REVISTA MEXICANA DE ANÁLISIS DE LA CONDUCTA 1998, **24**, 111-126 NÚMERO 2 (SEPTIEMBRE)
MEXICAN JOURNAL OF BEHAVIOR ANALYSIS NUMBER 2 (SEPTEMBER)

NATURE AND NURTURE IN SKINNER'S BEHAVIORISM

HERENCIA Y AMBIENTE EN EL CONDUCTISMO SKINNERIANO

BRYAN D. MIDGLEY AND EDWARD K. MORRIS[1]
UNIVERSITY OF KANSAS

ABSTRACT

Behavior analysis has been characterized as falling exclusively on the nurture side of the nature-nurture dichotomy. An examination of Skinner's behaviorism, however, reveals that it acknowledges both nature and nurture as determinants of behavior. Skinner did reject explanations of innate and acquired behavior in terms of instincts and habits, arguing instead that innate and acquired behavior are a function of selection by consequences--phylogenic and ontogenic contingencies. He distinguished these contingencies themselves in three ways: according to their temporal relation to behavior, their consequences, and what they select. Phylogenic contingencies correspond to the evolutionary history of the species, they work their effects through the survival and procreation of the species, and they bridge past and present via genes. Ontogenic contingencies, in contrast, contribute to the behavioral history of an individual, they work their effects through the reinforcement of behavior, and they bridge past and present via nongenetic biological factors. The variables of which innate and acquired behavior are a function--phylogenic and ontogenic contingencies--represent Skinner's version of the nature-nurture dichotomy.

Key words: nature-nurture, Skinnerian behaviorism, innate and acquired behavior, phylogenic and ontogenic contingencies, instinct and habit

---

[1] Portions of this article were drafted while the first author was supported as a predoctoral trainee by a grant from the National Institute of Child Health and Human Development (2 T32 HD07173-13A). Appreciation is extended to Don Bushell, John Colombo, Ann Cudd, and Kathy Zanolli for serving on the first author's comprehensive orals committee, and to Sigrid Glenn, Phil Hineline, and Martha Peláez for critical reviews of a manuscript from which this article is drawn. None of our colleagues should be assumed to agree with the analysis contained within and no one but the authors, of course, is responsible for any remaining errors in fact or logic. Correspondence should be addressed to Bryan D. Midgley, Department of Human Development and Family Life, University of Kansas, Lawrence, Kansas, 66045-2133, USA. Email: bdm@falcon.cc.ukans.edu..ls2

RESUMEN

El análisis del comportamiento se ha caracterizado por ponerse exclusivamente del lado del ambiente en la dicotomía herencia-ambiente. Sin embargo, un examen del conductismo Skinneriano revela que el conductismo reconoce ambas, a la herencia y al ambiente como determinantes del comportamiento. Skinner rechazó las explicaciones del comportamiento innato y adquirido que se basan en los instintos y en los hábitos y propuso en cambio que tanto el comportamiento innato como el adquirido son función de la selección por consecuencias--filogenéticas y ontogenéticas. Skinner distinguió estas contingencias de tres maneras en base a: (a) su relación temporal con el comportamiento, (b) sus consecuencias, y (c) lo que seleccionan. Las contingencias filogenéticas corresponden a la historia evolutiva de las especies, logran sus efectos a través de la supervivencia de éstas y unen el pasado y el presente a través de los genes. Por otra parte, las contingencias ontogenéticas contribuyen a la historia del comportamiento de un individuo, logran sus efectos a través del reforzamiento de la conducta y unifican el pasado y el presente a través de factores biológicos no genéticos. Las variables de las cuales el comportamiento innato y adquirido es función--las contingencias filogenéticas y ontogenéticas--representan la versión de Skinner en la dicotomía herencia-ambiente.

Palabras Clave: herencia-ambiente, conductismo Skinneriano, comportamiento innato y aprendido, contingencias filogenéticas y ontogenéticas, hábito e instinto

Nature and nurture are commonly regarded as fundamental determinants of behavior, with nature referring to heredity or evolution, and nurture to the environment or learning. Although nature and nurture are cast in terms of a dichotomy, we typically acknowledge both and recognize that "neither operates to the exclusion of the other" (Catania, 1998, p. 371). That is, we properly conceptualize the nature-nurture dichotomy as a continuum (e.g., Catania, 1998, p. 371; Fantino & Logan, 1979, pp. 475-476; Kimble, 1989).

Critics of behavior analysis, however, have characterized it as falling exclusively to the nurture or environmental side of the dichotomy (e.g., Garcia, & Garcia y Robertson, 1985; Gould & Marler, 1987a, 1987b). Indeed, this is cited as a reason for behavior analysis' alleged demise. As Gould (1982), for example, writes of behaviorism:

> It is now widely accepted that behaviorism is on the decline, its loss of vigor the result of its inability to come to grips even with the existence of innate behaviors, much less with their mechanisms and evolutionary origins. (p. 8)

Such characterizations, however, are fundamentally flawed (Skinner, 1974, pp. 4, 243-244; Todd, 1987; Todd & Morris, 1992). Behavior analysis actually falls "on the middle ground" (Skinner, 1977, p. 1007), acknowledging *both* nature and nurture as determinants of behavior. In this paper, we seek to clarify Skinner's position on nature and nurture. We focus on Skinner, instead of behavior analysis more generally or alternative versions thereof (see, e.g., Rachlin, 1992), for two reasons. First, contemporary behavior analysis refers to no one easily identified, circumscribed system. Although behavior analysts may agree on some fundamental concepts (e.g., reinforcement and the three-term contingency), they do not agree on all of them, as seen, for example, in the molar-molecular controversy (e.g., Henton & Iversen, 1978; Herrnstein, 1970), the mechanism-contextualism debate (e.g., Marr, 1993; Morris, 1993), and differing perspectives on private events (e.g., Rachlin, 1995; Skinner, 1953, pp. 257-282).

Second, we focus on Skinner because no one is more closely identified with behavior analysis. His work fundamentally informs much of the discipline and the relation of his behaviorism to the nature-nurture dichotomy per se has not, to our knowledge, yet been systematically examined (but see Moore, 1994, 1995). These rationales notwithstanding, we do not equate the whole of behavior analysis with his work, deny the contributions of behavior analysts other than Skinner, or regard the entirety of his work as representative of the latest thinking in the field.

In exploring Skinner on the nature-nurture dichotomy, we first discuss his ultimate explanations for innate and acquired behavior: phylogenic and ontogenic contingencies. Second, we explore the ways in which he distinguished between these two sets of contingencies, that is, in terms of temporal relations, consequences, and what is selected. And third, we consider the concepts he invoked when explaining the control of innate and acquired behavior by phylogenic and ontogenic contingencies: temporal gaps, changed organisms, and causal chains. Throughout this paper, we use the term "innate" broadly, referring to everything that, from Skinner's perspective, is considered inborn (e.g., respondent and operant conditionability, unconditioned eliciting stimuli and elicited responses, releasers and released behavior, primary positive and negative reinforcers; see, e.g., Michael, 1985, pp. 101-102; Skinner, 1969, pp. 201-202).

Explaining Innate and Acquired Behavior

As already pointed out, Skinner acknowledged both innate and acquired behavior (e.g., Skinner, 1966, 1975a, 1981, 1984, 1988; see Michael, 1985; Reese, 1986; Reynolds, Catania, & Skinner, 1963). What he rejected were their explanations cast in terms of a hypothetical "inner causal agent" (Skinner, 1953,

p. 116; see Skinner, 1953, pp. 27-31), in particular, instincts and habits. About these, Skinner (1966) commented:

> Until we have identified the variables of which an event is a function, we tend to invent causes. Learned behavior was once commonly attributed to "habit,".... "Instinct," as a hypothetical cause of phylogenic [i.e., innate] behavior, has had a longer life. We no longer say that our rat possesses a marble-dropping habit, but we are still likely to say that our spider has a web-spinning instinct. (p. 1208)

Instead of instincts and habits, Skinner accounted for innate and acquired behavior by appealing to contingencies of selection (see Skinner, 1981). In his words:

> I do not believe in a strict dichotomy between "ontogenic behavior" and "phylogenic behavior," if by behavior one means a stored habit or an instinct, but I think it is quite easy to distinguish between ontogenic and phylogenic *contingencies of selection*, and that was one of the points of "Phylogeny" [i.e., "The Phylogeny and Ontogeny of Behavior," 1966]. (Skinner, in Catania & Harnad, 1988, p. 420; cf. Skinner, in Catania & Harnad, 1988, p. 409)

Phylogenic contingencies or "contingencies of survival" refer to natural selection and explain how organismic characteristics such as innate behavior are selected, which are then transmitted to subsequent members of a species (Skinner, 1966, 1974). Similarly, ontogenic contingencies or "contingencies of reinforcement" refer to selection in the behavioral domain and explain how acquired behavior becomes part of a repertoire during an organism's individual behavioral history (Skinner, 1966, 1974). Phylogenic and ontogenic contingencies, then, not instincts and habits, are the variables of which innate and acquired behavior are respectively and *ultimately* a function.

For Skinner, however, no particular behavior was a function of only phylogenic or ontogenic contingencies. He recognized that innate and acquired behavior are intertwined (e.g., Skinner, 1974, pp. 45-49; see Skinner, 1980b). For example, the acquisition and maintenance of operant behavior require an organism that has an evolved "susceptibility to reinforcement by certain kinds of consequences" (Skinner, 1981, p. 501). Several phenomena mistakenly assumed to be incompatible with Skinner's behaviorism illustrate that innate and acquired behavior may "intrude" on one another (Skinner, 1983, p. 12) or that phylogenic and ontogenic contingencies may intermingle (Skinner, 1974, pp. 45, 47-48). Among these are the Breland Effect (i.e., the "misbehavior" of organisms; Breland & Breland, 1961), the Garcia Effect (i.e., taste-aversion conditioning; e.g., Garcia & Garcia y Robertson, 1985), and autoshaping (e.g., Brown & Jenkins, 1968; see Skinner, 1983). From Skinner's perspective, no behavior is purely innate or purely acquired--except in the first instance of the former--since phylogenic and ontogenic contingencies do not act in isolation.

At this point, we need to make a distinction that sometimes goes unappreciated, but that allows Skinner's position on nature and nurture to be understood more clearly. The distinction is between "ontogenic contingencies" as experimental *operations* (i.e., sources of variance) and as the *class of determinants* for all acquired behavior. As experimental operations, ontogenic contingencies are independent variables (e.g., schedules of reinforcement), that is, variables introduced or varied in the context of other variables that are held constant (e.g., level of deprivation, behavioral history; see Skinner, 1953, pp. 156-157). In contrast, as a class of determinants, ontogenic contingencies do not specify *an* operation (contrived or natural); rather, ontogenic contingencies is a collective label for *all* the determinants of acquired behavior (i.e., contingencies and possibly other variables, e.g., establishing operations).[2] In this sense, ontogenic (and phylogenic) contingencies are not sources of variance, but rather are *the two* general determinants of behavior--their intermingling notwithstanding. This second meaning of ontogenic contingencies helps explain what is meant when behavior is said to be a function of two, and only two, generic contingencies (cf. Skinner, 1966).

Phylogenic and Ontogenic Contingencies

With innate and acquired behavior accounted for in terms of phylogenic and ontogenic contingencies, we turn to the defining characteristics of these contingencies to clarify further Skinner's version of the nature-nurture dichotomy. Skinner distinguished between these contingencies in at least three ways: (a) their temporal relation to behavior, (b) their consequences, and (c) what they select.

---

[2] Skinner did occasionally acknowledge variables that might not easily be subsumed under either phylogenic or ontogenic contingencies. "Third variables," for example, included not only "conditioning, drive, and emotion" (e.g., Skinner, 1980a, p. 195), but also drugs (e.g., narcotics), blood supply, and injury to the nervous system (Skinner, 1930, p. 51; 1931, p. 442), as well as "general fatigue, asphyxiation, and disease" (Skinner, 1938, p. 416).

Temporal Relations

First, according to Skinner (1966), "the contingencies responsible for unlearned behavior acted a very long time ago" in the evolutionary history of a species (p. 1208), whereas ontogenic contingencies operate during the lifespan of individual organisms and are responsible for acquired behavior. Thus, whereas phylogenic contingencies are relatively remote from future instantiations of the selected innate behavior, ontogenic contingencies are relatively near and determine the selected acquired behavior.

Consequences

The second way in which phylogenic and ontogenic contingencies are distinguished lies in their consequences. As Skinner (1966) said of phylogenic contingencies:

> A given response is in a sense strengthened by consequences which have to do with the survival of the individual and species. A given form of behavior leads not to reinforcement [as in operant ontogenic contingencies] but to procreation. (p. 1206)

In other words, survival and the production of offspring are the functional consequences of innate behavior, which is therefore more likely to occur in future members of a species. In contrast, reinforcement is the functional consequence of acquired (i.e., operant) behavior, which is therefore more likely to occur during the remaining lifespan of an individual (Glenn & Madden, 1995; Skinner, in Catania & Harnad, 1988, p. 76; Smith, 1986; on Skinner's "evolutionary analogy," see Plotkin, 1987a, 1987b; Richelle, 1987a, 1987b).

Selection

The third way in which phylogenic and ontogenic contingencies are distinguished lies in what they select. As Skinner argued:

> [Phylogenic] contingencies select variations in genes which contribute to the "innate" behavior of a species, and different ontogenic]... contingencies contribute to the selection of variations which compose "learned" behavior. (Skinner, in Catania & Harnad,1988, p. 405)

Here, Skinner seems to have distinguished between two domains--behavioral and biological. In the behavioral domain, phylogenic and ontogenic contingencies differ in what they select--innate and acquired behavior, respectively. In the biological domain, phylogenic contingencies also select genes, whereas what ontogenic contingencies select or how they operate on the organism was left unspecified by Skinner, at least in the passage above. Nonetheless, we tentatively conclude (and later, try to argue) that, for Skinner, ontogenic contingencies operate on the organism biologically, for example, neurologically (e.g., Skinner, in Catania & Harnad, 1988, p. 422). We address this issue in the next section.

Before doing so, though, we briefly explain Skinner's perspective on the biological domain. Skinner was primarily interested in an independent science of behavior, one that did not *require* an appeal to biology (e.g., Skinner, 1975b, pp. 42-43). That is, he could study behavior with little concern for the biological organism other than as "a locus, a point at which many genetic and environmental conditions come together in a joint effect" (Skinner, 1974, p. 185). Skinner, however, did not regard the biological organism as a black box (Skinner, 1989, p. 18) and addressed its role--albeit generally--in the analysis of behavior. Discussing this role may further clarify Skinner's version of the nature-nurture dichotomy, to which we now turn.

Temporal Gaps, Changed Organisms, and Causal Chains

To understand the processes involved in the selection of innate and acquired behavior, we turn to three other concepts in Skinner's system: temporal gaps, changed organisms, and causal chains. Because Skinner did not always speak to these issues unambiguously, this section is more interpretative of his work than the preceding ones.

Temporal Gaps

Both innate and acquired behavior occur after the contingencies that selected them are no longer present. Skinner referred to the intervals between past contingencies (phylogenic and ontogenic) and present or future behavior (innate and acquired) as "temporal gaps" (e.g., Skinner, 1953, p. 54; 1974, p. 236; 1975b, p. 43; see Skinner, 1978, p. 49; 1989, p. 18). For Skinner, these gaps presented a problem: How can we account for the control of current or future behavior by past contingencies? Skinner's solution: Something bridges the temporal gap, in particular, a changed organism (e.g., Skinner, 1971, pp. 195-196; 1974, p. 237; Skinner, in Catania & Harnad, 1988, pp. 409, 422).

Changed Organisms

In general, the changed organism that Skinner emphasized refers to a behaviorally changed organism, that is, to change in an organism's response repertoire and the variables of which it is a function. In the context of phylogenic and ontogenic contingencies, though, change also involves biological change (see Delprato & Midgley, 1992; Hayes, 1992; Lee, 1988, pp. 162-163; Parrott, 1983; cf. Branch, 1977; Glenn & Madden, 1995). For instance, Skinner in replying to Eibl-Eibesfeldt (1988), noted that Eibl-Eibesfeldt raises a question about the product [of phylogenic and ontogenic contingencies]. Both kinds of contingencies change the organism--"the wiring of the neuronal networks." Phylogenic contingencies do so in a way involving the genome, ontogenic contingencies in a different way, in the individual organism (see Skinner, in Catania & Harnad, 1988, pp. 301-302, 422). In other words, Skinner identified the changed organism as the link bridging the temporal gap between historic contingencies--either phylogenic or ontogenic--and current or future behavior (see earlier section on *Selection*). In general, the sequence from (a) contingencies to (b) biological organism to (c) behavior constitutes a three-link "causal chain" (cf. Skinner, 1953, pp. 34-35). With the changed organism, Skinner was not, of course, implying a self-actional organism; ultimate control still rested with the environment. Skinner's interest in biology, then, did not undermine a behavioral science. [Relatedly, see Skinner's (1987, pp. 100-101) metaphor of the organism-as-storage-battery, where the battery does not store electricity, but is changed when recharged.]

Another, related way in which Skinner occasionally described the organism's role was with the concept of mediation (e.g., Evans, 1968, p. 23; Skinner, 1957, p. 435; 1969, pp. 283-284; 1971, p. 14; see Skinner, 1980a, pp. 198-199, on "intervene"). For Skinner, mediation implied not cognitive, but biological mediation (see Delprato & Midgley, 1992; Lee, 1988, pp. 161-163; MacCorquodale, 1970). The distinction between the two comes down to what Skinner saw as the storage of *hypothetical* things (e.g., memories) versus *actual* biological changes (see Lee, 1988, p. 163). Of Skinner's appeal to biological mediation, Lee (1988) explains:

> Accepting action-at-a-distance requires that we accept temporal gaps only at the psychological level of integration and not across all levels. Accepting this, Skinner (e.g., 1972, pp. 269-270, 1984a, 1984b) insisted that the temporal gap between past contingencies and current performance at the psychological level is *mediated* by the physiology of the organism. Presumably, past contingencies change the organism so that it behaves differently now. Describing this *physiological*

> *mediation* of the effects of past contingencies is properly the task of the physiologist. (p. 162, emphasis added)

For Skinner, then, biological mediation was acceptable in a science of behavior. It, like the changed organism, implied a link, part of a biological system, that bridges temporally displaced events in the behavioral domain (Lee, 1988, p. 162).[3] This position on the changed organism (or biological mediation) was central to Skinner's explanation of the control of innate and acquired behavior by phylogenic and ontogenic contingencies (i.e., nature and nurture), that is, via causal chains.

Causal Chains

The preceding discussion suggests that Skinner saw the concept of the "causal chain" (e.g., Skinner, 1953, pp. 34-35, 160, 279; 1956, p. 92; 1974, p. 231) as useful in explaining both innate and acquired behavior (see Skinner, 1974, pp. 236-237; 1975b, pp. 42-43; 1978, p. 49). Indeed, causal chains integrate all of the main concepts discussed to this point: innate and acquired behavior, phylogenic and ontogenic contingencies, temporal gaps, changed organisms, and biological mediation. We describe these chains in what follows, beginning with their initial links--phylogenic and ontogenic contingencies, respectively.

Phylogenic contingencies. Remote phylogenic contingencies are linked to current or future innate behavior by causal chains. The chains consist of a sequence of events occurring over a species' evolutionary history: Organisms are exposed to phylogenic contingencies; phylogenic contingencies select innate behavior and genes; genes are replicated, leading to the development of biological organisms that, as current members of a species, are biologically different from other, past members; and the current biological organisms are more likely than their predecessors to engage in certain innate behaviors under particular conditions. The replicated genes and the biological organisms are the middle links--the mediators--in a causal chain. That is, replicated genes and the biological organisms to which they give rise (i.e., the organisms' biological structures and functions) bridge the temporal gap between (a) phylogenic

---

[3] Biological mediation might also mean participation, in the sense that "all psychological events are at the same time biological events," because biological organisms participate in all psychological events (Kantor & Smith, 1975, p. 453). This meaning appears consistent with Skinner's (1964) comment that, "An adequate science of behavior must consider events taking place within the skin of the organism, not as physiological mediators of behavior, but as part of behavior itself" (p. 84).

contingencies, which operate in the evolutionary history of the species, and (b) the current or future innate behavioral repertoire of the members of the species.

Ontogenic contingencies. Likewise, ontogenic contingencies are linked to current or future acquired behavior by causal chains. These chains, however, consist of a sequence of events occurring within an individual's behavioral history: An organism is exposed to ontogenic contingencies, ontogenic contingencies select acquired behavior and change the organism biologically (e.g., neurologically), and the biologically changed organism is therefore more likely than its earlier self to engage in certain acquired behaviors under particular conditions. The changed organism is the middle link--the mediator--in a causal chain. That is, the biological organism bridges the temporal gap between (a) ontogenic contingencies, which operate in the behavioral history of the individual, and (b) the current or future acquired behavioral repertoire of the individual.[4]

Skinner (1974) identified the biological effects of ontogenic contingencies in his comments about "the physiologist of the future," where he illustrated how all three fundamental concepts--temporal gaps, changed organisms, and causal chains--are integrated in the explanation of acquired behavior:

> The physiologist of the future will tell us all that can be known about what is happening inside the behaving organism. His account will be an important advance over a behavioral analysis, because the latter is necessarily "historical"--that is to say, it is confined to functional relations showing *temporal gaps*. Something is done today which affects the behavior of an organism tomorrow. No matter how clearly that fact can be established, a step is missing, and we must wait for the physiologist to supply it. He will be able to show how an *organism is changed* when exposed to contingencies of reinforcement and why the changed organism then behaves in a different way, possibly at a much later date [a reference to causal chains]. What he discovers cannot invalidate the laws of a science of behavior, but it will make the picture of human action more nearly complete. (pp. 236-237, emphasis added)

---

[4] Skinner was largely silent on the precise relation between ontogenic contingencies and biological changes (but see, e.g., Skinner, in Catania & Harnad, 1988, pp. 24-25). Some recent scholarship suggests, however, that selection is a causal mode that may also operate in the biological (i.e., neurological) domain, as well (cf. Glenn & Madden, 1995).

SUMMARY AND CONCLUSION

In summary, Skinner rejected explanations of innate and acquired behavior in terms of instincts and habits, arguing that the variables of which innate and acquired behavior are ultimately a function are contingencies of selection--phylogenic and ontogenic. He distinguished between them in three ways: Their temporal relation to behavior, their consequences, and what they select. In explaining the control of innate and acquired behavior by phylogenic and ontogenic contingencies, Skinner argued that exposure to contingencies changes organisms biologically: Phylogenic contingencies make future members of a species genetically different from their predecessors, whereas ontogenic contingencies make individual organisms biologically (e.g., neurologically) different from their earlier selves. In both cases, biologically changed organisms (and replicated genes, with phylogenic contingencies) fill the temporal gap in the causal chain between past contingencies and current or future behavior (cf. Schnaitter, 1978, pp. 7-8). For Skinner, phylogenic and ontogenic contingencies correspond, respectively, to nature and to nurture. Phylogenic and ontogenic contingencies are Skinner's version of the nature-nurture dichotomy (cf. Catania, 1998, p. 371; Plotkin, 1987b).

We close with a few final comments. First, although we have argued that Skinner acknowledged both nature and nurture, he was critical of "genetic explanations" for what are more likely instances of acquired behavior (e.g., Skinner, 1974, p. 49). Indeed, he regarded much human behavior as acquired during the individual's lifespan (cf. Gewirtz & Peláez-Nogueras, 1996) and thus advanced a developmental perspective wherein behavioral history is crucial (Skinner, 1953, p. 31; cf. Bijou & Baer, 1978; Morris, 1992). Also, while Skinner acknowledged biological factors in the analysis of behavior, he conducted almost no empirical research on them (but see, e.g., Skinner & Heron, 1937). Skinner's criticism of "genetic explanations" and overriding empirical interest in behavioral principles, as opposed to biological variables, then, are probably two reasons why Skinner is sometimes labeled an environmentalist.

Second, we recognize that the nature-nurture dichotomy itself has properly been the subject of criticism and debate (e.g., Johnston, 1987; Lehrman, 1970). Our intention, however, has not been to evaluate the dichotomy, but to demonstrate that Skinner's behaviorism is not appropriately placed on only the nurture side. Once this is understood, behavior analysis can then ask if the nature-nurture dichotomy--the dichotomy between phylogenic and ontogenic contingencies--is the best way in which to conceptualize the determinants of behavior (e.g., Gottlieb, 1988).

Third, if behavior analysis does reconsider the nature-nurture dichotomy, it might turn to alternative conceptualizations that are in keeping with a natural science perspective. One alternative is the developmental systems perspective, which conceptualizes inheritance as reaching beyond genes, emphasizes the role of development in the construction of acquired *and* innate characteristics, and takes a systemic, not self-actional or mechanistic, view of causality. In short, the developmental systems perspective argues that "nature and nurture are not alternative causes but product and process," respectively (Oyama, 1985, p. 131; see Gottlieb, 1992; Gray, 1992; Lickliter & Berry, 1990). We leave this reconsideration for another time (see, e.g., Midgley & Morris, 1992).

REFERENCES

Bijou, S. W., & Baer, D. M. (1978). *Behavior analysis of child development*. Englewood Cliffs, NJ: Prentice-Hall.

Branch, M. N. (1977). On the role of "memory" in the analysis of behavior. *Journal of the Experimental Analysis of Behavior, 28*, 171-179.

Breland, K., & Breland, M. (1961). The misbehavior of organisms. *American Psychologist, 16*, 681-684.

Brown, P. L., & Jenkins, H. M. (1968). Auto-shaping of the pigeon's key-peck. *Journal of the Experimental Analysis of Behavior, 11*, 1-8.

Catania, A. C. (1998). *Learning* (4th ed.). Upper Saddle River, NJ: Prentice Hall.

Catania, A. C., & Harnad, S. (Eds.). (1988). *The selection of behavior: The operant behaviorism of B. F. Skinner: Comments and consequences*. Cambridge: Cambridge University Press.

Delprato, D. J., & Midgley, B. D. (1992). Some fundamentals of B. F. Skinner's behaviorism. *American Psychologist, 47*, 1507-1520.

Eibl-Eibesfeldt, I. (1988). Difficulties with phylogenetic and ontogenetic concepts. In A. C. Catania & S. Harnad (Eds.), *The selection of behavior: The operant behaviorism of B. F. Skinner: Comments and consequences* (pp. 421-422). Cambridge: Cambridge University Press.

Evans, R. I. (1968). *B. F. Skinner: The man and his ideas*. New York: E. P. Dutton.

Fantino, E., & Logan, C. A. (1979). *The experimental analysis of behavior: A biological perspective*. San Francisco: Freeman.

Garcia, J., & Garcia y Robertson, R. (1985). Evolution of learning mechanisms. In B. L. Hammonds (Ed.), *Psychology and learning: The master lecture series* (Vol. 4, pp. 191-243). Washington, DC: American Psychological Association.

Gewirtz, J. L., & Peláez-Nogueras, M. (1996). In the context of gross environmental and organismic changes, learning provides the main basis for behavioral development. In S. W. Bijou & E. Ribes (Eds.), *New directions in behavior development* (pp. 15-34). Reno, NV: Context Press.

Glenn, S. S., & Madden, G. J. (1995). Units of interaction, evolution, and replication: Organic and behavioral parallels. *The Behavior Analyst, 18*, 237-251.

Gottlieb, G. (1988). Lingering Haeckelian influences and certain other inadequacies of the operant viewpoint for phylogeny and ontogeny. In A. C. Catania & S. Harnad (Eds.), *The selection of behavior: The operant behaviorism of B. F. Skinner: Comments and consequences* (pp. 428-430). Cambridge: Cambridge University Press.

Gottlieb, G. (1992). *Individual development and evolution: The genesis of novel behavior*. New York: Oxford University Press.

Gould, J. L. (1982). *Ethology: The mechanisms and evolution of behavior.* New York: Norton.

Gould, J. L., & Marler, P. (1987a). Learning by instinct. *Scientific American, 256*, 74-85.

Gould, J. L., & Marler, P. (1987b). [Letter to the editor]. *Scientific American, 256,* 4.

Gray, R. (1992). Death of the gene: Developmental systems strike back. In P. Griffiths (Ed.), *Tress of life: Essays in philosophy of biology* (pp. 165-209). Dordrecht: Kluwer.

Hayes, L. J. (1992). The psychological present. *The Behavior Analyst, 15*, 139-145.

Henton, W. W., & Iversen, I. H. (1978). *Classical conditioning and operant conditioning: A response pattern analysis.* New York: Springer-Verlag.

Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior, 13*, 243-266.

Johnston, T. D. (1987). The persistence of dichotomies in the study of behavioral development. *Developmental Review, 7*, 149-182.

Kantor, J. R., & Smith, N. W. (1975). *The science of psychology: An interbehavioral survey*. Chicago: Principia.

Kimble, G. A. (1989). Psychology from the standpoint of a generalist. *American Psychologist, 44*, 491-499.

Lee, V. L. (1988). *Beyond behaviorism*. Hillsdale, NJ: Erlbaum.

Lehrman, D. S. (1970). Semantic and conceptual issues in the nature-nurture problem. In L. R. Aronson, E. Tobach, D. S. Lehrman, & J. S. Rosenblatt (Eds.), *Development and evolution of behavior: Essays in memory of T. C. Schneirla* (pp. 17-52). San Francisco: Freeman.

Lickliter, R., & Berry, T. D. (1990). The phylogeny fallacy: Developmental psychology's misapplication of evolutionary theory. *Developmental Review, 10,* 348-364.

MacCorquodale, K. (1970). On Chomsky's review of Skinner's Verbal behavior. *Journal of the Experimental Analysis of Behavior, 13*, 83-99.

Marr, M. J. (1993). Contextualistic mechanism or mechanistic contextualism?: The straw machine as tar baby. *The Behavior Analyst, 16*, 59-65.

Michael, J. L. (1985). Behavior analysis: A radical perspective. In B. L. Hammonds (Ed.), *Psychology and learning: The master lecture series* (Vol. 4, pp. 99-121). Washington, DC: American Psychological Association.

Midgley, B. D., & Morris, E. K. (1992). Nature = f(nurture): A review of Oyama's The ontogeny of information: Developmental systems and evolution. *Journal of the Experimental Analysis of Behavior, 58*, 229-240.

Moore, J. (1994). Some thoughts about "selection by consequences." In C. Chiasson (Chair), *Theoretical, philosophical, and conceptual issues*. Paper session conducted at the meeting of the Association for Behavior Analysis, Atlanta, GA.

Moore, J. (1995). Some thoughts on the relation between behavior analysis and behavioral neuroscience. In J. Goldschmidt (Chair), *Behavior and biology*. Paper session conducted at the meeting of the Association for Behavior Analysis, Washington, DC.

Morris, E. K. (1992). The aim, progress, and evolution of behavior analysis. *The Behavior Analyst, 15*, 3-29.

Morris, E. K. (1993). Behavior analysis and mechanism: One is not the other. *The Behavior Analyst, 16*, 25-43.

Oyama, S. (1985). *The ontogeny of information: Developmental systems and evolution*. Cambridge: Cambridge University Press.

Parrott, L. J. (1983). On the differences between Skinner's radical behaviorism and Kantor's interbehaviorism. *Mexican Journal of Behavior Analysis, 9*, 95-115.

Plotkin, H. (1987a). Plotkin replies to Richelle. In S. Modgil & C. Modgil (Eds.), *B. F. Skinner: Consensus and controversy* (pp. 152-153). New York: Falmer Press.

Plotkin, H. (1987b). The evolutionary analogy in Skinner's writings. In S. Modgil & C. Modgil (Eds.), *B. F. Skinner: Consensus and controversy* (pp. 139-149). New York: Falmer Press.

Rachlin, H. (1992). Teleological behaviorism. *American Psychologist, 47*, 1371-1382.

Rachlin, H. (1995). Things that are private and things that are mental. In J. T. Todd & E. K. Morris (Eds.), *Modern perspectives on B. F. Skinner and contemporary behaviorism* (pp. 179-183). Westport, CT: Greenwood.

Reese, E. P. (1986). Learning about teaching from teaching about learning: Presenting behavioral analysis in an introductory survey course. In V. P. Makosky (Ed.), *The G. Stanley Hall lecture series* (Vol. 6, pp. 69-127). Washington, DC: American Psychological Association.

Reynolds, G. S., Catania, A. C., & Skinner, B. F. (1963). Conditioned and unconditioned aggression in pigeons. *Journal of the Experimental Analysis of Behavior, 6*, 73-74.

Richelle, M. (1987a). Richelle replies to Plotkin. In S. Modgil & C. Modgil (Eds.), *B. F. Skinner: Consensus and controversy* (pp. 150-152). New York: Falmer Press.

Richelle, M. (1987b). Variation and selection: The evolutionary analogy in Skinner's theory. In S. Modgil & C. Modgil (Eds.), *B. F. Skinner: Consensus and controversy* (pp. 127-137). New York: Falmer Press.

Schnaitter, R. (1978). Private causes. *Behaviorism, 6*, 1-12.

Skinner, B. F. (1930). *The concept of the reflex in the description of behavior.* Unpublished doctoral dissertation. Cambridge, MA: Harvard University.

Skinner, B. F. (1931). The concept of the reflex in the description of behavior. *Journal of General Psychology, 5*, 427-458.

Skinner, B. F. (1938). *The behavior of organisms: An experimental analysis*. New York: Appleton-Century-Crofts.

Skinner, B. F. (1953). *Science and human behavior*. New York: Free Press.

Skinner, B. F. (1956). What is psychotic behavior? In E. F. Gildea (Ed.), *Theory and treatment of the psychoses: Some newer aspects* (pp. 77-99). St. Louis: Washington University Studies.

Skinner, B. F. (1957). *Verbal behavior*. New York: Appleton-Century-Crofts.

Skinner, B. F. (1964). Behaviorism at fifty. In T. W. Wann (Ed.), *Behaviorism and phenomenology: Contrasting bases for modern psychology* (pp. 79-108). Chicago: The University of Chicago Press. (With commentaries)

Skinner, B. F. (1966). The phylogeny and ontogeny of behavior. *Science, 153*, 1205-1213.

Skinner, B. F. (1969). *Contingencies of reinforcement: A theoretical analysis*. New York: Appleton-Century-Crofts.

Skinner, B. F. (1971). *Beyond freedom and dignity*. New York: Knopf.

Skinner, B. F. (1974). *About behaviorism*. New York: Vintage.

Skinner, B. F. (1975a). The shaping of phylogenic behavior. *Journal of the Experimental Analysis of Behavior, 24*, 117-120.

Skinner, B. F. (1975b). The steep and thorny way to a science of behavior. *American Psychologist, 30*, 42-49.

Skinner, B. F. (1977). Herrnstein and the evolution of behaviorism. *American Psychologist, 32*, 1006-1012.

Skinner, B. F. (1978). Humanism and behaviorism. In B. F. Skinner (Ed.), *Reflections on behaviorism and society* (pp. 48-55). Englewood Cliffs, NJ: Prentice-Hall.

Skinner, B. F. (1980a). The experimental analysis of operant behavior: A history. In R. W. Rieber & K. Salzinger (Eds.), *Psychology: Theoretical-historical perspectives* (pp. 191-202). New York: Academic Press.

Skinner, B. F. (1980b). The species-specific behavior of ethologists. *The Behavior Analyst, 3* , 51.

Skinner, B. F. (1981). Selection by consequences. *Science, 213*, 501-504.

Skinner, B. F. (1983). Can the experimental analysis of behavior rescue psychology? *The Behavior Analyst, 6*, 9-17.

Skinner, B. F. (1984). The evolution of behavior. *Journal of the Experimental Analysis of Behavior, 41*, 217-221.

Skinner, B. F. (1987). Cognitive science and behaviorism. In B. F. Skinner, *Upon further reflection* (pp. 93-111). Englewood Cliffs, NJ: Prentice-Hall.

Skinner, B. F. (1988). Genes and behavior. In G. Greenberg & E. Tobach (Eds.), *Evolution of social behavior and integrative levels: The T. C. Schneirla conference series* (Vol. 3, pp. 77-83). Hillsdale, NJ: Erlbaum.

Skinner, B. F. (1989). The origins of cognitive thought. *American Psychologist, 44*, 13-18.

Skinner, B. F., & Heron, W. T. (1937). Effects of caffeine and benzedrine upon conditioning and extinction. *The Psychological Record, 1*, 340-346.

Smith, T. L. (1986). Biology as allegory: A review of Elliott Sober's The nature of selection. *Journal of the Experimental Analysis of Behavior, 46,* 105-112.

Todd, J. T. (1987). [Letter to the editor]. *Scientific American, 256,* 4.

Todd, J. T., & Morris, E. K. (1992). Case histories in the great power of steady misrepresentation. *American Psychologist, 47,* 1441-1453.