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The Journal of Animal Behavior Technology (JABT) is a fully peer-reviewed journal of essays of interest to behaviorologists, behavior analysts, and animal behavior technologists. JABT publishes essays of all kinds, including review of topics, original research papers, short communications, critical reviews, persuasive essays, theoretical works, technical articles, and commentary.

The Association of Animal Behavior Professionals (AABP) was founded to promote excellence and a strong commitment to nonaversive methods among behaviorologically oriented technologists of companion animal behavior. The AABP seeks to establish a community of members aspiring to and sustaining these principles.

Audience: Behaviorologists, behavior analysts, animal behavior technologists, animal trainers.

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Table of Contents

Editorial

Welcome to the seventh issue of the official journal of the Association of Animal Behavior Professionals. In this issue, two articles are presented. In the first, a long standing and almost universally committed error in the classification of certain kinds of punishers is discussed. The second article, reprinted from The Journal of Behaviorology, is the transcript of an interview with Dr. Stephen Ledoux, who some readers may remember as the key note speaker at a recent APDT conference. The interview covers a number of topics and will provide the reader some insight into behaviorology as a discipline. One issue, raised in the interview, of behaviorology as the natural science of behavior informing behavior analysis as the technological or applied branch is not a settled matter. Although some behaviorologists likely see behaviorology as the basic natural science of behavior and behavior analysis, potentially, as an applied branch, others see behaviorology as both the independent natural science of behavior *and* technology of that science. For example, I am a behaviorologist and contribute to basic science, but most of my efforts are applied in teaching, writing, and educating others to engage in the training of companion animals. I have no interest is operating under the "behavior analyst" label, particularly while it suffers credibility and identify issues, being tied to psychology, a decidedly non-scientific discipline. I would be an example of a behaviorologist operating mostly in applied settings.

Enjoy!

James O'Heare, DLBC

Editor, JABT

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Correct Classification of Conditioned Punishers as Added versus Subtracted Stimuli

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Abstract

This paper clarifies a theoretical matter with respect to the commonly misused terminology surrounding conditioned subtracted punishers. Although discussion of conditioned subtracted punishment is uncommon in the literature, particularly behaviorological and behavior analytic textbooks, the topic is more common in animal training texts, and a general review of such sources showed that in every instance of its definition and/or exemplification, the term is misapplied. In all of these cases, conditioned subtracted punishers were added stimuli that acquired their punitive capacity through being paired with other subtracted punishers. However, this categorization of an added stimulus as a conditioned subtracted punisher is incorrect. Such stimulus *additions* are properly categorized as conditioned *added* punishers regardless of whether the stimulus they were paired with was added or subtracted. Behaviorologists, behavior analysts, and behavior technologists can ensure clarity by categorizing such stimulation accurately.

Most behaviorological and behavior analytic texts cover the topic of added and subtracted punishment. Of those sources that cover this topic, few provide a depth of coverage to include discrimination between conditioned and unconditioned punishers. Conditioned and unconditioned punishers are discussed more frequently in animal training texts, likely because these kinds of stimuli are common in such applied settings. However, in all sources sampled for review, none categorized conditioned subtracted punishers in accordance with established categorization standards. Here is a brief analysis of this error provided as an effort to prompt more accurate use of such terms.

Ledoux (2014, pp. 150–160; 2015, pp. 202–203) has provided a comprehensive classification of postcedent stimulation consistent with figure 1.

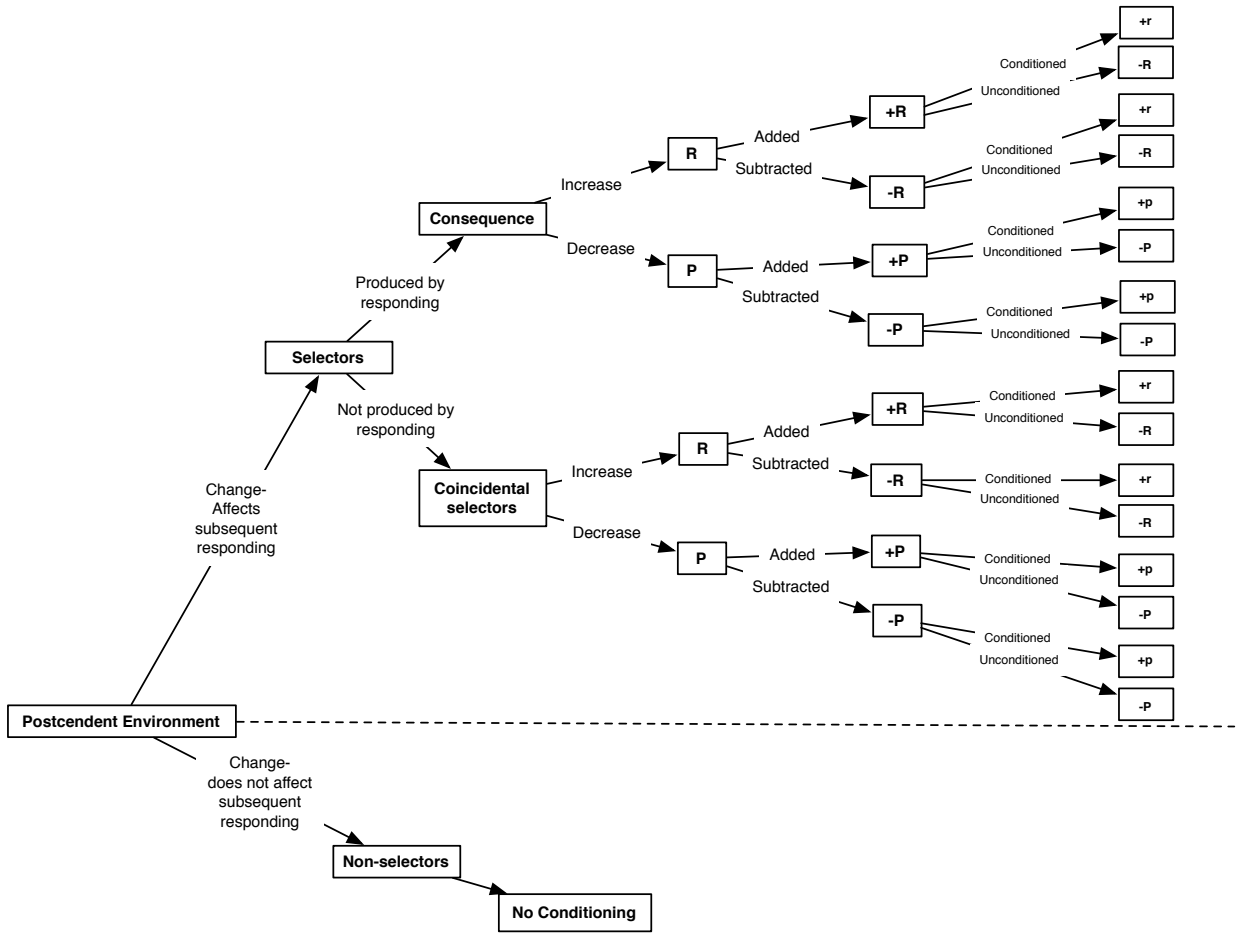

Figure 1. Diagram depicting the complete range of postcedent events resulting in changes in behavior. R = unconditioned reinforcer or where its status as conditioned or unconditioned is unspecified. P = unconditioned punisher or where its status as conditioned or unconditioned is unspecified. r = conditioned reinforcer and p = conditioned punisher. + = added and - = subtracted. Adapted from Ledoux (2010; 2015)

The technical term "conditioned subtracted punisher" is used here in accordance with current behaviorological terminology practices (Ledoux 2015; 2010). Those outside of behaviorology, including many behavior analysts, are likely familiar with the older, more confusing, terms "positive" and "negative" with respect to consequences, but the terms "added" and "subtracted" respectively alleviate confusion with the common terms "good" and "bad," and more accurately reflect the presentation or increase in stimulation, or removal or decrease in stimulation.

A subtracted punisher is defined, consistent with the algorithm found in Figure 1, as *a stimulus, the subtraction of which during or immediately following a response class member, results in a decrease in the rate or relative frequency of that response class on subsequent occasions*. This is similar to definitions found in most behaviorological and behavior analytic sources. A conditioned punisher is defined as *a stimulus that has acquired its punitive capacity from having been paired with an unconditioned punisher or another established conditioned punisher*. Again, this uncontroversial definition is common among behaviorological and behavior analytic sources. A conditioned subtracted punisher would thus be defined as *a stimulus, the subtraction of which during or immediate following a response class member, results in a decrease in the rate or relative frequency of that response class on subsequent occasions, having acquired its punitive capacity from having been paired with an unconditioned punisher or another established conditioned punisher*.

Added or subtracted stimulation is defined as such by whether *the stimulus in question* is added (i.e., presented or increased) to, or subtracted (i.e., withdrawn or reduced) from, the environment. The classification of a stimulus as added or subtracted is *not* defined by whether *the stimulus that it was paired with,* to establish it as a conditioned stimulus, was added or subtracted.

In all sampled sources, conditioned subtracted punishers were either defined specifically as stimuli paired with unconditioned subtracted punishers, or examples were provided that described the pairing of an added stimulus with unconditioned subtracted punishers. This practice, though common, is an error in classification since it either *allows* for an added stimulus or *requires* an added stimulus to be classified as a subtracted stimulus. Presumably, this is because the added stimulus acquired its punitive function by being paired with a subtracted punishment. But this error conflates a subtracted stimulus with an added stimulus that was paired with a subtracted stimulus. Again, stimuli are defined by whether they, themselves, are added or subtracted, and not be what class of stimuli they were paired with to establish them as conditioned stimuli.

In applied settings, a conditioned punisher can be added or subtracted, but the stimuli are almost universally added as a practical matter. Here is a common scenario exemplified within the literature as "conditioned subtracted punishment." A dog being trained to sit on cue, exhibits a non-criterion behavior when the cue is delivered and the trainer *adds* the vocalization "Oops" (or "Too bad," "Try again," etc.) and immediately subtracts social attention by turning away. The subtraction of an ongoing added reinforcer constitutes subtracted punishment, assuming it results in a decrease in the rate or relative frequency of the non-criterion behavior and the previously neutral stimulus (the vocalized "Oops") acquired its punitive function as a result of repeated pairing with the subtracted social contact.

It would be erroneous to classify the added vocalization "Oops" as a conditioned *subtracted* punisher. This stimulus would, in fact, be properly classified as a conditioned punisher, or more specifically, a conditioned added punisher, regardless of how the subject came to be conditioned to react to it (i.e., what it was paired with). If such a stimulus is added, it is properly classified as a conditioned added punisher (regardless of what kind of stimulus it was paired with) and if such a stimulus is subtracted, it is properly classified as a conditioned subtracted punisher.

A review of the literature revealed no instances of properly classified uses of conditioned subtracted punishers in applied settings, instances in which the conditioned stimulus was actually subtracted.

Under many contingencies, the term conditioned punisher is likely adequate, but when behaviorologists, behavior analysts, behavior technologists, and animal trainers are under contingencies to provide a finer scale classification of such stimuli, the scientist or professional is urged to take care to classify the stimulus by whether it, itself, is added or subtracted in order to ensure clarify.

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An Interview on Behaviorology: Supporting a Sustainable Society

Stephen F. Ledoux[1]

Dale Hallatt

& Thomas Hallatt[2]

These questions and answers relate the preparations behind an October 2013 interview of the first author by the second author for an environmentally supportive documentary film project. The Prosocial Progress Foundation, in the United Kingdom, organized this project and titled it *Prosocial Progress: A Blueprint for Social Sustainability*. The project involved eight interviewees. As you can see by selecting this project under Films at www.prosocialprogress.org, this group also featured others familiar to behaviorologists including Julie Vargas, Zuilma Gabriela Sigurdardóttir, and Janet Twyman. In general, the range of questions for each interviewee centered on the relevance of the natural science of behavior—under old or new labels—to various aspects and areas of prosocial change. The questions that the interviewer asked this interviewee, in advance as well as at the interview, focused on the nature of behaviorology and its contributions to contingency arrangements that could increase the scientifically informed, prosocial activities of citizens, particularly with respect to solving global problems. The questions and answers here report the material that the first author prepared (with feedback from the other authors) for the interview which, of course, varied from this preparation.

[1] Stephen Ledoux is Professor of Behaviorology at SUNY–Canton and, after the Hallatt brothers gave him the questions, he authored these answers to them; address correspondence to ledoux@canton.edu.

[2] While Dale Hallatt asked the questions at the interview, both he and Thomas Hallatt wrote the questions, which arose from their work at the Prosocial Progress Foundation.

This article first appeared in the Journal of Behaviorology, 2014, Volume 17, Number 1. and may be accessed in that source at http://www.behaviorology.org/wp-content/uploads/2014/04/V17N1.pdf

Question 1 of 22. One of your recent articles appeared in the journal American Scientist in 2012. Entitled "Behaviorism at 100," the article addressed the extent and status of the natural science of behaviour after its first 100 years. What circumstances led to this article?

Answer 1 of 22. At least four factors came together over several years to produce that article:

- The major factor is that traditional natural scientists, like physicists, chemists, and biologists, have been working for decades on improving solutions to some serious and growing global problems. They have also pointed out that since both the problems and the solutions involve a large component of human behavior, they really could use a natural science of human behavior to help with this component. But most of them have not been in circumstances which could clarify for them that such a science already exists.
- In addition, 2012 marked the 100th year both of the natural science of behavior, and of American Scientist, which is the journal of Sigma Xi, the scientific research society.
- Also, back in 1963, B. F. Skinner published his paper, "Behaviorism at Fifty," which addressed the extent and status of the natural science of behavior after its first 50 years. The time had come for a look at the second fifty years.
- And one of the most significant developments in this natural science occurred in the second fifty years, which is that this natural science became an independent natural science under the label, Behaviorology, which was adopted officially only in 1987.

All of those factors came together to make the "Behaviorism at 100" paper appropriate for the first issue of the 100th volume of American Scientist in January 2012. There it could reach many concerned natural scientists and engineers, and inform them that a natural behavior science, one that can help solve global problems, already exists. Also, a couple of months later, the journal *Behaviorology Today*—which is now called the *Journal of Behaviorology*—featured the longer, peer–reviewed version of the article; it is available on both the americanscientist.org website and on the behaviorology.org website.

Question 2. Could you define what is meant by the term natural science of behaviour, otherwise known by the term behaviourology?

Answer 2. Behaviorology, and the term "natural science of behavior," refer to the basic science concerned with behavior. This science works on two fronts. The primary, experimental side of the science works to discover, understand, predict, control, and interpret the independent variables—especially the accessible environmental independent variables—that are responsible for behavior, both the behavior of humans and the behavior of other animals; in this way, it reveals the nature of human nature. At the same time, the engineering side of the science works to develop and test effective applications and interventions that can change these variables in ways that lead to improved behavior. Some professional applications of this science help people and society become better at changing these variables in ways that bring about improvements in behavior, improvements that benefit individuals as well as humanity. Currently the most common name for such professional applications is ABA, which stands for Applied Behavior Analysis.

Question 3. Why is the behaviourology discipline classified as a natural science just like the disciplines of physics and biology? Is it because behaviourology utilizes methods that are as empirically based, as are those used by other natural sciences?

Answer 3. Empirically based methods are only part of what qualies a discipline as a natural science. The other necessary part involves adherence to the general philosophy of science, sometimes called naturalism, to which all natural sciences adhere. Perhaps the most fundamental component of naturalism respects dealing only with real events, natural events, as independent and dependent variables. This lays the foundation for the work to explain such events in terms of functional relations with other real events. Of course, this approach sets aside any need for recourse to events that we must describe as unreal

or non–natural or mystical or superstitious. Your examples, behaviorology and biology and physics, all qualify as natural science, because they not only use empirical methods but they also adhere to the tenets of naturalism.

Question 4. Would you say that psychology is a non–natural science?

Answer 4. Actually, I would say that psychology is a non–natural discipline. The term science seems inappropriate, because when most people hear this term, they think natural science; they think about disciplines like physics or chemistry or biology or astronomy or geology, all natural sciences. While psychology uses scientific methods, natural scientists consider good methodology alone as inadequate for applying the science label to a discipline. Natural sciences require sound methods that only involve real variables, which necessarily excludes psychology, because its most basic categories are not real. In oversimplified terms, here is how that works. Psychology separated from philosophy by adopting some empirical methods. However, it retained many of philosophy's mystical categories. Indeed, psychology converted some theological mystical categories into secular mystical categories, which seemed to make them more acceptable. For example, it converted the theological mystical category of the soul into the secular mystical category of the mind; but essentially nothing else changed. Such categories, including mind, psyche, self, and so on, constitute psychology's very core of causality, a core in which the spontaneous activities of such supposed, mystical, inner, body–directing agents make behavior happen; we call the appeal to such mystical inner agents agentialism. Psychology's adamant, by–definition retention, to this day, of these and similar mystical, even if secular, categories excludes it from natural–science status. Of course, not all psychologists agree with their discipline over its mystical status but, by remaining in and supporting psychology, they continue to accept and encourage this mystical status. Nevertheless, the whole psychology discipline suffers from the doubts that the general public, as well as the natural sciences, must entertain over psychology's offer of efforts that are grounded in mystically, rather than scientifically, based accounts.

Question 5. How can behaviourology improve society? In what kinds of areas of society can it be applied?

Answer 5. Behaviorology is a rather young science. Still, under various names over the past decades, it has developed successful interventions in a range of areas that society deems important. In sampling a small cross section of current application areas, we could mention successful services to those special populations of adults and children dealing with developmental disabilities, autism, depression, phobias, and so on. We should also mention successful services to the larger populations of citizens regarding such common areas as industrial safety, many aspects of education including instruction and classroom management, performance management in business and industry, companion–animal and service–animal behavior training, dignified dying, penal rehabilitation, and other areas too numerous to mention.

Question 6. Can behaviourology help improve society in the broader context of global problems?

Answer 6. Behaviorological scientists are turning more and more attention to interventions supportive of generating and maintaining sustainable lifestyles. For starters, some of these interventions may even relate to helping humanely reduce humanity's survival–endangering overpopulation level. With population currently running at 150% of the planet's carrying capacity, and still increasing, overpopulation underlies virtually every global problem that people want to address. Some of the most obvious examples include air pollution, water pollution, soil runoff and depletion, habitat depletion, resource depletion, and global warming with all its long–term negative effects; in every case, behind the particular problem is the reality of too many people crowding the planet. Apparently, procreative sex, which produces the population, fails today to provide the species survival benefit that it previously provided throughout history, up until about a century ago. Instead procreative sex

now threatens our survival by continuing to increase our already excessive population level. We must ask ourselves: Can contingencies change us to appreciate non–procreative sex around the world? Can we encourage any non–procreative—and non–exploitative—sex involving one or more consenting adults, regardless of gender, as a way of reducing procreation? Can we allow, without religious persecution or secular prosecution, sex between loving couples of the same gender, which cannot produce babies? And can we allow, and even find ways to encourage, without religious or secular retribution, sex between loving couples of the opposite gender with the assistance of available conception preventatives or treatments so as to reduce the production of babies? While humanity will always produce enough babies for species survival, family planning is a widely established and respected practice with a very long history!

So, yes, behaviorology can assist the natural–science team efforts in the broad context of solving global problems, including by explaining the contingencies behind a "yes" answer to those questions about ways to reduce overpopulation. These efforts currently promote species survival by helping humanity humanely reduce population levels. Of course, I can see a range of complex problems arising from such efforts—for example, fewer children in schools—but I also see that people can solve such problems far more easily than the problems that arise if we fail to reduce overpopulation humanely. In that case, the inevitable worst effects of global warming will reduce overpopulation in disastrously inhumane ways. Helping avoid that is but one way that behaviorology contributes to the team efforts to solve global problems and build sustainable lifestyles.

Question 7. In an accessible manner, could you define the term operant conditioning?

Answer 7. In possibly oversimplified terms, operant conditioning occurs when a stimulus evokes a response that produces a consequence that alters the rate at which that kind of response occurs. Perhaps that was too brief. Let's consider the term operant conditioning as referring to a three–step process. We see the first step when the energy from an environmental stimulus effects our nervous–system receptors in a way that evokes a response. We see the second step when the occurrence of that response produces some stimulus change in the environment. And we see the third step when, as a result of that stimulus change affecting our nervous system, a change occurs in the subsequent rate of that kind of behavior. We use the term operant conditioning to describe this sequence of steps. Now, note that the term operant comes from behavior that operates on, and changes, the environment. Of course, behavior, an instance of which we call a response, does not occur spontaneously—it does not pop out of nothing—but rather it is the product of environmental stimuli. We should make a couple of other points. We use the word conditioning, because the occurrence of the consequential stimulus, which the evoked response produces, then conditions, as in produces, the change in the nervous system responsible for the change in the rate of that kind of behavior; this shows the interrelation of the three steps of the operant–conditioning process. Also, and perhaps most importantly, this process already begins affecting each of us while we are still in the womb, and it continues to affect each of us on a moment by moment basis throughout life, building and changing the differing behavior repertoire that makes each of us the "person" that we are. For example, neither you nor I are the same person we were at the start of this interview; the ever–ongoing and subtle but real operant–conditioning process has changed us in small but cumulative ways, and will continue to do so, hopefully for the better...

Question 8. Could you explain what is meant by the term contingencies of reinforcement?

Answer 8. Behaviorologists actually use that term contingencies of reinforcement generically, to refer to the full range of possible contingency relations among stimuli and responses. Let me explain. Many types of stimuli, occurring either before or after a response, affect behavior, and each has a name. For antecedent stimuli, we use terms like function–altering stimulus or evocative stimulus, depending of the role of the stimulus. We use the term reinforcer for a consequential

stimulus that has produced an increase in the rate of a behavior, and we use the term punisher for a consequential stimulus that has produced a decrease in the rate of a behavior. When combinations of these or other types of stimuli form functional relationships with responses, in which each part sequentially depends upon the others, we say that each part is contingent upon—as in "is dependent upon"—another part. For example, the occurrence of a response is contingent upon the occurrence of an evocative stimulus. Similarly, the occurrence of a consequence is contingent upon the occurrence of a response. And the occurrence of a subsequent change in the rate of that kind of response is contingent upon the occurrence of the consequence. Each of these constitutes a contingent relation, and together they constitute a contingency. Now, one type of contingency involves reinforcers, so we could say that it constitutes a contingency of reinforcement. However, the tradition has developed instead to use the term contingencies of reinforcement to encompass, generically, all types of environment–behavior contingent relations, not just those containing reinforcers.

Question 9. Could you describe what is meant by the term schedules of reinforcement?

Answer 9. That term, schedules of reinforcement, refers to the various patterns regarding how reinforcers follow responses. Sometimes reinforcers occur after every response, a schedule that we call continuous reinforcement. At other times reinforcers occur intermittently, that is, after only some responses rather than after every response. This intermittent occurrence of reinforcers can depend on the occurrence of a fixed, or a varying, number of responses, and we label these as fixed–ratio or variable–ratio reinforcement schedules. Alternatively, the intermittent occurrence of reinforcers can depend on the occurrence of a single response after a fixed, or a varying, amount of time has elapsed, and we label these as fixed–interval or variable–interval reinforcement schedules. We consider these four schedules as the basic schedules of reinforcement, although they are not the only types of reinforcement schedules, and each of these basic schedules produces a different but characteristic pattern of responding.

For a commonplace example, let's consider the variable–ratio schedule. This is the schedule on which reinforcers occur in numerous circumstances, including during games of chance and gambling, and the characteristic response pattern that this schedule produces—a pattern of relatively rapid and steady responding—unsurprisingly evokes images of the behavior of players on traditional casino "one–armed bandit" slot machines, often working on into the night, often until the player runs out of funds. Now, contingencies, like those in variable–ratio schedules, produced gambling centuries before science discovered and analyzed this schedule. Back then, as now, the laws of nature, including the laws of behavior, affected people in ways that compelled purveyors of games of chance intuitively to arrange variable–ratio schedules to produce large and lucrative amounts of player behavior. And today, as back then, the effects of variable–ratio schedules—not the "gambling habits" of fictitious inner agents—are responsible for the behavior that often reduces the wealth of many individuals, while swelling government coffers from lotteries and gambling taxes.

Overall, schedule research leads to some important conclusions. Let's list three. For starters, many features of behavior emerge as the effects of particular schedules of reinforcement. Also, schedules with only subtle contingency differences often produce distinctly different response patterns. And the direct effects of reinforcement schedules reveal a wide range of putative inner–agent emotional and "motivational" causes of behavior to be misleading and unnecessary accounts.

Question 10. Is there any overlap that you see between behaviourology and the brain sciences? If so, could you point to a particular overlap, perhaps the effect of reinforcement on neural structures? Could you also touch on what kinds of overlap exist between behaviourology and physiology, and provide an example?

Answer 10. That is a complicated set of questions. Brain scientists and behaviorologists are

all natural scientists. As such, brain scientists remain uninterested in either interpreting their physiological data in support of mystical notions, or in applying their science in the address of mystically grounded questions, such as where to find the mind inside the brain. Instead the coordination of behavior and brain sciences leads productively to the address of questions such as what happens at the physiological level when reinforcing stimuli feed energy traces back into the nervous system.

But before going there, your question about disciplinary overlaps is particularly important because, with many natural scientists lacking adequate access to behaviorological science, a trend has arisen that attempts to shoehorn "causes" of behavior simply into physiology, genes, or evolution. We recognize these attempts as unnecessary because, while the closest of these, physiology, explains how a behavior occurs (as in the process of the nervous system mediating behavior) behaviorology explains why a behavior occurs (as in dealing with the independent variables of which behavior is a function). That is, physiology details the working of the physically stimulated nervous and muscular systems that makes a response occur, which we call the bodily mediation of the response. Meanwhile, behaviorology details the functional relations—what people often simply call "causes"—that physically stimulate the nervous system in the first place, making the muscles contract. This contraction, then, is the occurrence of the response. For example, behaviorology addresses the functional relations between independent variables, such as a boulder blocking a forest path, and the dependent variables of body–mediated behavior, such as the nervous–system–induced muscle contractions, that the boulder evokes, that take the body around the boulder.

Now let's return to your question about the effect of reinforcement on neural structures, a question about what happens at the physiological level when reinforcing stimuli feed energy traces back into the nervous system. To begin, the description of a simple contingency—strictly on the analytical level of behaviorology—involves a stimulus evoking a response that produces a consequence that increases the rate of that kind of response (which, by the way, makes us call that consequence a reinforcer). Let's elaborate this contingency while considering the analytical levels of both physiology and behaviorology. An environmental stimulus provides a physical energy trace into a body's nervous system that, as part of evoking a response, produces temporary changes in neural structure, changes that we describe as the ring of some neurons or bundles of neurons which, for this description, induces the muscular activity that we call a response. Of course, our physiology colleagues can give you a richer, more detailed account. Anyway, that response then produces some stimulus change in the environment which feeds an energy trace back into the nervous system. There, this energy trace produces neural structural changes of a more permanent kind, such that the mediation of that kind of response will now occur more readily or more easily when the evocative stimulus occurs again. We witness this as an increase in the subsequent rate of that kind of response. For example, when a request for a drawn cartoon evokes a cartoon–drawing response, and the resulting, finished cartoon produces a compliment, the compliment feeds an energy trace back into the nervous system through the ears that alters neural structures such that later requests for a drawn cartoon more readily evoke cartoon–drawing responses, which we observe as an increase in the subsequent rate of cartoon drawing.

Question 11. Behaviorology talks about the "environment." Is this merely everything around us?

Answer 11. Our talk of the environment, and environmental stimuli, indeed encompasses all real parts, and aspects, and characteristics of the reality around us. But we must also recognize that part of that reality, part of the environment, exists within the skin, skin that is not any sort of boundary to the laws of the universe. Thus, at various times we simply speak of the environment, or we may specify the external, or the internal, environment. While we may have less access to behavioral events in the internal environment, those events are still real. This includes the full range of purely neural behaviors, such as thinking and consciousness, as

well as neuro–muscular behaviors, such as talking and walking.

Now, within the constraints of an interview, we can't pursue the kind of complexity that the internal environment involves, with its thinking and consciousness neural behaviors (so let me refer you to some other resources: ... [see Ledoux, 2014 or 2012a, or Fraley, 2008]); we can, however, account a little for complexity itself, perhaps in a way that helps clarify the context of our discussion. Let's do that simply by mentioning what I call the Law of Cumulative Complexity: This law states that "the natural physical/chemical interactions of matter and energy sometimes result in more complex structures and functions that endure and naturally interact further, resulting in an accumulating complexity" [Ledoux, 2012b, p. 10]. The origin of the universe and of life, the vast range of life forms, the interrelations of physiology and behaviorology, and the extent and significance of thinking and consciousness neural behaviors, are all outcomes of the Law of Cumulative Complexity. All of these are cumulatively complex; all are entirely natural.

And, by the way, we are using the term natural in its comprehensive scientific sense here. That is, we are not using it in the limited sense of the "great outdoors" or what you experience on vacation "away from it all." Instead, we use the term natural in its full sense of referring to all real, measurable pieces, parts, aspects, and characteristics of the universe, including humans, human nature, human behavior, and this planet that provides us a home.

Question 12. Could you describe how behaviourology does away with personal agency and free will? What about freedom? For example, cannot operant conditioning be given to people in society as a tool so that they can better control their environments, which would lead to a potentially heightened sense of freedom? What are your thoughts on this?

Answer 12. The phrase, "does away with," regarding self agents and free will, is perhaps somewhat misleading, because science does not work that way. Science, self agents, and free will all rest on basic assumptions—but not the same assumptions, and certainly not equal assumptions—about how to approach questions regarding human nature and human behavior. While considering some assumptions behind each of these—science, self agents, and free will—let's remember that no one can prove or disprove assumptions, although these can turn out to be helpful or harmful. Let's consider free will, self agents, and science in turn. Free will rests on theological assumptions, made up millennia ago, about some mystical maxi god, who moves mountains, and the souls that this maxi god instills in humans, giving them the status of agents free to do good or evil. Somewhat similarly, self agents, as inner agents that more recent disciplines posit to reside inside each human body, rest on secular assumptions that these more recent disciplines made up to avoid the theological complications of maxi gods by emphasizing some mini gods who only move arms and legs while inhabiting human bodies; supposedly these assumed inner agents initiatively, spontaneously decide what the body is to do and tell the body to do it. That is, the theological soul got reinvented originally as the secular mind, then the secular psyche, then the secular self or person or personality. Science, on the other hand, does not make up its assumptions. The assumptions of science include dealing only with real, that is, natural, events as independent and dependent variables, and such assumptions derive from at least the last 400 years of validated experimental research findings and their successful engineering applications that surround us (just look around...) By virtue of the incompatibility of its assumptions with the assumptions behind free will and self agents, science—which means natural science, including behaviorology—simply sets aside anything mystical (like free will and self agents) in its analyses, due to that mystical status. Note, however, that as behavioral phenomena, mostly verbal, concepts like free will and self agents become subjects for scientific analysis by behaviorological science.

Question 13. And what about freedom?

Answer 13. Ahh, yes; freedom. With the concept of freedom, we face difficulties similar to those that we faced with free will and self agents.

These difficulties arise due to each of us carrying a lifetime of traditional cultural conditioning that has, for thousands of years, developed contrary to scientific realities. So, let's be blunt, and allow any usual negative emotional reactions to run their course—and calm down—while we explain the status of freedom and control. Being blunt, independent variables control all behavior, while freedom remains an important independent–variable controlled feeling. This reality invites little attention or opposition so long as behavior controls remain positive, such as control by added reinforcers since positive controls induce feelings of full freedom. On the other hand, lots of attention and opposition accrue whenever behavior controls remain negative, such as control by coercion and punishment since negative controls induce feelings of being pushed around or bullied. With freedom, as certain important feelings that result from emotions, which particular stimuli elicit, the notion of freedom as a lack of control shares the same fate as self agents and free will; we scientifically set this notion aside. By the way, you can easily substitute words like "choice" for freedom in discussions like these...

Now, let's recognize that our scientific analysis is not taking away whatever anyone has as freedom. Instead the analysis can enhance people's feelings of freedom; people and society benefit when people feel free, and as a society we want people to feel freer than they have ever felt. Scientific knowledge provides a solid basis for increases in feeling free for sound reasons. In practical terms feelings of freedom increase with increases in positive, non–coercive controls on behavior. For example, when your employer pays you well, you feel that you have the freedom to go to work or not, but you still go; you would be crazy not to! But when your employer pays you poorly, a coercive circumstance, you feel that you have no freedom to go to work or not; instead you feel forced to go, and you go; you would be crazy not to! And remember that the word "you" refers not to any ethereal inner agent but simply to a physical body. So, the bottom line is that the more the informed use of positive operant–conditioning practices increases in society, the better will be two–way control between people and their environments, and the more they will appropriately feel free about that control.

Question 14. Would you advocate educating the public on adopting behaviourology–specific terms for everyday language descriptions of behaviour?

Answer 14. I think I would begin by advocating that the public receive as much education in behaviorology as it receives in physics or chemistry or biology. This would enhance applications of behaviorological principles and practices not only for solving local personal or social problems but also, as part of the multi–science mix, for solving more widespread, global problems. In time this could indeed lead to increased scientific accuracy in the everyday language that we use to describe behavior. But what is more important, I think, is that as more people become more familiar with the laws of behavior, the misuse of this science for purely personal power or gain becomes more difficult. Widespread familiarity with a science provides a major countercontrol to the misuse of that science. This seems a more immediate worry than concern about speeding up our language evolution, even though that too would probably be of help to us.

Question 15. What kinds of suspicions do you think the mainstream have regarding behaviour analysis? Are their suspicions well–founded? And do you see behaviour analysis as separate from the general field of study known as psychology? If so, why?

Answer 15. The mainstream may lack suspicions about behavior analysis. This term was once simply an older term for the natural science of behavior. This is the term that was in use during a period that we call the "shared history," the period when both this natural science and the discipline of psychology inhabited the same academic departments, while the natural scientists of behavior made their attempts to change psychology into a natural science. When those attempts repeatedly failed, the natural scientists of behavior began to take their natural science outside of psychology, while still using the behavior–analysis label for the science. However, the behavior analysts came under contingencies to

build the political power that was needed to help bring effective interventions to needy populations such as autistic children. Unfortunately, this distracted them from following up on their independence origins. Most of those who did follow up on their independence origins became behaviorologists. So then, for some time, two labels—behavior analysis and behaviorology—were available to name the natural science of behavior. Then a new wrinkle occurred that reduced the possible labels to only one. This wrinkle involved the psychology discipline officially claiming the behavior–analysis label through the exercise of some historically based options. And this wrinkle is what raises suspicions, not so much in the mainstream as among traditional natural scientists who then express legitimate concerns over whether or not behavior analysts are still natural scientists. If they are not natural scientists, then they belong under the psychology label and should be supervised by psychologists; and if they are under psychology, then they are telling the world that they are not natural scientists... But if they still are natural scientists, then they belong under the behaviorology label where normal peer supervision is appropriate. In the interim, while some go one way and some go the other way, the ambiguity raises credibility questions regarding behavior analysis, especially regarding some very much needed contributions to solving global problems. Also, for those "behavior analysts" who remain natural scientists of behavior, their moving out of psychology—and using the behaviorology label as the name for the basic science that informs their Applied Behavior Analysis, ABA—would justify their professional work, programs, status, certification, licensing, and so on, outside of, and independent of, psychology.

Question 16. Could you explain what is meant by the term recombination of repertoires and the role it plays in understanding complex human behaviours? In what way could such a process benefit the education system?

Answer 16. The term recombination of repertoires refers to the process in which several separately conditioned environment–behavior relations come together to produce a new relation—one that conditioning has never directly affected—in which a new stimulus evokes a new response that still produces a reinforcing consequence. While this looks to be mysterious, or the result of directives from some inner agent, it is simply another product of scientifically grounded functional relationships, although we look to our physiology colleagues for important components of these accounts. For example, the parts of a typical child's home environment readily—and usually separately—condition not only the behavior of grasping objects but also the behavior of climbing on objects as well as the behavior of moving objects around (although no 24/7 video camera records these events). So, when a new situation confronts the child, such as a big cookie atop a high table out of the child's reach, these separate repertoires come together to produce a solution. The stimuli in this situation evoke the child's behaviors of moving a stool up to the table, climbing on the stool, and grasping the cookie, all of which constitutes a recombination of the earlier, separately conditioned components. We can easily surmise the contribution that the process of recombination of repertoires makes to complex human behavior, given the vast complexity of the environment and the vast—and ever expanding—number of functional parts that conditioning produces in each person's extensive behavior repertoire. The education system is an integral part of the complex environment, and the repertoire–recombination process supports the value of conditioning, perhaps through general–education requirements, extensive responses from a wide range of disciplines during a person's formal educational career.

Question 17. Could you explain what is meant by the term equivalence relations? Could this explanation of implicit conditioning be used within the education system as well in order to expedite learning?

Answer 17. Even more than some other terms that we have discussed, the term equivalence relations refers to a topic that really requires a description far more extensive than what we can cover in an interview [see the references]. Let's just say that when some conditioning directly establishes the function of some members of a

related group of stimuli, other group members begin functioning appropriately as well; they function in ways equivalent to the ways the original stimuli function. Equivalence relation phenomena present a substantial potential for a revolution in education, but implementation first requires educating potential teachers about behaviorology in general and about equivalence relations in particular.

Question 18. Could you please outline what Project Follow Through was about? Did the behaviour–science based models become successfully applied in the education system? Is this reliable evidence that behaviour–science applied to the classroom can be effective? What kinds of resistance have behaviour–science educational techniques come up against?

Answer 18. Project Follow Through was the most extensive and expensive federally funded educational experiment in U.S. history. It looked at how the outcomes, on a variety of standard measures—from children taught with a range of distinct instructional models, which whole districts voluntarily sponsored—compared with the outcome measures from children whose school districts across the U.S. had not adopted any particular model. The results of Project Follow Through led to a major observation: While some models produced a range of poorer outcomes than those of the comparison group, other models produced consistently better outcomes, particularly the Direct Instruction and Behavior Analysis models. Importantly, these successful models explicitly derived—before the behaviorology label was in general use—from the application of the principles and concepts of the natural science of behavior. The Project Follow Through research had predictably revealed some science–based instructional approaches that work in education.

However, that revelation of some best practices for regular education received little dissemination even to the very teachers who, along with their students, would benefit from implementing its findings. So, sadly, those findings get widely ignored. When giving a workshop about a decade ago to about 100 teachers and staff at a public, kindergarten to pre–college school, I asked who was familiar with Project Follow Through; only two people said that they had even heard of it. Also, while the results of Project Follow Through focused mainly on student outcomes from the first several years of the project, the funding of various of its models continued for many years. Unfortunately, this funding was not limited to the models that produced improved student outcomes; models that had produced poor outcomes, models that seemed to be fancied by the educational establishment, continued to receive funding. This ignoring of Project Follow Through data not only indicates some blind respect for ineffective, agentially–focused methods that comport with popular mysticisms, but also indicates some persistence of the discredited notion that behaviorological laws are largely irrelevant to normal humans.

Question 19. What kind of role can behaviourology play in orienting our culture to one that is much more socially sustainable? What kinds of behaviours do you think the field of behaviourology can assist in positively reinforcing in order to bring about a more sustainable culture on the planet?

Answer 19. I am fairly convinced that no single discipline can achieve such an outcome alone. While "orienting our culture to one that is much more socially sustainable" clearly involves human behavior in major ways, which increases the pertinence of behaviorology, other aspects of this task involve all the other natural sciences to one extent or another. Very likely a widespread understanding of behaviorological principles and practices would substantially ease the task, but I think humanity can only accomplish this task with all the sciences, and the non–mystical humanities as well, working together in a team effort. Of course, part of behaviorology's contributions to such an effort may reside in keeping that effort focused on scientifically sound directions by continuing to clarify the need to reduce the effects of, and even to set aside, all the magical thinking, theological and secular, that otherwise interferes with completing the task of reorienting the culture to one that is fully sustainable. This interference

occurs through such magical thinking leading to put–downs of science, blaming victims, and justifying inappropriate compromises with harmful notions like free will and self agents, compromises that humanity can simply no longer afford. Yet another part of behaviorology's contributions includes providing the appropriate behavioral intervention technologies that humanity needs to build more successfully the interactive, prosocial repertoires of patience, collaboration, cooperation, empathy, and critical thinking, among disparate individuals, groups, and peoples. Humanity needs to strengthen these prosocial behaviors as a way to counter the current momentum toward, as you have described on your prosocialprogress.org website, the "increasing pain and suffering [occurring] through cumulative competitive, and unsustainable behavioral practices" that we currently perpetrate against each other and the world around us. Many behaviorological principles and practices are imminently pertinent to solving such problems.

Question 20. Do you think that the sustainable goals anchored to behaviourology could only come about in a new type of economic system, one which is based on the sharing of resources and cooperation in order to decrease the aversive environment that capitalistic institutions produce for many people?

Answer 20. An economy is a complex web of interconnected contingencies that share in controlling a vast amount of daily behavior across society. The current, confrontational, exploitative, and excessively competitive economic system—rooted in profits before people—bears substantial responsibility for bringing about our current problems, leaving it likely quite inadequate to the task of solving those problems. Unless we go extinct, sooner or later humanity will have a fully sustainable, nationally diverse and multi–cultural planetary society, although we may have to pass through another long dark age first. That kind of society, and even many of the intermediate steps to get there, will require a different kind of economy, a likely very different kind of economy from our current one, to support the vastly changed kinds of contingencies that make for a successfully prosocial, cooperative culture. Beyond that basic outlook, since economics resides outside my specialities, I would be presumptuous to try to second guess how, economically, we will get from where we are now to that kind of fully sustainable society. Still, when society reaches the point at which it works in a sustainable manner, I think we can be sure that the economic system will operate in fundamentally different ways from the way our current economies operate.

Question 21. How long do you think it will take until the general public is able to recognise the huge benefits offered by the methods derived from a natural science of behaviour? What will it take until governments are onboard with this, and begin taking behaviourology into account when orienting new social programs to support prosocial and sustainable behaviors while preventing problematic, unsustainable behaviours?

Answer 21. I find that the people I know personally, many of whom work for government agencies, are good people providing their best efforts with the tools available to them. Unfortunately, their tool box contains items that are quite detrimental to successfully establishing a sustainable society, such as the age–old but false, and misleading, notions that human behavior comes from the directives of theological and secular inner agents, notions that currently pervade the world's governmental and legal systems. Worse, their tool box lacks the strategies and tactics that behaviorology could add to the tools available from other natural sciences. I think it will take at least as long for the general public, and governments, to recognise and implement the beneficial methods that derive from a natural science of behavior, as it takes to develop and provide the requisite education and practice in this natural science to these groups through the widespread development of behaviorology departments and programs in higher education. While the certain interrelation of these two suggests a kind of "chicken–and–egg" problem, most likely we need to start with lots of behaviorology Ph.D. programs so that graduates are available not only to expand research on behavior and on applications supportive of sustainable living, but also to teach additional

cohorts of students, especially those who become teachers in society's regular education classrooms.

On the other hand, at the undergraduate and master's degree levels, perhaps we should begin by instituting programs in what we might call Behaviorology and Green Engineering. These programs—which could become quite popular—would have two equal components. One component would assure well–rounded coverage of all the traditional natural sciences, including those like physics, chemistry, and biology, that students have already contacted in their pre–college education. Recognizing that most students will not have had previous exposure to natural behavior science, the other component would provide detailed coverage of the behaviorology discipline and its applications, interventions, and engineering interactions with the other natural sciences, particularly focused on solving global problems.

With all the research and application development that we can expect from the serious establishment and expansion of behaviorology departments and programs across a widespread cross section of universities and colleges around the globe, I think we might begin to see meaningful developments toward a sustainable society within a matter of years. How many years? Well, we may have less than 50 years before the worst effects of global warming become inescapable, so we better make it happen in substantially fewer years than that. Let's not debate how long these educational efforts might take; let's just keep moving things along. We all have contributions to make to solving our global problems. And the clock is ticking.

Question 22. Earlier, you described a number of factors as coming together to produce your "Behaviorism at 100" article, which began to show other natural scientists that behaviourology, the natural science of behaviour, exists and has a part to play on the natural–science and engineering teams working to solve global problems. Is that article the only resource available to help people work on these problems?

Answer 22. The unabridged version of that article actually became the core of the first chapter in a book for that audience, and for anyone concerned about environmental issues and human survival. This book, with the title, *Running Out of Time—Introducing Behaviorology to Help Solve Global Problems*, details this natural science of why human behavior happens, a natural science that can help build a sustainable society in a timely manner. Using ordinary examples of everyday human behaviors, this 600–page book serves to convey—in a friendly, conversational manner—a basic behavior repertoire in behaviorology and its applications. After the first chapter provides an historical overview, the remaining 23 chapters address the principles, methods, concepts, and practices of behaviorology, along with some scientific answers to some long–standing human questions (e.g., questions about values, rights, ethics, morals, language, consciousness, personhood, life, death, and reality) while continually pointing to interconnections with solutions to global problems. For U.S. $63 the publisher (BehaveTech Publishing of Ottawa, Canada) is releasing this hardcover book in early February 2014. It contains an extensive glossary, bibliography, and index, and you can purchase copies through local bookstores or from the main distributor, Direct Book Service, Inc., at 800-776-2665. They will likely answer the phone with "Dogwise," because one of their oldest and most popular specialities involves books about our canine friends; several of these books already specifically apply the laws of behavior that Running Out of Time... systematically introduces. (Of course, an eBook edition will also be available.) On a lighter note, through its web site, www.behaviorology.org, The International Behaviorology Institute [TIBI] offers a CD of the public–radio interview with the organizers of the first behaviorology convention that was held in Potsdam, NY, in 1988. These organizers were Lawrence Fraley, Stephen Ledoux, Ernie Vargas, and Julie Vargas. Even more resources are listed in the bibliography in the Running Out of Time... book.

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