Differing Views of Contingencies: How Contiguous?

Kennon A. Lattal and Timothy A. Shahan
West Virginia University

The contingency between environmental events and behavior has proven to be a useful concept in the study of both behavior and cognition. There is common ground in the definition of contingency in both domains, but interpretations of the basis of its action differ. For behavior analysts the contingency acts through both its direct, response-strengthening effect and indirectly through its function as a discriminative stimulus. Cognitive accounts, as represented in the work of both Bower and Watson, focus more on the organism's detection and interpretation of the contingency as the basis of its action. Despite such conceptual differences, Watson's quantitative descriptions of contingency effects seem relevant to feedback functions that describe reinforcement schedule performance and, as such, may bear on research involving combinations of response-dependent and response-independent food presentations and on superstitious behavior.

Key words: contingency, contiguity, response-independent events, superstitious behavior

In their analyses of the effects of contingencies on the behavior of young children, Bower (1997) and Watson (1997) raise several issues that are germane to behavior-analytic conceptualizations of contingency. An answer to the question posed in the title of this commentary follows from a consideration of the points of similarity and difference between their analysis and the use of the contingency concept in behavior analysis. We first review some of the uses of the term *contingency* in behavior analysis and then contrast a cognitive interpretation of the action of contingency, as illustrated by these two papers, with a behavior-analytic account of both the direct and indirect, discriminative, effects of the contingency on behavior. Having thus noted some differences, we then consider several ways in which the views of Bower and Watson complement basic schedule research on contingency effects in learning.

Contingency and Contiguity

Despite its ubiquity as a concept, the term *contingency* is imprecise because

of its varied use both within behavior analysis and more generally within psychology, as the present articles illustrate. Within behavior analysis, for example, the term is used variously to describe generic functional relations between environmental events and behavior, schedules of reinforcement, and response–reinforcer relations (Lattal & Poling, 1981). With respect to the latter, which is most directly related to the work of Bower and Watson, each of several definitions of contingency share the common feature of describing the relation between behavior and events that “follow,” but they also differ in details and precision. Some definitions of contingency are probabilistic, describing the likelihood of an event (typically a putative reinforcer) occurring in the presence or absence of a certain stimulus or response (e.g., Rescorla, 1967; Schoenfeld & Farmer, 1970; Scott & Platt, 1985). Others emphasize the temporal relation between responses and reinforcers (Skinner, 1948; Zeiler, 1968), and still others emphasize the correlation between aggregates of responses and consequences (Baum, 1973; Herrnstein, 1970; Herrnstein & Hineline, 1966). Both Bower's and Watson's definitions are more or less probabilistic, with Watson's being more explicit on this

Address correspondence to Kennon A. Lattal, West Virginia University, Department of Psychology, Box 6040, Morgantown, West Virginia 26505-6040 (E-mail: klattal@wvu.edu).

point and Bower's being more implicitly so.

Contingency sometimes has been defined operationally in terms of a dependency between a response and putative reinforcers that follow, a procedure that Bower seems also to have found useful. As such, contingency is separable from contiguity, the temporal relation between behavior and events that follow, although in most standard experimental arrangements the two are confounded (Sizemore & Lattal, 1977, 1978; Williams, 1976). Contiguity often arises as a result of the interaction between behavior and the a priori contingency, although under some circumstances contiguity alone is suggested by some to mimic the effects of contingency (e.g., Skinner, 1948). For these reasons, we agree with Watson's conclusion that contiguity is not a useful index of contingency. Despite the controversies that surround the notion of superstition, the idea persists in the experimental analysis of behavior that accidental temporal relations between responses and reinforcers are important in some learning situations (e.g., the changeover delay in concurrent schedules). If purely accidental reinforcement is possible, then contiguity cannot be a precise index of an a priori dependency between behavior and events that follow. Even though contiguity may not be a useful index of contingency, it still may be sufficient for response acquisition and maintenance. This possibility begs the question of the role of the contingency, defined in terms other than contiguity, in learning.

Direct and Indirect Effects of Contingency

Historically in behavior analysis contingencies have been conceptualized as having their effects directly on behavior. This view stands in contrast to that of theorists like Bower and Watson, who suggest that reinforcement contingencies have their effects indirectly, as a result of the organism de-

tecting, recognizing, or perceiving, and then engaging the contingency:

Operant learning is based upon the organism's ability to detect relations between its actions and events in the world. (Bower, 1997, pp. 141–142)

The simple fact that a consequence of behavior is capable of altering the strength of the behavior does not specify how this fact provides detection and engagement of that contingency. What is needed is some mechanism that either directly or indirectly detects the essential structure of the beneficial contingency. (Watson, 1997, p. 130; cf. Watson, 1979, p. 34)

Despite these assertions, the experimental evidence is strong that contingency detection is not necessary for contingencies to have their effects on behavior (e.g., Greenspoon, 1955; Hefferline, Keenan, & Harford, 1959; Rosenfeld & Baer, 1970; Svartdal, 1992). This evidence does not negate an indirect role for contingency *detection* in response maintenance, but only suggests that it is not necessary.

Even though contingency detection is not necessary for response maintenance, one question is whether it is possible. Another question is that given that contingency detection occurs, what role might it play in response maintenance? Bower and Watson suggest that the role of contingency is mediated by an active organism who detects contingencies and then acts on that detection. However, their index of detection is a change in behavior (e.g., Watson, 1979), which confounds the direct strengthening effect and the indirect discriminative effects of the contingency. Even more problematic is the fact that their index of contingency detection is measured by the response that in turn may be maintained only by the direct response-strengthening effects of reinforcement (cf. Lattal, 1975).

Lattal (1975, 1979; see also Killeen, 1978) used a conditional discrimination procedure to analyze the detection of contingencies independently of their direct, response-strengthening effects on behavior. A signal detection analysis allowed the separation of direct biasing effects of the reinforcement con-

tingency from the discriminative effects of the contingency. The results show that contingencies are detectable, independently of their direct response-strengthening effects. Furthermore, performance can be biased by a predominance of one type of contingency over another, even when the detection of, that is, sensitivity to, both contingencies is constant (e.g., Killeen, 1978; Lattal, 1979).

Given that contingencies can be detected, the question of how such detection enters into the control of operant behavior remains. As noted above, both Watson and Bower suggest that behavioral effects of contingencies are mediated by processes within the organism. For example, Bower says,

It is my contention that human newborns treat these [contingency] relationships as possible hypotheses and act to test the validity of these hypotheses. . . . I would make clear, however, that I do not assume that a rat or a newborn has ongoing internal monologues in which it formulates hypotheses and works out ways to test them. I assume the whole process is more or less automatic, as automatic as the conveyance and divergence of our eyes in binocular vision. That said, I must also make it plain that I have no objection to any formulation that does posit internal monologues in some private language. (Bower, 1997, p. 143)

Thus, perceptions of contingencies give rise to hypotheses which in turn give rise to actions. Watson proposes, then, that cognitive descriptions of behavior controlled by contingencies are both acceptable and useful, and often may in fact truly reflect the causes of the behavior. Such an analysis seems to be similar to Dennett's (e.g., 1983) suggestions for using intentional language in describing the behavior of nonhuman animals. Bower's suggestion faces problems similar to those faced by Dennett. Just as it is unclear when to invoke intentional explanations of behavior and when it is "automatic," it similarly is unclear when behavior is under the direct control of the contingency, that is, is "automatic" in Bower's description, and when it is controlled by a putative rule about the contingency.

An observation more in keeping with a behavior-analytic account of action is that the contingencies may function as discriminative stimuli under some conditions. The discriminative stimulus serves the same antecedent function as hypothesized internal causes, such as perception, rules, or intentions, but without the burdensome conceptual baggage. The studies cited above illustrate the validity and utility of considering reinforcement contingencies as discriminative stimuli. The experimental details of how contingencies come to function as discriminative stimuli and the circumstances under which they function as discriminative stimuli are beyond the scope of this commentary. The important point is that there are environmentally based behavioral mechanisms that account for the effects of contingencies that both Bower and Watson describe in terms rather foreign to behavior analysts.

The Logic and Evolution of Contingencies

A wealth of experimental evidence, like that cited above and by both Watson and Bower, indicates that contingencies operate in an orderly manner. In that sense it seems reasonable to say that organisms behave logically. But to assume that logic is the cause of behavior does not follow. Logic is a human construction imposed on natural phenomena. The operation of the physical world may be described lawfully, that is, logically, but the physical world does not use the laws of physics to operate. Similarly, the behavior of living organisms may be described lawfully, but such behavior need not be construed as though the organisms were using the rules of logic or the laws of behavior to act.

The operation of contingencies in natural settings gives rise to questions about their origins as well as the mechanisms by which they have their effects on behavior. Watson observes that contingency is a behavioral primitive with

his statement that "contingency is primal" (p. 129). It is difficult to argue with the position that contingencies between environmental events and behavior are ubiquitous and essential to survival. Whether the contingency is the chicken or the egg is less clear and seems to us less important. The important feature of contingencies is not their primacy but their contribution to the acquisition and maintenance of behavior that allows organisms to survive and proliferate.

Some Converging Interests

Despite our differing views concerning the role of contingency in learning assigned by Bower and Watson, in other ways the ideas expressed in both papers complement behavior-analytic investigations of contingency effects. At the most general level, it is encouraging to know that we share with the cognitive accounts of Watson and Bower the recognition of the critical role played by contingencies in controlling behavior. More specifically, the results of experiments with animals on the role of contingency in learning can be related to the ideas of both authors. For example, Watson's assertion that long delays to reinforcement are functionally similar in their effects to reinforcers delivered independently of responding has been investigated extensively with nonhuman subjects (e.g., Gleeson & Lattal, 1987). The suggestion that delayed reinforcement is difficult to distinguish from response-independent food presentations also has been supported by Warner (1990). As we noted above, Bower proposed that operant learning is defined by the fact that an organism can "detect relations between its actions and events in the world" (1997, p. 142). Although we cannot accept such a definition of operant behavior, the suggestion that response-event relations can serve as discriminative stimuli is borne out in the research with nonhumans described in the preceding

section, as well as by the research of both Bower and Watson.

Watson's forward and backward conditional probability analysis of contingencies relates directly to the operation of the response-reinforcer relation in schedules of reinforcement. He observes that both the probability of a reinforcer given that a response has occurred (forward probability) and the probability that a response has occurred given that a reinforcer has occurred (backward probability) are important in defining contingency. Response probability, or rate of response when a reinforcement schedule is involved, is the outcome of these two probabilities. In a variable-ratio (VR) schedule, for example, the backward probability is 1.0 because every reinforcer is preceded by a response, but the forward probability is less than this because more responses than reinforcers occur. A higher VR response requirement reduces the forward probability, thereby reducing that element of the contingency and lowering response rates. Watson thereby concludes that different schedules involve different contingencies, where contingency is defined in terms of the forward and backward probability. As noted in the section on definitions of contingency, one definition of a contingency of reinforcement is a schedule of reinforcement. Watson's analysis therefore might prove to be useful in a quantitative framework for describing schedules as contingencies. In that the forward probability involves taking intermittency of reinforcement into account in definitions of the contingency, the analysis also seems conceptually similar to the description of molar feedback functions for reinforcement schedules (e.g., Baum, 1973; Nevin & Baum, 1980).

The applicability of Watson's contingency analysis is more complicated in the analysis of schedules in which there is no programmed dependency, that is, no contingency, between responses and food delivery (cf. Skinner, 1948) or those in which only a portion

of the food deliveries require a response (Lattal, 1974). Watson describes an experiment with infants that is similar to the latter type of schedule. A mobile was activated each time an infant kicked and in addition was activated at random times. This procedure yields a forward probability of 1.0 (because every kick is followed by a mobile movement) and a backward probability of less than 1.0 (because sometimes the mobile activates without a kick). The backward probability might be construed as the number of response-produced mobile movements divided by the total number of mobile movements, but for an operational detail: Some of the response-independent mobile movements also might be preceded by a response, which seems to complicate this calculation. Strictly speaking, these presentations are response independent, but they may function in a dependent manner in that they affect behavior in the same way as those that are actually response dependent. Whether these food presentations that are temporally contiguous with the response but operationally independent of it should be considered in calculating the backward probability is unclear. Similarly, determining the forward conditional probability also is complicated in this example because changes in response rates, engendered by the changing proportions of response-dependent and response-independent mobile presentations, will change this probability by altering the number of responses that are considered in the conditional probability calculation. Watson (1979) has considered some of these issues, and the interested reader may wish to refer to this earlier analysis.

Conclusion

Contingency is perhaps the most important concept in behavior analysis (Lattal, 1995). The work of both Bower and Watson illustrates some of the ways that the contingency construct also has been a useful integrative con-

struct in developmental psychology. Whenever people consider important issues in psychology from different perspectives, it is neither difficult nor surprising to find differences in definition and interpretation. The pleasant surprise in the papers by Bower and Watson is, despite many conceptual differences between the views expressed in these papers and a behavior-analytic view of contingency, that there are both common interests in, and specific points of contiguity regarding, the role of contingency in the actions of organisms. These points of contiguity include our common concerns with defining a somewhat ambiguous but widely used concept; understanding the role of contingency as a determinant of behavior; often parallel, or at least related, ideas about and experimental evidence for the effects of contingencies on behavior; and similar interests in, but divergent conclusions about, the logic and evolutionary significance of contingencies between environmental events and behavior.

In closing we note that in 1979 Watson observed that "it seems extraordinary, but the long history of research on instrumental learning in man and animals has never examined learning in a situation . . . in which the stimulus is sometimes being produced by [the organism's] behavior and sometimes the stimulus is occurring on its own" (1979, p. 39). At the time this statement was published, a number of such experiments in fact had been published in behavior-analytic outlets (e.g., Lattal, 1974; Lattal & Bryan, 1976; Rachlin & Baum, 1972; Schoenfeld & Farmer, 1970; Zeiler, 1976, 1977). This state of affairs underlines the need for more open lines of communication, such as that offered by the present series of articles, between researchers who are investigating common problems from different theoretical perspectives.

REFERENCES

- Baum, W. M. (1973). The correlation-based law of effect. *Journal of the Experimental Analysis of Behavior*, 20, 137-153.

- Bower, T. G. R. (1997). Contingencies, logic, and learning. *The Behavior Analyst*, 20, 141–148.
- Dennett, D. C. (1983). Intentional systems in cognitive ethology: The "Panglossian paradigm" defended. *The Behavioral and Brain Sciences*, 6, 343–390. (Includes commentary)
- Gleeson, S., & Lattal, K. A. (1987). Response-reinforcer relations and the maintenance of behavior. *Journal of the Experimental Analysis of Behavior*, 48, 383–393.
- Green spoon, J. (1955). The reinforcing effect of two spoken sounds on the frequency of two responses. *American Journal of Psychology*, 68, 409–416.
- Hefferline, R. F., Keenan, B., & Harford, R. A. (1959). Escape and avoidance conditioning in human subjects without their observation of the response. *Science*, 130, 1338–1339.
- Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior*, 13, 243–266.
- Herrnstein, R. J., & Hineline, P. N. (1966). Negative reinforcement as shock-frequency reduction. *Journal of the Experimental Analysis of Behavior*, 9, 421–430.
- Killeen, P. (1978). Superstition: A matter of bias, not detectability. *Science*, 199, 88–89.
- Lattal, K. A. (1974). Combinations of response-reinforcer dependence and independence. *Journal of the Experimental Analysis of Behavior*, 22, 357–362.
- Lattal, K. A. (1975). Reinforcement contingencies as discriminative stimuli. *Journal of the Experimental Analysis of Behavior*, 23, 241–246.
- Lattal, K. A. (1979). Reinforcement contingencies as discriminative stimuli: II. Effects of changes in stimulus probability. *Journal of the Experimental Analysis of Behavior*, 31, 15–22.
- Lattal, K. A. (1995). Contingency and behavior analysis. *The Behavior Analyst*, 18, 209–224.
- Lattal, K. A., & Bryan, A. J. (1976). Effects of concurrent response-independent reinforcement on fixed-interval schedule performance. *Journal of the Experimental Analysis of Behavior*, 26, 495–504.
- Lattal, K. A., & Poling, A. D. (1981). Describing response-event relations: Babel revisited. *The Behavior Analyst*, 4, 143–152.
- Nevin, J. A., & Baum, W. M. (1980). Feedback functions for variable-interval reinforcement. *Journal of the Experimental Analysis of Behavior*, 34, 207–217.
- Rachlin, H., & Baum, W. M. (1972). Alternative reinforcement: Does the source matter? *Journal of the Experimental Analysis of Behavior*, 18, 231–241.
- Rescorla, R. A. (1967). Pavlovian conditioning and its proper control procedures. *Psychological Review*, 74, 71–80.
- Rosenfeld, H. M., & Baer, D. M. (1970). Unbiased and unnoticed verbal conditioning: The double agent robot procedure. *Journal of the Experimental Analysis of Behavior*, 14, 99–107.
- Schoenfeld, W. N., & Farmer, J. (1970). Reinforcement schedules and the "behavior stream." In W. N. Schoenfeld (Ed.), *The theory of reinforcement schedules* (pp. 215–245). New York: Appleton-Century-Crofts.
- Scott, G. K., & Platt, J. R. (1985). Model of response-reinforcer contingency. *Journal of Experimental Psychology: Animal Behavior Processes*, 11, 152–171.
- Sizemore, O. J., & Lattal, K. A. (1977). Dependency, temporal contiguity, and response-independent reinforcement. *Journal of the Experimental Analysis of Behavior*, 25, 119–125.
- Sizemore, O. J., & Lattal, K. A. (1978). Unsignalled delay of reinforcement in variable-interval schedules. *Journal of the Experimental Analysis of Behavior*, 30, 169–175.
- Skinner, B. F. (1948). "Superstition" in the pigeon. *Journal of Experimental Psychology*, 38, 168–172.
- Svartdal, F. (1992). Sensitivity to nonverbal operant contingencies: Do limited processing resources affect operant conditioning in humans? *Learning and Motivation*, 23, 383–405.
- Warner, J. E. (1990). *The discrimination of delayed and response-independent events*. Unpublished master's thesis, West Virginia University, Morgantown.
- Watson, J. S. (1979). Perception of contingency as a determinant of social responsiveness. In E. B. Thoman (Ed.), *Origins of the infant's social responsiveness* (pp. 33–64). Hillsdale, NJ: Erlbaum.
- Watson, J. S. (1997). Contingency and its two indices within conditional probability analysis. *The Behavior Analyst*, 20, 129–140.
- Williams, B. A. (1976). The effects of unsignalled delayed reinforcement. *Journal of the Experimental Analysis of Behavior*, 26, 441–449.
- Zeiler, M. D. (1968). Fixed and variable schedules of response-independent reinforcement. *Journal of the Experimental Analysis of Behavior*, 11, 405–414.
- Zeiler, M. D. (1976). Positive reinforcement and the elimination of reinforced responses. *Journal of the Experimental Analysis of Behavior*, 26, 37–44.
- Zeiler, M. D. (1977). Elimination of reinforced behavior: Intermittent schedules of not-responding. *Journal of the Experimental Analysis of Behavior*, 27, 23–32.