signalers who do not, in the human sense, intend to provide it” (Seyfarth & Cheney 2003, p. 168; see Tomasello 2008, for a recent review of evidence on this point). Conversely, in humans, even a concrete noun is taught in a cooperative context that involves both speaking and listening and requires that the child respond in a relational way (Penn et al. 2008). For example, a child taught a *see mother* → *say “mama”* relation is also taught a *hear “mama”* → *orient toward mother* relation. Human infants eventually derive the pairwise relationship when only one member of the above pair is trained (see Hayes, Barnes-Holmes, & Roche, 2001, for a review), which may explain why speaking and listening stimulates the same linguistic regions of the brain (Menenti, Gierhan, Segaert & Hagoort 2011). Broadly speaking, the major human transition might have provided the cooperative environmental context for human symbols to operate in this relational way (cf., Nowak & Highfield 2011; Tomasello et al. 2005; Tomasello 2009), resulting in an enormous increase in variation. Very much as X genes with two alleles at each locus results in 2^X combinations, each potentially producing a different phenotype for natural selection to act upon, a human symbolic system consisting of a few handfuls of object → sign relations will be able to derive thousands of pairwise and combinatorial relationships between objects, signs, and their relationships, each potentially resulting in a different phenotype for natural selection to act upon (Deacon 1998).

However our symbolic inheritance system and its combinatorial properties arose, the result was a quantum jump in our capacity for open-ended behavioral and cultural change. The best way to see this is by standing back from the “trees” of single scientific studies to see the “forest” of human evolution. A single biological species spread out of Africa and inhabited the globe, adapting to all climatic zones and occupying hundreds of ecological niches, in just tens of thousands of years. Each culture has mental and physical toolkits for survival and reproduction that no individual could possibly learn in a lifetime. Then the advent of agriculture enabled the scale of human society to increase by many orders of magnitude, resulting in mega societies unlike anything our species had previously experienced. The human cultural adaptive radiation is comparable in scope to the genetic adaptive radiations of major taxonomic groups such as mammals and dinosaurs (Pagel & Mace 2004). What else is required to conclude that humans have an elaborate capacity for open-ended behavioral and cultural change?

2.5. The Contribution of the Human-Related Disciplines to Core Evolutionary Theory

Evolution requires heritable variation but the mechanism of inheritance need not be genetic. Most evolutionists will agree with this statement, yet the vast majority of evolutionary research has focused on genetic inheritance mechanisms—so much that for most people “evolution” is nearly synonymous with “genes.” It is therefore important to expand core evolutionary theory beyond genetics to include other mechanisms of inheritance. Jablonka and Lamb (2005) have made an excellent start in their book, *Evolution in Four Dimensions*. Starting with a concise historical account of why genetic

inheritance became so central in evolutionary theory, they then show how epigenetics, learned behavior, and symbolic systems also qualify as inheritance systems and how all four systems interact with each other to produce evolutionary change.

Epigenetics is a biological subject, but most of the research on learning and symbolic thought has occurred in the many human-related disciplines, including humanities and the human behavioral sciences. Research in these disciplines is sometimes cognizant of evolutionary theory, but more often it takes place without reference to evolution or in perceived opposition to it. A good example is the intellectual tradition of social constructivism, which has long been perceived as opposed to evolutionary accounts of human nature (Seegerstrale 2001; Wilson 2005, 2009). Insofar as evolutionists failed to include symbolic inheritance systems in core evolutionary theory, social constructivists were right to point out that something was missing. Yet, social constructivists did not converge upon the idea of cultural evolution as a Darwin Machine comparable to the immune system and explore how that level of analysis interacts with genetic, epigenetic, and learning processes. Everyone was wrong and progress requires movement on all sides. Evolutionists need to consult the human behavioral sciences and humanities respectfully—to discover what they know about learning and symbolic systems. Scientists and scholars from the human behavioral sciences and humanities will benefit by thinking about their work as inside the orbit of evolutionary theory, however irrelevant or wrong-headed evolution might have appeared in the past. This kind of integration is already occurring at a pace regarded as fast even in cultural evolutionary terms—but it can go even faster. When

complete, we will have a proper basic scientific foundation for an applied science of intentional change.

3. Toward an Applied Science of Change

Like the basic human behavioral sciences and the humanities, the applied human behavioral sciences are a vast archipelago of disciplines that seldom communicate with each other. The scientific caliber of any particular discipline, in terms of theoretical justification and empirical methods, ranges from exemplary to nonexistent. Hardly any of them take modern evolutionary science into account and they, in turn, are almost completely unknown to modern evolutionary scientists.

One purpose of this target article is to bring some exemplary research programs in the applied behavioral sciences to the attention of evolutionary scientists, and vice versa: benefits flow both ways. Evolutionary scientists might be surprised to learn that there are proven methods for accomplishing positive behavioral and cultural change at all scales, from individuals to large populations. The theory and practice behind these methods are highly relevant to the development of core evolutionary theory. Applied behavioral scientists might be surprised to learn how much their particular discipline can benefit from integration with all other basic and applied disciplines, using evolution as the common theoretical framework. It is beyond the scope of this paper to provide a comprehensive review: instead, we provide examples to illustrate the potential for a broader integration.

3.1. Change at the Level of Individuals

When the cognitive revolution dethroned behaviorism in academic psychology during the second half of the 20th century, behaviorism did not disappear. Instead, it developed into a robust set of methods for accomplishing behavioral change in a variety of applied disciplines such as Applied Behavior Analysis (Baer et al. 1968) and Behavior Therapy (Wolpe 1958). Behavior therapy was gradually supplemented (not replaced) by cognitive therapy, which in turn has been supplemented by acceptance and mindfulness-based techniques with proven efficacy (in what is sometimes called a “third wave” of psychotherapeutic methods; Hayes 2004). When the elements of behavioral, cognitive, and mindfulness-based therapies are examined in detail, they map impressively onto the elements of learning and symbolic thought as Darwin Machines.

We begin with the enigma of how people with perfectly healthy brains and bodies can nevertheless become so dysfunctional that they seek therapy. One of the most basic facts about evolution is that it results in both dysfunctional and functional outcomes. Many products of evolution are not adaptive in any sense. Even traits that count as adaptive in the evolutionary sense of the word can be maladaptive from the standpoint of human welfare; for example, by benefiting some individuals at the expense of others or by achieving short-term goals at the expense of long-term goals. Another basic fact about evolution concerns path dependence. Evolution from a less adapted state to a more adapted state will not take place if the intermediate steps are not adaptive.

These dysfunctional outcomes of evolution can be expected no matter what the mechanism of inheritance. It follows that, if learning qualifies as a Darwin Machine, so that individuals can be regarded as open-ended evolving systems with their actions selected by consequences, then evolution will sometimes take them where they prefer not to go.

In addition to dysfunctional outcomes common to all evolutionary processes, there are dysfunctional outcomes inherent to any Darwin Machine built by genetic evolution. Operant and classical conditioning are learning processes that themselves evolved (Ginsberg & Jablonka 2010). In operant conditioning, behaviors are selected not only by differential survival and reproduction, but by reinforcers, which Skinner properly interpreted as genetically evolved adaptations that lead, on average, to the adoption of genetically adaptive behaviors. "On average" includes many exceptions. Moreover, the direct and immediate costs and benefits of behaviors more readily function as consequences that select behaviors, compared to those effects that are more diffuse, delayed, or indirect. Cascades of these more subtle effects of behaviors can easily outweigh direct effects, meaning that direct and immediate consequences are not a reliable selection criterion for long-term adaptation.

Due to these dysfunctional consequences of learning as a Darwin Machine, people who are functioning perfectly normally as evolutionary processes occasionally find themselves in highly dysfunctional states requiring therapy. Behavior therapy works by altering the selective environment: for example, by repeatedly exposing clients who fear spiders to the objects of their fear without adverse consequences so that they can acquire a wider range

of responses besides avoidance in their presence (Craske & Barlow 2008). In this fashion, a learned and repertoire-narrowing effect (fear and avoidance) that happens to be dysfunctional can be extinguished and replaced with new responses by humans, in much the same way as most species do. The fact that many human phobias have clear links to dangers that existed in the genetic ancestral environment (e.g., spiders, snakes, heights, closed spaces, open spaces, and strangers) can be regarded as part of the innate component of the learning Darwin Machine, analogous to the innate component of the immune system.

Cognitive behavior therapy goes beyond behavior therapy by encouraging clients to re-conceptualize their problems (e.g., Beck 2011). In evolutionary terms, the reason that cognitive therapy adds value to behavior therapy is because people are influenced by a symbolic Darwin Machine in addition to a learning Darwin Machine. A laboratory rat would benefit from behavior therapy but not from cognitive therapy. A person benefits from both because the symbolic Darwin Machine was added to the learning Darwin Machine over human evolutionary history, but did not replace it.

As a simple example of overcoming a problem by re-conceptualizing it, people who are anxious about flying can sometimes put themselves at ease by concentrating on the statistics showing that flying is much safer than driving. The symbolic representation of flying as safe can help counteract sensory input that it is dangerous (e.g., Flatt & King 2010). Everyday life is rife with examples of people who behave as they do because it makes sense in terms of a conceptual framework, such as a religion, a political ideology, or a scientific theory, not because of a history of operant conditioning of motor responses.

Through organized examination and testing of beliefs in addition to behavior therapy methods, cognitive behavior therapy uses this universal human capacity for therapeutic purposes, and is one of the best empirically supported therapeutic interventions.

Acceptance and mindfulness-based therapies also encourage clients to re-conceptualize their problems, but in a different way than cognitive therapies do. The emphasis is on detaching oneself from the internal dialogue and becoming mindful of one's true values, rather than trying to solve problems by eliminating difficult thoughts and feelings. We will describe a particular kind of mindfulness-based therapy called Acceptance and Commitment Therapy (ACT, pronounced as one word), in part because it is well-validated, and in part because it rests upon a strong theoretical foundation called Relational Frame Theory (RFT), which can profitably be related to core evolutionary theory (Hayes et al., 2001). In general, however, the pattern of results we describe here with ACT apply with equal force to all of the newer acceptance and mindfulness-based treatments such as Dialectical Behavior Therapy (Linehan, 1993) and Mindfulness-Based Cognitive Therapy (MBCT; Segal et al. 2002). For a recent review of such methods see Hayes et al. (2011).

RFT is derived from the functional contextual wing of behaviorism but acknowledges that Skinner failed in his quest to explain language and other forms of symbolic thought in terms of simple operant conditioning. Instead, humans have evolved specialized abilities for relating events (Penn et al., 2008); due to this evolved capacity, humans can learn to create networks of symbolic relations and transfer whole networks across contexts.

Although this may begin in the mutual relation between speakers and listeners, human

cognitive abilities carry arbitrary relational learning far beyond that situation. A learned relation of a particular kind between A and B and B and C automatically results in derived relations between A and C or C and A, but seems to require multiple exemplars of the key relational tasks (Berens & Hayes 2007). For example, if a person learns that three arbitrary events are related in the order $X < Y < Z$, and if Y is then paired with a shock, Z will elicit *more* arousal than Y even though there were never any shocks paired with Z (Dougher, Hamilton, Fink, & Harrington 2007). The essence of metaphorical thinking is that a network of relations formed in one context (e.g., a rose) can be transferred to another context (e.g., my love). There is growing evidence that the core ability to relate symbols and objects in this way is learned (e.g., Barnes-Holmes et al. 2004), beginning in infancy (e.g., Luciano et al. 2007). Whether these abilities are uniquely human or merely highly elaborated in humans is unclear, but the more important point is that RFT is beginning to delineate some of the proximate mechanisms of the symbolic Darwin Machine that will be needed to expand core evolutionary theory.

An important concept from RFT that ACT uses is *cognitive fusion*. The useful human capacity for creating networks of relations and transferring them across contexts can cause particular symbotypes to dominate over others, even when they are dysfunctional, especially when alternative symbotypes appear unavailable or the paths to them obscure. Using the venerable evolutionary metaphor of adaptive landscapes (e.g., Pigliucci & Kaplan 2006), in which altitude represents fitness, a dysfunctional symbotype is like a small peak separated from higher peaks by even more dysfunctional valleys. An example is the common tendency toward *experiential avoidance* in which avoidant responses to aversive

events are linked to their emotional and cognitive effects, spreading avoidance far beyond its original context (Hayes et al. 1996). Any number of symbolic connections can trigger a memory of a painful loss, fear of a panic attack, or the expectation of failure and avoiding these connections greatly reduces healthy behavioral variability. This pattern persists both because it is logical at the symbolic level and because it is reinforcing over the short term. A depressed person who decides to stay in bed appears to be sensibly avoiding further pain, and initially feels a sense of relief, but later develops further depression and self-loathing. An alcoholic who takes the next drink feels better immediately and worse only later. In terms of the learning Darwin Machine, the short-term transient benefits are more reinforcing than the long-term diffuse costs.

Deliberately trying to avoid a symbolically invoked experience tends to be counterproductive, because it increases attention focused on the experience and its likely negative outcomes. This often later elicits the experience itself, expanding the range of events associated with the aversive event. For example, trying not to think of a painful memory by listening to pleasant music will soon enough lead to the music itself invoking the memory (Wenzlaff & Wegner 2000). Experiential avoidance of painful private experience is arguably one of the most persistent and pathologically repertoire narrowing processes known in human psychology (Hayes et al. 1996; Hayes et al. 2006; Wenzlaff & Wegner 2000; see also Kashdan 2009) precisely because it creates an adaptive peak that prevents further healthy hill-climbing processes.

ACT uses acceptance and mindfulness methods to *increase healthy flexibility and variability in the person's actions (emotional, cognitive, and behavioral)* and examines values to *change the selection criterion for these actions*. In other words, ACT deliberately manages the variation-and-selection process, which makes it easy to relate to core evolutionary theory. ACT encourages people to identify their most important life goals and to keep them firmly in mind as criteria for selecting behaviors. At the same time, it promotes a mindful, open, and curious stance toward one's thoughts, feelings, and experiences, which reduces their automatic dysfunctional interference with the pursuit of important life goals.

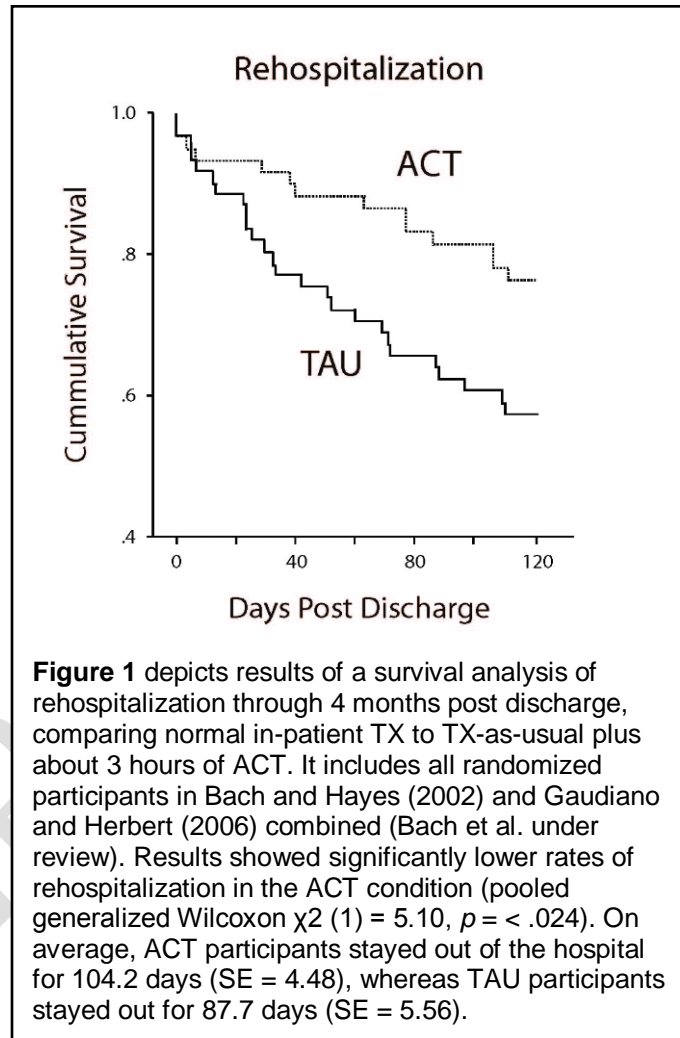
It is no coincidence that some methods of ACT and other acceptance and mindfulness-based interventions converge with religious and meditational practices—symbolic systems that have been managing the variation-and-selection process for millennia (Wilson 2002b). For example, powerful metaphors and exercises are used to manage the variation-and-selection process. Here is one ACT metaphor: when you are trying to have only certain feelings, imagine that you are a chess player locked in a battle with an emotional archrival that requires all your concentration. Now imagine that you are the chess *board*. The game is still happening, but you see it from a different perspective; you hold all of the emotional pieces, both painful and pleasant. The board can move, but only by taking all the pieces with it. In another ACT metaphor, you imagine you are driving a bus toward a destination. Imaginary “people” on the bus are the distressing thoughts and feelings that are not necessarily of your own choosing. In fact some of them are downright scary. Instead of stopping the bus and trying in vain to get them to leave, your challenge is to reach your destination with them coming along for the ride.

Metaphors such as these empower experiential methods in ACT (e.g., exposure; contemplative practices) that support different symbotypes and new behavioral options in pursuit of one's most important life goals. Paradoxically, accepting that given thoughts and feelings might not go away can be an important step toward making them go away in the sense that they become less salient and central, because they are no longer the focus of attention or have the threatening implications that they once did. Equally important, when combined with values work, it supports the key processes of increasing healthy variation and selection by chosen consequences.

Solving recalcitrant problems with the use of brief metaphors and exercises might seem too good to be true—until the concept of a symbotype is taken seriously. Because evolutionists are familiar with the genotype-phenotype relationship, they fully expect that by changing the genotype (e.g., by inducing a mutation), they can change the phenotype. Billions of dollars are spent on research showing the effects of genetic variation on phenotypic variation and on developing techniques of “gene therapy” that involve changing the genes of an individual person. As soon as we start thinking about the symbotype-phenotype relationship as similar to the genotype-phenotype relationship (which is itself an example of transferring a network of verbal relations across contexts), the idea of changing a wide range of behaviors with a single metaphor (comparable to a single gene substitution) becomes plausible—and a lot easier to accomplish than changing genes. Even better, we have no need to speculate because ACT and other mindfulness-based therapies are

empirically supported therapeutic methods, tested by using the gold standard of evaluation: the randomized controlled trial (RCT).

Figure 1 shows the combined results of two studies that applied about three hours of ACT to people hospitalized with psychotic symptoms (e.g., hallucinations or delusions). Over the next 4 months (Bach & Hayes, 2002) and continuing for the next year (Bach et al. in press), survival analysis showed that treatment-as-usual participants in the first study of this method had more than double the risk of hospitalization as compared to those receiving ACT.



The study was replicated with a more demanding control condition (Gaudiano & Herbert 2006). Figure 1 shows a survival analysis that includes all 120 patients randomized in both studies. During the four months post discharge there were 44% fewer hospitalizations in the ACT condition, a statistically significant difference. Mediation analysis showed that positive effects were not due to elimination of symptoms—but rather to greater response openness and flexibility in the presence of symptoms (Gaudiano, Herbert, & Hayes 2010;

Bach et al. under review). In the treatment group, those who admitted to symptoms were several times *more* likely to stay out of the hospital (Bach & Hayes 2002) because when accepted and no longer believed, the symptoms did not dominate over behavior as much as when they were denied and avoided. John Forbes Nash, Jr., the Nobel Prize-winning mathematician portrayed in the 2001 movie *A Beautiful Mind* is an example of someone who learned to manage his psychotic experiences by accepting their presence, declining the invitation to become entangled with them, and focusing instead on his values of family and work and the behaviors that moved him in that direction.

A recent RCT with children suffering from chronic pain (Wicksell et al. 2009) compared the impact of 10 one-hour individual sessions focused on the combination of greater emotional openness and values-based action in the presence of pain, to state-of-the-art multidisciplinary pain management, including medication (amitriptyline), individual and group meetings with staff psychiatrists and psychologists, medical management, physiotherapy, and other services. Although patients in the multidisciplinary condition received nearly twice as much psychosocial intervention as well as medication, patients in the acceptance condition did significantly better in most outcomes, including functional disability, pain interference, pain, and pain-related distress. The reason was that participants had a more open and flexible attitude toward pain and its relationship to behavior, which led to more flexible and values-based behavior (Wicksell et al. in press, a).

Table 1. Examples of areas with RCTs suggesting that acceptance and mindfulness methods impact significant problems via processes of change that alter variation and selection

Problem	Method Tested / Examples of RCTs	How It Works / Study
Anxiety	Acceptance Based Behavior Therapy: Roemer et al. 2008	Accepting internal experiences and increased engagement in valued activities reduces worry and increases quality of life (QOL); Hayes et al. 2010
Depression	MBCT: Teasdale et al. 2000; Segal et al. 2010 ACT: Bohlmeijer et al. 2011; Zettle et al. 2011	MBCT: Less rumination and increased openness/awareness reduces depression; Shahar et al. 2010. ACT: Depressing thoughts are less believable and have less impact on mood and activity; Zettle et al. 2011
Diabetes management	ACT: Gregg et al. 2007	Greater ability to act in the presence of diabetes-related thoughts and feelings increases disease management; Gregg et al. 2007
Epilepsy	ACT: Lundgren et al. 2006;	Acceptance of emotions, persistence in facing difficult thoughts, and values success increases QOL and seizure control; Lundgren et al. 2008
Pain	ACT: Dahl et al. 2004; Wicksell et al. 2008; Wicksell et al. 2009	Acceptance of pain and values-based action leads to lower life interference; Vowles et al. 2007; Vowles & McCracken 2008; Wicksell et al. in press a; in press b.
Psychosis	ACT: Bach & Hayes 2002; Bach et al. in press; Gaudiano & Herbert 2006; Gaudiano et al. 2010	Reduced believability of hallucinations leads to lower distress and hospitalization; Gaudiano et al. 2010; Bach et al., under review.

Problem	Method Tested / Examples of RCTs	How It Works / Study
Smoking	ACT: Gifford et al. 2004; in press	Greater flexibility in the presence of smoking-related thoughts and feelings improves outcome; Gifford et al. 2004; in press
Substance abuse	Mindfulness-Based Relapse Prevention: Bowen et al. 2009. ACT: Hayes et al. 2004; Luoma et al. in press	MBRP: Mindfulness reduces cravings and their impact when negative emotions appear; Witkiewitz & Bowen 2010. ACT: Not suppressing shame leads to less rebound, more TX involvement and better outcomes: Luoma et al. in press
Suicidal behavior	DBT: Linehan et al. 1991	Reduced experiential avoidance and increased display of behavioral skills improves outcome; Berking et al. 2009; Neacsiu et al. 2010
Tinnitus distress	ACT: Westin et al. in press	Acceptance of noise reduces its behavioral impact; Hesser et al. 2009; Westin et al. in press
Weight loss and eating	ACT: Juarascio et al. 2010; Lillis et al. 2009	Reduced entanglement with self-stigma and shame leads to less bingeing and greater weight loss; Lillis et al. 2009; 2011a; 2011b
Work site stress	ACT: Bond & Bunce 2000; Brinkborg et al. 2011; Flaxman & Bond 2010	Greater psychological flexibility reduces psychological distress; Flaxman & Bond 2010; Muto et al. 2011

In Table 1 (above), we list a sample of RCTs in which processes of change are known and the efficacy of ACT and/or similar acceptance and mindfulness-based therapies such as DBT and MBCT have been demonstrated. The studies show that these methods are helpful across a surprisingly broad range of problems. Both the breadth of impact and the consistency of the process of change evidence make it clear that these methods draw upon general principles that govern human behavior, which are not restricted to any particular disorder. Greater psychological openness and an increased focus on values is helpful in virtually any clinical area

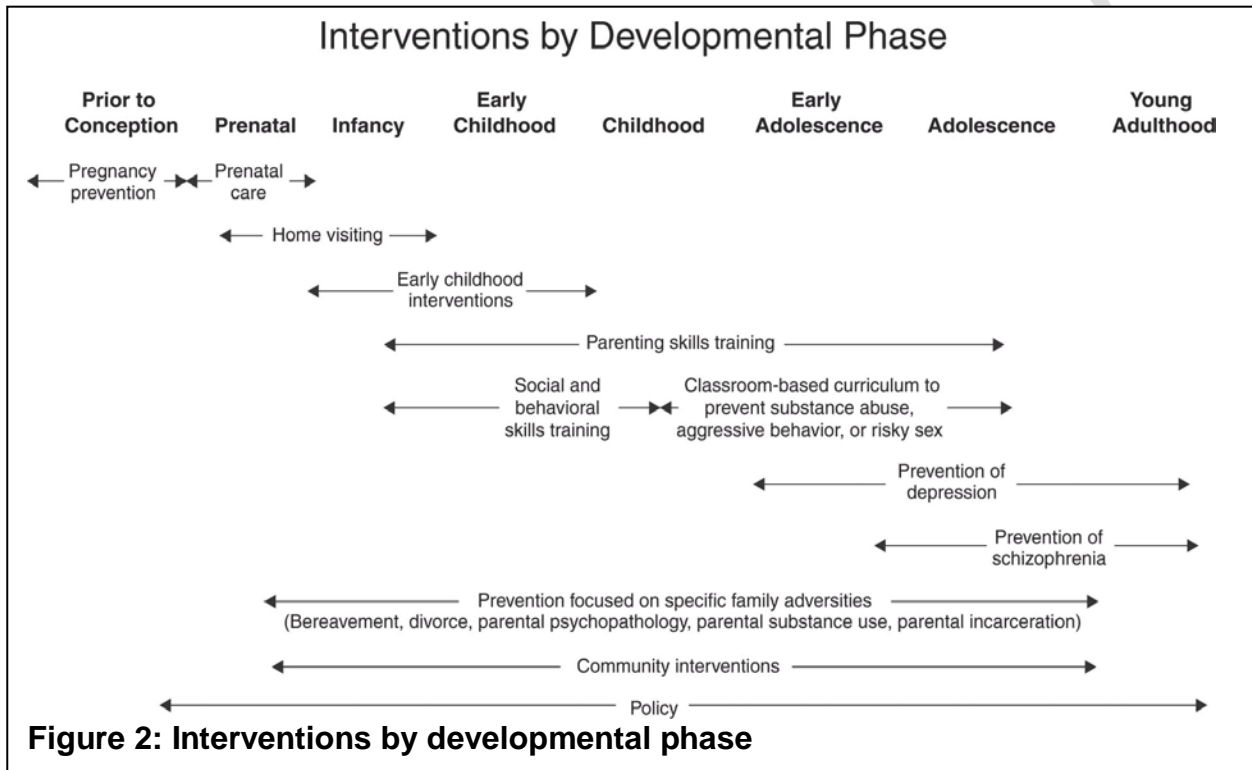
The best way to appreciate the generality of these methods is from an evolutionary perspective: they are broadly applicable because they help manage variation and selection. Genetic evolution and the immune system are understood in rich mechanistic detail. Learning and symbolic thought are much more poorly understood, in part because they have only recently been envisioned as evolutionary processes comparable to genetic evolution and the immune system. The fact that elements of ACT and other acceptance and mindfulness-based methods are often found in spiritual and religious practices suggests that some of these practices may have been selected as a strategy because they help people transcend immediate consequences in order to achieve longer term success.

Once we appreciate that all evolutionary processes result in both dysfunctional and functional outcomes, and that even functional outcomes from an evolutionary perspective can be dysfunctional from the perspective of long-term human welfare, the need to manage the variation-and-selection processes taking place all around us becomes manifest. Another

applied discipline, prevention science, is dedicated to finding science-based solutions to a diversity of real-world problems such as how to prevent children from playing in streets, how to prevent classroom environments from becoming disruptive, how to prevent self-destructive behaviors in adolescents, how to prevent crime, and how to reduce the incidence of smoking. In short, prevention scientists have developed the same ability to manage behavioral and cultural change in everyday settings that clinical scientists are generating in clinical settings—and they can prove it. The Institute of Medicine’s report on prevention (National Research Council & Institute of Medicine, 2009) documents numerous effective preventive interventions for all phases of human development, from the prenatal period through adolescence. Figure 2 (below) is from that report. Each set of brackets denotes an intervention or set of interventions that have been shown through rigorous experiments to have effects many years after implementation. There are family-focused and school interventions, as well as community and policy interventions that affect entire populations.

Embry and Biglan (2008) have compiled a list of over 50 evidence-based kernels (see Table 2 for a sample). A kernel is “a behavior-influence procedure shown through experimental analysis to affect a specific behavior and that is indivisible in the sense that removing any of its components would render it inert” (Embry 2004). Some interventions involve change at the individual level, using principles similar to behavioral, cognitive, and mindfulness-based therapies. Others involve change at the level of small groups and large populations, as described in the following two sections. Lists of empirically validated methods (including some of the methods we describe in this paper) are maintained by the Substance

Abuse and Mental Health Services Administration (the National Registry of Evidence-Based Programs and Practices; <http://nrepp.samhsa.gov>), the American Psychological Association (www.div12.org/PsychologicalTreatments/treatments.html), and the What Works Clearinghouse (<http://ies.ed.gov/ncee/wwc/>).



As we stated at the beginning of this article, a science of positive intentional change is closer than one might think, once successful research programs in the applied behavioral sciences are related to core evolutionary theory. In this way, applied disciplines largely unknown to evolutionists can expand core evolutionary theory, and core evolutionary theory can provide a general theoretical foundation for the applied disciplines.

Table 2: Examples of kernels for selected, indicated and universal prevention

Kernel	Selected Prevention	Indicated Prevention	Universal Prevention
Prize Bowl/Mystery Motivator (reinforcement)	Reduce alcohol, tobacco, or drug use (Petry et al. 2004; 2005; Stitzer & Petry 2006). Improve engagement in treatment goals (Petry et al. 1998; 2000)	Reduce problem behavior in high-risk children or youth (Maus 2007; Moore et al. 1994; Valum 1996)	Improve engaged learning and reduce disruptions of whole class (Bennett 2007; DeMartini-Scully et al. 2000; Madaus et al. 2003)
Goal/Node Mapping (relational frame)	Reduce relapse or recidivism rates (Collier et al. 2001; Czuchry & Dansereau 1999). Improve recovery (Pitre et al. 1998)	Prevent ATOD use rates (Collier et al. 2001; Czuchry et al. 1999; Newbern et al. 2005; Pitre et al. 1998). Improve attainment of therapeutic goals (Newbern et al. 1998; 1999)	Increase academic success or cognitive processes (Blankenship & Dansereau 2000; Czuchry & Dansereau 1998; Nesbit & Adesope 2006; O'Donnell et al. 2002)

Kernel	Selected Prevention	Indicated Prevention	Universal Prevention
Omega-3 fatty acid supplementation (physiological)	Treat depression, borderline, and/or bipolar disorder (Freeman et al. 2006). Reduce autism symptoms (Amminger et al. 2007; Richardson 2006)	Prevent emergence of psychotic episodes in prodromal adolescents (Amminger et al. 2010)	Improve children's cognitive performance and prevent behavioral disorders (Dunstan et al. 2004; 2007; Helland et al. 2003; Hibbeln et al. 2007)
Public posting (antecedent)	Reduce community illegal behaviors (Biglan et al. 1995; 1996; Embry & Biglan 2009)	Improve problematic behavior in therapeutic settings (Bacon-Prue et al. 1980; Lyman 1984)	Reduce impulsive or risky behaviors in general population (Houten et al. 1980; Kehle et al. 2000). Improved academics (Gross & Shapiro 1981; Van Houten et al. 1974; 1985) Promoting participation or community goods (Jackson & Mathews 1995; Stokes et al. 1978)

3.2. Change at the level of small groups

Modern society requires cooperation to function adaptively at all scales, from a single neighborhood, classroom, or business, to the global village. Evolutionary science has much to say about cooperation in two senses. First, it addresses the question of how cooperation can succeed as an evolutionary strategy in any species, not just our own (Wilson & Wilson 2007; Wilson 2011b). Second, it addresses the question of how we evolved to be so much more cooperative than any other primate species, rivaling social insect colonies and multicellular organisms in group-level functional organization.

Any social species has two pathways to evolutionary success. Individuals can succeed at the expense of other members of their own group, or they can succeed as a coordinated group that survives and reproduces better than other groups. Between-group selection can be direct, as in warfare, or indirect, simply by performing better as a group in the daily round of raising children, procuring food, defending against predators, transmitting learned information, and so on. Both levels of selection operate in most social species, producing a mix of cooperative and selfish traits.

The balance between levels of selection is not static but can evolve (Maynard Smith & Szathmari 1995). When between-group selection becomes sufficiently strong compared to within-group selection, then groups become so cooperative that they begin to qualify as organisms in their own right. It is important to stress that organisms in this sense are defined in terms of their *organization*, not their physical boundaries. A social insect colony qualifies as an organism, even though its members might be dispersed over an area of

several square kilometers, because they coordinate their activity for common survival and reproduction as much as a multicellular organism, whose cells happen to be in physical contact. In fact, the specialized cells of the vertebrate immune system are not in physical contact. They are dispersed throughout the body and communicate via cytokines from a distance, much like a social insect colony pheromones.

A shift in the balance between levels of selection requires mechanisms that suppress selection within groups, so that between-group selection can become the primary evolutionary force. This is what evolved in our species, which caused us to become so much more cooperative than other primate species (Boehm 1999). Much of what we think of as moral psychology can be understood in these terms (Haidt 2012; Joyce 2006), and is designed to operate primarily in small groups. In the ancestral human social environment, individuals were not necessarily genetically related (Hill et al. 2011), but they were well known to each other, a single individual or coalition could not dominate everyone else, it was relatively easy to establish norms by consensus, and misbehavior was relatively easy to detect and punish (Boehm 1999). The conscious psychological mechanisms that maintain the moral order are the tip of an iceberg of mechanisms that take place beneath the surface of conscious awareness. As Alexis de Tocqueville (1935/1990, p. 45) observed, “The village or township is the only association which is so perfectly natural that, whenever a number of men are collected, it seems to constitute itself.”

Modern social environments can depart from ancestral social environments in a number of ways that potentially lead to dysfunctional outcomes. Individuals can become marginalized

or excluded from their groups—a virtual death warrant in the past. The mechanisms of social control can break down, especially when groups become large but even when they remain small (e.g., the relationship between tenants and absentee landlords). There are also dysfunctions caused by groups that function only too well in pursuit of short-term goals at the expense of their own long-term welfare, that interfere with other groups, or that otherwise interfere with society at a larger scale. Examples include gangs and drug cartels. These dysfunctions are perfectly “natural,” in the sense that they have existed throughout human history, but they still pose problems that need to be solved for the benefit of overall human welfare.

Studying human society from a multilevel, biocultural evolutionary perspective is new even among evolutionists, with most developments taking place within the last 20 years. It offers a new paradigm for managing human social interactions in a practical sense, especially compared to the neoclassical economic paradigm based on individual utility maximization. And, as with the study of individual change, various branches of the applied behavioral sciences offer outstanding examples of the successful management of small groups that can be related to the principles that emerge from core evolutionary theory.

The work of Elinor Ostrom (1990; 2005; 2010) and colleagues on groups that attempt to manage common-pool resources provides one such example. Prior to Ostrom’s work, the received wisdom of economics was that common-pool resources inevitably result in the tragedy of overuse, a problem that can be solved only by privatization or top-down regulation. Ostrom shared the 2009 Nobel in economics for showing that *groups of people*

are capable of managing their common resources on their own, at least if certain conditions are met. She did this by assembling a worldwide database of groups attempting to manage common-pool resources, in addition to theoretical models drawn from political science, game theory, and, increasingly, evolutionary theory. Empirically, she was able to identify eight design features that enable groups to manage their common-pool resources successfully:

1) *Group identity*. Members of the most successful groups have a strong sense of group identity and know the rights and obligations of membership, along with the boundaries of the resource being managed.

2) *Proportional costs and benefits*. Having some members do all the work while others get the benefits cannot be sustained over the long term. In the most successful groups, everyone is expected to do their fair share and those who go beyond the call of duty receive appropriate recognition. When leaders receive special privileges, it is because they have special responsibilities for which they are held accountable.

3) *Consensus decision-making*. People hate being bossed around but will work hard to implement a consensus decision—to do what *we* want, not what *they* want. In addition, the best decisions often require knowledge of local circumstances that *we* have and *they* lack, making consensus decision-making doubly important.

4) *Monitoring*. Even when most members of a group mean well, the temptation to receive more than one's share of the benefits and to contribute less than one's share of the costs always exists. In addition, at least some individuals might try to game the system actively. If lapses and transgressions are undetectable, the group enterprise is unlikely to succeed.

5) *Graduated sanctions*. Friendly gentle reminders are usually sufficient to keep people in solid citizen mode, but there must also be the capacity to apply stronger sanctions, such as punishment or exclusion, if transgressions continue.

6) *Fast and fair conflict resolution*. When conflicts arise, they must be resolved quickly and in a manner that both parties consider fair. This typically involves a hearing in which respected members of the group, who can be expected to be impartial, make an equitable decision.

7) *Local autonomy*. When a group is nested within a larger society, such as a farmer's association dealing with the state government, the group must have enough authority to create its own social organization and make its own decisions, as outlined in 1-6.

8) *Polycentric governance*. When a group is nested with a larger society, relationships among groups and higher-level entities (such as state and federal regulatory agencies) must reflect the same principles outlined above for single groups, a point we will expand upon in the next section.

These design features, which are empirically derived from the performance of contemporary groups, are consistent with the basic evolutionary dynamics of cooperation in all species and the specific factors that caused us to become such a highly cooperative species. They provide a surprisingly practical how-to guide for any group attempting to achieve common objectives, not just groups attempting to manage common-pool resources. For example, Wilson (2011c) and Wilson et al. (2011a) relate the Ostrom design features to groups that attempt to create playgrounds and community spaces.

It is important to stress that modern groups do not necessarily adopt the Ostrom design features on their own, as if they were purely instinctive. The reason that Ostrom could derive the design features in the first place is because groups varied in their employment of them, both with failures and successes. Anyone familiar with modern-day groups can attest to the frequent absence of one or more of the design features. Neighborhoods seldom have a strong sense of group identity (a violation of design feature #1). Groups frequently consist of a few beleaguered volunteers who do most of the work (a violation of design feature #2). Discipline in schools is frequently neither fast nor based on a procedure that the students perceive as fair (a violation of design feature #6). Why aren't these design features more purely instinctive? We could ask the same question of other basic biological adaptations. How can women so easily abandon breastfeeding in favor of bottle-feeding, for example, when breastfeeding has been the signature mammalian adaptation for over 200 million years? Part of the answer is that female mammals had no alternative to breastfeeding, and therefore no reason to evolve a preference for it compared to an alternative. Similarly, throughout their evolutionary history, humans had no alternative to

living in small social groups and thus didn't necessarily evolve the instincts for creating them when alternatives became available.

It is also important to distinguish between the design features and their implementation in any particular group. In genetic evolution, a highly designed adaptation such as a wing can be implemented in different ways, such as an insect's wing, a bird's wing, or a bat's wing. The one-to-many relationship between a design feature and its implementations can be demonstrated in the laboratory. In one classic experiment, the same phenotypic trait of wing vein length was selected in a number of isolated laboratory populations of drosophila (Cohan 1984). There was a phenotypic response to selection in each population but the specific genes that evolved differed between the populations. The one-to-many relationship also exists for antibody formation: people evolve different antibodies in response to the same disease because more than one antibody can successfully bind to a given antigen; the one that becomes amplified is largely a matter of chance.

The same one-to-many relationship exists for learning and cultural evolution as Darwin Machines. Ostrom's database of groups attempting to manage common-pool resources includes groups that were faced with an identical problem, such as different Nepalese farmer associations attempting to manage their irrigation systems (Ostrom 1990). They arrived at different implementations of the various design features (e.g., how to monitor), just as the different populations of drosophila evolved different genes for wing vein length. The groups had adapted to their environments through an open-ended process of cultural evolution, not by the expression of genetically evolved modules triggered by the

environment. The need for local groups to discover the implementations that work best for them is one reason why cookie-cutter policy solutions don't work and groups need local autonomy (design feature #7).

The design features that enable groups to function as adaptive units are so general that they have been independently derived on other "islands" of the applied behavioral science "archipelago," without any awareness of Ostrom or core evolutionary theory. An alternative school called the Sudbury Valley School embodies most of the design features and functions exceptionally well (www.sudval.org). The governance of the school is democratic, with students taking part in all of the major decisions, including hiring and firing of faculty. Norms of good behavior are agreed upon by consensus, monitoring is efficient, and conflicts are resolved by a judicial committee that all students and staff members are expected to take turns serving upon. Within this strong democratic and normative environment, students have complete freedom to learn what they want, without any formal courses or examinations. The adult staff facilitates the self-motivated learning by the students and provides explicit instruction when asked.

Peter Gray, who wrote the first introductory psychology textbook centered on evolution and whose son attended the Sudbury Valley School, has interpreted its practices from an evolutionary perspective and evaluated its performance by tracking its alumni (Gray & Chanoff 1986; Gray & Feldman 2004). Gray (2009) notes that, in hunter-gatherer societies and many traditional cultures, learning and teaching take place largely without explicit instruction. Instead, children spend most of their time in mixed age groups. The older

children are strongly motivated to become adult and the younger children are strongly motivated to become like the older children. Learning the skills and roles of the society takes place in the context of self-motivated practice and play. It is an open question whether the skills of modern society can be learned in this fashion. Reading, writing, and mathematics were invented only a few thousand years ago and might not be learnable with the same ease as hunting, gathering, and warfare (Geary 2004, 2011). On the other hand, Gray argues all cultures have bodies of knowledge comparable to reading, writing, and mathematics. Is there really such a difference between an American boy learning his timetables and an Australian aborigine boy learning his song lines (Chatwin 1988)? When evaluated in terms of the success of its alumni, the Sudbury Valley School compares very favorably with more conventional schools at a fraction of the cost of a public school education, not to speak of an elite private school education.

Conventional schools can also implement the design features more than they customarily do. A grade-school teacher invented a set of practices called “The Good Behavior Game (GBG),” which prevention scientists have refined and assessed over a period of decades (see review by Embry, 2002). The Game, as played in several thousand classrooms today, has most, if not all, of the Ostrom design features. The GBG begins by establishing norms of good behavior by consensus. Even first graders are able to list the appropriate dos and don’ts: but the important fact is that they are *their* lists and not lists arbitrarily imposed upon them by the teacher and school. Once the norms of good behavior have been established and suitably displayed in the classroom, the class breaks up into groups that compete to be good while doing their schoolwork. Groups that manage to avoid a certain

number of misbehaviors receive a small reward, such as picking from a prize bowl of activities like singing a song or dancing for a minute. At first they play the game for brief periods with immediate rewards. Gradually the game lengthens and is played without being previously announced. The rewards are also gradually delayed until the end of the day or week, until the norms of good behavior become the culture of the classroom.

Competing as groups is highly motivating and causes peer pressure within the group to reward good rather than deviant behavior. Potentially destructive aspects of between-group competition are managed by periodically shuffling the composition of the group. These and other elements of the GBG are now conceptualized as “kernels,” as we described earlier (Embry 2002; Embry &

Biglan 2008).

Not only can the GBG have a transformative effect on classroom behavior over the short term, as

Figure 3 shows for 43 classrooms,

but it has long-term effects that

extend into adulthood. In a

longitudinal study that began in the 1980s in the Baltimore City School District, the GBG was implemented in the first and second grades for some classrooms but not others in a randomized controlled design. No intervention took place after the second grade. By the sixth grade, students from the GBG classrooms were less likely to be diagnosed with

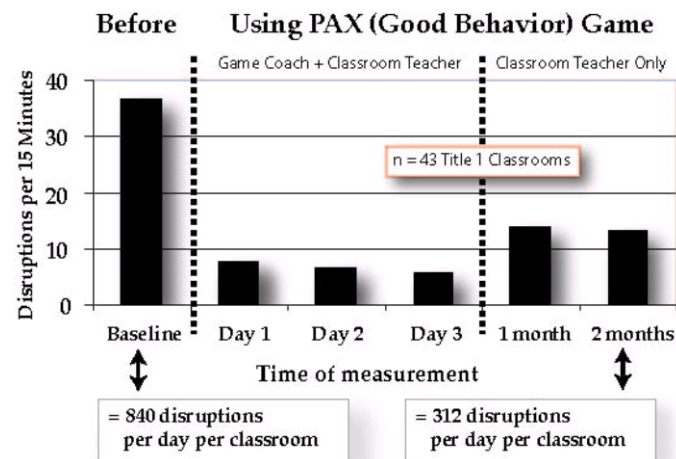


Figure 3: GBG outcomes for 43 classrooms

conduct disorder, to have been suspended from school, or to be judged in need of mental health services. During grades six through eight, they were less likely to use tobacco or hard drugs. In high school, they scored higher on standardized achievement tests, had a greater chance of graduating and attending college, and had a reduced need for special education services. In college, they had a reduced risk for suicidal ideation, lower rates of antisocial personality disorder, and lower rates of violent and criminal behavior. The GBG was exceptionally effective at achieving these outcomes for boys (Bradshaw et al. 2009; Kellam et al. 2008).

These lifelong positive outcomes illustrate the cumulative effect that cooperative behavior can have over the course of child development. The benefits of cooperation are like money in the bank earning compound interest. Children raised in cooperative social environments have multiple assets, and those raised in uncooperative environments have multiple liabilities. Rather than treating these liabilities as isolated factors, the single most important prevention measure is to create social environments in which cooperation succeeds as an evolutionary strategy (Biglan et al. 2004). This objective can be accomplished surprisingly easily, once the design features that enable groups to function as cooperative units have been identified, as the GBG attests.

Interventions that start during the adolescent stage of the life cycle are inherently more challenging than early childhood interventions, since the life challenges, personal habits, and social networks of at-risk adolescents are often firmly entrenched. Interventions that involve working with at-risk adolescents in groups often backfire because the positive

reinforcement of deviant behavior within the peer group outweighs the coaching that the adults are trying to provide. This well-documented phenomenon, called deviance training (Dishion et al. 1996), illustrates how well-meaning efforts to manage behavioral change that seem reasonable on the surface can nevertheless fail for reasons that can be easily understood from an evolutionary perspective.

The difficulty of working with adolescent peer groups extends to classroom interventions. The Promise Academy, a school associated with the highly publicized Harlem Children's Zone, started in 2004 with a first-grade and a sixth-grade class (Tough 2008). Intensive efforts to improve academic performance, based on the same educational principles, succeeded for the first graders but failed for the sixth graders. The Promise Academy has since improved its success with the older students, but only with an intensive effort that includes an extended day, extended school year, meal and healthcare programs, and so on (Whitehurst & Croft, 2010). Other successful schools for at-risk teenagers are similarly intensive (e.g., Angrist et al. 2010; Henig 2008).

These discouraging results can be interpreted in two ways. First, it is possible that at-risk adolescents have become difficult to change as *individuals*, because of developmental mechanisms that are less flexible later in life than in early childhood. For example, consider the cost and intensity of adolescent treatment strategies compared to early prevention strategies such as the Good Behavior Game (Drake et al. 2009). Second, they might have become more difficult to change as *groups*, since peer groups play a larger role in the lives of adolescents than young children. The latter interpretation implies that at-risk

adolescents might be capable of transformational change, given an appropriately designed social environment that is accepted by the adolescent peer group.

Strategies that have paid careful attention to the science of behavioral change show remarkable promise. The Morningside Academy in Seattle uses many of the procedures from the Good Behavior Game and related behavior analysis studies for students K-10, with exceptional success (Johnson 1997). The Juniper Gardens projects in Kansas City, Kansas, show robust longitudinal academic results using peer-to-peer tutoring within classrooms (Greenwood 1991a; 1991b), which also embraces the core principles of Ostrom's key findings. A natural randomized-control study of London high schools studied by Rutter and colleagues (1979) reveals that improvements in academic success, behavior, delinquency, and attendance were achieved by strategies that hauntingly echo Ostrom's observations. Also, the Good Behavior Game works in 12th-grade classrooms (Kleinman & Saigh 2011).

A new program for at-risk ninth and tenth graders called the Regents Academy, which is the first to be designed explicitly from an evolutionary perspective, has achieved impressive results during its first year (Wilson et al. 2011b). The evolutionary principles used to design the Regents Academy include the Ostrom design features, the need for learning to occur in a safe and secure social environment, and the need for long-term learning goals to be rewarding also over the short term. Not only did the Regents Academy students greatly outperform their comparison group in a randomized controlled design, they performed on a par with the average high school student on the state-mandated exams. At least according to this metric, a single year erased years of academic deficits. The

Regents Academy operates during the normal school day and year; similar programs are feasible for most public school districts.

This kind of improvement at the adolescent stage of the life cycle might seem too good to be true, but no more so than the effective therapeutic interventions for adults at the individual level reviewed in section 3.1. Once we appreciate that people of all ages are adapting to their immediate environments, it becomes clear that the wrong environmental intervention will make change appear difficult or impossible, while the right environmental intervention will make change appear effortless. Contemporary evolutionary science can help us find the right environmental interventions better than we could before.

3.3 Change at the Level of Large Populations

Changing behavioral and cultural practices at a large spatial and temporal scale is inherently more challenging than for individuals and small groups—but still possible with a sufficiently clear vision of what needs to be done. An important principle to keep in mind is that our genetically evolved adaptations for cooperation, including the cultural transmission of learned behavior, evolved in the context of small face-to-face groups and do not necessarily work well in the context of larger groups. A village or township might seem to constitute itself naturally, as Tocqueville observed, but an old nation such as France or the new American democratic experiment is another matter. New products of cultural evolution are needed to interface with old products of genetic evolution for society to function at these larger scales (Richerson & Boyd 2005).

The growing scale of human society over the course of human history is increasingly being studied from a multilevel biocultural evolutionary perspective. According to Turchin (2003; 2005), empires tend to originate in geographical regions with chronic warfare, which acts as a crucible for the cultural evolution of exceptionally cooperative societies. The most cooperative expand into empires, but then cultural evolution *within* the empires favor practices that eventually lead to their collapse. New empires almost invariably form at the boundaries of old empires, not at their centers, which become “black holes” for cooperation at a large scale (see also Putnam 1992).

In this halting fashion, with much carnage along the way, modern human society manages to function at a remarkably large scale. However there is enormous room for improvement, especially with respect to global problems such as climate change and the worldwide economy. There will be no between-planet selection, so addressing these problems will require another kind of selection—the intentional selection of policies with large-scale and long-term human welfare in mind. Devising such enlightened policies will require a sophisticated knowledge of evolution. The challenges will be daunting, but at least in principle, the right kind of environmental intervention could cause the difficult to become easy, as is already beginning at the level of individuals and small groups.

We will describe two interventions from the field of prevention science that successfully changed cultural practices at the level of counties, states, and nations. The first intervention reduced the very specific practice of convenience store clerks in Wyoming and Wisconsin illegally selling cigarettes to minors. The second intervention employs a population

approach to improving parenting practices, which has been assessed in RCTs at the county level and is in the process of being implemented around the world. These fall short of addressing the gravest problems afflicting our planet, but they still show how evolutionary science can be used to accomplish intentional positive change above the level of individuals and small groups.

The federal government monitors rates of illegal tobacco sales to minors by employing minors to enter convenience stores and attempt to buy cigarettes. States that exceed a certain level of illegal sales stand to lose millions of dollars of federal block grants.

Wyoming and Wisconsin were in this situation when they engaged the services of Embry to find a solution. Biglan had already designed and validated an intervention at the level of whole towns in Oregon (Biglan et al. 1995; 1996), which Embry expanded to the statewide scale. The intervention involved the following components:

1) Establish a meaningful consensus that selling tobacco to minors is wrong. Norms tend to be easily established by consensus in small groups but more work is required at the level of a whole state. Embry and Biglan accomplished their objective with a billboard marketing campaign, endorsements by well-known and respected individuals, and by communicating with convenience store owners, who in turn communicated with their clerks. Signs were also placed in convenience stores as a visible reminder of the norm.

2) A “reward and reminder” procedure for reinforcing clerks’ behavior. Embry and Biglan employed a team of minors to enter convenience stores and attempt to buy cigarettes.

Clerks who upheld the law were positively reinforced with praise, coupons donated by local businesses, and even articles in the local press. Clerks who failed to check for ID were gently reminded that they had violated the law. The principle of abundant praise coupled with mild punishment that escalates only when necessary tends to occur spontaneously in small groups but requires more work to establish at the level of a whole state.

3) *A managed variation-and-selection procedure to discover best practices.* A competition was held among the convenience store clerks for the best way to respond to a minor trying to buy tobacco. The winning entries were printed on cards that clerks could simply hand to the customers. One card read, "I don't think so. Folks like me make about \$7 an hour. If I sold tobacco to you, which is illegal, I could get fined \$500. I'd have to work 107 hours to pay for that. That's about 2-1/2 weeks full-time. How many shifts will you work to help me?" Once again, best practices tend to be identified and copied spontaneously in small groups, but more work is required to identify and copy them on a larger scale.

In short, the mechanisms that cause small groups to "naturally constitute themselves," as Tocqueville put it, don't necessarily work on a larger scale, *but they can be made to work* if they have a clear vision of what to do. The intervention succeeded at reducing cigarette sales to minors at a statewide scale, as Figure 4 shows. Moreover, this resulted in a lower incidence of smoking by minors, according to independently collected survey data.

Tallying the financial costs and benefits, the intervention was highly cost effective for the states, thanks to the federal regulation that would have caused them to lose millions of

dollars in block grants. The convenience store owners lost millions of dollars of revenue, but they willingly did so to uphold a norm established by consensus and to maintain their reputations as solid citizens. The convenience store clerks received short-term rewards for good behavior and benefitted over the long term by not having to deal as often with a tense situation. Of course, the main

benefit was to reduce the incidence of cigarette smoking, saving lives over the long term, but the long-term benefits could not be achieved without a system for reinforcing the appropriate behaviors over the short term. This general principle applies as forcefully to global problems such as climate change and the worldwide economy as to a statewide problem such as illegally selling cigarettes to minors.

Prevention scientists in Australia (Sanders et al. 2002) developed a population approach to improving parenting practices, Triple P (for Positive Parenting Program). Child abuse is one of the most severe societal problems worldwide. Five children die each day in the United States due to child abuse. Despite growing efforts to deal with the problem from a variety of perspectives, the rate of child abuse in America has increased 35% during the past 10 years (<http://www.childhelp.org/pages/statistics>). Extreme child abuse is the tip of an iceberg of parenting practices that harm the long-term welfare of children, resulting

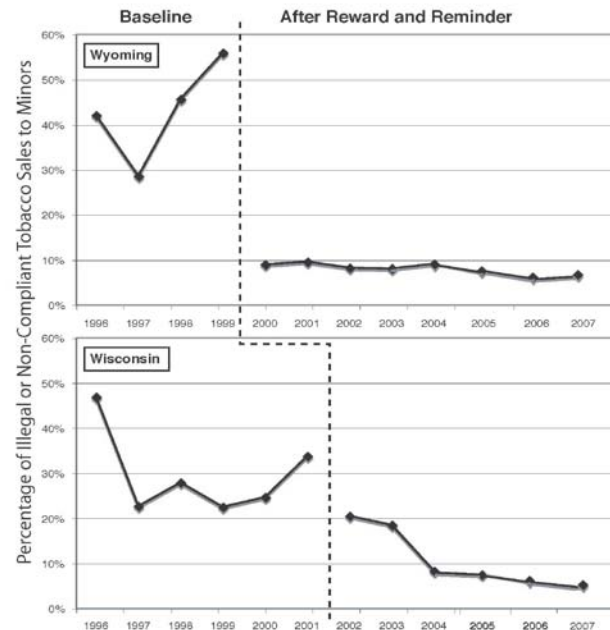


Figure 4: Wyoming & Wisconsin R&R Outcomes

in depression, academic failure, teenage pregnancy, substance abuse, and crime. If we can solve some of these problems by improving parenting practices, we can substantially improve the quality of human life on earth.

How can we explain the paradox of parents who harm their children? Core evolutionary theory provides part of the answer by showing that the interests of parents only partially overlap with the interests of their children. Parents evolve to maximize their lifetime reproductive success, which can involve withholding support from particular children (Trivers 1972). Men are especially likely to invest in mating effort rather than parental effort. Relations between step-parents and step-children are likely to be especially problematic because there is no genetic interest at all (Daly & Wilson 1988; 2001).

These insights are valid as far as they go, but they also provide an outstanding example of how core evolutionary theory has failed to include learning and symbolic systems as evolutionary processes in their own right. More than 40 years of research from within the behavioral tradition shows how high levels of coercive interactions can be selected within families in a tragic co-evolutionary race to the bottom (Patterson 1982; Forgatch et al. 2008; Reid et al. 2002). Each family member learns that, when another is behaving in an unpleasant manner (e.g., criticizing, teasing, or attacking), then escalating his or her own aversive behavior will frequently cause the other person to stop momentarily. The process has been labeled negative reinforcement because the reinforcer is the removal or cessation of an aversive event. A parent's abusive behavior is shaped by the effect of getting the child to stop doing things that annoy the parent or to do things that the parent demands. A

child's resistance is shaped by the effect of reducing parents' demeaning or aversive behavior. In short, both the parent and the child are behaving adaptively in an extremely local sense, even though the results are disastrous for both over the long term. Left unmanaged, evolution often takes us where we don't want to go. A similar coercive process has been shown to underpin the development and maintenance of depressive behavior in families (Biglan et al. 1988).

Over 50 experimental evaluations demonstrate that parents locked in a negative co-evolutionary spiral with their children can learn to adopt a positive co-evolutionary spiral by providing high levels of positive reinforcement for cooperative behavior and mild, consistent negative consequences for uncooperative behavior (e.g., de Graaf et al. 2008; Nowak & Heinrichs 2008; Patterson et al. 2004). The techniques can work for any family, even those with few material resources or for step-parents. Most successful interventions are designed to work for single families or small groups. Triple P's novelty is that it employs a multilevel approach that can change parenting in large populations. The first level involves using mass media to reach parents with information and advice about effective parenting. The second provides advice to parents from childcare providers and human service workers who frequently contact the parents through brief individual consultations or 90-minute group seminars. Level 3 provides more-intensive training in skills for dealing with circumscribed child problems. Level 4 provides a series of sessions designed to help parents develop skills for dealing with a wider range of issues. Finally, level 5 provides help with additional issues that affect parenting, such as parental depression and marital discord.

Prinz, Sanders, and colleagues (2009) tested Triple P in 18 South Carolina counties and showed for the first time that it is possible to prevent child abuse in entire populations. They randomized nine counties to receive the intervention and nine to no intervention. They trained 649 service providers in the intervention counties to work with parents.

Two years after the start of the study, the counties that did not receive the program showed large increases in substantiated child abuse, out-of-home placements due to child abuse problems, and increases in hospital-reported child injuries. These same increases showed up in the 28 South Carolina counties that did not participate in the study. However, the counties that had Triple P performed significantly better on all three measures: fewer children were abused, as indicated by both substantiated maltreatment and hospital reports of injuries due to abuse, and fewer children went into foster care. Prinz et al. (2009) point out that, for a community with 100,000 children, the differences translate into 688 fewer cases of child abuse, 240 fewer out-of-home placements, and 60 fewer children needing hospitalization. Using very conservative estimates of cost-effectiveness, the dollars saved by implementing Triple P greatly outweigh implementation cost. Triple P is now implemented in over 20 nations worldwide, using a dissemination strategy as novel as its implementation strategy. It rigorously evaluates its own practices and oversees the training of those who implement the program in any particular locality. It provides a model of intentional science-based change at a worldwide scale.

Table 3. Community interventions and policies affecting entire populations

Community Interventions Evaluated in Randomized Trials

Project and Target	Intervention	Outcomes	References
Project Northland— adolescent alcohol use	Community organizing, youth action teams, print media regarding norms about underage drinking, parent education and involvement, classroom-based social-behavioral curricula	Reduced adolescent alcohol use and improved attitudes and normative beliefs about its use	Perry et al. 1996, 2000, 2002
Communities Mobilizing for Change on Alcohol— adolescent alcohol use	Community policy and norm changes through the actions of community leadership teams	Lower levels of alcohol sales to underage youth; fewer purchase attempts by 18- to 20-year-olds; lower rates of alcohol consumption among young adults, fewer arrests for DUI	Wagenaar et al. 2000
Project SixTeen— adolescent tobacco use	Classroom-based prevention curricula; media advocacy, youth antitobacco activities; family communication about tobacco use; rewards to clerks for not selling to youth	Reduced prevalence of youth smoking	Biglan et al. 2000
Midwestern Prevention Project—adolescent tobacco, alcohol, and other drug use	Classroom curriculum; parent training; education of community leaders; media campaign focusing on prevention policies and practices.	Reductions in tobacco, alcohol, and marijuana use	Pentz et al. 1989a; 1989b; 1989c

Community Interventions Evaluated in Randomized Trials

Project and Target	Intervention	Outcomes	References
Communities that Care—multiple youth problems (substance use, school dropout, violence, pregnancy)	Creation of coalitions of community leaders trained in assessing risk and protective factors; implementation of relevant, empirically supported programs	Reduction in targeted risk factors and initiation of delinquency	Hawkins et al. 2008
Aban Aya—multiple youth problems (violence, substance abuse, unsafe sex) among early adolescent African Americans	Social skills curricula, focused social competence or social competency curricula plus in-service training of teachers and staff; local task force to develop policies, run schoolwide fairs, seek funds for the school, and lead field trips for parents and children; parent training workshops	Both interventions reduced violent behavior, provoking behavior, school delinquency, drug use, and recent sexual intercourse	Flay et al. 2004
Prosper—multiple youth problems	Implementation of a selected parenting program (Strengthening Families) and one of two school-based drug abuse prevention curricula (Life Skills Training or Project Alert)	Reductions in cigarette, alcohol, marijuana, and inhalant use	Spoth et al. 2007; Spoth et al. 2007

Policies			
Domain	The Policy	Outcome	References
Alcohol use	Increasing the tax on alcoholic beverages	Reduction in: alcohol consumption; alcohol-related morbidity and mortality; traffic crash deaths; sexually transmitted disease; violence; and crime	Campbell et al. 2009; Wagenaar et al. in press; Wagenaar et al. 2009
	Limiting the density of alcohol outlets	Large and significant reductions in alcohol consumption and interpersonal violence	Campbell et al. 2009
	Reducing the hours of alcohol sales	Reductions in alcohol consumption and related harm (e.g., violence)	Stockwell & Chikritzhs 2009 Popova et al. 2009
Tobacco use	Increasing the tax on tobacco products	Reduction in youth initiation of smoking and adult rates of consumption	Chaloupka. & Grossman 1996; Chaloupka & Pacula 1998; Lewit et al. 1997
	Restrictions on smoking indoors	Reduction in smoking rates	Levy et al. 2004
	Increasing access to smoking cessation treatment and telephone support lines	Increased quit rates	Levy et al. 2004

In addition to the two examples described in detail in this section, numerous other interventions have achieved effects in whole populations. Table 3 lists seven community-wide interventions that have been evaluated in randomized trials and shown to affect the incidence or prevalence of one or more youth problems, including tobacco, alcohol, and other drug use, and delinquency. The table also lists policies regarding alcohol and tobacco use that have been shown to affect population rates of consumption or problems related to consumption. One example is increased taxation on alcohol, which has been shown to reduce alcohol consumption, alcohol-related morbidity and mortality, traffic accident deaths, sexually transmitted disease, violence, and crime. The Promise Neighborhoods Research Consortium website lists and describes many other well-evaluated policies. See <http://promiseneighborhoods.org/policies/>.

4. General Discussion

This article has two main purposes. The first is to sketch a basic science of intentional change centered on evolution. The second is to highlight effective examples of intentional change from the applied behavioral sciences, which demonstrate that we are closer to achieving a science of intentional change than one might think.

Accomplishing the first goal requires resolving the paradox of elaborate genetic innateness and elaborate open-ended flexibility. For decades, evolution has been marginalized in the human behavioral sciences as a process that can explain the rest of life, our physical bodies, and a few basic urges, such as eating and having sex, but that has little to say about our rich behavioral and cultural diversity. Evolutionists, in turn, have concentrated almost entirely

on genetic evolution, which includes the concept of phenotypic plasticity, but which did not highlight learning and symbolic thought as evolutionary processes until very recently (Jablonka & Lamb 2006).

The 1980s and 90s witnessed a surge of interest in evolution in relation to human affairs. Terms such as evolutionary psychology and evolutionary anthropology signified that entire disciplines were being rethought from a modern evolutionary perspective. Much progress was made, but a particular configuration of ideas that became associated with the term “evolutionary psychology (EP)” set itself apart from the so-called “standard social science model (SSSM),” which included the very behavioral traditions that have been successful in developing the beginnings of a science of intentional behavior change. The polarized distinction between EP and the SSSM made elaborate genetic innateness seem even more difficult than before to reconcile with an elaborate capacity for open-ended change.

Every discipline has past experiences and narratives about them that are difficult to overcome and therefore limit the potential for future scientific change. In this context, the ACT principles of distancing oneself from narratives, increasing psychological flexibility, and mindfully working toward important life goals are as relevant to advancing scientific progress as to making healthy individual changes. Scientists and scholars of all stripes need to distance themselves from the repertoire-narrowing narratives of their particular disciplines, become open to the possibility of new interconnections and cooperative relations, and work toward a unified science of intentional change (Johnson 2010).

One step in this direction is to achieve a consensus that the paradox of elaborate genetic innateness and an elaborate capacity for open-ended change can be fully reconciled through the concept of Darwin Machines. Evolution is inherently an open-ended process capable of adapting organisms to their current environments by creating behavioral variation and selecting traits according to certain criteria. An evolutionary process built by genetic evolution must be elaborately innate for variation and selection to take place in a way that leads to genetically adaptive outcomes, on average. The immune system is an outstanding example of a Darwin Machine that is *both* elaborately flexible and elaborately innate, providing a guide for how to study the human capacity for behavioral and cultural change.

A second step toward a unified science of intentional change is to realize how much each current discipline has to contribute to the unification. It is not a matter of importing to other disciplines a framework that evolutionists have already perfected. Evolutionists have concentrated almost entirely on genetic evolution and paid scant attention to evolutionary processes at other levels of analysis. The dominant heuristic in narrow-school evolutionary psychology, when trying to explain a particular trait, is to assume that it is genetically determined, ask how it evolved by genetic evolution in the distant past, and then ask how it functions in the current environment. For traits associated with parental neglect, the heuristic has led to valid insights concerning the importance of such things as genetic relatedness or availability of resources. Yet, it missed the fast-paced process of selection by consequences, resulting in behavioral strategies in parents and offspring that are adaptive in the context of the immediate family environment but profoundly maladaptive over the

long term: practices that can change once these contingencies are identified and understood. Evolutionists therefore have much to learn from branches of the human behavioral sciences where learning as a variation-and-selection process has occupied center stage for decades.

The concept of human symbolic thought as a Darwin Machine is especially new for nearly all disciplines. Only a handful of evolutionists seriously theorize about culture as an evolutionary process and the role of symbolic thought in human cultural evolution. Within the human behavioral sciences and humanities, the disciplines that most appreciate social constructivism also tend to be most avoidant of evolution; yet, turned another way, social constructionists are making needed points about the importance of symbolic evolution.

The fact that symbolic systems, like genotypes and antibodies, exist in nearly infinite variety and that a symbotype-phenotype relationship exists that is similar to the genotype-phenotype relationship is profound in its implications for a science of intentional change. It would be hard to overestimate the degree to which our symbotypes organize our perception. A believer in Jesus literally sees the world differently than a believer in Ayn Rand, and *seeing* differently results in *acting* differently. This is true not only for religions and political ideologies, but also for scientific theories. Consider the possibility that severe personal and societal dysfunctions, which have defied solutions for decades, can in part be remediated by interventions in a handful of hours. Against the background of an evolutionary theory confined to genetic evolution, this claim seems too good to be true. Against the background of an evolutionary approach that actively manages a symbotype-

phenotype relationship, the possibility begins to make more sense. If we expect artificial selection, genetic engineering, and gene therapy to provide new solutions, then why not expect the same from their counterparts in learning and symbolic systems? In this fashion, expanding core evolutionary theory beyond genetic evolution results in new possibilities for action that were previously invisible. Indeed, as the behavioral and symbolic impact on epigenetic processes becomes better understood, this expansion promises to alter our perspective on the role of genetic evolution itself.

This new sense of theoretical possibility is interesting as far as it goes, but becomes far more interesting when substantiated by examples from the applied behavioral sciences. The first author of this paper (DSW) had never heard of the field of prevention science until the third author (AB) contacted him in 2007. DSW was amazed to discover examples of intentional cultural change, validated by the most rigorous experimental methods. He came to regard prevention science as “applied cultural evolution” and started to ask his colleagues in evolution, psychology, and other basic scientific disciplines if they had ever heard of the field of prevention science. Very few had. It was like a far-off island in an archipelago of disciplines with little communication among islands. Prevention science was even little known among other applied scientific disciplines.

Just as evolutionary biologists are accustomed to studying all traits in all species, a science of intentional change centered on evolution can be applied to any behavioral or cultural issue. Current theories and perspectives that inform public policies are an archipelago in their own right. Each “island” (e.g., rational choice theory in economics), is a symbolic

system that organizes perception, making some actions appear reasonable, others inadvisable, and others to disappear from view altogether. The policies are the phenotypes that emerge from the symbotypes. The policies are winnowed by selection to a degree—it's not as if we are doing *everything* wrong—but there is tremendous room for improvement by using an expanded evolutionary theory to organize our perception and the most rigorous experimental methods to evaluate the consequences of our actions.

Such a science of intentional change need not compromise norms of respect for the rights of individuals. Indeed, the importance of consensus decision-making for groups to function as cooperative units accentuates the need for democratic processes to formulate benign social policies. All of the interventions we have described were implemented because they targeted outcomes that were concerns of individuals or well-established threats to public health (e.g., youth tobacco use and child abuse). In no case was coercion used. Rather, the interventions created conditions that favored the selection of behaviors or cultural practices that were desired by individuals and communities.

The fragmentation of knowledge in the basic and applied human-related disciplines is so pervasive that people take it for granted, as if it can never change. It is time to imagine a new and more unified possibility. It is one thing to know that a given intervention works in a given context. It is yet another thing to know that it works for reasons that are very general and that can be applied to many other contexts. Evolutionary science seems fully capable of providing a unified theoretical framework for all human-related disciplines, including the humanities and the basic and applied human behavioral sciences. The success

stories that we have reviewed in this article are a small taste of what might be possible in the future as we learn to become wise managers of evolutionary processes. There is no alternative to attempting to manage change. The tools of evolutionary science can allow us to decide what we want to do and to set about doing it.

UNDER REVIEW

References

- Amminger, G.P., Berger, G.E., Schaefer, M.R., Klier, C., Friedrich, M.H., Feucht, M. (2007). Omega-3 fatty acids supplementation in children with autism: a double-blind randomized, placebo-controlled pilot study. *Biological Psychiatry*, 61: 551-53.
- Amminger, G.P., Schafer, M.R., Papageorgiou, K., Klier, C.M., Cotton, S.M., Harrigan, S.M., et al. (2010). Long-Chain Omega-3 Fatty acids for indicated prevention of psychotic disorders: a randomized, placebo-controlled trial. *Archives of General Psychiatry*, 67: 146-54.
- Angrist, J. D., Dynarski, S. M., Kane, T. J., Pathak, P. A., & Walters, C. R. (2010). Who benefits from KIPP? *National Bureau of Economic Research*, Working paper no. 15740.
- Bach, P. & Hayes, S. C. (2002). The use of Acceptance and Commitment Therapy to prevent the rehospitalization of psychotic patients: A randomized controlled trial. *Journal of Consulting and Clinical Psychology*, 70: 1129-1139.
- Bach, P., Hayes, S.C., & Gallop, R. (In press). Long-term effects of brief Acceptance and Commitment Therapy for psychosis. *Behavior Modification*.
- Bach, P., Gaudiano, B., Hayes, S.C., & Herbert, J. (under review). *Reduced believability of positive symptoms mediates improved hospitalization outcomes of Acceptance and Commitment Therapy for psychosis*.
- Bacon-Prue, A., Blount, R., Hosey, C., & Drabman, R.S. (1980). The public posting of photographs as a reinforcer for bedmaking in an institutional setting. *Behavior Therapy*, 11: 417.
- Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis*, 1: 91-97.

- Barkow, J. H., Cosmides, L., & Tooby, J. (Eds.). (1992). *The adapted mind: evolutionary psychology and the generation of culture*. Oxford, UK: Oxford University Press.
- Barnes-Holmes, Y., Barnes-Holmes, D., Smeets, P. M., Strand, P. & Friman, P. (2004). Establishing relational responding in accordance with more-than and less-than as generalized operant behavior in young children. *International Journal of Psychology and Psychological Therapy*, 4: 531-558.
- Beck, J. S. (2011). *Cognitive behavior therapy: Basics and beyond* (2nd ed.). New York: Guilford.
- Bennett, M.M. (2007). An interdependent group contingency with mystery motivators to increase spelling performance. ProQuest Information & Learning: US.
- Berens, N. M. & Hayes, S. C. (2007). Arbitrarily applicable comparative relations: Experimental evidence for a relational operant. *Journal of Applied Behavior Analysis*, 40: 45-71.
- Berking, M., Neacsiu, A., Comtois, K. A., Linehan, M. M. (2009). The impact of experiential avoidance on the reduction of depression in treatment for borderline personality disorder. *Behaviour Research and Therapy*, 47: 663-670.
- Biglan, A., Ary, D.V., Koehn, V., Levings, D., Smith, S., Wright, Z. et al. (1996). Mobilizing positive reinforcement in communities to reduce youth access to tobacco. *American Journal of Community Psychology*, 24: 625-638.
- Biglan, A., Ary, D.V., Smolkowski, K., Duncan, T.E., & Black, C. (2000). A randomized control trial of a community intervention to prevent adolescent tobacco use. *Tobacco Control*, 9: 24-32.

- Biglan, A., Brennan, P. A., Foster, S. L., Holder, H. D., Cunningham, P., Derzon, J. H. et al. (2004). *Helping adolescents at risk: Prevention of multiple problem behaviors*. New York: Guilford Press.
- Biglan, A., Henderson, J., Humphreys, D., Yasui, M., Whisman, R., Black, C. et al. (1995). Mobilising positive reinforcement to reduce youth access to tobacco. *Tobacco Control, 4*: 42-48.
- Biglan, A., Hops, H., & Sherman, L. (1988). Coercive family processes and maternal depression. In R.D. Peters & R. J. McMahon (Eds.), *Social learning and systems approaches to marriage and the family* (pp. 72-103). New York: Brunner/Mazel.
- Blankenship, J. & Dansereau, D.F. (2000). The effect of animated node-link displays on information recall. *Journal of Experimental Education, 68*: 293-308.
- Boehm, C. (1999). *Hierarchy in the forest: egalitarianism and the evolution of human altruism*. Cambridge, Mass: Harvard University Press.
- Bohlmeijer, E. T., Fledderus, M., Rokx, T. A., & Pieterse, M. E. (2011). Efficacy of an early intervention based on acceptance and commitment therapy for adults with depressive symptomatology: Evaluation in a randomized controlled trial. *Behaviour Research and Therapy, 49*: 62-67.
- Bolhuis, J. J., Brown, G. R., Richardson, R. C., & Laland, K. N. (2011). Darwin in mind: new opportunities for evolutionary psychology. *PLoS Biology, 9*, 001109. Available at <http://www.plosbiology.org/article/info%3Adoi%2F10.1371%2Fjournal.pbio.1001109>.

- Bond, F. W., & Bunce, D. (2000). Mediators of change in emotion-focused and problem-focused worksite stress management interventions. *Journal of Occupational Health Psychology, 5*: 156-163.
- Bowen, S., Chawla, N., Collins, S.E., Witkiewitz, K., Hsu, S., Grow, J. et al. (2009). Mindfulness-based relapse prevention for substance use disorders: A pilot efficacy trial. *Substance Abuse, 30*: 295-305.
- Boyd, R., & Richerson, P. J. (1985). *Culture and the evolutionary process*. Chicago: University of Chicago Press.
- Bradshaw, C. P., Zmuda, J. H., Kellam, S., & Ialongo, N. (2009). Longitudinal impact of two universal preventive interventions in first grade on educational outcomes in high school. *Journal of Educational Psychology, 101*: 926-937.
- Brewer, W.F. (1974). There is no convincing evidence for operant or classical conditioning in adult humans. In W.B. Weimer, D. S. Palermo, W. B. Weimer, & D. S. Palermo (Eds.), *Cognition and the symbolic processes*. Oxford UK: Erlbaum.
- Brinkborg, H., Michanek, J., Hesser, H., & Berglund, G. (2011). Acceptance and commitment therapy for the treatment of stress among social workers: A randomized controlled trial. *Behaviour Research and Therapy, 49*: 389-398.
- Bruner, J. S. (1973). *Beyond the information given*. Oxford, UK: W.W. Norton.
- Bruner, J. S. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.
- Bruner, J., (1984). Notes on the cognitive revolution: OISE's Centre for Applied Cognitive Science. *Interchange, 15*:, 1-8.

- Buller, D. J. (2005). *Adapting minds: evolutionary psychology and the persistent quest for human nature*. Cambridge, MA: MIT Press.
- Buller, D. J., & Hardcastle, V. G. (2000). Evolutionary psychology, meet developmental neurobiology: against promiscuous modularity. *Brain and Mind, 1*: 302-325.
- Calvin, W. H. (1987). The brain as a Darwin machine. *Nature, 330*: 33-34.
- Campbell, C.A., Hahn, R.A., Elder, R., Brewer, R., Chattopadhyay, S., Fielding, J. et al. (2009). The effectiveness of limiting alcohol outlet density as a means of reducing excessive alcohol consumption and alcohol-related harms. *American Journal of Preventive Medicine, 37*: 556-569.
- Campbell, T. D. (1960). Blind variation and selective retention in creative thought and other knowledge processes. *Psychological Review, 67*: 380-400.
- Carruthers, P. (2006). *The architecture of the mind*. Oxford: Oxford University Press.
- Chaloupka, F.J. & Grossman, M. (1996). *Price, tobacco control policies and youth smoking*, National Bureau of Economic Research Working Paper No. 5740. Cambridge: NBER.
- Chaloupka, F.J. & Pacula, R.L. (1998). *An examination of gender and race differences in youth smoking responsiveness to price and tobacco control policies*, National Bureau of Economic Research Working Paper No. 6541. Cambridge, NBER.
- Chatwin, B. (1988). *The songlines*. New York: Penguin.
- Cohan, F. M. (1984). Can uniform selection retard random genetic divergence between isolated conspecific populations? *Evolution, 3*: 495-504.
- Collier, C.R., Czuchry, M., Dansereau, D.F., & Pitre, U. (2001). The use of node-link mapping in the chemical dependency treatment of adolescents. *Journal of Drug Education, 31*: 305-317.

- Craske, M. G., & Barlow, D. H. (2008). Panic disorder and agoraphobia. In D. H. Barlow (Ed.), *Clinical handbook of psychological disorders: a step-by-step treatment manual* (4th ed., pp. 1– 64). New York: Guilford.
- Czuchry, M. & Dansereau, D.F. (1998). The generation and recall of personally relevant information. *Journal of Experimental Education, 66*: 293-315.
- Czuchry, M. & Dansereau, D.F. (1999). Node-link mapping and psychological problems: Perceptions of a residential drug abuse treatment program for probationers. *Journal of Substance Abuse Treatment, 17*: 321-329.
- Dahl, J., Wilson, K. G., & Nilsson, A. (2004). Acceptance and Commitment Therapy and the treatment of persons at risk for long-term disability resulting from stress and pain symptoms: a preliminary randomized trial. *Behavior Therapy, 35*: 785-802.
- Daly, M., & Wilson, M. (1988). *Homicide*. New York: Aldine de Gruyter.
- Daly, M., & Wilson, M. (2001). An assessment of some proposed exceptions to the phenomenon of nepotistic discrimination against stepchildren. *Annales Zoologici Fennici, 38*: 287–296.
- de Graaf, I., Speetjens, P., Smit, F., de Wolff, M., & Tavecchio, L. (2008). Effectiveness of the triple P positive parenting program on behavioral problems in children: A meta-analysis. *Behavior Modification, 32*: 714-735. DOI: 10.1177/0145445508317134.
- De Martini-Scully, D., Bray, M.A. & Kehle, T.J. (2000). A packaged intervention to reduce disruptive behaviors in general education students. *Psychology in the Schools, 37*: 149-56.
- Deacon, T. W. (1998). *The symbolic species: The co-evolution of language and the brain*. New York: Norton.

- Dishion, T. J., Spracklen, K. M., Andrews, D. W., & Patterson, G. R. (1996). Deviancy training in male adolescents friendships. *Behavior Therapy, 27*: 373-390.
- Dougher, M. J., Hamilton, D., Fink, B., & Harrington, J. (2007). Transformation of the discriminative and eliciting functions of generalized relational stimuli. *Journal of the Experimental Analysis of Behavior, 88*: 179-197.
- Drake, E. K., Aos, S., & Miller, M. G. (2009). Evidence-based public policy options to reduce crime and criminal justice costs: Implications in Washington state. *Victims & Offenders, 4*: 170-196.
- D Dunstan, J.A., Mitoulas, L.R., Dixon, G., Doherty, D.A., Hartmann, P.E., Simmer, K. et al. (2007). The effects of fish oil supplementation in pregnancy on breast milk fatty acid composition over the course of lactation: a randomized controlled trial. *Pediatric Research, 62*: 689-94.
- Dunstan, J.A., Roper, J., Mitoulas, L., Hartmann, P.E., Simmer, K., & Prescott SL. (2004). The effect of supplementation with fish oil during pregnancy on breast milk immunoglobulin A, soluble CD14, cytokine levels and fatty acid composition. *Clinical & Experimental Allergy, 34*: 1237-42.
- Edelman, G. M. (1988). *Neural Darwinism: the theory of neuronal group selection*. New York: Basic Books.
- Edelman, G. M., & Tononi, G. (2001). *A universe of consciousness: how matter becomes imagination*. New York: Basic Books.
- Ehrenreich, B., & McIntosh, J. (1997). The new creationism: biology under attack. *The Nation*, June 9, 1997: 11-16.

- Embry, D. D. (2002). The Good Behavior Game: a best practice candidate as a universal behavioral vaccine. *Clinical Child & Family Psychology Review*, 5: 273-297.
- Embry, D.D. (2004). Community-based prevention using simple, low-cost, evidence-based kernels and behavior vaccines. *Journal of Community Psychology*, 32: 575-591.
- Embry, D.D. & Biglan, A. (2008). Evidence-based kernels: Fundamental units of behavioral influence. *Clinical Child and Family Psychology Review*, 11: 75-113.
- Embry, D.D., Biglan, A. (2009). Effectiveness trial using Reward & Reminder™ visits to reduce tobacco sales to, and tobacco use by, young people: a multiple-baseline across two states. National Registry of Effective Programs and Practices. Washington, DC: Substance Abuse and Mental Health Administration.
- Evans, W.N., Farrelly, M.C., Montgomery, E. (1999). Do workplace smoking bans reduce smoking? *The American Economics Review*, 89:728-747. First printed as NBER Working Paper No. 5567 issued in 1996. <http://www.nber.org/papers/w5567>.
- Farmer, J.D., & Packard, N.H. (1987). The immune system, adaptation, and machine learning. *Physica*, 22D: 187-204
- Flatt, N., & King, N. (2010). Brief psycho-social interventions in the treatment of specific childhood phobias: A controlled trial and a 1-year follow-up. *Behaviour Change*, 27: 130-153. doi:10.1375/bech.27.3.130
- Flaxman, P. E., & Bond, F. W. (2010). Worksite stress management training: Moderated effects and clinical significance. *Journal of Occupational Health Psychology*, 15: 347-358.

- Flay, B.R., Graumlich, S., Segawa, E., Burns, J.L., & Holliday, M.Y. (2004). Effects of 2 prevention programs on high-risk behaviors among African American youth: a randomized trial. *Archives of Pediatrics & Adolescent Medicine*, *158*: 377-384.
- Fodor, J. A. (1983). *The modularity of mind*. Cambridge, MA: MIT Press.
- Fodor, J. A. (2000). *The mind doesn't work that way*. Cambridge, MA: MIT Press.
- Forgatch, M.S., Beldavs, Z.G., Patterson, G.R., & DeGarmo, D.S. (2008). From coercion to positive parenting: Putting divorced mothers in charge of change. In M. Kerr, H. Stattin, & R. C. Engels (Eds.), *What can parents do? New insights into the role of parents in adolescent problem behavior* (pp. 191-209). West Sussex, UK: Wiley.
- Freeman, M.P., Hibbeln, J.R., Wisner, K.L., Davis, J.M., Mischoulon, D., Peet, M. et al. (2006). Omega-3 fatty acids: evidence basis for treatment and future research in psychiatry. *Journal of Clinical Psychiatry*, *67*: 1954-1967.
- Garcia, J., Ervin, F.R., & Koelling, R.A. (1966). Learning with prolonged delay of reinforcement. *Psychonomic Science*, *5*: 121-122.
- Gaudiano, B. A., Herbert, J. D. & Hayes, S. C. (2010). Is it the symptom or the relation to it? Investigating potential mediators of change in Acceptance and Commitment Therapy for psychosis. *Behavior Therapy*, *41*: 543-554.
- Gaudiano, B.A. & Herbert, J.D. (2006). Acute treatment of inpatients with psychotic symptoms using Acceptance and Commitment Therapy. *Behaviour Research and Therapy*, *44*: 415-437.
- Geary, D. C. (2004). *Origin of mind: evolution of brain, cognition, and general intelligence*. Washington DC: American Psychological Association.

- Geary, D. C. (2011). Primal brain in the modern classroom. *Scientific American Mind*, August: 44-49.
- Gifford, E. V., Kohlenberg, B., Hayes, S. C., Pierson, H., Piasecki, M., Antonuccio, D., et al. (in press). Does acceptance and relationship focused behavior therapy contribute to bupropion outcomes? A randomized controlled trial of FAP and ACT for smoking cessation. *Behavior Therapy*.
- Gifford, E. V., Kohlenberg, B. S., Hayes, S. C., Antonuccio, D. O., Piasecki, M. M., Rasmussen-Hall, M. L., & Palm, K. M. (2004). Acceptance theory-based treatment for smoking cessation: An initial trial of Acceptance and Commitment Therapy. *Behavior Therapy*, 35: 689-705.
- Ginsberg, S. & Jablonka, E. (2010). The evolution of associative learning: A factor in the Cambrian explosion. *Journal of Theoretical Biology*, 266:11-20.
DOI:10.1016/j.jtbi.2010.06.017.
- Gray, P. (2009). Play as the foundation for hunter-gatherer social existence. *American Journal of Play*, 1: 476-522.
- Gray, P., & Chanoff, D. (1986). Democratic schooling: What happens to young people who have charge of their own education? *American Journal of Education*, 94: 182-213.
- Gray, P., & Feldman, J. (2004). Playing in the zone of proximal development: qualities of self-directed age mixing between adolescents and young children at a democratic school. *American Journal of Education*, 110: 108-145.
- Greenwood, C. R. (1991a). Classwide peer tutoring: Longitudinal effects on the reading, language, and mathematics achievement of at-risk students. *Journal of Reading, Writing, & Learning Disabilities International*, 7: 105-123.

- Greenwood, C. R. (1991b). Longitudinal analysis of time, engagement, and achievement in at-risk versus non-risk students. *Exceptional Children, 57*: 521-535.
- Gregg, J. A., Callaghan, G. M., Hayes, S. C., & Glenn-Lawson, J. L. (2007). Improving diabetes self-management through acceptance, mindfulness, and values: A randomized controlled trial. *Journal of Consulting and Clinical Psychology, 75*: 336-343.
- Gross, A.M. & Shapiro, R. (1981). Public posting of photographs: A new classroom reinforcer. *Child Behavior Therapy, 3*: 81-82.
- Haidt, J. (2012). *The righteous mind: why good people are divided by politics and religion*. New York: Pantheon.
- Hawkins, J.D., Brown, E.C., Oesterle, S., Arthur, M.W., Abbott, R.D., & Catalano, R.F. (2008). Early effects of Communities That Care on targeted risks and initiation of delinquent behavior and substance use. *Journal of Adolescent Health, 43*, 15-22.
- Hayes, S.C. (2004). Acceptance and commitment therapy, relational frame theory, and the third wave of behavioral and cognitive therapies. *Behavior Therapy, 35*, 639-665.
- Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational Frame Theory: A Post-Skinnerian account of human language and cognition*. New York: Plenum Press.
- Hayes, S. C., Luoma, J., Bond, F., Masuda, A., & Lillis, J. (2006). Acceptance and Commitment Therapy: Model, processes, and outcomes. *Behaviour Research and Therapy, 44*: 1-25.
- Hayes, S., Orsillo, S., & Roemer, L. (2010). Changes in proposed mechanisms of action during an acceptance-based behavior therapy for generalized anxiety disorder. *Behaviour Research and Therapy, 48*:238-245.

- Hayes, S. C., Strosahl, K., & Wilson, K. G. (2011). *Acceptance and Commitment Therapy: The process and practice of mindful change* (2nd edition). New York: Guilford.
- Hayes, S. C., Villatte, M., Levin, M. & Hildebrandt, M. (2011). Open, aware, and active: Contextual approaches as an emerging trend in the behavioral and cognitive therapies. *Annual Review of Clinical Psychology*, 7: 141-168.
- Hayes, S. C., Wilson, K. G., Gifford, E. V., Bissett, R., Piasecki, M., Batten, S. V., et al. (2004). A randomized controlled trial of twelve-step facilitation and acceptance and commitment therapy with polysubstance abusing methadone maintained opiate addicts. *Behavior Therapy*, 35: 667-688.
- Hayes, S. C., Wilson, K. W., Gifford, E. V., Follette, V. M., & Strosahl, K. (1996). Experiential avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. *Journal of Consulting and Clinical Psychology*, 64: 1152-1168.
- Helland, I.B., Smith, L., Saarem, K., Saugstad, O.D., & Drevon, C.A. (2003). Maternal supplementation with very-long-chain n-3 fatty acids during pregnancy and lactation augments children's IQ at 4 years of age. *Pediatrics*, 111: e39-e44.
- Henig, J. R. (2008). What do we know about the outcomes of KIPP schools? *Great Lakes Center for Education Research and Practice*, 1-26.
- Hesser, H., Westin, V., Hayes, S.C., & Andersson, G. (2009). Clients' in-session acceptance and cognitive defusion behaviors in acceptance-based treatment of tinnitus distress. *Behaviour Research and Therapy*, 47: 523-528.
- Hibbeln, J.R., Davis, J.M., Steer, C., Emmett, P., Rogers, I., Williams, C. et al. (2007). Maternal seafood consumption in pregnancy and neurodevelopmental outcomes in childhood (ALSPAC study): An observational cohort study. *Lancet*, 369: 578-585.

- Hill, K. (2010). Experimental studies of animal social learning in the wild: trying to untangle the mystery of human culture. *Learning and Behavior*, 38: 319-328.
- Hill, K. R., Walker, R. S., Bozicevic, M., Eder, J., Headland, T., Hewlett, B., et al. (2011). Co-residence patterns in hunter-gatherer societies show unique human social structure. *Science*, 331: 1285-1289.
- Hofmann, S. G., Sawyer, A. T., Witt, A. A., & Oh, D. (2010). The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *Journal of Consulting and Clinical Psychology*, 78: 169-183. DOI: 10.1037/a0018555.
- Hofstadter, R. (1959/1992). *Social Darwinism in American Thought*. Boston, MA: Beacon.
- Houten, N.P, Marini, Z. (1980). An analysis of public posting in reducing speeding behavior on an urban highway. *Journal of Applied Behavior Analysis*, 13: 383-395.
- Jablonka, E., & Lamb, M. J. (2006). *Evolution in four dimensions: genetic, epigenetic, behavioral, and symbolic variation in the history of life*. Cambridge, MA: MIT Press.
- Jackson, N.C. & Mathews, R.M. (1995). Using public feedback to increase contributions to a multipurpose senior center. *Journal of Applied Behavior Analysis*, 28: 449-455.
- Johnson, K. (1997). Morningside Academy. *Behavior and Social Issues*, 7: 31-35.
- Johnson, S. (2010). *Where good ideas come from: The natural history of innovation*. New York, NY: Riverhead Books.
- Joyce, R. (2006). *The evolution of morality*. Cambridge, MA: MIT Press.
- Juarascio, A. S., Forman, E. M., & Herbert, J. D. (2010). Acceptance and Commitment Therapy versus Cognitive Therapy for the treatment of co morbid eating pathology. *Behavior Modification*, 34: 175-190.

- Kashdan, T. (2009). *Curious: Discovering the missing ingredient to a fulfilling life*. New York: HarperCollins.
- Kehle, T.J., Bray, M.A., Theodore, L.A., Jenson, W.R., & Clark, E. (2000). A multi-component intervention designed to reduce disruptive classroom behavior. *Psychology in the Schools, 37*: 475-481.
- Kellam, S., Brown, C. H., Poduska, J., Ialongo, N., Wang, W., Toyinbo, P., et al. (2008). Effects of a universal classroom behavior management program in first and second grades on young adult behavioral, psychiatric, and social outcomes. *Drug & Alcohol Dependence, 95*: S5-S28.
- Kleinman, K. E., & Saigh, P. A. (2011). The Effects of the Good Behavior Game on the conduct of regular education New York City high school students. *Behavior Modification, 35*: 95-105. DOI: 10.1177/0145445510392213.
- Laland, K. N., & Galef, B. G. (Eds.). (2009). *The question of animal culture*. Cambridge, MA: Harvard University Press.
- Laland, K. N., & Hoppitt, W. (2003). Do animals have culture? *Evolutionary Anthropology, 12*: 150-159.
- Leonard, T. C. (2009). Origins of the myth of social Darwinism: the ambiguous legacy of Richard Hofstadter's Social Darwinism in American Thought. *Journal of Economic Behavior and Organization, 71*: 37-51.
- Levy, D.T., Chaloupka, F., & Gitchell, J. (2004). The effects of tobacco control policies on smoking rates: a tobacco control scorecard. *Journal of Public Health Management and Practice, 10*: 338-353.

- Lewit, E.M., Hyland, A., Kerrebrock, N. & Cummings, K.M. (1997). Price, public policy and smoking in young people. *Tobacco Control*, 6: S17-S24.
- Lillis, J., Hayes, S. C., Bunting, K., Masuda, A. (2009). Teaching acceptance and mindfulness to improve the lives of the obese: A preliminary test of a theoretical model. *Annals of Behavioral Medicine*, 37: 58-69.
- Lillis, J., Hayes, S. C., & Levin, M., (2011a). Binge eating and weight control: The role of experiential avoidance. *Behavior Modification*, 35: 252 - 264.
- Lillis, J., Levin, M.E., Hayes, S.C. (2011b). Exploring the relationship between BMI and health-related quality of life: A pilot study of the impact of weight self-stigma and experiential avoidance. *Journal of Health Psychology*, 16: 722-727. DOI: 10.1177/1359105310388321.
- Linehan, M. M. (1993). *Cognitive-behavioral treatment of borderline personality disorder*. New York: Guilford Press.
- Linehan, M.M., Armstrong, H.E., Suarez, A., Allmon, D., & Heard, H.L. (1991). Cognitive-behavioral treatment of chronically parasuicidal borderline patients. *Archives of General Psychiatry*, 48: 1060-1064.
- Luciano, C., Gómez-Becerra, I. & Rodríguez-Valverde, M. (2007). The role of multiple-exemplar training and naming in establishing derived equivalence in an infant. *Journal of Experimental Analysis of Behavior*, 87: 349-365.
- Lundgren, T., Dahl, J., & Hayes, S. C. (2008). Evaluation of mediators of change in the treatment of epilepsy with Acceptance and Commitment Therapy. *Journal of Behavioral Medicine*, 31: 221-235

- Lundgren, A. T., Dahl, J., Melin, L. & Kees, B. (2006). Evaluation of Acceptance and Commitment Therapy for drug refractory epilepsy: A randomized controlled trial in South Africa. *Epilepsia*, 47: 2173-2179.
- Luoma, J. B., Kohlenberg, B. S., Hayes, S. C. & Fletcher, L. (in press). Slow and steady wins the race: A randomized clinical trial of Acceptance and Commitment Therapy targeting shame in substance use disorders. *Journal of Consulting and Clinical Psychology*.
- Lyman, R.D. (1984). The effect of private and public goal setting on classroom on-task behavior of emotionally disturbed children. *Behavior Therapy*, 15: 395-402.
- Madaus, M.M.R., Kehle, T.J., Madaus, J., & Bray, M.A. (2003). Mystery Motivator as an intervention to promote homework completion and accuracy. *School Psychology International*, 24: 369-377.
- Maus, M. B. (2007). *Independent group contingencies for reducing disruptive behavior in preschoolers with PDD-NOS*. ProQuest Information & Learning.
- Maynard Smith, J. & Szathmary, E. (1995). *The major transitions of life*. New York, NY: Freeman.
- Menenti, L., Gierhan, S. M. E., Segaert, K., & Hagoort, P. (2011). Shared language: Overlap and segregation of the neuronal infrastructure for speaking and listening revealed by functional MRI. *Psychological Science*, published online 12 August 2011 DOI: 10.1177/0956797611418347.
- Moore, L.A., Waguespack, A.M., Wickstrom, K.F., & Witt, J.C. (1994). Mystery motivator: An effective and time efficient intervention. *School Psychology Review*, 23: 106-118.

- Muto, T., Hayes, S. C., & Jeffcoat, T. (2011). The effectiveness of Acceptance and Commitment Therapy bibliotherapy for enhancing the psychological health of Japanese college students living abroad. *Behavior Therapy, 42*: 323–335.
- National Research Council & Institute of Medicine. (2009). *Preventing mental, emotional, and behavioral disorders among young people: progress and possibilities*. Washington, DC: National Academy of Science.
- Neacsiu, A.D., Rizvi, S.L., Linehan, M. M. (2010). Dialectical behavior therapy skills use as a mediator and outcome of treatment for borderline personality disorder. *Behaviour Research and Therapy, 48*: 832-839. DOI: 10.1016/j.brat.2010.05.017.
- Nesbit, J.C. & Adesope, O.O. (2006). Learning with concept and knowledge maps: A meta-analysis. *Review of Educational Research, 76*: 413-448.
- Newbern, D., Dansereau, D.F., Czuchry, M., & Simpson, D. (2005). Node-link mapping in individual counseling: treatment impact on clients with ADHD-related behaviors. *Journal of Psychoactive Drugs, 37*: 93-103.
- Newbern, D., Dansereau, D.F., & Pitre, U. (1999). Positive effects on life skills motivation and self-efficacy: Node-link maps in a modified therapeutic community. *American Journal of Drug & Alcohol Abuse, 25*: 407-423.
- Nowak, C. & Heinrichs, N. (2008). A comprehensive meta-analysis of Triple P-Positive Parenting Program using hierarchical linear modeling: Effectiveness and moderating variables. *Clinical Child and Family Psychology Review, 11*: 114-144. DOI: 10.1007/s10567-008-0033-0.
- Nowak, M. & Highfield, R. (2011). *SuperCooperators: altruism, evolution, and why we need each other to succeed*. New York: Free Press.

- O'Donnell, A.M., Dansereau, D.F., & Hall, R.H. (2002). Knowledge maps as scaffolds for cognitive processing. *Educational Psychology Review, 14*: 71-86.
- Ostrom, E. (1990). *Governing the commons: the evolution of institutions for collective action*. Cambridge, UK: Cambridge University Press.
- Ostrom, E. (2005). *Understanding institutional diversity*. Princeton: University Press.
- Ostrom, E. (2010). Beyond markets and states: polycentric governance of complex economic systems. *American Economic Review, 100*: 1-33.
- Page, R.A., & Ryan, M.J. (2006). Social transmission of novel foraging behavior in bats: frog calls and their referents. *Current Biology 16*: 1201-1205. DOI 10.1016/j.cub.2006.04.038.
- Pagel, M., & Mace, R. (2004). The cultural wealth of nations. *Nature, 428*: 275-278.
- Patterson, G. R. (1982). *Coercive family process*. Eugene, OR: Castalia.
- Patterson, G. R., DeGarmo, D. & Forgatch, M.S. (2004). Systematic changes in families following prevention trials. *Journal of Abnormal Child Psychology, 32*: 621-633.
- Penn, D. C., Holyoak, K. J., & Povinelli, D. J. (2008). Darwin's mistake: Explaining the discontinuity between human and nonhuman minds. *Behavioral and Brain Sciences, 31*: 109-178.
- Pentz, M.A., Dwyer, J.H., MacKinnon, D.P., Flay, B.R., Hansen, W.B., Wang, E. et al. (1989a). A multicomunity trial for primary prevention of adolescent drug abuse. Effects on drug use prevalence. *Journal of American Medical Association, 261*: 3259-3266.
- Pentz, M.A., MacKinnon, D.P., Dwyer, J.H., Wang, E.Y.I., Hansen, W.B., Flay, B.R. et al. (1989b). Longitudinal effects of the Midwestern Prevention Project (MPP) on regular and experimental smoking in adolescents. *Preventive Medicine, 18*: 304-321.

- Pentz, M.A., MacKinnon, D.P., Flay, B.R., Hansen, W.B., Johnson, C.A., & Dwyer, J.H. (1989c). Primary prevention of chronic diseases in adolescence: Effects of the Midwestern Prevention Project (MPP) on tobacco use. *American Journal of Epidemiology*, *130*: 713-724.
- Perry, C.L., Williams, C.L., Veblen-Mortenson, S., Toomey, T.L., Komro, K.A., Anstine, P.S. et al. (1996). Project Northland: outcomes of a communitywide alcohol use prevention program during early adolescence. *American Journal of Public Health*, *86*: 956-965.
- Perry, C., Williams, C.L., Komro, K.A., Veblen-Mortenson, S., Stigler, M.H., Munson, K.A. et al. (2002). Project Northland: long-term outcomes of community action to reduce adolescent alcohol use. *Health Education Research*, *17*: 117-132.
- Perry, C.L., Williams, C.L., Komro, K.A., Veblen-Mortenson, S., Forster, J.L., Bernstein-Lachter, R. et al. (2000). Project Northland high school interventions: Community action to reduce adolescent alcohol use. *Health Education & Behavior*, *27*: 29-49.
- Petry, N.M., Bickel, W.K., Tzanis, E., Taylor, R., Kubik, E., Foster, M., et al. (1998). A behavioral intervention for improving verbal behaviors of heroin addicts in a treatment clinic. *Journal of Applied Behavior Analysis*, *31*: 291-97.
- Petry, N.M., Pierce, J.M., Stitzer, M.L., Blaine, J., Roll, J.M., Cohen, A. et al. (2005). Effect of prize-based incentives on outcomes in stimulant abusers in outpatient psychosocial treatment programs: A National Drug Abuse Treatment Clinical Trials Network Study. *Archives of General Psychiatry*, *62*: 1148-1156.
- Petry, N.M., Tedford, J., Austin, M., Nich, C., Carroll, K.M., & Rounsaville, B.J. (2004). Prize reinforcement contingency management for treating cocaine users: How low can we go, and with whom? *Addiction*, *99*: 349-360.

- Petry N, M., Tedford, J. & Martin, B. (2000). Reinforcing compliance with non-drug-related activities. *Journal of Substance Abuse Treatment, 20*: 33-44.
- Pigliucci, M., & Kaplan, J. (2006). *Making sense of evolution: The conceptual foundations of evolutionary biology*. Chicago: University of Chicago Press.
- Pinker, S. (1997). *How the mind works*. New York: W.W. Norton
- Pinker, S. (2002). *The blank slate: the modern denial of human nature*. New York: Viking.
- Pitre, U., Dansereau, D.F., Newbern, D., & Simpson, D.D. (1998). Residential drug abuse treatment for probationers: Use of node-link mapping to enhance participation and progress. *Journal of Substance Abuse Treatment, 15*: 535-543.
- Plotkin, H. (1994). *Darwin machines and the nature of knowledge*. Cambridge, MA: Harvard University Press.
- Plotkin, H. (2003). *The imagined world made real: toward a natural science of culture*. New Brunswick, NJ: Rutgers University Press.
- Plotkin, H. (2007). *Necessary knowledge*. Oxford: Oxford University Press.
- Popova, S., Giesbrecht, N., Bekmuradov, D., & Patra, J. (2009). Hours and days of sale and density of alcohol outlets: Impacts on alcohol consumption and damage: A systematic review. *Alcohol & Alcoholism, 44*: 500-516.
- Prinz, R.J., M.R. Sanders, C.J. Shapiro, D.J. Whitaker, & J.R Lutzker. (2009). Population-based prevention of child maltreatment: The U.S. Triple P System Population Trial. *Prevention Science, 10*: 1-12.
- Putnam, R. D. (1992). *Making democracy work: civic traditions in modern Italy*. Princeton: University Press.

- Reid, J. B., Patterson, G. R. & Snyder, J. (2002). *Antisocial behavior in children and adolescents: A developmental analysis and model for intervention*. Washington, DC: American Psychological Association.
- Richardson, A.J. (2006). Omega-3 fatty acids in ADHD and related neurodevelopmental disorders. *International Review of Psychiatry, 18*: 155-172.
- Richerson, P. J., & Boyd, R. (2005). *Not by genes alone: how culture transformed human evolution*. Chicago: University of Chicago Press.
- Roemer, L., Orsillo, S.M., & Salters-Pedneault, K. (2008). Efficacy of an acceptance-based behavior therapy for generalized anxiety disorder: Evaluation in a randomized controlled trial. *Journal of Consulting and Clinical Psychology, 76*: 1083-1089.
- Rutter, M., Maughan, B., Mortimore, P., Ouston, J., & Smith, A. (1979). *Fifteen thousand hours: Secondary schools and their effects on children*. Cambridge, MA: Harvard University Press.
- Sahlins, M. D. (1976). *The use and abuse of biology: an anthropological critique of Sociobiology*. Ann Arbor, MI: University of Michigan Press.
- Sanders, M. R., Turner, K. M. T., & Markie-Dadds, C. (2002). The development and dissemination of the Triple P-Positive Parenting Program: A multilevel, evidence-based system of parenting and family support. *Prevention Science, 3*: 173-189.
- Scher, S. J., & Rauscher, F. (Eds.). (2002). *Evolutionary psychology: alternative approaches*. Dordrecht: Kluwer.
- Segal, Z.V., Bieling, P., Young, T., MacQueen, G., Cooke, R., Martin, L. et al. (2010). Antidepressant monotherapy vs sequential pharmacotherapy and mindfulness-

- based cognitive therapy, or placebo, for relapse prophylaxis in recurrent depression. *Archives of General Psychiatry*, 67: 1256-1264.
- Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). *Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse*. New York: Guilford Press.
- Segerstrale, U. (2001). *Defenders of the truth: the sociobiology debate*. New York: Oxford University Press USA.
- Seligman, M.E. (1970). On the generality of the laws of learning. *Psychological Review*, 77: 406-418.
- Seyfarth, R. M., & Cheney, D. L. (2003). Signalers and receivers in animal communication. *Annual Review of Psychology*, 54: 145-173.
- Shahar, B., Britton, W.B., Sbarra, D.A., Figueredo, A.J., & Bootzin, R.R. (2010). Mechanisms of change in mindfulness-based cognitive therapy for depression: Preliminary evidence from a randomized controlled trial. *International Journal of Cognitive Therapy*, 3: 402-418.
- Skinner, B. F (1981). Selection by consequences. *Science*, 213: 501-504.
- Smith, C. (2003). *Moral, believing animals*. Oxford: Oxford University Press.
- Smith, Jr., M., & Szathmary, E. (1995). *The major transitions of life*. New York: W.H. Freeman.
- Smout, M., Longo, M., Harrison, S., Minniti, R., Wickes, W., & White, J. (2010). Psychosocial treatment for methamphetamine use disorders: a preliminary randomized controlled trial of cognitive behavior therapy and acceptance and commitment therapy. *Substance Abuse*, 31: 98-107.
- Sober, E., & Wilson, D. S. (1998). *Unto others: the evolution and psychology of unselfish behavior*. Cambridge, MA: Harvard University Press.

- Sompayrac, L. M. (2008). *How the immune system works* (3rd ed.). Hoboken, NJ: Wiley, Blackwell.
- Spoth, R., Guyll, M., Lillehoj, C., Redmond, C., & Greenberg, M. (2007). PROSPER study of evidence-based intervention implementation quality by community-university partnerships. *Journal of Community Psychology, 35*: 981-999.
- Spoth, R., Redmond, C., Shin, C., Greenberg, M., Clair, S., & Feinberg, M. (2007). Substance-use outcomes at 18 months past baseline: The PROSPER community-university partnership trial. *American Journal of Preventive Medicine, 32*: 395-402.
- Stitzer, M. & Petry, N. (2006). Contingency management for treatment of substance abuse. *Annual Review of Clinical Psychology, 2*: 411-34.
- Stockwell, T. & Chikritzhs, T. (2009). Do relaxed trading hours for bars and clubs mean more relaxed drinking? A review of international research on the impacts of changes to permitted hours of drinking. *Crime Prevention and Community Safety, 11*: 153-170.
- Stokes, T.F., Mathews, R.M., & Fawcett, S.B. (1978). Promoting participation in a community-based educational program. *Journal of Personalized Instruction, 3*: 29-31.
- Teasdale, J.D., Segal, Z.V., Williams, J.M.G., Ridgeway, V.A., Soulsby, J.M., & Lau, M.A. (2000). Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *Journal of Consulting and Clinical Psychology, 68*: 615-623.
- Tocqueville, A. d. (1835/1990). *Democracy in America* (G. Lawrence, Trans.). Garden City, NY: Anchor Books.
- Tomasello, M. (2008). *Origins of human communication*. Cambridge, MA: The MIT Press.
- Tomasello, M. (2009). *Why we cooperate*. Boston: MIT Press.

- Tomasello, M., Carpenter, J., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: the origins of cultural cognition. *Behavioral and Brain Sciences*, 28: 675-735.
- Tooby, J., & Cosmides, L. (1992). The psychological foundations of culture. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: evolutionary psychology and the generation of culture* (pp. 19-136). Oxford: Oxford University Press.
- Tough, P. (2008). *Whatever it takes: Geoffrey Canada's quest to change Harlem and America*. New York: Houghton Mifflin.
- Trivers, R. (1972). Parental investment and sexual selection. In B. Campbell (Ed.), *Sexual selection and the descent of man*. Chicago: Aldine.
- Turchin, P. (2003). *Historical dynamics: why states rise and fall*. Princeton, NJ: University Press.
- Turchin, P. (2005). *War and peace and war*. Upper Saddle River, NJ: Pi Press.
- Valum, J.L. (1996). *Student-managed study skills teams: academic survival for adolescents at risk of school failure*. US: ProQuest Information & Learning.
- Van Houten, R., Hill, S., & Parsons, M. (1975). An analysis of a performance feedback system: The effects of timing and feedback, public posting, and praise upon academic performance and peer interaction. *Journal of Applied Behavior Analysis*, 8: 449-457.
- Van Houten, R., Morrison, E., Jarvis, R., & McDonald, M. (1974). The effects of explicit timing and feedback on compositional response rate in elementary school children. *Journal of Applied Behavior Analysis*, 7: 547-555.

- Vowles, K. E., & McCracken, L. M. (2008). Acceptance and values-based action in chronic pain: A study of effectiveness and treatment process. *Journal of Clinical and Consulting Psychology, 76*: 397-407.
- Vowles, K. E., McNeil, D. W., Gross, R. T. McDaniel, M. L., Mouse, A., Bates, M., et al. (2007). Effects of pain acceptance and pain control strategies on physical impairment in individuals with chronic low back pain. *Behavior Therapy, 38*: 412-425.
- Wagenaar, A.C., Murray, D.M., & Toomey, T.L. (2000). Communities mobilizing for change on alcohol (CMCA): Effects of a randomized trial on arrests and traffic crashes. *Addiction, 95*: 209-217.
- Wagenaar, A.C., Salois, M.J., & Komro, K.A. (2009). Effects of beverage alcohol price and tax levels on drinking: A meta-analysis of 1,003 estimates from 112 studies. *Addiction, 104*: 179-190.
- Wagenaar, A.C., Tobler, A.L., & Komro, K.A. (in press). Effects of alcohol tax and price policies on morbidity and mortality: A systematic review. *American Journal of Public Health*.
- Wenzlaff, R. M., & Wegner, D. M. (2000). Thought suppression. *Annual Review of Psychology, 51*: 59-91.
- Westin, V. Z., Schulin, M., Hesser, H., Karlsson, M., Noe, R. Z., Olofsson, U., et al. (in press). Acceptance and Commitment Therapy versus Tinnitus Retraining Therapy in the treatment of tinnitus distress: A randomized controlled trial. *Behaviour Research and Therapy*.

- Whitehurst, G. J., & Croft, M. (2010). *The Harlem Children's Zone, Promise Neighborhoods, and the broader, bolder approach to education*. New York: Brown Center on Education Policy at Brookings.
- Wicksell, R. K., Ahlqvist, J., Bring, A., Melin, L. & Olsson, G. L. (2008). Can exposure and acceptance strategies improve functioning and quality of life in people with chronic pain and whiplash associated disorders (WAD)? A randomized controlled trial. *Cognitive Behaviour Therapy, 37*: 1-14.
- Wicksell, R. K., Melin, L., Lekander, M., & Olsson, G. L. (2009). Evaluating the effectiveness of exposure and acceptance strategies to improve functioning and quality of life in longstanding pediatric pain: A randomized controlled trial. *Pain, 141*: 248-257.
- Wicksell, R. K., Olsson, G. L., & Hayes, S. C. (in press a). Processes of change in ACT-based behavior therapy: Psychological flexibility as a mediator of improvement in patients with chronic pain following whiplash injuries. *European Journal of Pain*
- Wicksell, R. K., Olsson, G. L., & Hayes, S. C. (in press b). Mediators of change in Acceptance and Commitment Therapy for pediatric chronic pain. *Pain*.
- Wilson, D. S. (1990). Species of thought: a comment on evolutionary epistemology. *Biology and Philosophy, 5*: 37-62.
- Wilson, D. S. (1995). Language as a community of interacting belief systems: a case study involving conduct toward self and others. *Biology and Philosophy, 10*: 77-97.
- Wilson, D. S. (2002a). Evolution, morality and human potential. In S. J. Scher & F. Rauscher (Eds.), *Evolutionary psychology: alternative approaches* (pp. 55-70). New York: Kluwer.
- Wilson, D. S. (2002b) *Darwin's cathedral*. Chicago: University of Chicago Press.

- Wilson, D. S. (2005). Evolutionary social constructivism. In J. Gottschall & D. S. Wilson (Eds.), *The literary animal: evolution and the nature of narrative* (pp. 20-37). Evanston, IL: Northwestern University Press.
- Wilson, D. S. (2009). Evolutionary social constructivism: narrowing (but not bridging) the gap. In J. Schloss & M. Murray (Eds.), *The believing primate: scientific, philosophical, and theological reflections* (pp. 318-338). New York: Oxford University Press.
- Wilson, D. S. (2011b). Evolution of selfless behavior (Instant Expert Series). *New Scientist*, August 3, 2011. Available at <http://susansayler.wordpress.com/2011/08/07/david-sloan-wilson-selfless-evolution-instant-expert-series/>
- Wilson, D. S. (2011c). The Design Your Own Park Competition: empowering neighborhoods and restoring outdoor play on a citywide scale. *American Journal of Play*, 3: 538-551.
- Wilson, D. S. (2011a). *The Neighborhood Project: using evolution to improve my city, one block at a time*. New York: Little, Brown.
- Wilson, D. S., Kaufman, R. A., & Purdy, M. S. (2011b). *A program for at-risk high school students informed by evolutionary science*. Under review.
- Wilson, D. S., Marshall, D., & Iserhott, H. (2011a). Empowering the groups that enable play. *American Journal of Play*, 3: in press. Published online and available at <http://www.journalofplay.org/issues/213/220-empowering-groups-enable-play>.
- Wilson, D. S., & Wilson, E. O. (2007). Rethinking the theoretical foundation of sociobiology. *Quarterly Review of Biology*, 82: 327-348.
- Wilson, E. O. (1975). *Sociobiology: the new synthesis*. Cambridge, Mass: Harvard University Press

Witkiewitz, K. & Bowen, S. (2010). Depression, craving, and substance use following a randomized trial of mindfulness-based relapse prevention. *Journal of Consulting and Clinical Psychology, 78*: 362-374.

Wolpe, J. (1958). *Psychotherapy by reciprocal inhibition*. Oxford, UK: Stanford University Press.

Zettle, R. D., Rains, J. C., & Hayes, S. C. (2011). Do Acceptance and Commitment Therapy and Cognitive Therapy for depression work via the same process: A reanalysis of Zettle and Rains, 1989. *Behavior Modification, 35*: 265-283.

UNDER REVIEW

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