The Response–Stimulus Contingency and Reinforcement Learning as a Context for Considering Two Non-Behavior-Analytic Views of Contingency Learning

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This paper introduces a special section on the contingency. Bower and Watson were invited to present their views of contingency learning in human infants from outside the context of behavior analysis, and Cigales, Marr, and Lattal and Shahan provided commentaries that point out some of the more interesting and controversial aspects of those views from a behavior-analytic perspective. The debate turns on how to conceptualize the response–stimulus contingency of operant learning. The present paper introduces the contingency concept and contingency detection by subjects, as well as research practices in behavior analysis, in a context in which the dependency between infant responding and the presentation of environmental consequences may be disrupted through procedures in which ordinarily consequent events occur before the response or in its absence. These points can relate to and serve as an introduction to the Bower and Watson papers on infant contingency learning as well as to the three commentaries that follow.

Key words: contingency, infant operant learning, reinforcement

T. G. R. Bower and J. S. Watson are influential developmental psychologists. In the developmental literature of the past quarter century, while the author of this introduction has been reporting research on infant operant learning and has employed the operant paradigm as the theoretical basis for diverse facets of development, Bower and Watson have been publishing conceptual analyses and experimental reports on *contingency learning*, as operant learning is often labeled outside behavior analysis. In this context, we three had been discussing among ourselves the notion of the *contingency*.

In recent years, I had recruited Bower and his students to present reports of their research with neonates and infants that conformed to the operant learning paradigm in Developmental SIG portions of the Association for Behavior Analysis (ABA) program. In this frame, the 1996 ABA conference in San Francisco, near Watson's Berkeley base, provided the formal opportunity to invite him to join Bower, my-

self, and others in a broad discussion of the contingency concept from within and without behavior analysis. The symposium format permitted Bower's and Watson's presentations to be followed by commentary from individuals who operate within the frame of contemporary behavior analysis. This special section includes the invited symposium papers, the commentaries from the symposium, and the comments from one set of referees for publication of the symposium.

In this introductory paper, and in the papers and commentaries that follow, the response–stimulus (R-S) contingency provides the standard for discussions about operant learning. It is generally understood that R-S contingency relations provide the main basis for substantial adaptive learning. It has been proposed also, in the context of gross organismic and environmental changes, that R-S contingency relations provide the main basis for both nonsocial and social human behavioral development (e.g., Gewirtz & Pelaez-Nogueras, 1992, 1996a, 1996b). Occasioned by Bower's and Watson's interesting cognitive interpretations of

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their work on infant operant learning, the discussion here and in the subsequent commentaries will be in a context in which the dependency between responding and the presentation of environmental events that function as reinforcers can be disrupted through procedures in which the ordinarily consequent events occur before the response or in its absence.

In this introduction I will note some salient features of the papers that are to follow, examine the concept of *contingency*, relate it to such similar terms as *contiguity*, and distinguish the contingencies comprised of S-S, S-R, and R-S sequence types, with a particular focus on their roles in the learning of human infants. I shall consider also the role of contingency detection by subjects in operant learning. Finally, I shall consider how laboratory approaches to the notion of contingency routinely have been contrived to avoid dealing with occurrences that may be frequent in natural settings. These include cases in which (a) ordinarily response-dependent contingent events occur before, or in the absence of, the response and (b) R-S contingency occurrences deviate from the ideal along diverse contextual and practical dimensions. These laboratory approaches may deal only occasionally with cases in which response-independent presentations are used to delineate the role of the contingent event. In these ways, my treatment can tie in with, and perhaps serve as a constructive contrast to, the presentations and commentaries that follow.

The Contingency

The British empiricist and associationist philosophers dealt with the conception of *contingency* in their primary laws of association (Peters, 1965). The term *contiguity* has denoted a primary law of association in which, when two experiences have occurred together spatially or temporally, the subsequent occurrence of one tends to bring the other "to mind." At the same time, the

term *contingency* has been employed often in the field of inferential statistics to denote the probability or degree of an association (i.e., dependence) between two or more events. Hence, the terms *contingency* and *contiguity* overlap in meaning. In these literatures outside behavior analysis, the difference in usage appears to be that contiguity implies correlation but not temporal order, whereas contingency implies both order (as regards the S-R, R-S, or S-S relation) and dependency, and emphasizes more a summary of relations across occasions. In this frame, although the two terms overlap extensively in meaning, for convenience in this paper I shall emphasize *contingency* (except when *contiguity* is used by a cited author, e.g., Guthrie).

In the psychology of this century, the S-S contingency type has been exemplified in diverse learning theories, such as in Tolman's (e.g., 1932) sign-significate theory of learning and in Pavlov's (e.g., 1927/1960) conditioned reflex paradigm, in which an S-S contingency is generated by the unconditioned eliciting stimulus following the initially neutral conditioned stimulus. Another S-R contingency type, for which there was even a single instance of the co-occurrence in space and time of a stimulus and a response (movement), was emphasized and termed *contiguity* by Guthrie (1935/1952). There would be an increase in the likelihood that the response would follow a recurrence of the stimulus.

During the past 100 years, perhaps the most frequently emphasized contingency type has been the R-S contingency denoted by the response-dependent presentation of an event (providing the putative reinforcing or punishing stimulus for the response) that has been key to theories of operant learning. This emphasis was reflected early on in Thorndike's (1898) work and in such principles as Thorndike's (1911) law of effect (which emphasized that a subject's "satisfaction" or "dissatisfaction" underlay contingency effectiveness). In a more contemporary

vein, it was reflected also in the empirical law of effect in which, simply, a stimulus resulting in a systematic rise in the pattern of a response upon which it has been contingent is termed a *reinforcer* (Skinner, 1935).

An early approach by Skinner (1937/1959) to the conception of contingency can be instructive. In his rejoinder to Konorski and Miller (1937), Skinner discussed his use of the phrase "contingent upon" in place of the phrase "correlated temporally with" or "correlated with." He distinguished between respondent conditioning "which results from the contingency of a . . . stimulus upon a stimulus" and operant conditioning that results "from contingency [of a stimulus] upon a response" (p. 377). Skinner used the term *reinforcing stimulus* to refer to the stimulus contingent on the stimulus in respondent conditioning and contingent on the response in operant conditioning. In subsequent usage, the term *reinforcer* has rarely served to label the stimulus contingent on the conditioned stimulus in respondent learning. However, *reinforcer* is ubiquitous in operant learning, where the contingent stimulus is assumed to be necessary but not sufficient for describing a relation as reinforcement. The functional test of sufficiency for a contingency to be termed reinforcing (or punishing) is that, over occasions, a systematic increase or decrease results in the pattern of occurrence of the response attribute involved in the contingency. Because the R-S contingency implies that a behavior attribute will occur or reoccur only if another event occurs, functionally there can be no contingency without a systematic behavior change.

As was noted in the preceding paragraphs, the conception of contingency between two stimuli, two responses, or one event of each type implies a notion of covariation (i.e., correlation). That is, the events can co-occur, and the operant contingency tracks the degree to which the events occur together and not separately. To apply this logic to

the case of the environmental consequence of a target response comprising a strong contingency, the conditional probability of the reinforcing stimulus given the target response is high and the conditional probability of the reinforcing stimulus given no target response is low. Thus, decreasing the probability of the contingent stimulus (reinforcer) for the target response, or increasing its probability in the absence of the response (or even for some nontarget response), can be similarly effective in decreasing the contingency. In this frame, Galbicka and Platt (1984, 1989) have conceived of the contingency as reflecting the change in the probability of a stimulus event after a response event relative to another (or others) that constitute the background or context. This is what might be deemed the operant contingency. Even so, as Lattal and Shahan (1997) and Marr (1997) note in their commentaries, the use of the contingency term, particularly in describing the relation between behavior and events that follow (the reinforcer), has varied in diverse ways, some of which they describe.

In this context, a useful challenge to behavior analysis is to examine how Bower and Watson, investigators of operant learning who often employ nonbehavioral (cognitive) theoretical systems, approach the notion of contingency, and to wonder if and how the contingency conception of behavior analysis might evolve constructively in response.

Contingency Detection and Verbalization

Two additional points might be raised here (to use Kantor's language—e.g., 1959) about the protopostulates that have in the past distinguished cognitive from behavioral approaches to the conditioning process and its outcomes. (Although generic, these assumptions may also apply to the Bower and Watson papers.) The first point is about the confusion between the

contingency-detection response and the conditioned operant. The contemporary behavioral view is that, when contingencies have functioned effectively across occasions to produce the systematic increasing or decreasing response patterns that denote operant reinforcement or punishment learning in the subject, that result necessarily indicates that the contingencies have been detected reliably by said subject (whether or not the subject actually could verbalize that detection has occurred). Hence, the positing of a separate contingency-detection act on the part of a subject that, as Watson (1979) proposed, implies causality, is held to be gratuitous, either in preverbal or verbal subjects. In the inverse case, when the contingencies have failed to produce systematic response-change patterns in the subject, no assumption at all can be made about contingency detection.

Even so, a cognitive approach might assume that the subject learns to detect and discriminate the occurrence of a particular contingency, with or without that fact being reflected in a systematic change in the response being conditioned. Although the questions implied in such a distinction between operant learning and a conceivably very different type of incidental learning could be addressed within behavior analysis, such questions do not ordinarily arise in the types of experimental procedures employed. In the event of an ineffective contingency, before looking to change the contingent stimulus, a behavioral researcher's tactics routinely would be to vary the context of stimulus provision. If, as a result, the previously ineffective contingency becomes effective, then in some sense the change could denote that the contingency has been detected. But the notion of contingency detection would remain gratuitous.

A second point, about subject verbalizations or inferences from behavior change of mentalisms "explaining" the behavior denoting operant learning, may arise in cognitive explanations. In

behavior analysis, verbal responses may likely be joint outcomes of the same antecedent process as the non-verbal target behavior patterns being conditioned and, thus, are conceived not to provide independent explanations of the target behavior at issue. And mentalisms, whether or not denoted by behavior change, are terms that are given no place in a functional behavioral analysis (e.g., Gewirtz & Pelaez-Nogueras, 1993).

Functional Analysis in the Infant Laboratory and in Natural Settings

The experimental analysis of behavior has dealt effectively, even subtly, with environmental complexities such as the ones that will be noted below. Even so, it is unlikely that Bower and Watson are familiar with the relevant literature, and there are some points about the limitations of infant operant laboratory work and its relation to natural settings that may, in particular, put Watson's work into context.

R-S contingency occurrences, in which an environmental event (a presumptive stimulus) follows a behavior unit (a presumptive response), typically are contrived to be constant in laboratory research on infant operant learning. In the real world replete with noise, however, R-S contingency occurrences may vary from the ideal conception along diverse dimensions. (Watson has drawn our attention to one set of such variations.) Thus, in generating the contingency in the real world, the variations may be homogeneous or heterogeneous; and, on any one occurrence, they may be compatible with or diverge from the contingency. For instance, in contributing to the contingency, the contingent stimulus may follow the response immediately or may occur after a delay (or, as was earlier noted, it may even occur independent of, or prior to, the response); the stimulus that follows may be perceptually salient or vague, readily discriminable or embedded in background perceptual noise; occur after

every response or intermittently according to a temporal, ratio, or other principle so that only some fraction of the responses are followed by the stimulus consequence creating the contingency; or be comprised of a simple stimulus or of a pattern of many and diverse stimulus elements. Some such conditions could be homogeneous in establishing a contingency; others could attenuate, across occasions, the effects of the contingency on behavior. Most important for this overview, for any reason, such as those just listed or simply because the nature of the environmental event contributing to the contingency may preclude its functioning as an effective consequence for a particular response, that contingency may be ineffective across trials in generating a systematic change in the response unit.

The functional analysis of behavior has generated much basic and applied research in numerous areas of behavior analysis, including developmental learning with its emphasis on identifying stimuli that function to generate effective discriminative and reinforcing contingencies for particular response classes. For instance, most if not all infant operant learning research has been done in contrived settings under standard, constant laboratory procedures. Typically involved as independent variables for diverse target responses have been contingent continuous reinforcement training treatments and reversal treatments without reinforcement. These reversal conditions can be under extinction; under differential reinforcement of a response other than the target response (DRO), differential reinforcement of an alternative response (DRA), or differential reinforcement of an incompatible response (DRI); or under yoked control conditions in which the contingent stimuli that functioned as reinforcers in the earlier conditioning series are provided noncontingently. To hold temporal factors constant during conditioning, every instance of a narrowly-defined target response is usually fol-

lowed instantaneously by the very same stimulus of the very same sized unit, the putative reinforcer (or punisher); and, during reversal, the same number and density of identical stimuli are provided but are never contingent on the target response. Thus the environmental contingencies or noncontingencies are typically provided in exactly the same way across occasions by the proximal experimenter (often the parent whose behavior is under instructional control).

In this frame, studies have been conducted (a) to vary the temporal delays between target-response offset and onset of the contingent stimulus (e.g., Millar, 1972; Reeve, Reeve, & Poulson, 1993); (b) to explore the systematic diminution in reinforcer efficacy of a contingent stimulus for a response (termed *response habituation* or *stimulus satiation*) (Egel, 1981); or (c) to provide stimuli that, when presented contingent on the response, function as reinforcers, noncontingent on that response (to which the oxymoron *noncontingent reinforcement* has been applied; e.g., Baer & Wolf, 1970). But, apart from the possibility provided by noncontingent reinforcement procedures and Watson's and Bower's work presented in the papers that follow (until now unavailable in the behavior-analytic literature), there have been few, if any, reports of infant operant learning studies in which the usually contingent stimulus is presented either in the absence of the target response or preceding that response. In myriad studies of infant behavior that have been conducted under the general laboratory-research paradigm described above, the contingency relation among a response, its antecedents, and its consequences has been manipulated experimentally within very narrow ranges. It was on this basis (of which Bower and Watson were likely aware) that the principles underlying the operant learning paradigm have become established empirically in the laboratory for human infants (of which Bower and Watson were likely to be aware), as

these principles have been established for humans in other segments of the life span and for other species, preparations, and paradigms (Gewirtz, Carr, & Roth, 1995).

Using interactions between parents and their infants, there have been occasional attempts to validate ecologically in natural settings the behavior-analytic principles (or even the cognitive principles of Bower or Watson) generated by the standard procedures under stratified and homogeneous laboratory conditions. Even so, in such validation attempts, variables that are typically ignored in the extreme homogeneity of laboratory settings could come to the forefront. As noted earlier, conditions might occur in natural settings in which both the response and the contingent stimulus vary from occasion to occasion or from moment to moment, along any combination of simple or complex dimensions. Thus, there may be change in the reinforcement schedule; in the identity, magnitude, or duration of the contingent stimulus; in the definition of the response (in natural settings often being much broader) involved in the contingency; or in the delay (often substantial) between response offset and contingent stimulus presentation. There may be a change also in the presence or absence of contextual setting conditions, or in that varying subsets of other infant behaviors may be emitted concurrently or sequentially with the target response at different turn-taking positions in sequence.

The Papers That Follow

The approaches of the Bower and Watson papers that follow are far from identical. Yet, regardless of the terms they use, they share with behavior analysis a concern for the operant contingency. At the same time, in contrast to this introduction and the Cigales, Marr, and Lattal and Shahan commentaries, the approaches of those authors stem in part from interesting nonbehavioral and nonmainstream condition-

ing traditions. Bower's rational hypothesis-testing model that he advances as the basis of infant contingency detection stems at least in part from Piaget's (1936) theoretical approach. And Watson's emphasis within statistical conditional probability analysis is on two contingency indices, a forward time probability that reinforcement follows responses and a backward time probability that responses precede reinforcement. Yet, in their different ways, the issues implied in those positions represent variations of the operant contingency that can be constructively provocative. Equally provocative are issues that stem from particular researchers' commitment to laboratory research preparations in contrived settings, to observational research in natural settings, or to any of a variety of blended conditions.

In connection with some of the above-listed issues, one recalls similar questions that were pertinent a half century ago in studies of animal learning when the questions and answers of experimental cognitive psychology were compared to the questions and answers of the experimental analysis of behavior and its precursors. In the competition between alternative theories, for the most part it remained unrecognized that the questions asked and answers given were a function of the methods employed. In problem-solving contexts, cognitive experiments imposed few constraints initially on the responses (and sequences) that could contribute to the problem solutions and concluded that hypothesis testing was a necessary process leading to the outcome. In contrast, under the behavioral approaches of the period, preliminary research would constrain a problem, limiting alternative responses and sequences in the novel setting so that one target operant was emphasized, and the possibility of varied hypotheses was minimized. The unappreciated different starting points of the two approaches led inevitably to disparate conclusions. The cognitive conclusion was that hypothesis testing was

a likely factor in solution of the problem. The behavioral conclusion was that hypothesis testing could not be a factor in the solution. Moreover, the cognitive approach often took sudden breaks in learning curves to denote unseen but relevant cognitive changes termed *insight*, whereas behavioral approaches often took such sudden breaks at face value and perhaps speculated about environmental discontinuities that might be associated with such breaks. Although it was not recognized at the time, differences in their experimental preparations in the context of their different theoretical approaches necessarily led to their different conclusions (for the context, see, e.g., Walker, 1996).

A similar comparison may apply to the present discussion, with Watson as the example. In his current paper, he emphasizes primarily backward versus forward analysis of disassociation and necessary versus sufficient conditions. However, based on his earlier writings, Watson's noncognitive points may apply more to the natural than to the laboratory settings of behavior-analytic research on maternal-infant interaction. This is because he concluded that two separate features of contingencies must be taken into account, one being the conditional probability of a mother's response following her infant's response, less the estimated unconditional probability of the infant's response, and the second being the conditional probability of the infant's response preceding the mother's response, less the estimated unconditional probability of the mother's response. In the laboratory, the maternal response and infant response base rates (as well as response identities, concurrencies, timings, and the like) ordinarily are contrived not to be a factor, with the mother's contingent responding remaining the key element studied. Indeed, it may be constructive to follow Watson's idea in laboratory settings, and to take into account such factors as the base rates of each actor's responding. Hence, contingencies may trans-

late into conceptions like reinforcement differently in the laboratory than in natural settings by those attempting to identify the process and learning outcomes in infant (and maternal) behavior of mother-infant interaction.

Bower and Watson share with us a strong interest in the phenomena of operant learning, but their interests stem in differing ways from nonbehavioral, perhaps cognitive, and nonmainstream learning traditions. In the papers that follow, their emphases can be constructively provocative for the behavior-analytic approach to operant learning generally and for the field of infant operant conditioning in particular.

Summary

This introduction to the papers and commentaries that follow has considered the conception of contingency both in historical and functional behavior-analytic contexts. This has included the role of antecedent (discriminative) and consequent (reinforcing or punishing) stimuli in contingencies. Further, the implications of heterogeneous natural versus homogeneous laboratory research contexts for contingency models was discussed. Thus, in laboratory research on conditioning, there ordinarily are not occasions on which the usually contingent stimulus is presented either in the absence of the target response or preceding that response. The absence of such occasions has provided one basis for the discrepancy between routine behavior-analytic analyses and the proposals of Bower and Watson. It was suggested also that very different assumptions, constraints, and empirical questions are generated by different theoretical approaches, such as the cognitive versus the behavioral, that could necessarily lead to different research preparations and, inevitably, to their different conclusions. The requirement for a stimulus detection response, separate from the change in response denoting learning, was also questioned. In behavior analysis, a response detecting an antecedent or con-

sequent stimulus is inevitably involved in successful conditioning; hence, its inclusion in the explanation ordinarily is thought not to be required. In this context, it was thought that the very different theoretical approaches and assumptions, preparations, empirical questions, and conceptual conclusions about the conception of contingency in preverbal infants raised by Bower and Watson could put into constructive relief issues bearing on the contingency concept in behavior analysis.

REFERENCES

- Baer, D. M., & Wolf, M. M. (1970). Recent examples of behavior modification in pre-school settings. In C. Neuringer & J. L. Michael (Eds.), *Behavior modification in clinical psychology* (pp. 10–55). Englewood Cliffs, NJ: Prentice Hall.
- Bower, T. G. R. (1997). Contingencies, logic, and learning. *The Behavior Analyst*, 20, 141–148.
- Cigales, M. (1997). Intersections of behavior analysis with cognitive models of contingency detection. *The Behavior Analyst*, 20, 161–166.
- Egel, A. L. (1981). Reinforcer variation: Implications for motivating developmentally disabled children. *Journal of Applied Behavior Analysis*, 14, 3–12.
- Galbicka, G., & Platt, J. R. (1984). Interresponse-time punishment: A basis for shock-maintained behavior. *Journal of the Experimental Analysis of Behavior*, 41, 291–308.
- Galbicka, G., & Platt, J. R. (1989). Response-reinforcer contingency and spatially defined operant: Testing an invariant property of phi. *Journal of the Experimental Analysis of Behavior*, 51, 145–162.
- Gewirtz, J. L., Carr, J. E., & Roth, W. E. (1995). *An evaluation of the infant operant-conditioning literature*. Unpublished manuscript, Florida International University.
- Gewirtz, J. L., & Pelaez-Nogueras, M. (1992). B. F. Skinner's legacy to human infant behavior and development. *American Psychologist*, 47, 1411–1422.
- Gewirtz, J. L., & Pelaez-Nogueras, M. (1993). "Expectancy": Sleight-of-hand mentalism, not mechanism or process. *American Psychologist*, 48, 1156–1157.
- Gewirtz, J. L., & Pelaez-Nogueras, M. (1996a). El analisis conductual del desarrollo. In S. W. Bijou & E. Ribes (Coordinadores), *El desarrollo del comportamiento* (pp. 77–106). Guadalajara: Universidad de Guadalajara.
- Gewirtz, J. L., & Pelaez-Nogueras, M. (1996b). 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.
- Guthrie, E. R. (1952). *The psychology of learning* (rev. ed.). Magnolia, MA: Peter Smith. (original work published 1935)
- Kantor, J. R. (1959). *Interbehavioral psychology*. Chicago: Principia Press.
- Konorski, J., & Miller, S. (1937). On two types of conditioned reflex. *Journal of General Psychology*, 16, 264–272.
- Lattal, K. A., & Shahan, T. A. (1997). Differing views of contingencies: How contiguous? *The Behavior Analyst*, 20, 149–154.
- Marr, J. (1997). Infants' feats of inference: A commentary on Bower and Watson. *The Behavior Analyst*, 20, 155–159.
- Millar, W. S. (1972). A study of operant conditioning under delayed reinforcement in early infancy. *Monographs of the Society for Research in Child Development*, 37 (2, Serial No. 147).
- Pavlov, I. P. (1960). *Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex*. (G. V. Anrep, Trans.) New York: Dover. (original work published 1927)
- Peters, R. S. (Ed.). (1965). *Brett's history of psychology*. Cambridge, MA: MIT Press.
- Piaget, J. (1936). *The origins of intelligence*. New York: Norton.
- Reeve, L., Reeve, K. F., & Poulson, C. L. (1993). Parameters of delayed reinforcement in young infants. *Journal of the Experimental Analysis of Behavior*, 60, 515–527.
- Skinner, B. F. (1935). Two types of conditioned reflex and a pseudo-type. *Journal of General Psychology*, 12, 66–77.
- Skinner, B. F. (1937). Two types of conditioned reflex: A reply to Konorski and Miller. *Journal of General Psychology*, 16, 272–279. (Reprinted in *Cumulative record*, pp. 376–389, by B. F. Skinner, 1959, New York: Appleton-Century-Crofts)
- Thorndike, E. L. (1898). Animal intelligence: An experimental study of the associative processes in animals. *Psychological Monographs*, 2, No. 8.
- Thorndike, E. L. (1911). *Animal intelligence*. New York: Macmillan.
- Tolman, E. C. (1932). *Purposive behavior in animals and men*. New York: Appleton-Century.
- Walker, J. T. (1996). *The psychology of learning: Principles and processes*. Upper Saddle River, NJ: Prentice Hall.
- 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.