In Response

Prediction and Control in Loeb's Visualization and Skinner's Contingencies: Response to Hackenberg

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Hackenberg (1995) treats the views of Loeb and Skinner as being remarkably similar. Among the similarities, Hackenberg finds that both put practical control of subject matter above formal theory testing, both based their programs on analyses of reproducible units involving the intact organism, and both promoted technological applications of basic science. In particular, Hackenberg finds, "What united these various themes into a coherent approach was an unwavering emphasis on prediction and control as the fundamental goals of a scientific system" (p. 226). However, the views of Loeb and Skinner have also been seen as strikingly different (e.g., Moxley, 1992). This presents an apparent conflict. To some extent, this conflict can be resolved by examining the changes in the views of Loeb and Skinner. There are relatively more similarities between earlier Loeb and earlier Skinner, and there are relatively more differences between later Loeb and later Skinner. When these later views are not addressed, Skinner appears more Loeb-like and Loeb appears more Skinner-like. Although Hackenberg (e.g., 1995, p. 226) acknowledges some differences between Loeb and Skinner in respect to prediction and control, the career differences between Loeb and Skinner in this regard are much greater than what Hackenberg identifies. Particular-

ly in their later work, Loeb and Skinner differed profoundly on the meaning of prediction and control in relation to their respective views.

For example, Hackenberg (1995) says that Loeb, with Skinner, belonged to a tradition of productive knowledge rather than a tradition of "*contemplative* knowledge, gained passively through classification and description . . . [that] seeks to uncover the natural structure of the world or its underlying essences" (p. 231). However, Pauly (1987), Hackenberg's primary source, says that in "the only explicitly philosophical essay of his career" (p. 130) Loeb turned away from control and transformation of the world to a more passive search for pure knowledge:

In this paper Loeb [1915] publicly rejected the views of his intellectual idol, Ernst Mach, concerning the nature and purpose of science. Loeb argued that "the task of science" was not functional description and control; rather, it was "to visualize completely and correctly the phenomena of nature."

This essay was an element in a fundamental transformation that gradually took place in Loeb's outlook over the years from 1910 to 1918. He slowly shifted from broad hopes for biologists' present and future power to a belief that scientists could do only one, rather passive, thing: to look at nature and try to see the hidden mechanisms underlying biological processes. This change in emphasis from action to vision, from a practical positivism to an explicit epistemological reductionism, was accompanied in Loeb's mind by a different image of the social role of scientists; he no longer saw scientists as leaders in the transformation of the world, but as cloistral figures, removed from society, seeking pure knowledge. (p. 130)

In search of this pure knowledge, "From 1917 to his death in 1924

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[Loeb] investigated the physicochemical properties of gelatin" (p. 131). Pauly notes that an awareness of this change is important "for appreciating how [Loeb] became the archetypical 'mechanist' in twentieth-century biology" (p. 131).

For Loeb (1915), the task of science was to discover a complete and correct visualization of a hidden reality:

We may say it is the task of science to visualize completely and correctly the phenomena of nature, of which our senses give only very fragmentary and disconnected perceptions. We must try to visualize the numerous hidden processes and conditions connecting the disconnected phenomena we perceive. We have a right to speak of visualization on the basis of the assumption that all phenomena are determined by the grouping and displacement of discrete elements—molecules, atoms, the ions in liquids, electrons, positive nuclei of atoms and possibly others. Groupings and displacements of particles form the elements of our visual perceptions, and, in this way, mechanistic science and visualization of natural phenomena become identical. . . . It is the task of science to give a correct and complete visualization of all natural phenomena, since they are all apparently mechanical in character. (pp. 768–769; also cf. p. 772)

Loeb thereby identifies mechanistic science with the task he identifies for science: the complete and correct visualization of underlying elements and relations. Loeb assumes that if phenomena are mechanical then they are visualizable, which suggests that a key feature in making a mechanistic account attractive is its visualization. In this regard, explanations that can be geometrized with necessary relations between elements, for example, are more readily visualized than the changing probabilistic relations among class concepts in Skinner's three-term contingency.

Loeb's final pursuit of visualization in "the physicochemical properties of gelatin" is a natural culmination from following mechanistic principles. Loeb (1900) had long advanced explanations in terms of mechanistic reduction to matter in motion and believed "all life phenomena are ultimately due to motions or changes occurring in colloidal substances" (p. 14). Accordingly, Loeb

claimed, "Living organisms may be called chemical machines" (1906, p. 1); and Loeb's solution to the "problem of will" brought in the mechanistic principles of necessity and determinism:

The scientific solution of the problem of will seemed then to consist in finding the forces which determine the movements of animals, and in discovering the laws according to which these forces act. Experimentally, the solution of the problem of will must take the form of forcing, by external agencies, any number of individuals of a given kind of animals to move in a definite direction by means of their locomotor apparatus. . . . But if one part only of the animals moves in this definite direction and the other does not, we have not succeeded in finding the force which unequivocally determines the direction of their movement. (1912/1964, p. 36)

Prediction and control here mean demonstrating "the force which unequivocally determines" and "discovering the laws according to which these forces act." Such goals were supported by the mechanistic assumption of underlying scientific determinism, to which Loeb showed "a strong commitment" (Hackenberg, 1995, p. 226).

Scientific determinism was widely, if not universally, accepted in the 19th century and was a central feature in at least one strand of the Continental tradition in physiology in which Loeb was trained (cf. Moxley, 1992, p. 1301). This determinism was given a classic formulation by Laplace:

We ought . . . to regard the present state of the universe as the effect of its anterior state and as the cause of the one which is to follow. Given for one instant an intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it—an intelligence sufficiently vast to submit these data to analysis—it would embrace in the same formula the movement of the greatest bodies of the universe and those of the lightest atom; for it, nothing would be uncertain and the future, as the past, would be present to its eyes. (1814/1951, p. 4)

Popper (1982) presented this scientific determinism, with its formula that could reveal every past and future event, as analogous to a pictorial visualization:

The intuitive idea of determinism may be summed up by saying that the world is like a motion-picture film: The picture or still which is just being projected is *the present*. Those parts of the film which have already been shown constitute *the past*. And those which have not yet been shown constitute *the future*.

In the film, the future co-exists with the past; and the future is fixed, in exactly the same sense as the past. (p. 5, also cf. pp. xx-6)

The roll of film in itself is unchanging. The change we see in projection is merely an illusion. In theory, this metaphysical film can be shown to us on a metaphysical projector in either forward or in reverse, or it can be rolled out for a comprehensive view that only its supernatural producer can take in at a glance. In this way, such determinism offered the ultimate "visualization of natural phenomena" and supported Loeb's quest for a partial view of it.

However, a universe with such a fixed design for every detail is far removed from the one-way direction of our changing experiences and the accidental variations of evolutionary development. The natural selection-pragmatic tradition that Skinner joined (cf. Day, 1980; Moxley, 1992, in press) rejected this determinism (cf. Dewey, 1940/1991, pp. 106-107; Peirce, 1931-1963, 6.37-6.38, 6.65). Although Skinner (e.g., 1947, p. 23) made statements that suggest he accepted scientific or mechanistic determinism as central and foundational, this determinism became increasingly peripheral if it did not disappear entirely. Skinner (1983/1984) acknowledged that Bridgman "caught me up" (p. 60) for comments he had made in assuming determinism. Skinner (1974, p. 114) also acknowledged that a role for chance appeared to be at odds with a deterministic system and did not attempt to reconcile this conflict. Instead, Skinner said, "The origin of human behavior, like the origin of species, has got to be interpreted in terms of randomness and accident" (Trudeau, 1990). In discussing variation and selection in natural selection, operant conditioning, and cultural evolution, Skinner observed

that "variations are random and contingencies of selection accidental" (1990, p. 1207) and that "if there is freedom, it is to be found in the randomness of variations" (1990, p. 1208). This acceptance of important, foundational roles for chance and variation is not a traditional position for arguments in favor of determinism, in which random chance was commonly presented as a forced-choice, abhorrent, or nonexistent alternative to an orderly deterministic universe (cf. Hacking, 1990, pp. 1-16). Probabilistic orderliness, such as Skinner advanced, was not considered in this forced choice.

Accordingly, whereas control for Loeb (1912/1964, p. 36) meant unequivocal necessity, control for Skinner meant an empirical change in probability:

Human behavior is controlled not by physical manipulation but by changing the environmental conditions of which it is a function. The control is probabilistic. The organism is not forced to behave in a given way; it is simply made more likely to do so. (1973, p. 259)

There is no "force which unequivocally determines" here. Control for Skinner is not deterministic but probabilistic. Behavior is simply made "more likely."

In addressing the probabilistic relations in controlling contingencies, Skinner did not move toward the visualization of an underlying reality but to an ever-expanding consideration of the contingencies or contexts for behavior (see Moxley, 1992, in press). The private events of thinking and feeling as well as genetic and personal histories all became relevant in Skinner's account of behavior. Operant behavior was presented as selection by consequences in analogy with Darwinian and cultural evolution, and Skinner (1981, p. 501) explicitly excluded classical mechanism from an explanatory role in such accounts.

Furthermore, Skinner's role for verbal behavior within his three-term contingency is quite different from mechanistic accounts in which idealized ver-

bal behavior in geometrical, logical, or mathematical form is presented as the foundation for experience. For Skinner, the "verbal descriptions of reality are never as detailed as reality itself, and rule-guided or -governed behavior is never as subtle as behavior shaped directly by the contingencies described by the rules" (Skinner, 1988, p. 325). Thus, verbal behavior that expresses exact necessary relations cannot be the explanatory origin for—or an exactly complete and correct description of—any empirical event. Probabilistic contingencies underlie rules that express necessary relations. Rules do not underlie contingencies. If any rule or world formulation is placed first as the origin for behavior, the world we live in is turned around because, in the world we experience, "The contingencies always come first" (Skinner, 1989, p. 44). Rules or laws may be foundational for Loeb, but contingencies are foundational for Skinner.

Although similarities make the case for possible influences of Loeb on Skinner, differences make the case for distinguishing the more decontextualized, mechanistic tradition of metaphysical necessity that Loeb advanced in contrast to the more contextualized, selectionist-pragmatic tradition of empirical probability that Skinner advanced. Loeb's efforts to get a peek at immutable underlying necessities, which he had already assumed were there, was a logical result of following mechanistic principles. In contrast, Skinner's pursuit of a functional analysis for a probabilistic prediction and control of behavior took him to a selectionist tradition without such assumptions. In this sense, the views of Loeb and Skinner in regard to prediction and control can be seen as radically different.

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