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The roles of the analogy with natural selection in B.F. Skinner's philosophy

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ABSTRACT

Beginning in the 1950s, B.F. Skinner made increasing reference to an analogy between operant conditioning and natural selection. This analogy is the basis of an argument that, in contrast to Skinner's other critiques of cognitive science, is neither epistemological nor pragmatic. Instead, it is based on the claim that ontogenetic adaptation is due to a special mode of causation he called "selection by consequences." He argued that this mode of causation conflicts with explanations that attribute action to an autonomous agent with reasons for acting. This argument dismisses ordinary explanations of action, and has implications not only for cognitive science but also for morals. Skinner cited the latter implications to counter objections to the application of behavior analysis to the reform of society and its institutions.

Skinner's critique, however, rests upon empirical assumptions that have been criticized by other behavior analysts. Although for Skinner the major role of the analogy was to propose an empirical thesis, it also can play a metaphysical role—namely, to demonstrate the possibility of ontogenetic adaptation without reference to agents who have reasons for acting. These two roles, empirical and metaphysical, are the mirror image of the empirical and metaphysical roles of the computer analogy for cognitive science. That analogy also can be (and has been) interpreted as an empirical thesis. Its empirical implications, however, have been difficult to confirm. It also, however, has played a metaphysical role—namely, to demonstrate the possibility that a physical process could perform logical operations on states having propositional content. Neither analogy provides a well-confirmed, general answer to the question of how to explain the process of ontogenetic adaptation. But together they show there are two metaphysically coherent, but conflicting, answers to this question. Depending upon one's epistemology, the analogy with natural selection may provide a useful point of departure for a strategy of research. Such a pragmatic grounding for a research strategy does not, however, provide sufficient reason to abandon for purposes of ethics the concept of persons as autonomous agents.

1. Introduction

B.F. Skinner showed how to conduct an experimental analysis of learned behavior. The experimental analysis of behavior (EAB) has proved to be successful, resulting in a progressively expanding body of established fact. In his philosophical publications, Skinner sometimes applied these facts to the interpretation of behavior, thereby offering innovative arguments that drew upon the success of EAB. In his first major philosophical article (Skinner, 1945), he focused on subjective phenomena such as the experience of pain, and offered an interpretation of verbal behavior 'about' them. One of the established facts of EAB is that when a stimulus reliably signals that an operant is correlated with the occurrence of a subsequent reinforcing stimulus, the stimulus comes to exert control over responding in the sense that the probability of emission of a response increases in the presence of the stimulus. Skinner interprets this fact as applying to ordinary verbal behavior, which he describes as behavior under a special kind of stimulus control. Noting that subjective phenomena correlate imperfectly with the objective phenomena to which the verbal community would have access, he argues that the community is unable to bring verbal behavior 'about' the former under the same degree of stimulus control as achieved with the latter. Such verbal behavior is subject to error and imprecision in a way that other verbal behavior is not.

This was a novel and influential defense of behaviorism's traditional distrust of introspection. It rests upon the results of EAB, but "goes beyond the established facts" in the sense that it moves from the simple controlled setting of the laboratory to the complex uncontrolled setting of ordinary verbal behavior (Skinner, 1974, p. 19). This critique addressed a specific type of inside story—namely, introspective examination of consciousness. Skinner acknowledges the reality of these subjective phenomena (identifying them with physiological states), but argues that our verbal behavior about them constitutes an unreliable basis for scientific analysis.

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1.1. Qualia versus reasons

This argument targets mental states that philosophers call *qualia*. It therefore does not directly address a quite different type of mental state that has been of greater interest to contemporary philosophy of mind. Davidson's (1963) seminal article, "Actions, Reasons, and Causes," was a significant reason for this interest. Davidson takes as his point of departure the ordinary assumption that an agent's reason for performing an action can function as an explanation of that action. He argues that in order for a reason to do so it must be a cause. He then asserts that one's reason is able to be a cause only if it is identical with a physical state and he makes the innovative proposal that the form of identity in question is not between a type of physical state and a type of mental state, but is a special kind of identity that he calls "supervenience."

The details of his argument are not germane to current purposes, which are simply to say that a great deal of subsequent philosophy of mind consisted of a thread of proposals, counter-proposals, criticisms, and responses that can be traced back to this article.[1] Skinner's (1945) article also had lasting influence, but it does not appear to join issue with the questions that Davidson raised almost two decades later. The first was about *qualia,* whereas Davidson (1963) was about reasons.

One's *qualia* may provide evidence of one's reasons, but the distinctive feature of reasons is their propositional content. Suppose, for example, I currently desire that there be adequate light for reading at my desk and I believe that toggling the switch at the base of my lamp will supply adequate light. So I toggle the switch. According to Davidson, this combination of desire and belief explains why I toggled the switch only if it was my reason for toggling the switch and my reason for toggling the switch was the cause of my doing so. The propositional content expressed by the two subordinate clauses beginning with the word "that" are the mark of what the philosopher Franz Brentano (1838–1917) called "intentionality," which in this usage is a technical philosophical term. Intentionality characterizes the kind of mental state that can provide a reason for action.

Skinner (1945) did not purport to join issue with the question of whether reasons can function as causes. Indeed, as he makes clear in subsequent commentary, he was specifically addressing the tradition of introspective psychology. His argument therefore has no obvious relevance to the issue of reasons as causes of actions, nor is there anything to indicate Skinner intended it to do so.

1.2. Epistemological arguments versus pragmatic arguments

Skinner (1945) has an epistemological basis, thereby distinguishing it from a quite different type of philosophical argument Skinner frequently makes. This second type of argument relies upon means/ends reasoning and therefore can be classified as pragmatic. One version, for example, embraces the goal of helping people change their behavior. To achieve this goal, it is necessary to identify causes that can be controlled. EAB provides the type of knowledge required to do this by identifying causal relationships between environmental variables and behavior. Skinner argues that by targeting this kind of knowledge, and never getting distracted by "the inside story," EAB arrives at this goal faster than alternative approaches. Another version targets the goal of connecting the study of behavior with physiological analysis. Skinner argues that the type of knowledge attained through EAB will be more useful to physiology than the form of knowledge offered by cognitive psychology.

The details vary, but these arguments share a common philosophical grounding and a common purpose. They provide a justification for pursuing EAB as a better means than any available alternative to important ends. These arguments conclude that we ought to devote our energy and resources to behavior analysis, but they do not entail the falsity of the alternatives.

Skinner (1950) is a sophisticated version of this type of argument. Here the goal is a causal analysis of learned behavior. He acknowledges the existence of a causal gap between environmental cause and behavioral effect. Clearly, there are processes inside the organism that fill this gap. But he notes that unless there is a break in the causal chain that produces learned behavior, it must eventually trace back to the environment. Therefore, it should be possible to reach the goal of a causal analysis by skipping the intermediate links in the chain and searching for regularities linking environmental variables to behavior. He calls this "the direct route," thereby implying that it is a faster route to one's goal. This argument also forges an obvious connection to the claim that EAB provides the most useful target for physiology, inasmuch as EAB identifies the starting point and the ending point of a complete physiological analysis of learning.

1.3. The analogy with natural selection

The preceding arguments contrast with the one to which the present article is devoted. This argument specifically targets mental causation by an autonomous agent's reasons; the preceding arguments do not. The preceding arguments are either epistemological or pragmatic; this argument is neither. Based upon an extensive analogy between operant conditioning and natural selection, it draws a conclusion about a special mode of causation that Skinner asserts is incompatible with reasons as causes.[2]

2. Drawing the analogy

Skinner (1953) is the first publication in which he notes an analogy between operant conditioning and natural selection. He writes, "In both operant conditioning and the evolutionary selection of behavioral characteristics, consequences alter future probability. … Both processes raise the question of purpose for the same reason, and in both the appeal to a final cause may be rejected in the same way" (p. 90). He later returns to this theme: "We have seen that in certain respects operant reinforcement resembles the natural selection of evolutionary theory. Just as genetic characteristics which arise as mutations are selected or discarded by their consequences, so novel forms of behavior are selected or discarded through reinforcement" (p. 430).

This analogy with natural selection draws upon the established fact that reinforcement 'selects' behavior in the sense of causing it to recur. Skinner would emphasize this in his responses to comments on his canonical papers republished in *Behavioral and Brain Sciences* (Catania and Harnad, 1984): "Selection is not a metaphor, model, or concept; it is a fact. Arrange a particular kind of consequence, and behavior changes. Introduce new consequences, and new behavior will appear and survive or disappear" (p. 503; subsequent citations designated as "BBS"). Or elsewhere: "Could anything be more factual than the effect of reinforcement, either in a single instance or when scheduled? What is hypothetical about it? What needs to be modeled? The Law of Effect states a fact not a hypothesis. Consequences affect behavior" (BBS, p. 718).

His favorite example to explain the analogy is the shaping of a new operant. Skinner (1975) gives an especially clear account of shaping and its parallels to natural selection. First, he describes shaping: "In a

[1] Kim (2005) analyzes four decades of work on Davidson's suggestion.

[2] A comprehensive list of Skinner's philosophical arguments would also include his attempts to show that our use of mental concepts can be given behavioral "translations." Philosophers often misinterpret these attempts as asserting a logical or analytical thesis about how to define mental concepts as behavioral dispositions. If anything resembling a consensus can be said to exist in philosophy, it is that doing so is impossible. It would slow down the narrative of this article to explain why (although see Smith, 1994, pp. 89-97), or to sort through the intricacies of what Skinner actually means by his "translations." Fortunately, these issues are irrelevant to the matters addressed here.

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).

He then compares this to the process by which natural selection can shape behavior in the course of phylogeny. He cites an article by Wolfson (1948), who argued that the gradual drift of North America from Europe explains the fact that the North American population of Arctic tern flies east to Europe before turning south to continue its annual migration to Antarctica. As Skinner summarizes the argument, "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" (p. 119).

2.1. Selection by consequences as a mode of causation

Selection by consequences, Skinner says, is a special mode of causation that accounts for a specific type of phenomenon. In his Author's Response to R.C. Bolles, he writes: "As an explanatory mode, selection is responsible only for novelty, for origins" (BBS, p. 503). In response to H.C. Plotkin & F.J. Odling-Smee he asserts: "Selection is a causal mode only in the sense of causing novelty—whether in the *origin* of species, the *shaping* of new operants, or the *invention* of cultural practices" (BBS, p. 506, italics in original).

He is not denying that contingencies also *maintain* patterns of responding. Elsewhere he notes, "Contingencies work to maintain as well as to produce" (BBS, p. 707). What he means is that selection's distinctive role is to cause novelty or origins. "Once a given structure has been selected by natural selection and once a bit of behavior has been shaped by operant reinforcement, selection as a causal mode has done its work and a mechanical model may suffice. A survey of the current state of the organism—the responses in its repertoire, the relevant reinforcing consequences, the controlling stimuli—need not involve selection at all. Nor will the neurological account of how these variables are interrelated. Only if these structures are still changing will selection need to be considered as a causal mode" (BBS, p. 503). Thus, there might be more than one valid causal account of behavior that has reached evolutionary stasis, but there is only one causal account of the evolution of novelty: selection by consequences.

2.2. Selection as a critique of reasons as causes

By 1984, this analogy had become the basis for Skinner's critique of the type of causation that interested Davidson. This shift is most clearly indicated in Skinner's response to J.D. Ringen's (BBS, pp. 567–568) provocative summary of Skinner (1945). Ringen says Skinner "rejects the use of the 'intentional idiom' in scientific descriptions and explanations of verbal behavior," which implies that "explanatory reference to meanings, intentions, or psychological states of the speaker is prohibited." What Ringen here suggests is that Skinner's epistemological argument against introspection could be extended beyond *qualia* to the "intentional idiom," and thereby to the practice of citing reasons as causes of actions. He thus proposes there is a way to reinterpret the argument of Skinner (1945) so it would join issue with the concerns of Davidson (1963).

Skinner acknowledges Ringen's "excellent summary of my position" and says that when he wrote the target article he would have had little to add to it, "but I would put it rather differently today. The explanatory terms which have been used for more than 2000 years to explain human behavior are troublesome not because they raise questions about dimensions but because they assign the initiation of behavior to the person rather than to that person's genetic and personal history. … What causes trouble is the usurpation of the initiating role of the environment" (BBS, pp. 577–578). He makes a similar claim in his response to W. Timberlake: "What is wrong with cognitive science is not dualism but the internalization of initiating causes which lie in the environment and should remain there" (BBS, p. 508).

Only selection by consequences causes the rat eventually to clear a barrier it would not otherwise have cleared, or the Arctic tern eventually to undertake an eastward trip across the Atlantic Ocean that it would not otherwise have undertaken. Once this process of change comes to an end, various proximate causes may be adequate to explain subsequent instances of the behavior (although "contingencies work to maintain" it). Selection by consequences has no rival, however, as the causal mode that explains novelty or origins.

2.3. Selection and the process of adaptation

Although Skinner sometimes uses terms such as "novelty" or "origins" to describe what selection by consequences explains, a biologist would use the term "adaptation." Here is Skinner comparing the effect of ontogenetic and phylogenetic contingencies on behavior: "Both kinds of contingencies change the organism so that it adjusts to its environment in the sense of behaving in it more effectively. With respect to phylogenic contingencies, this is what is meant by natural selection. With respect to ontogeny, it is what is meant by operant conditioning. Successful responses are selected in both cases, and the result is adaptation" (BBS, p. 676). One can thus paraphrase Skinner's point as follows: there is a tight fit between the process of adaptation and the causal mode of selection by consequences. This tight fit holds wherever adaptation occurs, whether in ontogeny or phylogeny.

3. Natural selection as an explanation of evolutionary adaptation

Adaptation is a process of evolutionary change that alters features in a manner that makes them more effective in achieving a given consequence. The altered features are then referred to as "adaptations." One can know that a feature is the result of a process of adaptation without having a causal account of the process of adaptation itself. When Darwin collected specimens of the small birds he found on the Galapagos Islands, he noticed they had different features on different islands and that these features were adaptive for the distinctive conditions of each island. He already knew that the Galapagos Islands had been formed by volcanic eruptions. At their origin, they would have been devoid of plants and animals, whereas the South American mainland nearby would by then have had a complex aviary. Any island birds would have been the result of colonization from the South American continent. But the birds he collected were distinct from the birds of the mainland. They had adaptive features that their South American relatives did not. He reasoned that once the ancestors of these birds arrived on the islands, their descendants must have adapted to the different conditions on the different islands. This is to say, their current adaptive features must be adaptations.

At this point, Darwin did not yet have a theory to account for adaptation, but he had evidence the features were adaptations. The unusual circumstances of the formation of the Galapagos Islands allowed him to establish this as fact. This was the first step toward his theory of evolution. It won wide assent. What was controversial was his attempt to account for adaptation on the basis of natural selection (Ruse, 1979, pp. 160–201).

4. Operant conditioning as an explanation of ontogenetic adaptation

The adaptation of operant behavior to its reinforcing consequences is an established fact. As Skinner notes, just change the consequences of behavior and the behavior changes. Change the consequences again and the behavior changes again. This is not controversial. But to assert that selection by consequences is the cause of ontogenetic adaptation goes beyond this established fact and requires additional assumptions. Some of Skinner's BBS commentators call attention to the need for these additional assumptions. Their comments fall under two headings: assumptions about variation and assumptions about selection.

4.1. Assumptions about variation

Assumptions about variation affect the ability of selection by consequences to explain the process of adaptation. Skinner acknowledges making such assumptions. He writes, "The entire repertoire of an individual or species must exist prior to ontogenic or phylogenic selection but only in the form of minimal units. Both phylogenic and ontogenic contingencies 'shape' complex forms of behavior from relatively undifferentiated material. Both processes are favored if the organism shows an extensive, undifferentiated repertoire" (BBS, p. 670).

J.E.R. Staddon's criticism of Skinner's account focuses upon these assumptions: "The essence of Darwin's theory is of course not selection alone, but the interplay between selection and (heritable) variation. The major flaw in Skinner's approach is that he unnecessarily plays down the role of (behavioral) variation" (BBS, p. 697, parentheses in original). Staddon summarizes his criticism this way: "My major quarrel with Skinner is that he seems not to acknowledge that *selection* and *variation* are complementary concepts, whether used to explain ontogeny or phylogeny. Neither is adequate by itself. Because he relegates variation to the production of 'undifferentiated material' or 'minimal units' he seems to feel it necessary to give all explanatory weight to selection" (BBS, p. 698; italics in original).

We have seen above that Skinner does indeed think variation comes in minimal, undifferentiated units. He does not seem, however, to be dogmatic about this opinion. R. Dawkins, for example, discusses the "displacement activities" studied by ethologists. These occur when an animal is "frustrated," "thwarted," or "in conflict." It then sometimes will "perform an irrelevant act, scratch its head, say, or preen its wing" (BBS, p. 487). Dawkins suggests that displacement activities may be to the level of ontogeny what mutations are to the level of phylogeny. Skinner thanks Dawkins "for his refreshingly helpful commentary." He says his "only trouble with Dawkins's suggestion is that displacement activities tend to be stereotyped, but—who knows?—mutations may be, too" (BBS, p. 504). This reply not only affirms Skinner's inclination to believe that variation comes in undifferentiated, minimal units, but also displays his willingness to consider other possibilities.

4.2. An assumption about what is selected

A different assumption has to do with what is selected. Skinner writes that the causal mode of selection by consequences is made possible by a process of "replication with error" (BBS, p. 479). Dawkins attempts to draw out an implication of this assumption for the ontogenetic evolution of behavior. "I believe it is important to be even clearer than Skinner and Lorenz were about *exactly what* the entities being selected are, and exactly how they are to be distinguished from their consequences. The entities that are selected, at whatever level, must be 'replicators,' entities capable of forming lineages of duplicates of themselves in some medium." In the case of biological evolution, "the replicators are genes, and the consequences by which they are selected are their phenotypic effects, that is, mostly their effects on the embryonic development of the bodies in which they act" (BBS, p. 486; italics in original). He then suggests what for Skinner would be the parallel entities at the level of ontogenetic evolution: "The replicators are habits in the animal's repertoire, originally spontaneously produced (the equivalent of mutation). The consequences are reinforcement, positive or negative. The habits can be seen as replicators because their frequency of emergence from the animal's motor system increases, or decreases, as a result of their reinforcement consequences" (BBS, p. 486). He continues to explain the distinction between what gets selected and what are the consequences doing the selecting: "The important point is that the distinction between 'that which is selected' (the gene) and 'the consequences by which it is selected' (phenotypic effects) is stark and clear, and is made particularly so by the central dogma: There are causal arrows leading from genes to phenotypes but *not* the other way around (the other way around would constitute the well-known Lamarckian heresy). I would like to know whether the equivalent of the central dogma holds at Skinner's other levels"—i.e., at the levels of ontogenetic and cultural evolution (BBS, p. 486; italics in original).

Skinner replies, "There is clearly a question about what exactly is being selected and what are the selecting consequences," but he discusses this question only in relation to cultural evolution (BBS, p. 504). He unfortunately does not answer Dawkins's trenchant question about whether the "central dogma" of biology's Modern Synthesis has a parallel in operant conditioning. We are left to wonder why. We get a hint elsewhere when he writes: "I have said that a science of behavior stands in about the position of genetic theory prior to the discovery of the role of DNA". The facts in an experimental analysis of behavior correspond to the relations among the traits of successive generations, where the major operation is breeding and cross-breeding. T.H. Morgan and others could add additional information about chromosomes and to some extent group traits accordingly. That information might be said to correspond to established neurological facts, such as end organs, effectors, and the gross anatomy of the brain insofar as its relations with the facts of behavior have been established. We are waiting, of course, for the discovery of the equivalent of DNA. The mentalistic, neurological, and conceptual theories I criticized are concerned with supposed DNA equivalents" (BBS, pp. 541–542).

Skinner may thus have taken Dawkins to be asking a question that no one would be able to answer until the equivalent of the discovery of DNA is made for ontogenetic evolution. If that was the reason for his reticence, however, his reticence was misplaced. Dawkins went out of his way to make it clear he does not expect an analysis of ontogenetic replication analogous to that offered by DNA. Instead, he did his best to honor Skinner's approach by defining the replicator for learning as a 'habit.' He concedes that doing so "makes the whole application of the Darwinian analogy at this level difficult" (BBS, p. 486), but he is trying to draw out the implications of Skinner's analysis without making assumptions Skinner does not embrace. Hence, Dawkins speaks of habits, and not of whatever unknown structure or process might underlie them. A habit is a repetitive pattern of behavior. If what is selected by consequences are habits, then future behavior should repeat past behavior, except perhaps with a certain amount of error. A habit would be the behavioral equivalent of a biological trait—i.e., of a feature that is heritable.

Dawkins's suggestion could be applied to the example of a rat being shaped to jump over a barrier, using his distinction between "that which is selected" and "the consequences by which it is selected." The shaping would start with the barrier at a level the rat could easily clear. Its repertoire would consist of a variety of climbing and jumping habits that are sufficient to clear the barrier. That which is selected would be those habits sufficient to clear the barrier. The consequence by which they are selected would be access to food on the other side of the barrier. As the height of the barrier gradually increases, some of the habits in the rat's current repertoire would no longer enable the rat to clear it, so they would no longer have the consequence of gaining access to food and therefore would no longer be selected. At the same time, as a result of replication with error, new habits would emerge that do clear

the barrier and therefore have the consequence of leading to access to food and therefore are selected. Hence, there would be adaptation of the repertoire of habits to the changing contingencies of reinforcement.

Habits are not the type of entity Skinner would normally endorse, but Dawkins is suggesting that some kind of automatically reproducible behavior must exist if selection is to explain the ontogenetic adaptation of behavior. 'Habits,' in this sense, would be the analogues of heritable biological traits, which would be consistent with Skinner's statement that "the facts in an experimental analysis of behavior correspond to the relations among the traits of successive generations." The successful shaping of the rat's climbing and jumping behavior offers evidence of the existence of such habits, at least for the climbing/jumping behavior of this species.

The 'central dogma' of the Modern Synthesis is the thesis that the causal arrow moves from genotype to phenotype but not from phenotype to genotype. This rules out the Lamarckian thesis that features acquired during the lifetime of the organism can alter the 'germ line' that gets passed on to its offspring. Dawkins is suggesting that Skinner makes a similar assumption about the relation between habit and environment. An individual habit would (by analogy with the central dogma) not be altered by environmental feedback. Thus only selection *among* habits on the basis of their changing environmental consequences could lead to ontogenetic adaptation.

Skinner sometimes speaks of the "transmission" of something during the course of any form of evolutionary change. He speaks unselfconsciously of transmission of biological traits and cultural practices, but we find him placing scare quotes around this term when he applies it to operant behavior: "Traits in a species and practices in a culture are transmitted from generation to generation, but reinforced behavior is 'transmitted' only in the sense of remaining part of the repertoire of the individual" (BBS, p. 479). The scare quotes are presumably another way of acknowledging that we do not have an understanding of the physiological process underlying the repetition of reinforced behavior. But Dawkins has suggested there is no need to understand the underlying process in order to articulate the key issue about transmission. What selection accomplishes must be only to cause a habit to remain in the individual's repertoire. The habit itself must not change, except through error.

5. Selection by consequences and the process of adaptation

The preceding assumptions about variation and selection, whether at the level of phylogeny or ontogeny, would be sufficient to explain the process of adaptation. To see why, start with the premise that selection's immediate effect is only at the level of a population of individuals. Take a non-evolutionary example. Suppose all members of a certain basketball team are tall. How might we explain that? There are two quite different types of explanation (Sober, 1984, pp. 147–155). The first assumes that basketball players vary in height. If the coach then selects only tall players for the team, selection explains why all members of the team are tall. It would not, however, explain why any individual player is tall. On the other hand, a different type of explanation would be invoked if the coach arranged illegally for each player to receive growth hormone treatments. The result would be that they all become tall. This is a developmental explanation. It accounts for both a property of the population (why all members of the team are tall) and a property of the individuals making up the population (why each player is tall). As Sober (pp. 147–149) notes, Lamarck's theory explained evolution in the second way, Darwin's in the first.

But in the basketball example, selection explains only a property of the population. If selection's explanatory reach ended here, it would not be capable of explaining the adaptations possessed by individuals. But natural selection purports to do so. Its ability to do this is the basis of Skinner's claim it exemplifies a unique mode of causation. How does selection by consequences at the population level explain the adaptations of individuals?

It does so with the assistance of the assumptions noted above. Consider the Arctic tern example. Assume reproduction transmits traits from one generation to another with only small, undifferentiated random errors (mutations). The errors of transmission will ensure that the population is variable in its traits. If the continents are slowly drifting apart, however, terns that have the trait of making a slightly longer eastward journey will be selected over those that do not. The composition of the population will now change. The percentage of terns inclined to make a slightly longer journey eastward will increase. Errors of transmission will now occur in a population of terns with an increased percentage of individuals disposed toward a slightly longer eastward migration. This population is therefore more likely than was the preselected population to produce errors of transmission that cause an individual to have the trait of taking an even longer eastward journey. This is how selection by consequence causes individuals in a population to have adaptations.

The assumptions supporting Skinner's claim that selection by consequences explains ontogenetic adaptation consist in the transposition of these assumptions about natural selection to the analogous process of operant conditioning. If learned behavior evolves in the course of an organism's lifetime by analogy with evolution by natural selection, then selection by consequences explains adaptive change.

Skinner aims this conclusion at traditional explanations of behavior. He writes, "What is wrong with cognitive science is not dualism but the internalization of the initiating causes which lie in the environment and should remain there" (BBS, p. 508). Or elsewhere, "The crucial issue in behaviorism was not dualism, it was origin" (BBS, p. 608). Or again, "Radical behaviorism attacks and rejects traditional explanations of behavior in terms of internal initiating causes" (BBS, p. 721).

Thus the concept of agency is the target of Skinner's critique. He takes agency to imply the ability to initiate change, but the analogy with natural selection locates the initiation of change in the environment. He thus joins the debate at an unusual juncture. He would agree with Davidson's presupposition that the physical world is the only world, and therefore that all causation of behavior must ultimately be a case of physical events or processes causing other physical events or processes. Reasons could therefore function as causes only if they were identical with physical events or processes. How that might be possible is for Davidson the central question about reasons. Skinner does not enter into that discussion. He is not interested in the metaphysical status of reasons, but in the powers of agents. The agent, he asserts, cannot initiate behavioral change. Only the environment can. This is the critique of cognitive science upon which Skinner places the greatest weight at the end of his career.

6. The moral implications of Skinner's position

This critique is closely related to a moral objection sometimes raised to Skinner's philosophy. R. Harré, for example, expresses "the moral consternation that many people find accompanies their reading of the Skinnerian corpus. In some way, we feel, human life is being devalued and human beings degraded" (BBS, p. 595). The preceding analysis helps us identify the source of this "consternation."

Moral philosophy identifies two mutually exclusive ways to distinguish right from wrong. On the one hand, the distinction can be defined on the basis of good and bad consequences ("consequentialism"). Right actions produce good consequences; wrong actions produce bad consequences. On the other hand, the distinction can be defined on the basis of an agent's reason for performing an action ("non-consequentialism" or "deontology"). If the agent's reason for the action is good, then the action is morally right even if the consequences are bad. If the agent's reason for the action is bad, then the action is morally wrong even if the consequences are good. Jeremy Bentham (1748–1832) took the first approach. According to his utilitarian principle, right actions produce the greatest happiness of the greatest number. Immanuel Kant (1724–1804) took the second approach. His

categorical imperative directs us to act on the basis of reasons ('maxims') we could consistently will to be universally adopted.

Skinner's critique of the power of agents contradicts the presuppositions of this second approach to ethics. The issue is not determinism. The issue is what type of causes account for a person's behavior. Philosophers like Kant see moral value only in actions done for the right reasons. This is especially dramatic in the case of agents who undergo moral transformation, perhaps after an especially poignant experience. Although the experience leads to the transformation, and in this sense the transformation has an environmental cause, deontological ethics presupposes this experience would not have the power to change the agent's behavior if not for the intentional states and processes of the agent. The experience provides the occasion for change, but intentional states and processes determine the effect of the experience. If these intentional states do not explain the changed behavior, then even if the subsequent actions have good consequences, they have no moral value. This is why "reading of the Skinnerian corpus" leads some people to feel that "human life is being devalued and human beings degraded." For them, Skinner's philosophy drains human action of its moral value.[3]

There is no such implication, however, for consequentialists. They applaud any action that relieves suffering and promotes fulfillment. Skinner himself is a consequentialist, so he has no sympathy for objections to his philosophy based on the feeling that it devalues and degrades human life. Instead, he sees such objections as obstacles to moral progress—i.e., as interfering with the reduction of suffering and the promotion of fulfillment (Skinner, 1971). As he says, "Harré is quite right that I am a moralist" (BBS, p. 608). What sets him apart as a moralist is not however his consequentialism (which he shares with many other moralists), but his critique of deontology as based on a false presupposition about the causes of behavior.

6.1. Environmental control

This critique of reasons as causes is not the same as the claim that the environment controls learned behavior. After completing a series of experiments with schedules of reinforcement that began in 1950 and continued almost without interruption until 1955, Ferster and Skinner (1957) stated, "The primary purpose of the present book is to present a series of experiments designed to evaluate the extent to which the organism's own behavior enters into the determination of its subsequent behavior" (p. 3). They boast, "From a formulation of such results we should be able to predict the effect of any schedule." But they think this is "possibly the least important" result of their work. What is of greater importance is this: "The experimental analysis of schedules now permits the experimenter to achieve a degree of control over the organism which is of an entirely new order" (Ferster and Skinner, 1957).

Mere control over behavior, however, does not have the sweeping implications Skinner attributes to selection by consequences. There is no logical contradiction between Davidson's assumption that reasons can function as causes and Skinner's discovery that schedules of reinforcement can control operant behavior. Davidson, like Skinner, rejects any break in the chain of physical causation. He presupposes that agents and their reasons are part of this chain and therefore that no agent can perform an act that is uncaused.

For Davidson and his allies in cognitive science, environmental control of behavior is a plausible scenario of causation, especially if the behavior is learned. If learning requires experience and experience requires interaction with the environment, then one would expect the causal chain accounting for action to link it to the environment. This is the argument of Skinner (1950). A physicalist such as Davidson can acknowledge the cogency of this argument. The question of reasons as causes is the question of *how* the environment controls behavior. Do reasons play an essential role in connecting environmental cause with behavioral effect? If a subject wants food and believes operating a lever will deliver it, then the cognitive scientist is not surprised that one can control its behavior by imposing various contingencies upon the relation between lever pressing and food delivery. EAB's protocols require the experimental subject to be maintained at 80% of free feeding weight (thus ensuring it wants food), and to be habituated to the operation of the food dispenser (thus eliminating fear). The animal then has the experience of a correlation between operating the lever and the delivery of food (thus learning that the first leads to the second). The effects studied by EAB can thus be interpreted as the result of inducing the organism to have certain reasons for acting. The thesis that the environment controls such behavior is consistent with such explanations.

6.2. Initiating causes

Skinner's BBS formulation, however, is based on the concept of initiating causes. He writes, "We tend to regard ourselves as initiating agents only because we know or remember so little about our genetic and environmental histories" (BBS, p. 480). When we conduct an experimental analysis of learned behavior, he says, we can see its provenance. "The experimenter sees what is going on in an experimental space much more clearly than the casual observer because he has additional information about the history of the organism—its deprivational state, its history of reinforcement, possibly something about its genetics, and so on. To understand behavior, one must know the history of the organism as well as the present 'structure' of the behavior" (BBS, p. 574).

Stating the critique of agent causation in terms of initiating causes, however, fares no better than stating it in terms of environmental control. One cause leads to another and it is arbitrary, or perhaps a matter of one's interests or goals, whether a certain cause is chosen to be "the" initiating cause of an effect. One cause is more distal than other, or occurs earlier in a chain of causes than another, but (quantum effects aside) every more immediate, more proximate cause is the effect of some earlier, more distal, cause. It is not possible to identify a non-arbitrary link in this chain of causation at which to describe a cause as *the* initiating cause of something. There may be pragmatic reasons to prefer the causal variables studied by EAB. They are easier to manipulate and therefore useful when we want to change behavior; we make rapid progress in our understanding of behavior if we focus upon them; they capture generalizations that give physiologists their assignment; and so on. But there is no non-pragmatic reason for choosing one of these causes as *the* cause.

Furthermore, the thesis that selection by consequences is the initiating cause of ontogenetic adaptation is subject to the same objection as the argument from control. The cognitive scientist could accept Skinner's assertion that the environment is the initiating cause of adaptation, but then add that the explanation of the environment's ability to initiate adaptation must refer to the intentional states of the agent. So there is no contradiction between the environment being the initiating cause and the agent's reasons being part of the explanation of how the environment does so.

Davidson's project is to show how reasons can be part of the explanation of behavior even though we know that organisms are material systems. F. Dretske (1988) is an interesting example of someone who works on Davidson's project, yet makes extensive use of the results of behavioral research. Citing A.C. Catania, D. Premack, H. Rachlin, and J.E.R. Staddon, he incorporates their observations into his analysis. To acknowledge the initiating role of the environment as part of the explanation of intentional action, he speaks of the "triggering cause" of an action. The agent's reasons, by contrast, are a specific type of "structuring cause." For example, the queen's entrance is the triggering cause

[3] In this section, I speak as if individuals are consistent deontologists or consequentialists. But as Double (2006) persuasively argues, a close analysis of our moral judgments reveals that we are inconsistent in our basic moral commitments. We are sometimes consequentialists and sometimes deontologists, but never always one or the other.

of Clyde's standing up, but his respect for her is the structuring cause (p. 43). This distinction between triggering and structuring cause is part of an analysis of behavior that (as the book's subtitle says) examines the role of "reasons in a world of causes." This analysis goes well beyond my current purpose, which is just to note that the concept of an environmental initiating cause does not eliminate the possibility that reasons are an indispensible part of an explanation. The crucial issue is not what initiates a behavioral effect, but how the initiating cause comes to have that effect.

Skinner could reply that Dretske examines only a 'habit' (standing) that has already been acquired and that has come to be under the control of stimuli correlated with the entrance of the queen. Skinner already acknowledges that there can be multiple causal accounts of an operant once acquired. The unique role of the environment as an initiating cause is with the acquisition of a new operant. For this explandum, he asserts, there is but one explanans—namely, the initiating cause of the environment. But the cognitive scientist has the same rejoinder to this claim as before—namely, that the environmental cause that results in a new operant would not be effective if not for the beliefs, desires, and inferential processes that lead from new experience to new behavior. There is no logical contradiction between the phenomena of acquisition of a new operant and the assumption that acquisition depends upon intentional processes for its explanation.

7. A mode of causation

The analogy with natural selection describes a mode of causation that does not assign agents and their reasons the crucial role that ordinary explanations of action do. Use of terms such as "control" or "initiating cause" to clarify the point are not improvements on the analogy itself. The important question is not whether the environment controls or initiates adaptation, but how it goes about doing so. The analogy portrays a mode of causation that deprives agency of any role. The analogy itself is what contradicts the presuppositions of cognitive science.

7.1. As an empirical theory

Although it is an established fact that a rat's behavior adapts to the gradual increase in height of the barrier, the claim that this process of adaptation is explained by selection by consequences requires us to make some additional assumptions. When Skinner invokes the analogy with natural selection, he implicitly invokes these assumptions. In the version of the analogy he seems inclined to endorse, these assumptions are: (1) selection operates on habits, and (2) the initial difference among habits is minimal and the only source of further variation is error of replication. Call this the "analogy$_S$ with natural selection," where "S" denotes Skinner.

This analogy$_S$ implies (among other things) that an individual habit does not itself adapt to its consequences. This is the analogue of the central dogma of the Modern Synthesis. This is an important assumption in Skinner's critique of agency. But other assumptions are also important. Staddon is right to insist upon the crucial role of variation in the explanation of adaptation. The analogy$_S$ is making assumptions about variation that give selection the ability to account for ontogenetic adaptation. As already noted, the effect of selection itself is simply to reduce variation in a population. Without a source of new variants, selection would not be able to explain novelty or origins. It would explain only stasis.

This very point emerged somewhat unexpectedly in a dispute between Skinner and R. J. Herrnstein over the question of whether Skinner had ignored 'instinctual' behavior. Herrnstein (1977a) said he had; Skinner (1977) replied he had not; and Herrnstein (1977b) conceded that Skinner is the final authority on his own position. Herrnstein (1977b) added, however, that more is at stake than whether he was right about Skinner's position on instinct. The key issue, in his opinion, has to do with the law of effect, which is to say, with selection. "In Skinner's system, the law of effect serves a dual function: It produces learning and it maintains behavior. In contrast, I now believe that the law of effect is best reserved as a principle of maintenance, not of learning" (p. 1014). Herrnstein finds no role for selection other than to hold responding at a point of equilibrium, a role for which Skinner believes "a mechanical model may suffice."

Skinner, by contrast, finds selection's most important role to be a dynamic one. Herrnstein's position is actually quite similar to Staddon's. Selection's only direct effect is to reduce variation in a population of individuals. If it is a source of novelty, this can only be in conjunction with other processes that provide the variation upon which selection operates. But then it is not simply selection that explains change, but selection in conjunction with these other processes, including (as Staddon emphasizes) variation. Stripped of these other processes, selection explains only the maintenance of behavior, which is Herrnstein's point.

Assumptions about variation are deeply implicated in the question of agency. The cognitive scientist believes that agents possess intentional states and perform inferences from one intentional state to another. This alleged ability to draw inferences is supposed to lead to novel variations in behavior that are reliably adaptive even upon first occurrence. An example would be the ability to have 'insight' into the solution to a problem. Such an alleged ability would contradict the analogue of the central dogma, because 'habits' would be changed as the result of 'insight', rather than as the result of errors of transmission.

Skinner acknowledges "the problem of the First Instance. Where does the behavior come from that is taken over by contingencies of reinforcement?" (BBS, p. 609). But then he immediately appeals to the analogy$_S$, which implicitly assumes that variation is the result of errors of transmission. Cognitive science has proposed that novelty can be due to processes of inference and the analogy$_S$ contradicts that proposal. This contradiction does not refute the assumption of agency, however, unless the premises are true.

We have already seen that Skinner is not dogmatic about the assumptions of the analogy$_S$. Some behavior analysts simply reject some of them. Staddon (2014), for example, suggests that an organism brings a limited, differentiated repertoire of responses to a specific type of learning situation. Darwinian evolution has selected this repertoire based on its past tendency to be adaptive within that type of situation. It also imposes a temporal structure on the components of this repertoire so that the variations to be emitted first are those that had been most likely to lead to reinforcement in similar situations in the evolution of the species. Variations that had been less likely to be successful are emitted later, and only if earlier variations failed to result in reinforcement.

In his reply to Dawkins, Skinner did not rigidly reject the possibility that variation is structured or "stereotyped." He clearly prefers the assumption that variation comes in minimal, undifferentiated units, but this is an assumption that he was willing (reluctantly) to drop. Skinner evidently does not feel, however, that making such revisions in the analogy$_S$ would undermine the philosophical point he is trying to make.

This would be true, so long as the revisions merely incorporate structural constraints on the type of variations that are possible and the temporal order in which the organism emits them. Such "biological constraints on learning" can be accommodated by the analogy with natural selection. These constraints would ultimately, of course, be the result of selection operating at the level of phylogeny, which is a point Skinner frequently makes. Ontogenetic adaptation itself, however, would still be the result of selection operating on variation, so long as 'habits' are what get selected and variation is not the result of inference from past experience.

What Skinner dismisses without an adequate reason for doing so, however, is the possibility that biological evolution has produced physiological systems with states having propositional content and with a disposition to perform inferences from one such state to another. This

type of system would be due to selection by consequences operating at the level of phylogeny, but the process of adaptation during the lifetime of such an organism would not be due to selection by consequences at the level of ontogeny. This possibility is what is at issue.

The assumptions built into Skinner's analogy$_S$ would suffice to rule out this possibility, but it is not clear if these assumptions are true of more than a very limited behavioral domain. Biology is a science with few universal generalizations. As Ernst Mayr says, "Generalizations in modern biology tend to be statistical and probabilistic and often have numerous exceptions" (Mayr, 1988, p. 19). This leaves us with many possibilities. The analogy$_S$ could be true of all operant behavior of some species but of no operant behavior of others. Or it could be true of all operant behavior of some but of only some operant behavior of others. Or it could be true of some operant behavior of all species, but not of all operant behavior of any.

Furthermore, complexities in our understanding of evolution itself—complexities that have emerged since the heyday of the Modern Synthesis (see, for example, Jablonka and Lamb, 2014)—indicate that there are instances of inheritance of acquired characteristics (Lamarkism) and of directed mutation. Hence, recent changes in our understanding of what is possible in evolution raise questions about the analogy$_S$ itself, which seems based on assumptions about evolution that have only limited validity. And even if a revised version of analogy$_S$ provides a valid empirical theory of a certain domain, it may be invalid when applied to intentional human action, which is the domain of greatest philosophical importance. These are empirical questions to which philosophy has no answers.

7.2. As a metaphysical theory

Skinner's primary role for the analogy$_S$ was to argue that agency is an illusion, and he had two motives for making this argument. One was to criticize cognitive science, and the other was to remove a moral objection to the application of behavioral science to reform of human society. There is, however, another role the analogy could play, but one that Skinner did not specifically identify as such. Let us approach this role indirectly by examining cognitive science's claim that processes connecting one intentional state to another play an essential role in explaining behavioral adaptation. Go back to the 1940s and 1950s, when such a claim would have raised strong objections from academic psychologists. What is distinctive about intentional states is their propositional content. This content is supposed to determine how those states interact with one another. If I want adequate lighting at my desk and I believe that toggling the switch will cause there to be adequate lighting at my desk, these premises form a practical syllogism with the conclusion that I toggle the switch. This practical syllogism is supposed to explain why I toggle the switch, even if I have no subjective awareness of making this inference. How could there be causal relations among physical states based upon their propositional content?

To see how unusual intentional states are, consider the difference between a picture and a statement. A picture of a cat on a rug is also a picture of a cat on a specific location on the rug; but the statement that the cat is on the rug says nothing about where the cat is located on the rug. The picture furthermore will show the cat as having a certain posture—as standing, kneeling, or lying on its side. But the statement conveys none of that. This, as Ludwig Wittgenstein conceded, was the problem with his so-called "picture theory" of how a statement acquires its meaning. A statement is not at all like a picture.

We subjectively experience images that are similar to pictures. These *qualia* may help us solve certain problems, such as memorizing lists or planning a route from one place to another. Skinner's philosophy acknowledges the reality of such phenomena. Explaining behavior on the basis of these subjective states, however, is not at all like explaining it on the basis of intentional states. Intentional states do not manifest themselves as *qualia*, and they follow principles of causation based upon their propositional content. How, in a world of physical causes, is that even conceivable?

This is the metaphysical question to which the analogy with computers provides an answer.[4] States of computers have propositional content. When we run a program on a computer, it moves automatically from one physical state to another in a manner that is isomorphic to logical relations among the propositional content of these states. One could, if one wished, interpret this analogy as an empirical theory: the brain is a computer and the mind is its program. Indeed some cognitive scientists have done so. An early example was the interpretation of Chomsky's generative grammar of English as a program of how the brain of an English speaker processes a sentence. Chomsky (1959) himself suggested as much in the final section of his review of Skinner (1957), although he would soon begin acting as if he never made this suggestion and would dismiss any such interpretation as confusing "competence" with "performance." This interpretation of generative grammars was, quite reasonably, taken by psycholinguists to imply that sentences with grammatical derivations involving many formal operations would take longer to comprehend than sentences with derivations involving fewer formal operations. This prediction, however, was tested and fell short of expectations (Slobin, 1966). Almost four decades later, some psycholinguists had become "disenchanted" with this interpretation of generative grammars (Ferreira, 2005). As an empirical theory, then, the computer analogy has, at best, delivered mixed results.

But the computer analogy nonetheless has a role as an answer to a metaphysical question. Skinner was aware of this role. He refers to a time in the 1960s when "the computer was coming into its own as a model of human behavior that avoids any charge of dualism" (BBS, p. 609). Although the computer analogy may not be an accurate empirical theory of how organisms operate, it has an important metaphysical function. It shows how something that once seemed inconsistent with physicalism is in fact possible.

A similar dual role is played by Skinner's analogy$_S$. Common sense cannot conceive of an explanation of ontogenetic adaptation that does not refer to the beliefs and desires of an agent. Even if the environment controls organisms and initiates their actions, their beliefs and desires seem to play an indispensable role in the causation of action. What the analogy$_S$ shows is that neither agents nor their reasons are necessary to conceive of a process that adapts actions to their environmental consequences. Interpreted as an empirical theory of ontogenetic adaptation, however, this analogy$_S$ faces serious challenges.

8. Metaphysics and the science of behavior

Metaphysics is about what is necessary and what is possible. Although most contemporary philosophers are reluctant to make assertions about what is necessary, questions about what is possible have been central to the philosophy of behavior, action, and mind. Skinner's analogy$_S$ can be used in two ways, one of which is empirical, the other of which is metaphysical. The metaphysical use is to show it is possible to conceive of ontogenetic adaptation without assigning an essential function to agents or their reasons. It succeeds in this role. This success lends support to, although it by no means demonstrates the validity of, Skinner's critique of agent causation.

At the midpoint of the twentieth century, cognitive science faced a metaphysical challenge of its own. How are inferential processes among the intentional states of an agent possible in a world of physical causes? The metaphysical function of the computer analogy is to answer this question. This answer lends support to, although it by no means demonstrates the validity of, an account of ontogenetic adaptation that

[4] This question needs to be distinguished from the question of how a physical system comes to represent a proposition. Searle (1992) has cogently argued that the computer analogy is of no help answering this question. (This, however, is a question Dretske (1988) addresses.) What the computer analogy does address, however, is the question of how to conceive of a material system that performs logical inferences on the basis of physical processes.

assigns an essential role to agents and their reasons.

Although these analogies provide adequate answers to their respective metaphysical questions, neither resolves the empirical question of how to explain the process of ontogenetic adaptation of a given species to a given environment. This question (these questions) will be answered only by empirical discoveries. What these analogies show is that there are two metaphysically coherent, but conflicting, answers.

8.1. A navigational example

This raises the question of what role Skinner's analogy$_S$ plays, or should play, with respect to the research program of EAB. The answer, it seems to me, depends on one's epistemology. A navigational example helps explain the connection between one's epistemological assumptions and the role of the analogy$_S$.

Suppose you are lost at sea in a boat whose navigation system is no longer functioning. You know that beyond the western horizon, which you can identify by the location of sunset, is a sparsely inhabited coast that contains only one harbor that can provide safety and supplies. How can you find that harbor? One approach, which we might call Bayesian, would use all the data at one's disposal and target the point on the horizon that one has the highest degree of confidence will lead to the harbor. Sail in that direction. If the harbor is not there, you must now decide whether to go north or south along the coast. Once again, you use all the information at your disposal, including any new information gained in sailing to this point, to choose one's direction. Continue sailing in that direction until you find the harbor or else reach a point at which you are more confident that the harbor is actually in the opposite direction. In that event, you reverse direction and retrace your route, continuing to sail in that direction until you find the harbor or else reach a point at which you become more confident that you should change direction. So you go back and forth this way until you reach the harbor.

An alternative, non-Bayesian strategy would be to ask how far along either coast you could travel before the probability of the harbor being there vanishes to zero. There will be two such points. Sail to the one that, based on all the information at your disposal, is likely to be closer to the actual location of the harbor. The harbor is probably not there. If it is not, start sailing along the coast toward the opposite extreme. The harbor is somewhere in that direction. Keep sailing. You will find it.

8.2. The logic of research strategies and the assumptions of morality

This second strategy seems to be one behavior analysts have adopted. As a set of assumptions about the dynamics of learned behavior, the analogy$_S$ provides a strategic starting point for a systematic empirical exploration of ontogenetic adaptation. By starting with the assumption that habits are what the environment selects and that variations are undifferentiated and undirected, one starts with extreme assumptions that can systematically be relaxed. This is an efficient way to explore a subject matter. For them, this is the relationship of Skinner's analogy$_S$ to the research strategy of EAB—it is the point of departure for a systematic search for the best account of ontogenetic adaptation.

Staddon and Simmelhag (1971) provided an early indication of the need to depart from the analogy$_S$'s assumptions about variation. Staddon (2014) updates the case. We saw in his reply to Dawkins that Skinner did not rigidly reject the possibility that variation is structured or "stereotyped." The analogy$_S$ assumes that variation comes in minimal, undifferentiated units, but this is evidently an assumption that Skinner himself was willing (reluctantly) to drop. There nonetheless would be no reason to turn to intentional processes as an explanation of adaptation so long as habits are what are selected and the behavioral analogue of the 'central dogma' of the Modern Synthesis is valid. Adaptation would not be explained as the application of inferential rules to a system of representations, or to anything else that could plausibly be interpreted as an intentional process.

There is (non-Bayesian) rationality to such a research strategy, but it is a species of pragmatic rationality. As with all pragmatic justifications for the behavior analytic program, it does not imply the falsity of cognitive science. It simply justifies, for the sake of a coherent and systematic exploration of a domain, starting with the observation that some forms of ontogenetic adaptation can be explained without appeal to intentional processes. The analogy$_S$ may justify *ignoring*, for immediate purposes, the possibility that adaptation is due to intentional processes; it does not justify the conclusion that it is *false* that adaptation is due to intentional processes.

To organize a research strategy around such a tentative assumption does not, however, provide sufficient reason to abandon our everyday concept of autonomy for purposes of assessing ethical norms. Respect for personal autonomy, for example, is the ethical grounding of the norm that human subjects must give informed consent before taking part in an experimental or therapeutic procedure. Like the rest of the scientific community, behavior analysts accept this norm. But then, that is evidence that when making ethical judgments, they are guided by the concept of personal autonomy. Another example is the norm that we should not expose human subjects to risk of personal harm merely for the sake of increasing our knowledge. Again, behavior analysts accept this norm. The justification for this norm, however, is the principle that persons must always be treated as ends and never only as means. This principle is one of the three ways Kant (1785/2012)Kant (1785/2012) formulated the categorical imperative, all three of which he argued were implications of the concept of personal autonomy. Evidently, when making normative judgments in the area with which they are most familiar and where they have the greatest professional stake, behavior analysts are committed to this concept.

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