SELECTION BY CONSEQUENCES IN THE ONTOGENY OF BEHAVIOR: THE PROBLEM OF THE FIRST INSTANCE

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ABSTRACT: Selection by consequences occurs in both phylogeny and ontogeny. In both domains, qualitative characters pose the 'problem of the first instance'—i.e., the problem that selection can explain the spread of a qualitative character within a population of individuals, but it cannot explain the first instance of that character. By contrast, selection is able to explain even the first instance of a quantitative character. Skinner limits the analogy between phylogeny and ontogeny precisely along this divide. Although qualitative characters exist in phylogeny, Skinner does not think they exist in ontogeny. This is one of the foundational differences between cognitive science and behavior science. The first purports to explain regularities in the ontogeny of qualitative characters, the latter purports to explain regularities in the ontogeny of quantitative characters.

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This paper is about selection by consequences in the ontogeny of behavior. A central contention of behavior analysis is that operant selection is able to account for adaptation, novelty, and creativity without reference to mind. Skinner (1953) introduced an analogy between natural selection and operant conditioning to explain how this is possible. The point of the analogy is that selection by consequences is a special mode of causation that explains adaptation, novelty, and creativity in both the phylogeny of species and the ontogeny of behavior. In neither case is it necessary to refer to insight, inference, purpose, plan, or intention. This analogy has played an increasing role in the interpretation of behavior analysis.

Selection by consequences, however, has a limitation, whether in phylogeny or ontogeny. Selection must await the occurrence of the first instance. In his replies to comments about some of his previously published articles, Skinner acknowledges "the problem of the First Instance." He asks, "Where does the behavior come from that is taken over by contingencies of reinforcement?" (Catania & Harnad, 1984, p. 609). He does not attempt to answer this question, but in the same publication he asserts: "As an explanatory mode, selection is responsible only for novelty, for origins" (p. 503). If it cannot account for the first instance, however, how does it fully explain novelty or origins? This is the question addressed below.

Phylogeny

The most problematic case for selection by consequences, whether in phylogeny or ontogeny, is a qualitative character. Consider natural selection of a binary character controlled at a single locus—that is, a character having two qualitatively distinct heritable traits—for example, smooth skin versus wrinkled skin in a pea. Such a character poses limited options for the process of natural selection. If one trait is fitter than the other, then selection will tend to increase the proportion of the population having that trait. Selection can then sweep through the population with the result that all peas are smooth, or all peas are wrinkled. Selection cannot however change the traits that are available to be selected. Mutation can do that. Migration of a new variant into the population can do that. But selection cannot. Its role here is passive. It can increase or decrease the portion of a population that exemplifies a novel variant, but it cannot create one.

A somewhat different example is provided by heterozygotes that are qualitatively distinct from the two homozygotes. Consider a hypothetical species of moths that have a white variant and a grey variant. Suppose crossing the two produces hybrids that have wings with grey speckles on a white background. That is, suppose wing color is controlled at a single locus by two alleles, but the alleles are co-dominant, so the trait of the heterozygote is qualitatively distinct from the trait of either homozygote. This population has three heritable traits. Natural selection will now have three options from which to select, but its role will be even more constrained than in our first example. Crossing hybrids with one another will produce a mixture of all three traits in the next generation. If the hybrid turns out to be fitter than the other two variants, selection can no longer even sweep the other

two variants out of the population. And, of course, it still cannot produce a novel variant.

If we were writing a performance review of selection, our theme would be that whenever the character in question is qualitative, selection's role is limited to removing unfit variants from the population. And even this role is constrained. Heterozygote superiority is just one of several examples of such constraints, but there is no need to belabor the point, which is simply that qualitative characters place numerous limitations on what selection can accomplish. They offer selection a finite number of discrete options, and selection is incapable of causing new options to emerge. Nor is selection always capable of removing all but one of those options from the population.

Just to be clear, calling a trait qualitative does not mean the population having that trait is without quantitative differences. The pea's surface is either smooth or wrinkled. Nevertheless, the population of smooth peas will have a mean of smoothness and there will be peas having more or less smoothness than the mean. The same will be true of the population of wrinkled peas. But the two populations are separate. On the continuum from perfectly smooth to grotesquely wrinkled, there is a gap that no pea will (or could) occupy. This gap is what makes the traits qualitative.

Another clarification: Only what is heritable can be selected, but any property can be selected *for*. The population of speckled moths will have a mean number of speckles per wing, with a bell curve of more or fewer speckles around this mean. If a specific number of speckles confers optimal fitness and this number of speckles is not heritable, then even if the environment selects *for* that number, what actually gets selected is just whatever is heritable. When we refer to a character as qualitative, we mean that there are a limited number of discrete heritable variations. In the pea example, there are two heritable traits. In the moth example, there are three. The environment can select *for* any arbitrary phenotype in the sense that individuals with that phenotype will tend to survive and reproduce at a higher rate, but if there are limited options that can be inherited in the next generation, what actually gets selected to recur (as opposed to what is selected *for*) is limited to whatever is heritable (see Sober, 1984, pp. 97-102).

In contrast to these examples of qualitative characters, selection's strong suit lies with quantitative characters. A standard example is height. The height of an individual is affected by numerous genes.[2] Suppose there are *n* different loci that influence height and that each locus has two alleles. The total number of unique combinations of alleles increases exponentially as a function of *n*. With numerous loci affecting height (possibly numbering in the hundreds), the total number of unique combinations of alleles will be very large. On the assumption that each allele has a small additive effect and that there is a certain amount of variation in how each combination is expressed in the phenotype due to the contribution of 'nurture,' the

[2] It also, of course, is affected by the environment during the development of the individual—e.g., by nutrition.

range of possible heights can be represented as a continuum. Unlike the phenotypes for qualitative characters, there are no gaps in this continuum. Every point on the continuum is possible, in the sense that there could be an individual organism that exemplifies that point.

Skinner (1975) illustrates the evolution of a quantitative character with an example that he borrows from Wolfson (1948).

> In 1948, Wolfson argued that "continental drift was the stimulus for the evolution of the more highly developed forms of migration [of birds]." He stated his hypothesis in four steps:
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> (a) Before the advent of continental drift many birds were performing short flights between breeding and feeding areas.
> (b) With the onset of drift these areas diverged slowly.
> (c) The birds continued their use of these areas because of their well-developed homing instincts.
> (d) As the distances increased, only those individuals that had the necessary energy for the flight survived.
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> Wolfson pointed to the fact that, for example, the Arctic tern, which breeds in northern North America and migrates to the Antarctic, first flies *eastward* across the Atlantic to Europe and then southward along the African coast. The eastward journey may at first have been very short, but as the continents separated, successive generations would have flown slightly greater distances and what seems now like a nonadaptive flight pattern is thus explained (pp. 118-119, italics in original).

The example assumes the conditions for natural selection of the character exist and that it is quantitatively defined by the distance the tern is disposed to fly east to the coast of Europe from its nesting ground in the north Atlantic.[3] Under these circumstances, at any given time there will be a mean distance that members of the population will be disposed to fly east. The distribution around this mean will fit a bell curve. So long as the drift of the tern's nesting ground westward between generations stays well within the outer edges of the bell curve, the entire bell curve for the succeeding generation will tend to shift to a higher mean and the leading edge will include novel variants that did not exist in previous generations. At the same time, selection will remove some variants from the other extreme of the bell curve. After enough generations, the entire bell curve will cover a range of variants that are completely outside the original range. The new range of variants available for

[3] The example does not assume that the full range of heritable phenotypes can be accounted for on the basis of genetic inheritance alone. It is consistent with the possibility, for example, that part of what a tern inherits genetically is a disposition to migrate with a flock of other terns, and that a juvenile tern learns to respond to certain migratory cues by flying with a flock that includes mature adults. A migratory route would in this case be heritable without being entirely genetically encoded. See Jablonka & Lamb (2014) for discussion of several kinds of heritability that are not genetically encoded.

selection will now be totally different from the range of variants available at the outset.[4]

The cliché that selection must await the occurrence of the first instance is clearly true of qualitative characters, which is what Skinner means when he acknowledges "the problem of the First Instance." But we have just seen that he also gives an example that shows selection is able to induce the first instance of a *quantitative* character. When selection for a quantitative character follows a trend line, selection can move the bell curve in the adaptive direction. When it does so, it causes novel traits to become available for selection, and these novel traits are likely to be adaptive. Given enough time, this process can create totally novel adaptations.[5]

The point is not that quantitative characters evolve without constraints. All aspects of evolution proceed under various constraints. Even if a quantitative character can be moved by selection along a continuum, change in one direction may be occur more rapidly than change in the opposite direction. Rausher & Delph (2015), for example, note that for certain taxa, a shift in flower color occurs more readily from blue to red, than from red to blue. They also note that movement in one direction sometimes cannot be reversed, so movement along a quantitative continuum can be a one-way street (p. 1660). But within such constraints, the process of selection is able to cause heritable traits to become available for selection that did not previously exist in the population. Selection is thus able to account for the origin of a novel quantitative trait whereas it is unable to account for the origin of a novel qualitative trait.

Ontogeny

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[4] The Wolfson article has an additional significance. It illustrates the scientific prejudice against theories that do not provide accounts of underlying mechanisms to forge links between events that are correlated in a lawlike way. Wolfson published his article before the discovery of plate tectonics. His argument received a great deal of ridicule at the time, on grounds that the forces required to move continents were absurdly beyond anything that could be accounted for. I visited with Dr. Wolfson in 1982, more than three decades after he published his paper about bird migration. He was still unhappy about the negative effect the criticism of his theory had had upon his career. By the 1980s, of course, continental drift was accepted as fact and migratory patterns of birds had become textbook examples of evidence for it. He found it to be especially rankling that an argument that was ridiculed in the 1940s was considered textbook obvious in the 1980s, but nothing about its conclusion or the evidence for it had changed.

[5] To call the trait of flying east "adaptive" may seem to contradict Wolfson's acknowledgment that flying east before flying south is inefficient, and thus in this respect is not adaptive. But the term is being used in a different context. The overall migration of the tern is less than maximally efficient, and in this sense, fails to be adaptive; but Wolfson notes that each small step in the evolution of the migratory route was itself adaptive. It is well known that such a hill-climbing patterns of evolution can lead to adaptations that are suboptimal, and thus, in this sense, are not adaptive.

Turning now to ontogeny, in the case of phylogeny it was necessary to distinguish between characters that are heritable and those that are not. The analogue in ontogeny is between responses that can be reinforced and those that cannot. The potential operants are those types of responses that can be reinforced. By analogy with natural selection, individual operant responses exhibit variability. If one variant is more closely correlated with reinforcing stimuli than others, responses of this type will tend to occur more frequently than others. The population of operant responses will therefore tend to include a higher proportion of that type of response.

Skinner says that the key conceptual innovation of behavior analysis was to focus on rate of behavior as the dependent variable. He compares the progress in the analysis of behavior that followed focus upon rate to that which occurred in chemistry that followed focus upon weight (Skinner, 1969, p. 110). Rate is necessarily a property of a population of responses. For rate to exist, there must be at least two instances of a certain type of response, so that the time between instances can be used to define the rate. For rate to change, there must be a minimum of three instances, so that the time between the first and second instance can be compared to the time between the second and third. In practice, to draw reliable conclusions about rate, the population must be much larger than three. When a type of response is performed repeatedly, the ordinary term for that is "habit." Skinner (1989) writes, "The main difference between an operant and a habit seemed to be one of size" (p. 125). A laboratory operant is a very simple habit. A complex habit is thus composed of simple operants that have a functional unity. What Skinner calls the key conceptual innovation was thus to focus on the rate at which habitual behaviors (whether simple or complex) are performed.

Rate is a quantitative aspect of a population of responses, but that does not mean that the type of response whose rate is being studied has a quantitative definition. If adaptation, novelty, and creativity are our interest, then the distinction between qualitative and quantitative definitions of response is important. When Skinner illustrates creativity in the domain of ontogeny, he turns to responses whose defining features can be measured along a continuum. Such quantitative aspects of behavior can be shaped through differential reinforcement of successive responses. If the only responses that receive reinforcement are those that exceed the current mean, a new mean arises in the direction along the continuum that received differential reinforcement. New responses will now occur farther along the continuum and if they are reinforced, the population of responses will move even farther along the continuum. Skinner (1975) illustrates this with the climbing and jumping behavior of the rat.

> In a simple demonstration, a box is divided into two parts by a low wall, and a hungry rat is placed on one side and food on the other. The rat possesses an initial repertoire of responses (climbing and jumping), with which it crosses the wall and which are reinforced by the food. As a result, responses having the required topography are strengthened and soon occur on later occasions. If the wall is then made slightly higher, only some of these responses will be successful, but they will begin to occur more frequently, and as a result, new topographies of response will appear that will meet even more demanding

> contingencies when the height of the wall is again increased. If the height is not increased too rapidly (if some responses are always successful), a very energetic and skillful repertoire will result. The rat will eventually go over a wall that it would never cross if it had not been exposed to such a program (p. 117).

For Skinner, this example is not an outlier. Instead, it illustrates what he thinks is the typical pattern of operant learning.

Indeed, precisely here is a respect in which operant conditioning fails to be analogous to natural selection. Skinner believes that there is nothing in operant behavior, when rigorously conceived, that is analogous to qualitative traits. In a passage titled "The continuity of behavior" Skinner (1953) writes:

> Operant conditioning shapes behavior as a sculptor shapes a lump of clay. Although at some point the sculptor seems to have produced an entirely novel object, we can always follow the process back to the original undifferentiated lump, and we can make the successive stages by which we return to this condition as small as we wish. At no point does anything emerge which is very different from what preceded it. The final product seems to have a special unity or integrity of design, but we cannot find a point at which this suddenly appears. In the same sense, an operant is not something which appears full grown in the behavior of the organism. It is the result of a continuous shaping process (p. 91).

In the discussion that follows, he makes it clear that he thinks all operants are quantitative. He illustrates his point by describing how one might condition a pigeon to acquire the operant of pecking a spot.

> We first give the bird food when it turns slightly in the direction of the spot from any part of the cage. This increases the frequency of such behavior. We then withhold reinforcement until a slight movement is made toward the spot. This again alters the general distribution of behavior without producing a new unit. We continue by reinforcing positions successively closer to the spot, then by reinforcing only when the head is moved slightly forward, and finally only then the beak actually makes contact with the spot. We may reach this final response in a remarkably short time. A hungry bird, well adapted to the situation and to the food tray, can usually be brought to respond in this way in two or three minutes (p. 92).

He continues:

> This is an effective procedure because it recognizes and utilizes the continuous nature of a complex act. The total act of turning toward the spot from any point [in] the box, walking toward it, raising the head, and striking the spot may seem to be a functionally coherent unit of behavior; but it is constructed by a continual process of differential reinforcement from undifferentiated behavior, just as the sculptor shapes his figure from a lump of clay (pp. 92-93).

Moving from pigeon to human being, a human child learns to control its limbs, to reach for objects, to roll over, to crawl, to stand, to walk, to grasp objects, and to

control its vocalizations, through a process of successive approximation. Skinner viewed every human operant as continuous and quantitative in nature. Ontogenetic change in the operant behavior of human beings would therefore be the result of shaping, and "if we are to account for many of its quantitative properties, the ultimately continuous nature of behavior must not be forgotten" (p. 93).

Just as the continuous, quantitative characters studied by biologists are ultimately underlain by multiple genes, the continuous, quantitative characters studied by behavior analysts are, according to Skinner (1953), ultimately underlain by what he calls the "elements" of behavior. These elements, rather than the observed features of responses, are the real units of selection, in the sense that when the environment selects *for* a certain type of behavior, what it actually selects are these elements. "[An element] is a sort of behavioral atom, which may never appear by itself upon any single occasion but is the essential ingredient or component of all observed instances. The reinforcement of a response increases the probability of all responses containing the same elements" (p. 94). These elements would be analogous to the alleles at multiple loci that underlie quantitative characters in phylogeny. Skinner relates this theoretical claim immediately to the analysis of verbal behavior, which supplies "an enormous number of verbal responses" that are "executed by the same musculature," and therefore "presumably composed of a fairly small number of identical elements" (p. 94). In his opinion, the grammarian mistakenly regards verbal behavior as composed of discrete units such as words, whereas "a rigorous analysis shows that the word is by no means the functional unit" (p. 94). For example, idioms and frequently used figures of speech consisting of entire sequences of words "may vary together under the control of a single variable" (p. 95). At the same time, however, we must recognize functional units as small as the separate speech sounds "in order to account for such distorted verbal responses as spoonerisms and certain verbal slips, as well as the stylistic devices of alliteration, assonance, rhyme, and rhythm" (p. 95). He acknowledges that "we lack adequate tools to deal with the continuity of behavior or with the interaction among operants attributable to common atomic units," but the operant, as exemplified experimentally by the pigeon's key peck or the rat's lever press, is nonetheless "a valid level of analysis" which "may be given a functional unity" (p. 95), and therefore may be subjected to experimental analysis of rate of response under conditions of intermittent reinforcement. This, of course, is the topic upon which he conducted his most influential research.

Skinner's analysis is remarkably theoretical.[6] The categories of operant behavior, he believes, are continuous. There may often be the *appearance* that an operant is qualitative, but that is an artifact of continuous responses that operate on the environment in a functionally unified way—e.g., to depress a lever or compress a key. Shaping of the continuous, quantitative features of behavior would therefore be the only way for selection to affect the ontogeny of behavior. All change in operant behavior would be the result of shaping, even presumably the maintenance

[6] The "elements" of behavior are a rare example of Skinner inferring the existence of hypothetical entities.

and extinction of rate of response of a functionally unified operant such as the lever press or key peck.

We have seen that Skinner candidly admits he is unable to explain many responses that appear to be qualitatively novel. He believes that the person who emits such a response is doing so because the elements of that response were strengthened in other functionally distinct situations. Skinner offers no way to identify these elements. He agrees that the novel response cannot be due to prior reinforcement of that type of response, because (by definition) it has not previously occurred in the subject's repertoire. Nonetheless, if all operant behavior is the result of the strengthening of "elements," then there must be an unknown way for the individual elements that have previously been selected to come together to form the novel response.

Skinner distinguishes between explanations and interpretations (Skinner, 1974, pp. 19-20). An explanation is an account within a controlled setting that permits confirmation that a given independent variable controls the dependent variable. An interpretation, on the other hand, is a form of scientifically guided speculation about behavior occurring outside a controlled setting but based upon one or more behavioral processes that have been confirmed in controlled settings. He has no explanation for the apparent novelty of much human behavior, but he does offer an *interpretation* of a how such novel responses might occur.

For example, Skinner (1953) considers the case of suicide. He begins with the plausible assumption that a typical case of suicide is a form of escape from a punishing consequence. "Obviously a man does not kill himself because he has previously escaped from an aversive situation by doing so." Therefore, suicide cannot be interpreted as a functional unity that is performed habitually. The only alternative would be that "the components of the behavior must have been strengthened separately" (p. 232). He considers the act of someone "who jumps into a brook to bring his life to an end" (p.223). Although suicide is a response that cannot be measured for its frequency, one can look at the components of the response that might previously have been strengthened. He suggests, for example, the "general behavior of throwing objects into water."

> It has a specifiable result: the objects disappear. This behavior is readily generalized; having thrown an old hat into the brook, we get rid of a pair of shoes in the same way. It is not impossible that throwing oneself into a brook may be merely a dramatic example of destroying oneself with the behavior which has destroyed other things (p. 223).

This act of suicide, then, would be what he elsewhere refers to as a case of "multiple causation." There would be a learned tendency to respond to aversive stimuli through escape. But now this learned tendency interacts with a learned tendency to make something disappear by throwing it into the brook. Skinner believes "it is not impossible" that this confluence of tendencies could produce the novel act of throwing oneself into the brook (p. 223).

Skinner's appeal to multiple causation unfortunately obscures the ability of selection to explain quantitatively novel responses. It makes it seem as if what explains novelty is only the fortuitous conjunction of two separate processes, neither of which by itself accounts for the novel event. A more revealing way to interpret his example, however, would be that different aspects of one event are explained by different factors (see Dretske, 1988, for a sophisticated account of this strategy of interpretation). For example: Why did the subject commit suicide? To escape an aversive stimulus. Why did he throw himself into the brook to commit suicide (rather than, say, swallow a capsule of cyanide)? Because he had learned to get rid of things by throwing them into the brook. There are thus two different explanations here. By separating them, we can gain a better understanding of the explanatory resources of selection.

A key feature of Skinner's concept of a typical operant is its "molarity"—by which I mean the way it supervenes upon a purely physiological or topographical description of behavior (Enc, 1995.) An operant such as a key peck or lever press cannot be defined by a sequence of muscle movements or by a topography of response. An operant can be performed by means of an indefinite number of sequences of "colorless movements" of body parts. An experimental analysis of the changing rate of such a response does not set out to explain why one sequence of such movements rather than another occurs. It concerns itself only with whatever sequences have the effect of closing the circuit—i.e., that "operate" on the environment in a certain way. This is also true of the "climbing and jumping" behavior that Skinner cites in illustrating the process of shaping a quantitative feature of behavior. How the animal climbs and jumps over a barrier of a specific height is not what shaping purports to explain. It explains only the animal's evolving effectiveness in surmounting barriers of increasing height.

Returning to the question of how the process of selection is able to account for a novel response, consider again the case of suicide. Skinner conjectures that operant selection of human behavior ultimately applies only to properties that are continuous and quantitative in nature. That is to say, operant selection always moves an aspect of responding along some continuum of possibilities. Assume, for purposes of interpretation, that it is possible for selection to move behavior along a continuum defined by the degree of self-harm. Although a subject's suicide can occur only once, less damaging acts of self-harm could have been differentially reinforced. The reproaches of others could, for example, have been withdrawn only when the degree of self-harm exceeded the level of self-harm that was previously reinforced. If withdrawal of the reproach of others functioned as negative reinforcement, then the withdrawal of reproach only when the current level of self-harm exceeds past levels would tend to lead to an increase in the probability of more damaging actions in the future. A series of such episodes might increase the degree of self-harm until it reached the ultimate level.[7] In brief, then, so long as what is

[7] Other variables could, of course, affect a tendency to harm oneself, including unanticipated effects of medications, genetic predispositions, and episodes of acute depression. One or more of these variables might thus contribute to the quantitative level of

novel about a response is quantitative, it is possible to provide a plausible interpretation of how it might have been the result of selection.

Novel behavior thus poses a conceptual challenge for selection by consequences only in the case of a truly qualitative response. This is where (as we have already seen) selection is at a pronounced disadvantage. And this is why examples of syntactically novel utterances offer what appear to be examples of the limitations of operant selection. They purport to be qualitatively discrete responses, and thus beyond the reach of shaping. With this type of response, the problem of the First Instance looms large.

Metaphysics

How does Skinner deal with this issue? His most direct treatment occurs in a long note, "The dependent variable" (Skinner, 1969, pp. 88-92), that he added to the republication of an article that originally appeared in the *Journal of the Experimental Analysis of Behavior* (see p. 309). In this note he writes, "An emphasis on topography of behavior at the expense of controlling relations is an example of the Formalistic Fallacy" (p. 89). Linguists and psycholinguists, he says, are prone to committing this fallacy. "By rearranging fragments of recorded verbal behavior (e.g., "words") new records (e.g., "sentences") are generated, which are then treated as though they were verbal responses" (p. 89). The fallacy is "most damaging when verbal behavior is analyzed as if it were generated through the application of rules. This is most likely to happen when verbal behavior is studied as a function of uncontrollable variables, since contingencies of reinforcement are not then available as an alternative to the generation of behavior from rules" (p. 90).

Although Skinner criticizes "linguists and psycholinguists" for choosing independent variables that cannot be controlled, the title of the note indicates that his fundamental objection is the choice of *dependent* variable. A formal (syntactic) property of behavior is qualitative. Words and sentences are discrete units. Their formal properties do not vary continuously in the manner of quantitative characters but are separated from other formal properties by discrete boundaries. True, these boundaries have a degree of vagueness or imprecision to them (as seemingly do all boundaries when analyzed with sufficient precision), but they delineate discrete properties in the same manner as the qualitative traits of biology. Selection for such qualitative properties will be unable to account for novel types of behavior. This is the problem of the First Instance, which we have already encountered in the natural selection of qualitative characters. Selection can alter the proportion of the population that has a given qualitative trait, but it cannot create a novel qualitative trait. The Formalistic Fallacy is thus a label for the choice of a dependent variable that is qualitative. Choosing to study such variables is associated with taking them to be "a function of uncontrollable variables," because "contingencies of reinforcement are not then available as an alternative" (p. 90).

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self-harm to which one is disposed. But the contribution of operant conditioning to the overall level would be by means of the shaping of a quantitative operant.

Skinner's argument moves in a tight circle. Formal units of behavior are unacceptable because the only option to account for them would be to appeal to variables that cannot be controlled. Although contingencies of reinforcement offer independent variables that can be controlled, they are not capable of accounting for novel qualitative properties of behavior. Therefore, the study of formal properties of behavior is a "fallacy."

What, however, is the implication for the phenomena studied by linguists and psycholinguists? Are they not real? Not capable of being explained scientifically? Not worthy of consideration? It is not easy to say what the problem with such phenomena is, except to say that they pose the problem of the First Instance in a manner that selection by consequences is incapable of solving.[8]

Skinner and the "formalist"—namely, Chomsky (1959)—disagree on several issues. Chomsky believes, for example, that our intuitions give us reliable data about the processes that underlie our linguistic abilities.[9] Skinner, on the other hand, does not believe an analysis of intuitions, or for that matter, of any form of evidence outside the physiologist's laboratory, could give us valid insights into the processes that underlie our abilities. This is an epistemological issue about which Chomsky and Skinner simply disagree. It is an issue, however, about which Skinner also disagrees with a wide variety of other psychologists, including fellow behaviorists such as John Staddon (2014) and Jack McDowell (2010)—both of whom think data outside the physiologist's laboratory can tell us something important about underlying processes.

This is not the issue Skinner is raising in his note about the dependent variable. He is making a metaphysical (as opposed to epistemological) point about

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[8] A complete treatment of the topic of novelty requires acknowledgement of a possibility that is appropriately consigned to a footnote. What if novelty itself is selected for? Doing so would then produce qualitatively novel responses that would otherwise never have occurred. Skinner, in fact, makes this point when he discusses the question of how to induce porpoises to produce novel responses (Skinner, 1969, pp.201-203). There is definitely an increase in novel responses when novelty is selected for. This phenomenon does not, however, address the issue at hand. Human behavior exhibits instances of qualitatively novel responses that are appropriate to the context. Selecting for novelty can increase the likelihood of novel responses, but it does not reliably produce responses that are appropriate to context. This problem does not exist in the case of phylogeny, where qualitatively novel traits do not show a pattern of being appropriate (adaptive) on first occurrence. They initially occur without reference to appropriateness and are then selected only if they enhance fitness. Unless one is willing to argue that qualitatively novel but appropriate human action is an illusion—that is, that such actions occur in the same "random" way observed in phylogeny—ontogeny faces a problem that phylogeny does not face.

[9] Chomsky would later deny that grammars imply anything about underlying processes. That was the point of introducing the distinction between competence and performance. But one cannot read the last section of Chomsky (1959) without seeing that, at this point in the development of his theory—and this is the point at which his influence on psychology was at its peak—he does indeed believe that grammars tell us something about the processes underlying "performance."

the categories that a science of behavior uses to describe the world. Some categories are not useful for purposes of arriving at broad scientific generalizations. As mentioned above, he cites the progress made in chemistry once it began to focus upon weight. The most profound issue he has with cognitive science is about the dimensions along which broad generalizations exist. A behavior analysis draws its generalizations along different dimensions than does a cognitive analysis.

To use a philosophical term introduced by Nelson Goodman (1955), the "Formalistic Fallacy" is the assumption that qualitatively defined categories of response are "projectable predicates"—i.e., predicates for stating valid scientific generalizations. Or to put the same point in virtually equivalent terms, it is the assumption that qualitative response categories are "natural kinds," i.e., the categories of nature about which broad causal regularities exist (Quine, 1969). Or to make the point in yet a third way, it is the assumption that "the natural lines of fracture along which behavior and environment actually break" are qualitative (Skinner, 1972, p. 458). The issue is, what are the categories that define the causal relations of nature? Like any scientist, Skinner assumes there are such categories. He knows already in the 1930s that he has found some of them. He harbors doubts about the qualitative categories of cognitive science. He tries to justify his doubts in many ways. Ultimately, however, the issue can only be resolved empirically. The right metaphysics should make it possible to discover broad empirical generalizations, because it provides the "projectible predicates" or "natural kinds" that correspond to "the natural lines of fracture along which behavior and environment actually break."

Cognitive science is based on a different metaphysics than behavior analysis. All of its basic categories are qualitative or discrete. It presupposes a totally different set of allegedly projectible predicates or natural kinds. There is no proof that the study of such qualitative properties is a "fallacy." The only demonstration that a given set of categories is projectible is the long-term success or failure of the program of research that studies them.

Conclusion

The point of Skinner's emphasis on selection by consequences was to show how it is possible to account for adaptation, novelty, and creativity without referring to mental processes such as rules, representations, inferences, etc. This effort succeeds when applied to quantitatively defined aspects of operant responses. With these, selection by consequences can explain even the first instance of a novel response.

Skinner thought that qualitative aspects of behavior do not offer a basis for stating the broad generalizations that science seeks. Cognitive science specializes in focusing on this type of category. The act of focusing upon such categories is what Skinner called the "Formalistic Fallacy." It would, he thought, lead in the long run to nothing productive, whereas he knew the categories studied by behavior analysis had already resulted in a program of research that had found genuine causal relationships.

This is where things stand. There is tension between two ways of analyzing behavior. This tension exists on many fronts. The current essay explores only one of them—namely, the problem of accounting for novel behavior. This tension between rival metaphysical systems has been the condition of psychology for well over half-a-century. Perhaps some currently unavailable insight will show how to synthesize the two. Until it is found (if it is found), psychology is destined to live with this tension.

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