PREFERENCE FOR STARTING AND FINISHING BEHAVIOR PATTERNS

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Pigeon's key pecking was reinforced with food in two experiments in which the correspondence between preference for starting one of two reinforced behavior patterns and the likelihood of finishing it subsequently was examined. Reinforcers were scheduled according to concurrent schedules for two classes of interresponse times, modified such that reinforcers followed a center-key peck terminating either a shorter interresponse time started by a left-key peck or a longer interresponse time started by a right-key peck. In Experiment 1, the times when reinforcers potentially were available were not discriminated, whereas in Experiment 2 they were. Absolute reinforced pattern durations were varied. The relative frequency of starting a particular pattern was highly correlated with relative frequency of that completed pattern in both experiments. Other relations between starting and finishing a pattern depended on whether reinforced interresponse times were discriminated. For instance, preference for starting a pattern sometimes correlated negatively with the likelihood of subsequently completing it. The present experiments are described as capturing part of the ordinary language meaning of "intention," according to which an organism's behavior at one moment sets the occasion for an observer to say that the organism "intends" in the future to engage in one behavior rather than another.

Key words: preference, concurrent schedules, interresponse times, intention, key peck, pigeons

Extrapolating a science of behavior to situations that in ordinary language are described in mentalistic terms may be facilitated by developing more complex reinforcement contingencies. Contingencies involving patterns of responses at different places and at different times have long been recognized as playing an important role in this extrapolation (Hunter, 1920). Two recent examples are short-term "memory" and "self-control" procedures. These procedures require a subject to wait for certain periods of time during which responding has no programmed consequences: A response may commit a subject to wait for a specified period of time. But more generally, a subject may be free to respond at any time, and although a choice may be made that typically initiates a certain behavior pattern, a subject may be free at any time to quit before finishing it. A problem arises when starting a pattern is not a commitment to finish it. What is the relation between starting and finishing

a pattern? The present two experiments demonstrate a new method for the experimental analysis of this relation. The method shows some ways in which preference for starting a pattern is related to the likelihood of finishing it after it is started.

Both experiments used a modified version of a procedure developed to study how a subject's choice behavior can be brought under control of its own recent waiting time (Shimp, 1982, 1983, 1984). In these earlier experiments, choices of left or right side keys were reinforced depending on the durations (shorter or longer) of the previous waiting time. Here, choices initiated rather than terminated reinforced temporal patterns involving waiting times.

EXPERIMENT 1

Concurrent schedules of reinforcement for two temporally defined behavior patterns were arranged so that initiating a shorter or longer reinforced waiting time took the form of pecking a left or a right key. Finishing an initiated pattern consisted of pecking a center key after a specified shorter or longer waiting time. The procedure permitted us to analyze relations between preference for starting a particular pattern and completing it.

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Table 1
Experimental conditions.

Condition	Reinforced interresponse times (s)		Total number of days	Number of days with final parameter values
	Shorter	Longer		
1	0.5-1.0	2.0-3.5	16	16
2	1.0-2.0	3.0-6.0	15	15
3	1.5-2.0	4.5-7.0	20	20
4	2.0-3.0	6.0-9.0	25	13
5	3.0-4.0	9.0-12.0	55	23
6	0.5-1.0	1.5-3.0	15	8

METHOD

Subjects

Three White Carneau pigeons were maintained within ± 10 g of 80% of their free-feeding weights. Subjects 1 and 3 were experimentally naive. Subject 2 had participated in an experiment on short-term memory for items in a list. Water and grit were available at all times in the home cages, where a 14:10 hr light/dark cycle was in effect.

Apparatus

Three standard three-key Lehigh Valley Electronics pigeon chambers were interfaced to a Digital Equipment Corporation PDP® 12/30 which arranged experimental contingencies and recorded the data. A minimal force of approximately 0.15 N was required to operate the keys. Ventilator fans and white noise helped to mask extraneous sounds.

Procedure

The procedure consisted of two parts, a temporal shaping contingency to establish two center-key behavior patterns (waiting times) and a side-key choice contingency. These contingencies are described separately.

Shaping contingency. The procedure was similar to that of previous experiments in which shorter and longer patterns of pecking a single operandum were concurrently reinforced (Hawkes & Shimp, 1974; Shimp, 1983). This contingency consisted of two parts: A variable-interval (VI) schedule to arrange a distribution of minimum interreinforcement intervals and a pattern-selection procedure to assign each

reinforcer arranged by the VI schedule to a particular one of the reinforced patterns.

1. Variable interval schedule. A single VI schedule arranged reinforcement with a probability of .05 every 1.0 s so that the mean programmed interreinforcement interval was 20 s. When reinforcement was arranged, the VI timer stopped and the reinforcer remained available until a key peck terminated the selected pattern. No additional reinforcement could be arranged until a previously arranged one was delivered.

2. Pattern-selection procedure. Each reinforcer arranged by the VI schedule was assigned to one of the two reinforced patterns. The assignments were random in the sense that each pattern was equally likely to have a particular reinforcer assigned to it, and one assignment did not depend on the previous one.

Side-key choice procedure. Pecks on lighted (white) side keys started particular behavioral patterns. This procedure worked as follows. A key peck on either of two illuminated side keys turned both off and turned on a white center key. Each peck on an illuminated side key started a waiting time (an interresponse time) that was then terminated by the following peck on the illuminated center key. Note that an interresponse time was initiated by a peck on a side key and terminated by a peck on the center key. A center-key peck that terminated an interresponse time in the shorter reinforced class was reinforced if a variable interval had timed out, the pattern selection procedure had allocated the next reinforcer to the shorter pattern, *and* the interresponse time had been initiated by a left-key peck. Similarly, a center-key peck that terminated an interresponse time in the longer reinforced class was reinforced if a variable interval had timed out, the pattern selection procedure had allocated the next reinforcer to the longer pattern, *and* the interresponse time had been initiated by a right-key peck. In summary, left- and right-key pecks started shorter and longer reinforced patterns, respectively. Any unreinforced center-key peck turned off the center keylight and turned on both side keylights.

Experimental conditions. Table 1 summarizes how the durations of the two reinforced patterns were varied while their relative duration was maintained at a roughly constant ratio: The longer reinforced pattern was usu-

Fig. 1. The relative frequency of interresponse times of different durations over the last 5 days of a condition in Experiment 1 for the two conditions with the shortest (Condition 6, top row) and longest (Condition 5, bottom row) reinforced interresponse times, indicated below the horizontal axes. Filled symbols connected by solid lines and open symbols connected by dashed lines represent distributions initiated by left- and right-key pecks, respectively. Bird 3 died before Condition 6 was finished.

ally about three times longer and three times wider than the shorter one.

Miscellaneous details. Reinforcement consisted of 2.0-s access to the same mixed grain that provided the subjects' daily diet. During reinforcement, all lights in the chamber were off except for one directly over the food hopper. During all other times the houselight remained on. When lit, any key appeared white. Each session lasted 1 hr and was conducted at approximately the same time, usually 5 days a week. Conditions were terminated, after a minimum of 15 days, when a variety of informal criteria suggested performance was adequately stable.

RESULTS

Figure 1 shows the relative-frequency distributions of interresponse times for the two most extreme conditions (Conditions 6 and 5

with the shortest and longest reinforced interresponse times, respectively). The data in Figure 1 are averages over the last 5 days of a condition. The distributions have the typical properties of such distributions (Shimp, 1968; Staddon, 1968): They show distinct modes corresponding to the two classes of reinforced interresponse times, each mode is at or near the lower bound of the corresponding reinforced category, and dispersion is greater for longer than for shorter categories (Gibbon, 1977).

In Figure 2 the filled symbols represent the relative frequency of left-key pecks (left-key pecks divided by the total left- and right-key pecks), that is, preference for starting shorter reinforced patterns, as a function of the absolute durations of the two reinforced patterns, indexed by the lower bound of the shorter. The open symbols represent the relative frequency of occurrence of the completed shorter rein-

Fig. 2. The relative frequency of left-key pecks (filled symbols) and the relative frequency of the shorter of the two reinforced patterns (open symbols) as a function of the absolute durations of the two reinforced patterns, indexed by the lower bound of the shorter. Points are based on the last 5 days of conditions. Vertical lines represent ± 1 SE. The horizontal dashed line at 0.75 represents the relative reciprocal of the shorter pattern, which was one third as long as the longer pattern. Points for similar Conditions 1 and 6 are identified by corresponding numbers.

forced patterns (patterns in the shorter reinforced category divided by the total completed patterns in either reinforced category) that is, preference for the shorter completed pattern, as a function of the same variable.

Did we manage to vary the degree to which a subject initiated a particular pattern? For 2 of the 3 birds, the answer is yes. For Bird 1, there was no important, systematic effect. The average performance therefore does not represent all individual performances. Two of the 3 subjects started the shorter reinforced pattern least often when the reinforced patterns were shortest and most often when they were longest. The relative frequency of the shorter reinforced completed pattern depended on the same variable in a highly similar manner. Indeed, when averaged (lower right panel of Figure 2), both functions are very similar to the function obtained previously with rats (Shimp, 1984), pigeons (Hawkes & Shimp, 1974; Palmer, Donahoe, & Crowley, 1985), and college students (Shimp, Childers, & Hightower, *in press*) relating preference for the shorter of two reinforced interresponse times to their absolute durations. Thus, the functions begin near indifference and rise to roughly the time-allocation matching value (Shimp, 1983, 1984) at 2 s.

The similarity between the two functions in Figure 2 indicates that preference for starting one pattern rather than the other was similar to preference for producing that entire pattern rather than the other. Preference defined at the brief moment of initiating a pattern was quantitatively similar to preference defined in terms of completed shorter and longer patterns. But it does not follow that starting a pattern and finishing it otherwise corresponded closely, as Figure 3 shows. Figure 3 shows the proportion of times when a subject finished the pattern it had started, as a function of the time required to emit it. It shows the number of shorter reinforced patterns (left-key pecks followed by center-key pecks that terminated interresponse times in the shorter reinforced category) divided by the total left-key pecks (filled symbols) and the corresponding number of longer reinforced patterns divided by the total right-key pecks (open symbols) as a function of the absolute duration of the reinforced patterns. Condition 1 was anomalous in that the correspondence between

starting and finishing was unusually low. Other peculiarities have often been found before on the first condition of experiments on reinforced interresponse times. Presumably, variation in the durations of the reinforced categories helps in some sense to establish time since the last response as a controlling dimension. But apart from the anomalous Condition 1, Figure 3 shows that the correspondence between starting and finishing a pattern declined rapidly as a function of how much time it took to finish it. The degree to which the contingency successfully shaped a correspondence between starting and finishing depended greatly on the temporal characteristics of the reinforced patterns. The likelihood of finishing a pattern that was started was a rapidly declining function of how much time it took to finish it.

A comparison of Figures 2 and 3 reveals an interesting, somewhat counterintuitive higher order relation between preference, on the one hand, and the correspondence between starting and finishing, on the other. Consider that the curves in Figure 2 tend to go up and those in Figure 3 tend to go down. Thus, when preference for starting the shorter pattern was minimal, the correspondence between starting it and finishing it was maximal. Similarly, when preference for starting the shorter pattern was maximal, the correspondence between starting and finishing was minimal. As side-key preference became more extreme, subjects less often completed the pattern they began.

DISCUSSION

We have shown that the absolute durations of two response sequences control the correspondence between starting and finishing them. The relation between preference for starting one rather than another pattern and finishing it is subject to control through conventional operant methodology. The correspondence between starting and finishing fell rapidly so that when the patterns were only a few seconds in duration, the correspondence was only about half as strong as when they were about a second in duration. If in the present context one wants to have a subject finish what it chooses to start, then the time required to finish it must be short.

There was a dissociation between two variables one might intuitively have expected to

Fig. 3. The relative frequency of correct terminations of patterns initiated by left-key pecks (open symbols) and the corresponding relative frequency of correct terminations of patterns initiated by right-key pecks (filled symbols), as functions of the absolute durations of the two reinforced patterns, indexed by the lower bound of the shorter. Points for Conditions 1 and 6 are discriminated by corresponding numbers. Vertical lines represent ± 1 SE. Each point is an average over the last 5 days of a condition.

covary. When their preference between reinforced patterns was most extreme, pigeons most often failed to finish what they started. This dissociation is reminiscent of one previously obtained when side-key choices followed rather than, as here, preceded temporal patterns. In earlier experiments (Shimp, 1982, 1983, 1984), as nonhumans' preference for a shorter reinforced pattern increased, the accuracy of their side-key probe behavior about which of the two patterns they had most recently produced became worse.

In passing, note that the two functions in Figure 2 have the same qualitative features as the function in the experiment of Hawkes and Shimp (1974). It therefore seems unlikely that the latter's shape was due to varying roles of autoshaped key pecks with varying absolute durations of reinforced patterns. Palmer *et al.* (1985) interpreted the results of Hawkes and Shimp to reflect this sort of varying contribution of autoshaped key pecks to the overall preference between the two temporal patterns. But Figure 2 shows the same functional relation existing at the level of preference between side-key pecks. We do not see how autoshaping could explain such a preference. Palmer *et al.* made an interesting discovery, namely, that more autoshaped key pecks occur as the reinforced patterns lengthen. But this finding does not seem to explain the shape of either function in Figure 2 or of that in the experiment of Hawkes and Shimp.

EXPERIMENT 2

Experiment 1 demonstrated a way to control the correspondence between starting and finishing behavioral patterns. But how general are the results of Experiment 1? They presumably depend greatly on the nature of the reinforced temporal patterns. In Experiment 1, these patterns were interresponse times and were not signaled, so that a subject may be said to have been required to keep track of how long it had been since the last response. An experiment by Palmer *et al.* (1985) showed that in cases in which reinforced interresponse times were correlated with lighted keys, pigeons produced some autoshaped key pecks as well as key pecks under control of the time since the last response. In general, the experiment of Palmer *et al.* showed less control by time when the reinforced interresponse times

were discriminated. One might imagine that reducing control by time might affect the correspondence between starting a pattern that requires timing and then finishing it. Therefore in Experiment 2 we explored the generality of the results of Experiment 1 by adding visual cues to signal the reinforced interresponse-time categories.

METHOD

Subjects and Apparatus

Three White Carneau pigeons, different from those in Experiment 1, were maintained within ± 10 g of 80% of their free-feeding weights. All 3 subjects had participated in a variety of experiments involving short-term memory for items in a list and for recently emitted behavioral patterns. In addition, Subjects 2 and 3 had participated in an experiment using paced VI schedules. The apparatus was the same as in Experiment 1.

Procedure

The procedure for Experiment 2 differed from that for Experiment 1 by correlating reinforced patterns with a visual stimulus, as in Hawkes and Shimp (1974). This procedure worked as follows. Each peck on an illuminated side key initiated a sequence of visual stimuli on the center key. The houselight was off and the keylight was on whenever the time since the last response fell in *either* class of reinforced interresponse times. The houselight was on and the keylight was off at all other times (except during reinforcement when only a food hopper light was on). Any unreinforced center-key peck turned off the center key (if it was on) and turned on both side keys. Consider the following example. A pigeon pecks the lighted right key. Both side keys go off and, for a time thereafter, stay off. Suppose that the time corresponding to the lower bound of the shorter reinforced category now elapses. The center key comes on, and stays on if no center-key peck occurs, until the upper bound is reached, when it goes off. After a time corresponding to the lower bound of the longer reinforced category, the center key comes back on again, if no center-key peck has occurred. A peck on the lighted center key then terminates the longer reinforced pattern and is reinforced if the variable interval has timed out and the reinforcer has been randomly assigned to the longer pattern.

Experimental conditions. Table 2 summarizes how the durations of the reinforced patterns were varied. Other details were as in Experiment 1.

RESULTS

Figure 4 shows the relative-frequency distributions of interresponse times for the two conditions in Experiment 2 (Conditions 10 and 4) that correspond to the two conditions represented in Figure 1 for Experiment 1. The data are averages over the last 5 days of a condition. In comparison to the corresponding Figure 1 in the nondiscriminated case of Experiment 1, it is clear from Figure 4 that the keylight signaling the possibility of reinforcement affected the distributions in several ways. These differences between Figures 1 and 4 are typical of differences found previously with nondiscriminated and discriminated interresponse-time schedules (Palmer et al., 1985; Shimp, 1968, 1969; Staddon, 1968). Thus, the distributions in Figure 4 have relatively more responses in the reinforced categories and do not so clearly show the widening of the distribution as the corresponding reinforced category lengthens.

In addition, Figure 4 shows that signaling the potential availability of reinforcement achieved the goal of reducing control by time since the last response. This reduction in temporal control is reflected in Figure 4 by the small modes, entirely absent in the corresponding nondiscriminated case in Figure 1, where a pigeon pecked the "wrong" occasion on which the center key was lit. That is, after a left-key peck (or right-key peck) pigeons occasionally incorrectly terminated a longer (or shorter) interresponse time. These pecks on a lighted center key, on the wrong occasion of its being lighted, quite likely reflect the autoshaped key pecking identified by Palmer et al. (1985). These pecks are not under discriminative control of time since the last response.

In summary, Experiment 2 produced local patterns of behavior similar to those in previous discriminated interresponse-time experiments. Now let us see how the reduction in temporal control achieved in Experiment 2 affected the correspondence between started patterns and finished patterns.

Figure 5 corresponds to Figure 2 and reveals a similar outcome. As in Experiment 1, 1 of 3 birds (Bird 3) failed to show the expected

Table 2
Experimental conditions.

Condition	Reinforced interresponse times (s)		Total number of days	Number of days with final parameter values
	Shorter	Longer		
1	1.0-2.0	3.0-6.0	20	20
2	1.5-2.0	4.5-7.0	15	15
3	2.0-3.0	6.0-9.0	35	13
4	3.0-4.0	9.0-12.0	15	15
5	3.5-5.0	10.5-15.0	15	15
6	4.0-5.0	12.0-18.0	20	20
7	6.0-9.0	18.0-27.0	15	15
8	3.0-4.0	9.0-12.0	15	15
9	1.5-2.0	4.5-7.0	15	15
10	0.5-1.0	1.5-3.0	15	15

result. We do not know why. As for Figure 2, the reader is cautioned that average performance does not reflect all individual performances. As in Experiment 1, two of the three individual functions closely resemble the results in Hawkes and Shimp (1974) and Palmer et al. (1985). The present discussion of Figure 5 and the subsequent discussion of Figure 6 are therefore limited to Birds 1 and 2. As in Experiment 1, preference for starting one pattern rather than the other depended on the time it took to perform those two patterns in the same way as did the corresponding preference among completed patterns: Preference between side keys and preference between completed patterns depended on their durations in highly similar ways, and, for all practical purposes, in the same way as in Experiment 1.

Figure 6 corresponds to Figure 3 and shows the correspondence between starting and finishing a pattern. Figures 3 and 6 differ in two striking ways. First, there is vastly greater variability in Figure 6. Perhaps this is due to the variable contribution of autoshaped key pecks. Second, as the reinforced patterns lengthen, the function for finishing a shorter pattern after starting it rises or stays at about the same level. (In Figure 3, the corresponding curve falls.) On the other hand, the function for finishing a longer pattern after starting it stays about the same or falls as the reinforced patterns lengthen, and in this agrees with the corresponding results in Figure 3.

Fig. 4. Relative frequency of interresponse times of different durations over the last 5 days of a condition in Experiment 2 for the two conditions with the same reinforced interresponse times as in the two conditions represented in Figure 1 for Experiment 1: Top and bottom rows represent Conditions 10 and 4, and reinforced interresponse times are indicated below the horizontal axes.

The divergence of the two curves in Figure 6 follows naturally from the Palmer *et al.* (1985) discovery that the frequency of auto-shaped key pecks increases in the present situation as the reinforced patterns lengthen. Increasing auto-shaped key pecks not under control of the time since the last peck would occur to the keylight signaling the shorter pattern, regardless of the side-key peck initiating the pattern. This comparison between Figures 3 and 6 shows that the correspondence between starting and finishing a pattern depends on the degree of control by time since the last response, as manipulated by discriminated versus nondiscriminated reinforced interresponse times.

Now let us compare Figures 5 and 6 in the same way we compared Figures 2 and 3. The comparison turns out somewhat differently be-

cause of the difference in temporal control in the two experiments. As the curves in Figure 5 increase, only the curve for the longer pattern in Figure 6 decreases. The counterintuitive outcome obtained in Experiment 1 with both shorter and longer patterns applies here only to the longer. The reason presumably is the role of auto-shaped key pecks discussed above. These key pecks changed the function between starting and finishing for shorter patterns and therefore changed the higher order relation between preference, on the one hand, and starting and finishing a pattern, on the other.

DISCUSSION

Experiment 2 produced preference functions qualitatively similar to those of Experiment 1. Discriminated versus nondiscriminated conditions did not change preference

Fig. 5. The relative frequency of left-key pecks (filled symbols) and the relative frequency of the shorter of the two reinforced patterns (open symbols) as a function of the absolute durations of the two reinforced patterns, indexed by the lower bound of the shorter. Points are based on the last 5 days of conditions. Vertical lines represent ± 1 SE. The horizontal dashed line at 0.75 represents the relative reciprocal of the shorter pattern, which was one third as long as the longer pattern. Points for similar conditions are identified by corresponding numbers.

importantly for starting one pattern versus another. However, the reduction in temporal control, and concomitant presumed increase in autoshaped key pecking (Palmer et al., 1985) brought about by the discriminated conditions, changed the correspondence between starting and finishing a pattern. We found an increas-

ing correspondence for the shorter pattern and a decreasing correspondence for the longer pattern. As a result of this difference in the correspondence between starting and finishing for shorter and longer patterns, the relation between preference and this correspondence was different from that in Experiment 1. The cor-

Fig. 6. The relative frequency of correct terminations of patterns initiated by left-key pecks (open symbols) and the corresponding relative frequency of correct terminations of patterns initiated by right-key pecks (closed symbols), as functions of the absolute durations of the two reinforced patterns, indexed by the lower bound of the shorter. Points for similar Conditions 2 and 9, and 4 and 8, are discriminated by corresponding numbers. Vertical lines represent ± 1 SE. Each point is an average over the last 5 days of a condition.

response between starting a shorter pattern and completing it increased as the patterns became longer, even though temporal control was reduced in comparison to Experiment 1. Thus, conditions can be arranged so that the correspondence between starting and finishing a pattern that takes time can be *facilitated* by *reducing* temporal control.

GENERAL DISCUSSION

We developed a relatively complex contingency in which a subject first pecked one of two side keys and started one of two corresponding waiting times. Starting either waiting time was not a commitment to finish it: The procedure permitted a subject to wait a

time appropriate to the initiating peck, a time appropriate to the other one, or any other time. A subject was always free to finish or not finish a waiting pattern it initiated (although reinforcement could not occur if it did not finish a pattern it had initiated). We manipulated the likelihood of finishing a pattern by visually cueing reinforced waiting times, and we manipulated preference for the shorter waiting time by varying the absolute durations of the two reinforced categories. We were able thereby to establish a variety of relations between preference for starting a waiting pattern and the likelihood of finishing it after it was started. Some of these relations seem rather counter-intuitive. For instance, conditions were identified in which preference for beginning to wait a particular duration was high, in that subjects usually initiated it, yet once they initiated it, they seldom finished it: They seldom waited for the reinforced duration. Conversely, in some other conditions, preference for a waiting time was low upon its initiation, but once initiated, it was usually finished. These results seem to suggest different controlling relations for different components of a reinforced temporal pattern. Initial choice of waiting times and successful completion of chosen waiting times did not systematically covary. Combinations of experimental variables and contingencies can be arranged so that the relation between initiating and successfully completing a behavior pattern can assume many different forms.

Skinner (1989) has noted that contingencies involving time tend to invite the use of cognitive or mentalistic vocabulary from ordinary language. For instance, ordinary language usage might have an observer say of a subject in the present experiment, after watching the subject for some time and then seeing it peck the left key, "Oh, I know what the pigeon wants to do next: This time it intends to wait the shorter time." It is perhaps constructive in the context of JEAB's special issue on cognition to refer briefly to the relation between experiments such as the present one and ordinary language usage such as this imagined observer's exclamation. To be specific, let us focus on the notion of intentionality.

Operant behavior, by most of its definitions, is behavior under the control of its consequences, and is therefore the sort of behavior about which a nonacademically trained person might say, in plain English, that it occurs because the behaving organism wants its con-

sequences. A nonbehaviorist, watching a demonstration of a cat escape from a Thorndikean puzzle box, might say, "The cat escaped from the box because it wanted to eat the food it saw outside." Again in plain English, the cat intended to get out and eat the food. It therefore got out and ate the food. Thorndike developed the Law of Effect (Thorndike, 1931) precisely to avoid having to attribute to unobserved, mentalistic intentions this ability implicit in plain English to cause future behavior. One might say that much of the intent of behaviorism, both as a philosophy and a science, has been to show how mentalistic concepts can be avoided in the development of psychology as a science. Intentionality and "purpose" have long been at the heart of this problem, and whether behaviorism and/or operant conditioning has, or even in principle can, successfully deal with intentionality remains a bone of contention (Dennett, 1978; Putnam, 1988; Skinner, 1957, 1989; Timberlake, 1988; Wittgenstein, 1953).

We mention these thorny matters because we see one of the long-term roles of experiments such as the present one, which consists chiefly in the development of new reinforcement contingencies permitting the behavioral analysis of more complex performance, as helping to fill in the details of general accounts suggested by Skinner (1953, 1957, 1989), who noted that "... such terms as 'meaning' and 'intent' appear to refer to properties of behavior" but "they usually conceal references to independent variables" (Skinner, 1953, p. 36). Similarly, consider the following:

Originally a synonym of propose, the word *purpose* has caused a great deal of trouble. Like other words suggesting probable action, it seems to point to the future. The future cannot be acting now, however, and elsewhere in science purpose has given way to words referring to *past* consequences. When philosophers speak of intention, for example, they are almost always speaking of operant behavior. (Skinner, 1989, pp. 13-14)

Consider the present experiment in this light. Recall the observer described above whose ordinary language exclamation suggested knowledge of a pigeon's momentary intention, and whose exclamation seemed under the control of future behavior. This observer's verbal behavior describing the pigeon's intention to perform a specific future behavior might be controlled by the discriminative stimulus consisting

of the pigeon's peck on the left key. It is clear how this observer's verbal attributions of intentionality could be reinforced reliably.

But in general, the process of clarifying concealed variables, observational histories, and operant contingencies involved in the language of intentionality is no easy matter. The problem is indeed so difficult that there is sharply divided opinion about its ultimate solution. Skinner's view has been that it defines a challenging task that behavior analysis will ultimately overcome (Skinner, 1953). But others see the problem as so formidable that it clearly spells the inadequacy of behavior analysis itself (Chomsky, 1959; Gardner, 1985). We would like only to note that the ultimate outcome is not yet in view but that it is clear that Skinner's view might prove correct only if behavior analysts continue to develop methodology for the control of ever more complex performances.

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