

Contingency and Behavior Analysis

Contingencia y análisis de la conducta

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Abstract

The concept of contingency is central to theoretical discussions of learned behavior and in the application of learning research to problems of social significance. This paper reviews three aspects of the contingency concept as it has been developed by behavior analysts. The first is the empirical analysis of contingency through experimental studies of both human and non-human behavior. The second is the synthesis of experimental studies in theoretical/conceptual frameworks to yield a more general account of contingency and to integrate the concept with other behavioral processes. The third aspect is one of practical considerations in the application of the contingency concept in both laboratory and applied settings.

Key words: contingency, contingency functions, contiguity, molar analysis, molecular analysis.

Resumen

El concepto de contingencia es central tanto para las discusiones teóricas sobre conducta aprendida, como para aplicar los hallazgos de la investigación sobre aprendizaje a problemas de relevancia social. Este trabajo revisa tres aspectos del concepto de contingencia tal y como ha sido desarrollado por los analistas conductuales. El primer aspecto es el análisis empírico de la contingencia a través de estudios experimentales de la conducta, tanto con humanos como con no humanos. El segundo aspecto es la síntesis de estudios experimentales en marcos teórico/conceptuales, tanto para dar una descripción más general de la contingencia, como para integrar el concepto con otros procesos conductuales. El tercer aspecto se

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refiere a consideraciones prácticas para la aplicación del concepto de contingencia, tanto en el laboratorio como en situaciones aplicadas.

Palabras clave: contingencia, funciones de la contingencia, contigüidad, análisis molar, análisis molecular.

Contingency and Behavior Analysis

Imagine, if you will, the first single-celled organism, or perhaps its precursor, floating about in the primordial soup. For whatever phylogenic or ontogenic reason, it turns to one side and thereby encounters a richer concentration of protochemicals essential to its survival. Thereafter, it more often than before turns to that side. This imaginary scene is at least a successive approximation to the first instance of what we in behavior analysis refer to as a contingency. The rest is reinforcement history.

The concept of contingency is central in any discussion of learned behavior and in the application of learning research to problems of social significance. Indeed, more than any other single process, principle, concept, or idea, it is the *raison d'être* of behavior analysis. It ties together behavior analytic basic research and its applications. Furthermore, it provides the thread that weaves our empirically-based understanding of behavior to conceptual issues and phenomena presently beyond empirical evaluation.

Because the contingency concept is so important to what we do as behavior analysts in the laboratory and in applied settings, it seems valuable to revisit the concept to both review what we have learned about it and to consider what is left to be known. I first will review experimental work bearing on the definitions and functions of contingencies. Then I will consider the synthesis of the contingency concept as it relates to levels of behavior analytic description and explanation. Finally, I will address some practical considerations in the application of the contingency concept in both the laboratory and in applied settings.

Background

By way of embarking on an analysis of contingency, let us return to our now frequently-turning-to-one-side protozoan. After pausing briefly to observe the behavior and record the data, we can quickly jump forward in time. As we do so, we encounter *en route* many ideas that play an important role in the evolution of the contingency concept: Aristotelian philosophy, the mechanics of Galileo and Newton, Bacon's keen observa-

tions on induction, analyses of cause and effect by the Scottish philosopher Hume, and Darwin's incisive descriptions of natural selection. Finally, we land in the laboratory of Edward L. Thorndike. Here, in the late 1800s, through extensive, careful laboratory work with cats escaping from puzzle boxes, Thorndike provided the first experimental analysis of the contingency. These data were synthesized as the Law of Effect, which stated in part that:

Of several responses made to the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected to the situation so that, when it recurs, they will be more likely to recur (1911, p. 244).

This, one of American Psychology's first home-grown laws, sparked controversy because of concepts like satisfaction and connection, its at least superficial circularity, and its seemingly backward action of effect (e.g., Wilcoxon, 1969).

By the 1930s, Skinner had championed the empirical Law of Effect, clarified some of the controversial points raised in response to Thorndike's presentation, and invoked a refined version of it in disentangling Pavlovian and operant or instrumental conditioning. In reply to Konorski and Miller's (1937) comments on his distinction of two types of conditioned reflex and a pseudotype, Skinner first described conditioning that "results from the *contingency* (italics added) of a reinforcing stimulus upon a stimulus [Type S] ... and ... that resulting from a *contingency* (italics added) upon a response [Type R]" (1937/1961b, p. 377).

The contingency concept became widely used thereafter. The term "contingency" has several formal definitions, including uncertainty and fortuitousness (*The Random House Dictionary*, 1971; see Lattal and Poling, 1982, and Staddon, 1992 for other points related to the definitions of contingency). In behavior analysis, contingency sometimes is used as a synonym for a schedule of reinforcement, defined as the interrelations among discriminative stimuli, responses, and consequences over time (e.g., Skinner, 1969; Zeiler, 1972). At other times it is used more specifically to describe only the relation between responses and events that follow -- putative reinforcers or punishers. This latter usage is technically incorrect (see Lattal & Poling, 1982 for a discussion of this issue) but it will be employed here for the sake of brevity and because it is so common in behavior analytic speech and writing. Other definitions of contingency have been proffered (e.g.,

Gibbon, Berryman, and Thompson (1974); Rescorla, 1967; Scott & Platt, 1985). These latter definitions are useful, more quantitative elaborations on the second usage noted above; however, their development is beyond the scope of this review.

I shall use "contingency" most generally as a description of the relation between responses and other events. My remarks originate from research focusing on response-event relations where the events involve either food presentations or other putative reinforcers, although the remarks are equally applicable to procedures involving aversive events (e.g., Azrin, 1956). Finally, for ease of presentation, I shall distinguish between events—putative reinforcers ["rewards"] or punishers²—delivered independently of responding from those that result from responses by describing the former as either response-independent or free and the latter as response-dependent or earned.

Empirical Analyses of Contingency Functions

A considerable amount of the empirical work on contingency has involved the specification of the contingency as the relation between a given response or responses and subsequent food or other putative reinforcer presentations. Here, four functions of a contingency currently have been isolated: determining response rates, response patterns, response topography, and serving as discriminative stimuli.

Determining response rate

Perhaps the most salient effect of the relation between a response and a putative reinforcer, or punisher, is determining response rates, as illustrated by the data in Figure 1.

The top graphs, adapted from data reported by Lattal and Maxey (1971), show response rates of two rats during a two-component multiple schedule where the two components alternated and were correlated with either a bright or a dim light. Earned food presentations occurred in the component labeled "E" in the figure and an equivalent number and dis-

2 Events such as food presented independently of responding do not meet the functional definition of a reinforcer (an event that when made dependent on a response either increases or maintains behavior - e.g., Catania, 1991); however when such response-independent food presentations are made response dependent the necessary behavioral changes for defining a reinforcer usually are observed. Thus, the term "putative reinforcer" will be used here in to describe food presentations delivered independently of responding.

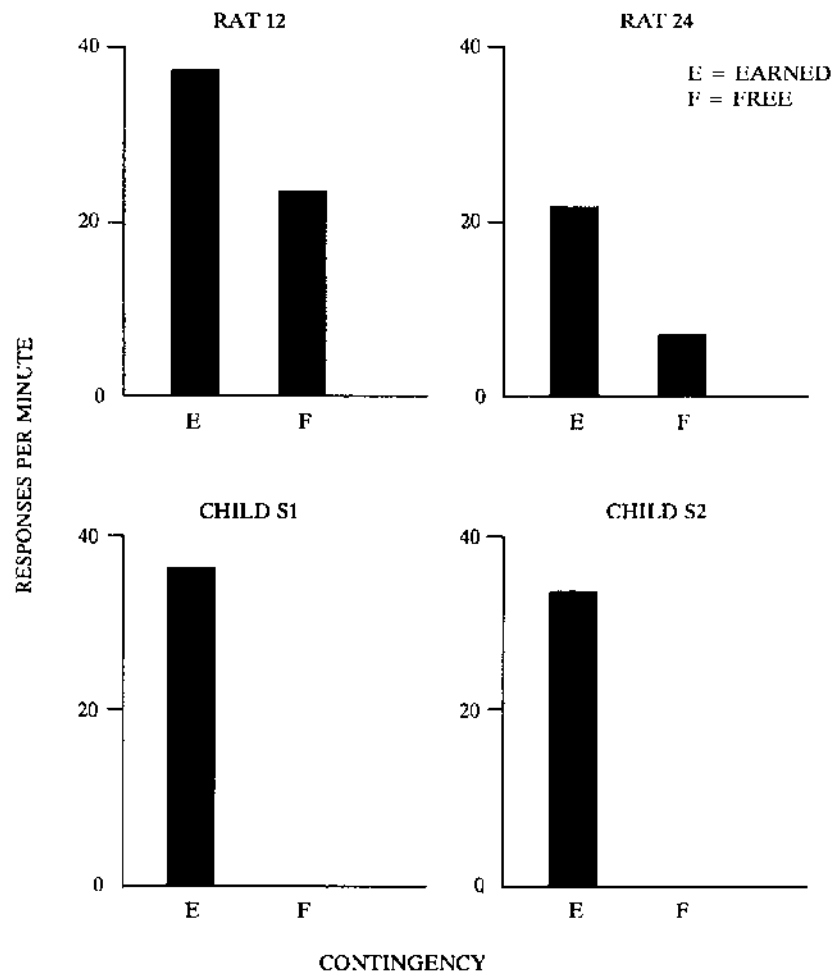
tribution of free food presentations occurred in the component labeled "F." The lower graphs are redrawn from data reported by Redd and Birnbrauer (1969). They show a measure of cooperative play by children during a multiple schedule where two different adults were present in each of the two components of the schedule. One adult dispensed rewards dependent on play and the second dispensed an equivalent number of rewards independently of play responses. The results of both experiments are similar: response-dependent rewards make the response more likely.

Organisms in natural settings commonly encounter a mix of events that result from their actions and others that occur independently of responding. Such a mix probably is more characteristic of natural settings than the preceding examples wherein rewards were either all earned or all independent of responding. Combinations of earned and free presentations of a previously-established reinforcer yield response rates that are between the two extremes. These effects are illustrated in Figure 2 for pigeons, monkeys, and children. The human data, shown in the bottom graphs, are replotted from data reported in a second experiment conducted by Redd (1969). Here, three different adult humans dispensed either all earned, all free, or a mixture of earned and free rewards to children where the target behavior was playing. The adults dispensing earned and free rewards controlled, respectively, the most and least play, and the adult dispensing a mix of the two controlled an intermediate level of play. Similar results were found by Lattal (1974) with pigeons, shown in the top graphs, where the percentage of earned and free food presentations was varied systematically during the experiment. The data in the middle set of graphs are replotted from an experiment by Bacotti (1978). Monkeys' responding first was established and maintained by a fixed-interval (FI) schedule in which the first response after the FI lapsed produced a shock (cf. Kelleher & Morse, 1977). Next, the proportion of earned and free shocks at the end of the FI was varied across conditions. The results were similar to those from Redd (1969) and Lattal (1974), where more conventional rewards were used: response rates were higher when more of the shocks were earned rather than free.

Data like those presented above illustrate the effects of contingency on the rate of behavior; however, some recent experiments have raised interesting questions about the relation between contingencies, the rate of behavior, and the strength of the behavior. For example, Nevin (1974, Experiment 5) and Lattal (1989) found that low response rates were more resistant to change, and in that sense stronger, than were high response

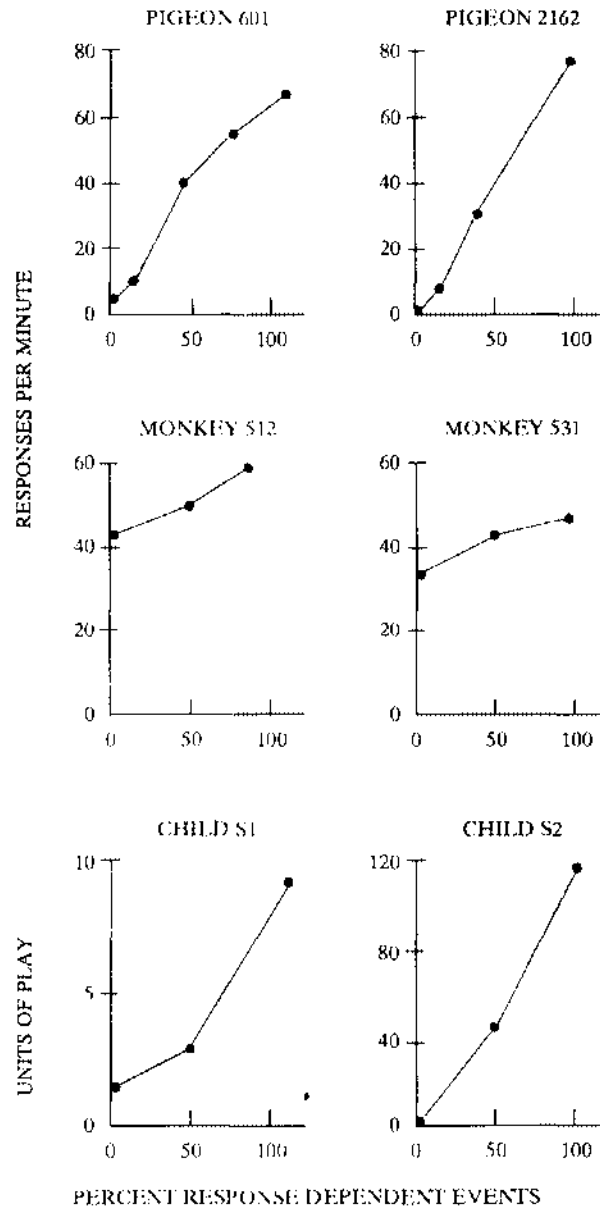
rates. Nevin, Smith, and Roberts (1987) have suggested that the inclusion of a response-reinforcer contingency *per se* does not result in stronger operant behavior, where strength again was defined as resistance to change.

Figure 1



Behavior of rats and children in two-component multiple schedules where one component arranged response-dependent (labeled E, for earned) and the other response independent (labeled F, for free) rewards. The rat and children data were adapted from, respectively, Lattal & Maxey (1971) and Redd & Birnbrauer (1969).

Figure 2

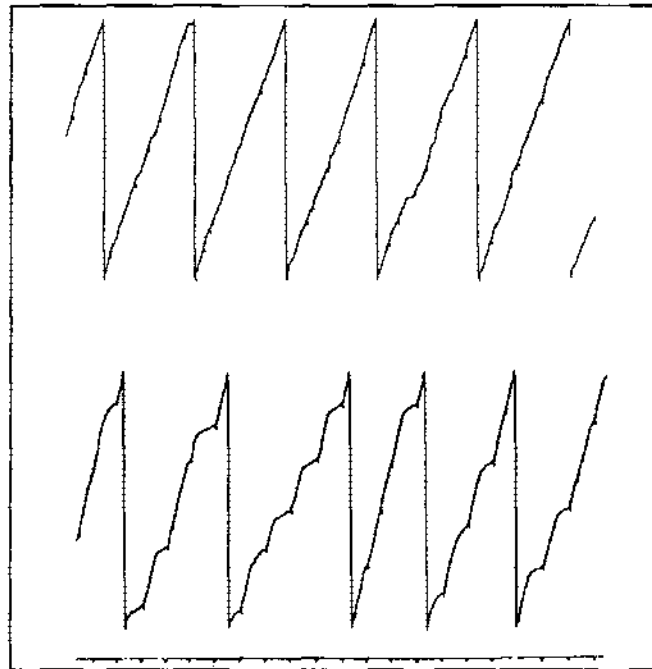


Behavior of pigeons, monkeys, and children as a function of the percent of events indicated in parentheses that were response dependent. The pigeon, monkey, and children data were adapted from, respectively, Lattal (1974), Bacotti (1978), and Redd (1969).

Determining response patterns

The pattern of responding, that is, the temporal distribution of responses, is determined largely by the temporal distribution of rewards without regard to whether they are earned or free (e.g., Zciler, 1968). However, combinations of earned and free rewards may interact to yield novel behavior patterns. For example, in one experiment, pigeons first were trained to key peck on a variable-interval (VI) schedule. Next, free food presentations delivered at regular (i.e., fixed) time periods were added onto the VI schedule. The result is shown in Figure 3. The top record from the VI baseline schedule shows a typical linear response pattern.

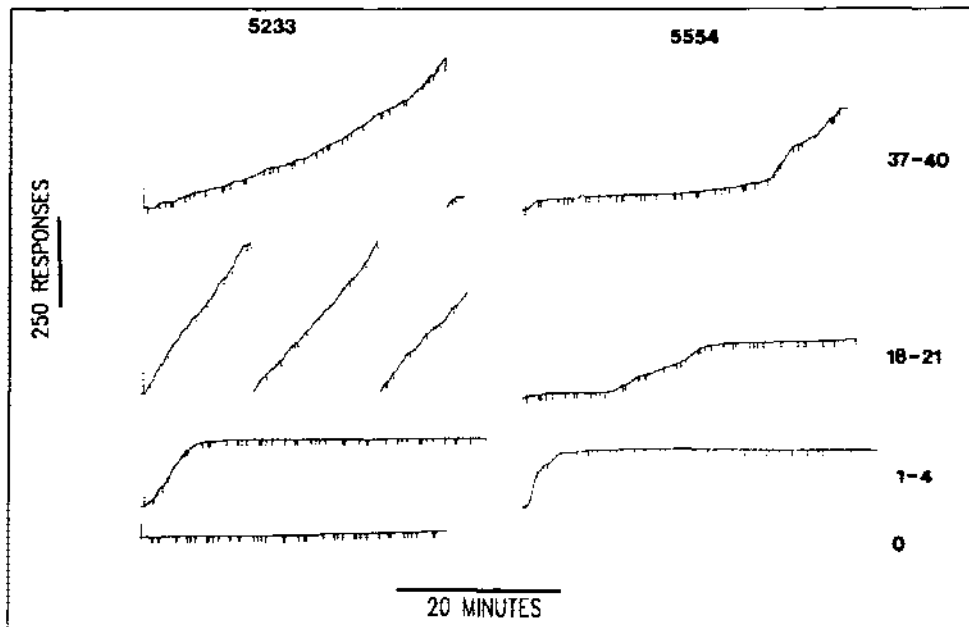
Figure 3



Cumulative records showing responding controlled by a variable-interval schedule in the absence (top record) and presence (lower record) of additional food deliveries at fixed times (every 2.5 min) that occurred independently of responding. The latter food deliveries are indicated by deflections of both the response and event pens in the lower record. In the upper record, deflections of the response pen show earned food deliveries. The response pen reset after 550 responses. The first 52 min of a 90 min session is shown in the record.

In the lower record, where free food presentations were added to the VI as noted, negatively accelerated responding developed between successive free presentations of food.

Figure 4



Cumulative records showing the effects of different locations of a block of four response-dependent food presentations on key-peck responding of pigeons. See text for details. (From Lattal, et al., 1989).

Figure 4 shows the effects on pigeon's key-pecking of moving a block of four response-dependent food presentations to different locations in a schedule where the other 56 food presentations were response independent (Lattal, Freeman, & Critchfield, 1989). All of the interfood intervals were different and averaged 60 s in duration. The ordinal locations of the earned, response-dependent food presentations are given on the right. For example, "1-4" indicates that the first through the fourth food presentation in the session was response dependent and that the fifth through the 60th occurred independently of responding. Response patterns tracked the location of the earned food presentations, with response rates highest in

the region where the earned food presentations occurred and lower elsewhere.

Determining response location and topography

A third function of a contingency is one of defining and controlling response location and topography. For example, Staddon and Simmelhag (1971, p. 13) suggested that the location of pecking was more variable under response-independent as opposed to response dependent food presentations.

The role of contingency in controlling response location and topography is further illustrated by an attempt in my laboratory to manually shape a pigeon's key peck with un signaled delayed reinforcement. Such reinforcement retains the response-reinforcer relation but the relation is degraded because of the temporal delay between the response and its consequence. With each approximation to the key-peck response, a shaping switch was operated, which in turn started a ten-second un signaled delay period. After the timer lapsed, the reinforcer was delivered. For over forty consecutive daily one-hour sessions I tried without success to shape the key peck. But the animal's behavior was revealing nonetheless. The pigeon would move systematically back and forth in front of the key, with the limits of its movements determined by the delay interval. When the delay was shortened to 1 s, key-peck responding of both that and another pigeon with no prior history was shaped quickly. Even so, the still-degraded (by 1 s) contingency allowed more variation in response topography than occurred when immediate reinforcement was used to shape responding of other naive animals.

Serving as Discriminative Stimuli

The final contingency function to be described here is a discriminative one. A first question is whether the contingency can serve this function. A positive answer to the first question still leaves a second question: how do such discriminations enter into schedule-controlled performance?

The first question can be formulated to ask whether organisms can distinguish situations where events occur in different temporal relations to their behavior. A modified matching to sample procedure has proven useful in answering this question. An example of such a procedure is diagrammed in Figure 5.

Figure 5

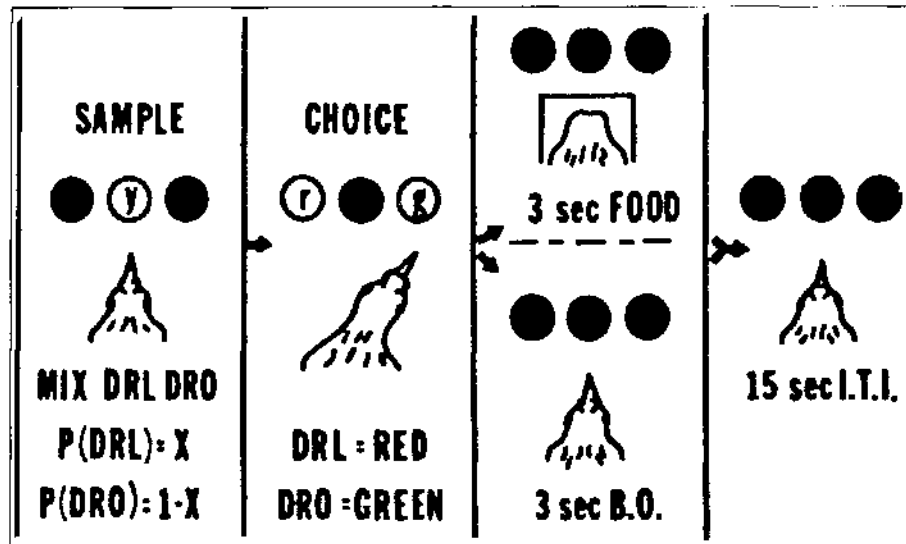
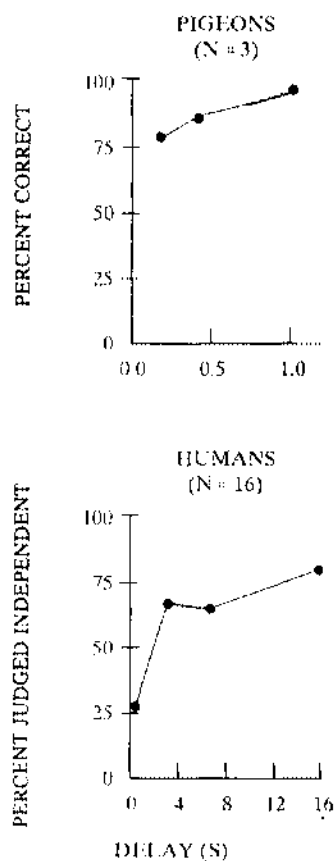


Diagram showing a modified conditional discrimination or matching-to-sample procedure in which different contingencies on the center key (peck or no-peck) lead to the choice component and determine the correct choice response. (From Lattal, 1975)

One of two contingencies, peck (according to a differential-reinforcement-of-low-rate, or DRL, schedule) or do not peck (arranged by a differential-reinforcement-of-other-behavior, or DRO, schedule), was in effect on the sample key (which was illuminated by the same color light during both contingencies) on different trials within a session. Meeting the requirement on the sample key turned off the sample key light and simultaneously yielded two choice keys. Pecking the left key produced food if the sample required a peck to produce the choice and pecking the right key produced food if the sample required the animal to refrain from pecking. Under such conditions choice accuracy was high, with over 80 percent correct choice responses (Lattal, 1975).

In one variation of the above procedure, Nussear and Lattal (1983) examined the effects of different pause requirements between a response and the onset of the choice component. The choice was between an immediate stimulus change from sample to choice component on half of the trials and a stimulus change that was separated from a peck by different time intervals — 0.25 s, 0.50 s, or 1.0 s during different conditions— on the other half of the trials.

Figure 6



Performance of pigeons (top) and humans (bottom) in selecting whether responding or its absence caused another event to occur, as a function of the time between the response and the subsequent event. See text for details. The pigeon data were adapted from Nussear & Lattal (1983) and the human data were adapted from Shanks, Pearson, and Dickinson (1989).

Choice performance was accurate and, as shown in the top half of Figure 6, for three pigeons, it was more accurate with greater temporal separation (delay) between the response and the onset of the choice component.

The lower half of Figure 6 shows some related results replotted from a study reported by Shanks, Pearson, and Dickinson (1989). Humans were asked to report whether or not their responses on a computer keyboard caused a triangle to appear on a nearby computer screen. A response always caused the triangle to appear. But as the delay between the response

and the consequence increased, subjects were more likely to report that the two events were independent of one another. Thus, with both pigeons and people the temporal relations between responses and consequences can control discriminative responding.

Turning to the second question of how such discriminations enter into schedule-controlled performance, methods derived from signal detection theory (Green & Swets, 1966) have proven useful. Through a combination of psychophysical and decision theory methods, a signal detection analysis allows assessment of the indirect effects of response sensitivity to the contingency separate from the direct effects of reinforcement on responding (Lattal, 1979, 1981; Killeen, 1978). More generally, in human behavior determining which of our actions cause changes in others has been suggested to play an important role in a wide range of social actions (e.g., Hinde, 1992).

The four functions of contingency reviewed here—determining response rate, pattern, and topography, and as discriminative stimuli—often operate in concert in natural settings to control behavior. Usually it is only in controlled settings that the functions can be separated and analyzed in detail.

Theoretical Accounts of Contingency Effects

Empirical investigations of contingency like those described above give rise to theoretical accounts focused on the time frames over which a contingency is effective. Some have proposed that contingency effects are local and more or less instantaneous. Others counter this idea with a view of contingency as having behavioral effects over extended or non-instantaneous, molar time periods. These contrasting points of view have led to different suggestions concerning the mechanisms underlying the reinforcement process.

In the former case, the contingency's function is viewed as ensuring temporal contiguity between response and reinforcer. Historically, in both operant and classical conditioning, reinforcers were viewed as being effective because of their closeness in time to either the conditional stimulus or the response. Skinner's (1948) account of adventitious reinforcement and subsequent theoretical accounts of reinforcement schedule performance (e.g., Anger, 1956), as well as numerous analyses of Pavlovian conditioning (e.g., Terrace, 1973) emphasized the importance of temporal contiguity in understanding reinforcement in both types of conditioning.

In the latter case, the contingency's function is viewed as one of ensuring a correlation between aggregates of responses and reinforcers in time (e.g., Williams, 1983). The idea of responses and reinforcers having effects that extend beyond the period immediately after their occurrence suggests that aggregates of responses and aggregates of reinforcers act on one another in time. When the contingency is described in terms of response-reinforcer relations over non-instantaneous time frames, the action of individual response-reinforcer relations often are subjugated to this more general relation. *Some* theoretical accounts of choice (e.g., Herrnstein, 1970) and of free-operant avoidance (e.g., Herrnstein & Hineline, 1966) provide the best examples of this view of contingency.

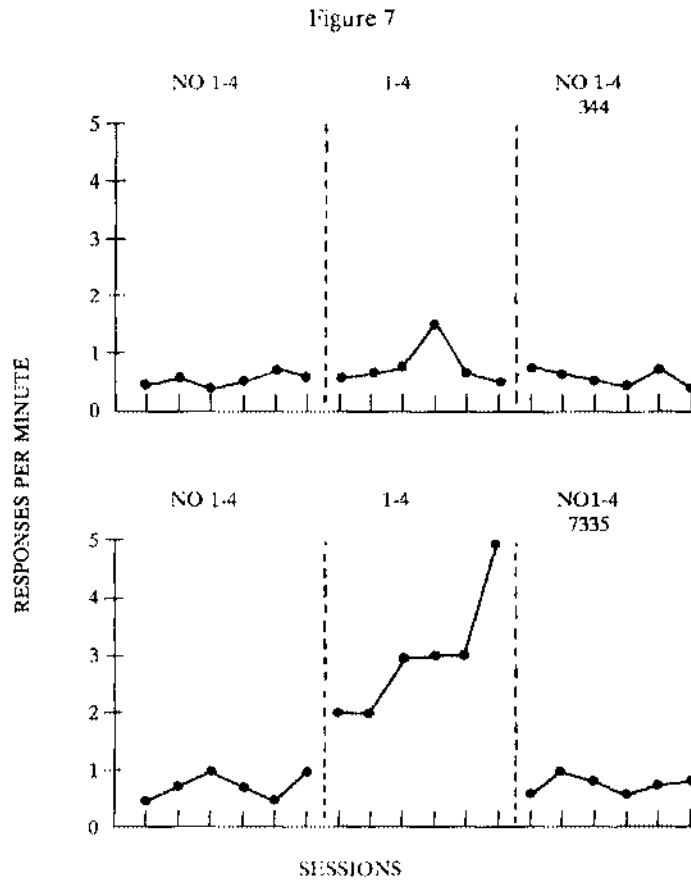
The molar view of contingency described in the preceding paragraph has its origins in Skinner's seminal papers written in the 1930s (e.g., Skinner, 1935/1961a; 1938) wherein he developed the idea of the operant as a class of responses, all of which operate similarly on the environment. Operants were fluid and flexible, not restricted to particular forms, in terms of either time or space. Thus, operants, which are formed on the basis of a contingency between responses and consequences, can be identified as either momentary responses or patterns of responses over non-instantaneous time periods. For example, Hawkes and Shimp (1975) showed that a temporal pattern of responding by pigeons over 5-s intervals could be changed from positively accelerated to linear to negatively accelerated by reinforcing these patterns differentially. The criterion for operant class membership is simply that members of the class affect the environment in similar ways (e.g., Glenn, Ellis, & Greenspoon, 1992). Thus, such characteristically human actions as social interchange or productivity can be included as operants in a way identical to the simple animal responses studied in the laboratory.

The Interrelatedness of Molecular and Molar Descriptions of Contingency

Embedded Relations

Even a contingency designed to control responding at the level of one response/one reinforcer may involve what has been described as extended, non-immediate, or molar effects. For example, on a food schedule of reinforcement, subsequent reinforcers cannot be collected until the first one in the sequence is obtained. Thus, responding may be controlled by both the reinforcer that follows immediately and by the contingency between

present responding and access to upcoming (from the experimenter's standpoint) reinforcers.



Responding of two pigeons as a function of the absence (labeled no 1-4) or presence (labeled 1-4) of a requirement that a sequence of four unsignaled intervals end with a response before a subsequent series of 56 response-independent food presentations. The data were replotted from Lattal, Freeman, & Critchfield (1989).

The pigeon data in Figure 7, replotted from Lattal et al. (1989; Experiment 5) illustrate this point. Free food presentations first occurred throughout a session at variable times averaging 60 s. Little responding occurred. In the next condition, free food presentations continued to occur, but with a

restriction. Before the free food presentations were available in the session, passing through a series of four intervals was required. The intervals varied in duration and a response at the end of each interval advanced the schedule to the next one. When the four intervals each had been followed by a response, the free food schedule was started. There was no stimulus change following completion any of the four intervals nor between the interval requirements and the free food schedule. Responding increased; slightly for one subject but substantially for the other, as shown in the second panel of the figure. These increases largely were the result of increased responding at the beginning of the session, where the contingency was in place. As shown in the third panel of the figure, eliminating the contingency between early session responding and subsequent free food reduced responding.

Attempts to Isolate Contiguity and Contingency Effects

Disentangling empirically the effects of temporal contiguity separately from those of contingency to determine either the primacy of one process over the other or to assess their independent contributions to maintaining behavior has proven tricky and controversial. A review of the many ways in which such disentanglement has been attempted is beyond the scope of this paper; however, an example illustrates some of the problems.

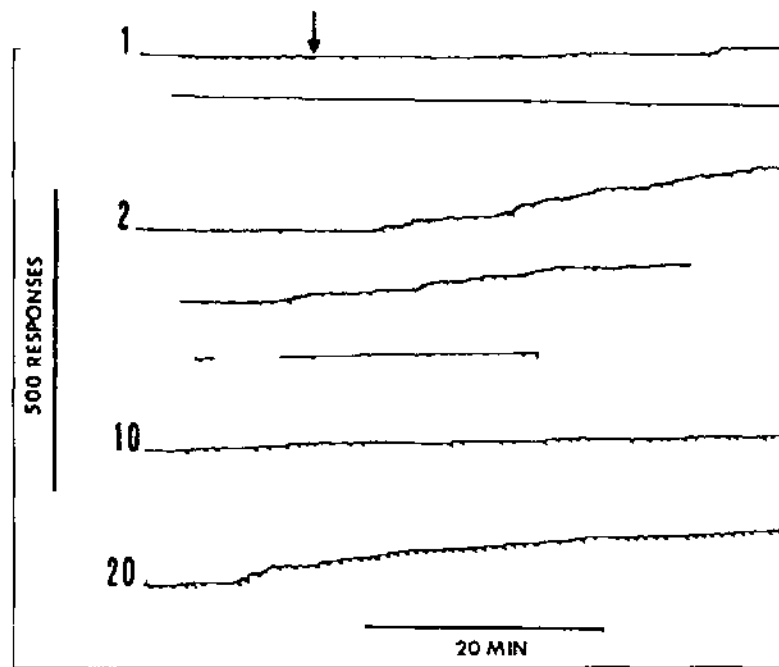
Unsignaled delay of reinforcement procedures (Sizemore & Lattal, 1977; Williams, 1976) are interesting in relation to the contingency-contiguity discussion because they represent a middle ground between free and earned food presentations. Free food presentations disrupt temporal contiguity and eliminate the correlation between responding and reinforcement. Earned reinforcers (those occurring immediately after responses) retain the correlation but simultaneously ensure response-reinforcer temporal contiguity. Unsignaled delays are between the other two. They retain the contingency; reinforcers cannot occur unless responses do but disrupt temporal contiguity.

Consider a direct comparison between free and unsignaled delayed food presentation effects on responding following a history of sustained responding with immediate reinforcement. In both procedures, temporal contiguity is disrupted but only the unsignaled delay procedure retains a correlation between responding and reinforcement. We have made several such comparisons with somewhat mixed results, particularly with longer delays (e.g., Gleeson & Lattal, 1987). At least two problems make the

results difficult to interpret. One is that response rate and temporal contiguity covary so that higher rates also yield closer average response-reinforcer temporal contiguity. The other is that delayed or free food presentations are imposed after a history of immediate reinforcement, which may continue to affect responding even after the contingencies change.

The problem of an immediate reinforcement history in the aforementioned results led us to eliminate such a history. Experimentally naive rats, pigeons, Siamese Fighting fish, and pet dogs learn new responses when the consequence of such responding occurs only after a relatively long (30 s) unsignaled delay period initiated by the response (e.g., Lattal & Gleeson, 1990; Lattal & Metzger, 1994).

Figure 8



Cumulative record of a rat's first exposure to an unsignaled delay of reinforcement procedure (to the right of the arrow in the top record) following a magazine training (to the left of the arrow in the top record). No training other than approach to the food magazine was given and each bar press response after reinforcement initiated a 30-s, resetting delay interval. The data are from Lattal and Gleeson (1990, Experiment 5).

Figure 8 shows magazine training (to the left of the vertical arrow) and the beginning of the first session (to the right of the arrow) in which each bar press response of a rat produced a reinforcer after a 30 s delay. The rat was not trained to respond; rather it simply was left in the operant chamber after magazine training. To the right of the arrow and in subsequent sessions (numbered on the left of the figure) each response initiated a 30 s un-signalized resetting delay. Responding occurred during the first session and continued for the next 20 sessions. Such results, at least on the surface, lend support to the notion that contiguity is not necessary for learning.

However, other experiments in our laboratory suggest a more complicated relation. When a backdrop of free food presentations are provided from the beginning of the experiment but each earned reinforcer cancels the next programmed free food presentation, responding under the Lattal and Gleeson procedure still develops. These preliminary findings suggest that responding can be established even when responding is not correlated with more frequent reinforcement. Such results underscore both the problems of disentangling contingency and contiguity experimentally and in considering them as different processes.

Conceptually, temporal-contiguity based accounts of behavior maintained by long delays require the invocation of mediational constructs that range from covert behavioral chains to cognitive processes. Such constructs are needed to ensure that the temporal gaps between responding and reinforcement are bridged. To many behavior analysts, however, accounts of delayed consequences of action and other reinforcement effects in terms of molar, correlational variables akin to those invoked in statistical thermodynamics is preferable to the specter of mediational processes that too easily become reified.

Reconciling Molecular and Molar Views of Contingency

The appropriate level for analyzing behavioral effects is among the oldest conceptual issues in psychology. The distinction between molar and molecular accounts of contingencies (e.g., Baum, 1989; Peele, Casey, & Silberberg, 1984) resonates to early debates leading to the separation of psychology from philosophy and physiology and the dividing of early psychology into schools (e.g., Heidbreder, 1933), and to more contemporary reductionist and nonreductionist views of behavior (e.g., Wertheimer, 1972).

I offer four considerations with respect to the role of molar and molecular variables related to response-reinforcer temporal contiguity in describing reinforcement effects. First, empirically it is difficult to disentangle a molar contingency and molecular temporal contiguity, as was suggested by the experiments described above. As one changes, typically so does the other. Rather than representing different processes they may be two aspects of a single reality. Second, time frames in learning are poorly defined (cf. Williams, 1983). How close is contiguous, and over what period can responses and reinforcers co-relate? A 30-s delay may be considered long in a 30-min session but short in a 30-hr session. Both contiguity and contingency must be considered relative concepts and as such can overlap with one another. Third, the functional definition of an operant precludes the *a priori* exclusion of either level from consideration (see, e.g., the experiment by Hawkes and Shimp, 1975, described above).

A final consideration is pragmatic. Pragmatism is a hallmark of behaviorism generally and of radical behaviorism in particular (Zuriff, 1986). The Watsonian goals of prediction and control of behavior echo Peirce's (Weiner, 1958) and James' (1907/1963) calls for a truth criterion based on "successful working." Radical behaviorism is equally pragmatic and so it should be in addressing the issue of levels of behavioral description. Our concern is with identifying orderly functional relations between features of the environment and behavior. Orderly functional relations have been found at levels characterized as molar and as molecular. In some instances and for some purposes, molar levels of analysis lead to accurate prediction and control of behavior and in other instances molecular levels attain these goals. The two levels of analysis are two aspects of one reality. Both are legitimate and appropriate. Both have predictive and heuristic value. The use of either seems best dictated by a pragmatic truth criterion of successful working, that is, successful prediction and control of behavior, within the appropriate context rather than by more fixed conceptual positions.

Considerations in the Application of Contingency

The effective use of contingency in either applied or research settings requires that other issues be considered beyond knowing about their functions and possible bases of operation. These considerations are summarized in Figure 9. The organism's physical make-up and its environment may be viewed as interacting with past and present situations to yield four classes of variables that potentially affect how the contingency controls behavior.

Figure 9

	PAST	CURRENT
PHYSICAL(ORGANISM)	PHYLOGENIC	PHYSIOLOGICAL
ENVIRONMENTAL	ONTOGENIC	ONTOGENIC

Matrix labeling the interactions between past and present events and physical and environmental influences on behavior.

The first consideration is the role of the organism's phylogeny, beyond a trivial anatomical one, in effecting behavior change through the application of contingency. The problem with phylogeny is not in properly acknowledging a role for evolutionary forces in contributing to current behavior, but, as has sometimes happened outside behavior analysis, in uncritically assigning them an exclusive or overriding role. Some evidence for phylogenetic constraints on contingency effectiveness is in the form of negative results. Other evidence, by behavior analytic standards, involves weakly defined or implemented contingencies. Phylogeny needs to be considered, but without undermining or overriding the role of the ontogenic considerations described below.

Physical or physiological states or conditions of the organism certainly affect contingency operation but, as with phylogeny, caution must be exercised in assessing the sources of behavioral control. Consider a procedure wherein the effects of d-amphetamine were examined on pigeons responding under a multiple fixed-ratio (FR) DRL schedule (Gibson, 1967). Under this schedule the FR and DRL schedule were correlated with distinct discriminative stimuli that alternated irregularly. The drug increased DRL responding and decreased FR responding. Thus, in the same organism in the same session the same drug both increased and decreased behavior. Such a finding suggests that the behavioral effects are not simply a result of the organism's physical state, which presumably is the same in both components of the multiple schedule, but rather are a function of the different contingencies in operation.

Within rather broad and loosely defined limits set by phylogenetic and physiological processes, one must turn to ontogeny in the form of past and current environments to understand the effective application of contingency. Some critics of behavior analysis have questioned whether environmental contingencies, past or present, have any role in human behavior. For

example, Deci (Deci & Ryan, 1985), Kohn (1989), and Lepper & Greene (1978) have suggested that contingencies developed and analyzed over the last 50 years undermine intrinsically motivated behavior and therefore are useless, if not dangerous. Aside from the questionable experimental evidence in support of their claims (see Dickinson, 1989, for a critique), the implicit idea that contingencies are not currently or historically operative in what such critics describe as intrinsically motivated behavior is antithetical to a behavior analytic world view. The forms of the "intrinsically motivated behavior" upon which these critics focus have been shaped as certainly as the bar-pressing of a rat in any undergraduate learning course. Contingencies are ubiquitous and environments are uncanny in creating them. This was precisely the point, and the strength, of Skinner's (1948) discussion of "superstition" in the pigeon, where he proposed that in the absence of experimenter-arranged contingencies environments still create them and thereby maintain behavior. Simply because we do not or cannot see them in the current repertoire does not constitute evidence of their absence in either bringing about or maintaining current behavior. Thus, it is never a question of whether a contingency is in effect, but rather which ones do we use in attaining behavior change.

Behavior analysts have only begun to explore the role of past contingencies on present behavior (e.g., Freeman & Lattal, 1990; Wanchisen, Tatham, & Mooney, 1989). Anecdotal evidence from traditional psychology suggests that such historical contingencies can be powerful (e.g., Freud, 1969). Whether such anecdotes are accurately described as historical effects or whether they are better described in terms of a functional analysis of the present environment is, at this point, unresolved. However, it is difficult to imagine that contemporary contingencies cannot be arranged to control behavior presumably brought about by contingencies no longer in effect. The use of contemporary contingencies in controlling behavior requires that other questions be addressed. For example, are the contingencies naturally in effect working, or is intervention invited? Ferster (1965) addressed this issue in his distinction between natural versus arbitrary reinforcement. Other considerations include whether one is better advised to use aversive or positive contingencies (Skinner, 1953; Iwata, 1988) and the role of verbal behavior in determining the effects of contingencies on human behavior (e.g., Perone, Galizio, & Baron, 1988).

Methodological questions also must be addressed for the effective use of contingency. For example, when arranged appropriately a contingency can control behavior with exquisite precision. But how precisely need we

control behavior? The rule of thumb is equally applicable in basic research and applied settings: take care to match the contingency to the circumstances. Basic researchers usually match the contingency to the anticipated effects of the independent variable. For example, if an independent variable is expected to have a large effect, a less restrictive contingency may still allow the effect of the independent variable to be observed. On the other hand, independent variables expected to have small effects may require more precision in controlling the baseline responding so the independent variable's effect can be seen. Applied behavior analysts must judge practical and ethical constraints in addition to being concerned with matching the baseline-maintaining contingency with expected effects.

With respect to such matching, a final point to consider is that, at least sometimes, less may be more. For example, we (Sizemore & Lattal, 1978; Lattal & Zeigler, 1982; Arbuckle & Lattal, 1988) have found that loosening a precise contingency by changing from immediate to briefly delayed reinforcement might actually improve performance, if response rate is the index. Other experiments have shown that animals will select a situation involving a choice of contingencies over one where only a single contingency is available (Catania & Sagvolden, 1980).

Conclusion

The contingency is what binds behavior analysis together as a science and a profession, and the Association for Behavior Analysis as an organization. We have come far in understanding our common bond but there still is much to do at both the theoretical and practical level. For example, with advancing computer technology there are new opportunities to expand the contingencies we can study empirically and implement in both laboratory and applied settings (Lattal, 1991). Similarly, Sidman's (1986) conceptual analysis of stimulus equivalence has extended the contingency concept to several higher orders of contingency operation in human conceptual and verbal behavior.

The contingency concept is not always as appreciated in either academic or applied settings as many behavior analysts believe that it should be. Yet, the discovery and articulation of its role in ontogenic selection must stand as one of the great achievements of 20th century behavioral science. The challenge for behavior analysis is to use hard data, gentle persuasion, and a few contingencies of our own to ensure that the contingency concept is even better understood and used even more effectively to benefit humankind.

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