

USE OF AN AMBIGUOUS-SAMPLE PROCEDURE TO
ESTABLISH A CUE TO FORGET IN PIGEONS

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Pigeons were trained on a variation of the matching-to-sample task in which on double-sample trials two samples, one associated with each of the comparison stimuli, were presented successively. Responding to the comparison associated with the first sample was reinforced on half the double-sample trials, and responding to the comparison associated with the second sample was reinforced on the remaining half. One of two postsample stimuli was presented following the termination of each colored sample. A vertical line was presented after a correct or target sample, and a horizontal line was presented after an incorrect or interfering sample. With extended training, each bird demonstrated above-chance accuracy on double-sample trials, providing *prima facie* evidence that one or both of the postsample stimuli exerted control over matching behavior. Experiment 2 provided evidence that the horizontal line functioned as a cue to forget the code activated by the preceding sample stimulus. It was concluded that a condition sufficient to establish a postsample stimulus as a cue to forget is that the postsample immediately follow presentation of a sample that, if it were to control test responding, would lead to nonreinforcement.

Key words: delayed matching to sample, ambiguous-sample task, directed forgetting, memory, delayed stimulus control, key peck, pigeons

Several studies have demonstrated that short-term retention in pigeons (Grant, 1981b, 1984a, 1986, 1988; Kendrick, Rilling, & Stonebraker, 1981; Maki & Hegvik, 1980; Maki, Olson, & Rego, 1981; Parker & Glover, 1987; Santi & Savich, 1985; Schwartz, 1986; Stonebraker & Rilling, 1981; Stonebraker, Rilling, & Kendrick, 1981), monkeys (Roberts, Mazmanian, & Kraemer, 1984), and rats (Grant, 1982) is influenced by presentation of cues to remember or to forget. Experiments using pigeons and monkeys have typically employed a delayed matching-to-sample task in which only some of the trials terminate in a test of retention. In a typical experiment, termination of the sample stimulus (e.g., red or green field) is followed by a postsample stimulus (e.g., vertical or horizontal line). Trials on which one of the postsample stimuli, say vertical, is presented terminate in the standard retention test. On trials in which the alternate postsample stimulus, horizontal in the present example, is presented, no test for sample memory occurs. After extensive exposure to this training regime, memory for the sample is tested occasionally on trials involving the hor-

izontal line. The basic finding is that matching accuracy is markedly lower on trials in which the horizontal line followed the sample than on trials in which the vertical line followed the sample, a phenomenon referred to as directed forgetting. The postsample stimulus controlling the higher level of matching accuracy (vertical line in the present example) is referred to as a remember cue, and the postsample stimulus controlling the lower level of matching accuracy (horizontal line in the present example) is referred to as a forget cue.

Two issues have been prominent in the empirical and theoretical analysis of directed forgetting. One issue concerns the mechanism through which a cue to forget reduces accuracy. The dominant view concerning this mechanism is predicated on the notion that animals postperceptually process or rehearse to-be-remembered information during the delay interval (e.g., Grant, 1981a, 1984b; Maki, 1981; Rilling, Kendrick, & Stonebraker, 1984). According to this view, presentation of a sample stimulus activates a memory code (Grant, 1981a; Honig & Thompson, 1982; Roitblat, 1984; Wasserman, 1986) that is then processed or rehearsed in working memory during the retention interval. Presentation of a cue to forget is believed to halt, or at least reduce, this postperceptual processing, resulting in enhanced forgetting. The notion that a cue to forget reduces rehearsal has been prominent

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in all theoretical discussions of directed forgetting, although there is some debate concerning whether this is the sole mechanism responsible for the phenomenon (see Rilling et al., 1984, for a two-process interpretation involving both rehearsal and retrieval mechanisms).

The present experiments addressed the second issue of prominence in the analysis of directed forgetting: the conditions that are necessary and sufficient for a postsample stimulus to acquire the capacity to function as an effective cue to forget. As noted above, the generally accepted view is that an effective cue to forget is a stimulus that has acquired the capacity to reduce processing of the memory code activated by a preceding sample stimulus. Thus, the issue of present concern could be restated as an attempt to specify the conditions that are necessary and sufficient for a postsample stimulus to acquire the capacity to reduce processing of the memory code activated by a sample stimulus.

Rilling et al. (1984) have suggested that a postsample stimulus will become an effective cue to forget only when that stimulus is presented on trials that do not require attention to subsequent events and stimuli. In accord with this notion, a postsample stimulus will come to function as an effective cue to forget if on such trials either the comparison stimuli are omitted or a stimulus requiring nondiscriminative responding is presented (e.g., Grant, 1981b; Maki & Hegvik, 1980; Maki et al., 1981), but will fail to function as an effective cue to forget if on such trials discriminative, albeit sample-independent, responding is required (Kendrick et al., 1981; Maki et al., 1981).

Recently, Colwill (1984) and Grant (1986) have obtained evidence that a postsample stimulus may become a cue to forget even though events subsequent to that stimulus require attention. In both of these studies, the postsample stimulus signaled that responding on the basis of the prior sample would lead to nonreinforcement. Colwill (1984) trained birds with samples of food and no food, and the comparisons were equally likely to consist of two colors or two line orientations. One member of each comparison pair was correct given a food sample, and the alternate member of the pair was correct given a no-food sample. Following acquisition of matching, a clicker was presented

during the delay interval on some trials involving a food sample and color comparisons. On these trials, a response appropriate to a no-food sample was reinforced. After extensive training, presentation of the clicker led to choice of the color associated with the no-food sample on about 75% of the trials, suggesting that the clicker functioned as a cue to forget the food sample. Moreover, the clicker was equally effective when tested on transfer trials involving a food sample and line comparisons. The transfer result is significant because the clicker was not presented on line-comparison trials during training and, therefore, could not have acquired control over responding to the line comparisons. Thus, the transfer result suggests that the tendency to respond to the comparison associated with a no-food sample on trials in which a food sample is followed by the clicker is mediated by clicker-induced forgetting of the code activated by the food sample.

Grant (1986) also obtained evidence that a postsample stimulus may function as an effective cue to forget even though events subsequent to that stimulus require attention. Birds were trained using an intratrial interference procedure in which red and green served as sample and comparison stimuli. (The trial types employed in this experiment are illustrated under the headings "single sample" and "double sample S2+" in Table 1.) On interference trials, both colors were presented successively as samples, and choice of the comparison associated with the second sample was reinforced at testing. The first, or interfering, sample was always followed by a horizontal line and the second, or target, sample was always followed by a vertical line. The sample stimulus on single-sample matching trials was followed by the vertical line. Thus, the contingencies were such that responding on the basis of a sample followed by a horizontal line led to nonreinforcement, and responding on the basis of a sample followed by a vertical line led to reinforcement. Subsequent testing revealed that the horizontal line functioned as a cue to forget. In one test, for example, the horizontal line was occasionally presented on single-sample trials. All 6 birds matched less accurately on trials in which the horizontal line followed the sample than on trials in which the vertical line followed the sample.

The findings of Colwill (1984) and Grant (1986) suggest that a condition sufficient to

establish a postsample stimulus as a cue to forget is that the postsample stimulus follow a sample that, if it were to control responding at testing, would lead to nonreinforcement. Although the findings of Colwill and of Grant are consistent with this proposition, neither set of findings requires such an assumption for their interpretation. Specifically, Colwill's findings could be interpreted by assuming that the birds learned to code the clicker in the same way as they coded the no-food sample. According to this view, the clicker did not control the processing of the code activated by the preceding food sample, but rather itself activated a code that controlled test responding directly.

Grant's (1986) findings can also be interpreted without appeal to the notion that a postsample stimulus that follows an incorrect sample will come to function as a cue to forget. Notice that in Grant's procedure the horizontal line, which came to function as a cue to forget, followed a sample stimulus that had two properties. First, the sample was an incorrect sample in that responding on the basis of that sample led to nonreinforcement and, second, the sample was less temporally contiguous with the test than was the correct sample. Grant's findings could be interpreted by assuming that both of these properties, rather than just the former, were critical to the establishment of the horizontal line as a cue to forget. According to this view, the horizontal line functioned as a cue to forget not because it followed an incorrect sample per se, but rather because it followed an incorrect sample that was more temporally distant from the test than was the correct sample. That both of these properties might be important is plausible in that birds may be able to learn to forget interfering information only if that information is more distant temporally from testing than is the to-be-remembered information.

Some uncertainty remains, therefore, as to whether a condition sufficient to establish a postsample stimulus as a cue to forget is that the postsample stimulus consistently follow an incorrect sample stimulus. The present experiments attempted to resolve the uncertainty by employing an extension of Grant's (1986) procedure in which the confound between whether a sample was correct or incorrect and temporal distance from the test was eliminated (the design is illustrated in Table 1). This was accomplished by using double-sample trials on

Table 1

Illustration of the trial types employed in Experiment 1.

Trial type		
Single sample	Double sample S2+	Double sample S1+
GV:G+/R-	RHGV:G+/R-	GVRH:G+/R-
RV:R+/G-	GHRV:R+/G-	RVGH:R+/G-

Note. G = green, R = red, H = horizontal line, V = vertical line. Events to the left of the colon were presented successively on the center key. The comparison stimuli, which were presented simultaneously on the side keys, are shown to the right of the colon. The correct and incorrect comparisons are denoted by the plus and minus signs, respectively.

which the incorrect sample was equally often presented first and second. A horizontal line always followed the incorrect sample, and a vertical line always followed the correct sample. If it is the case that a postsample stimulus that follows an incorrect sample comes to function as a cue to forget, then the present procedure should establish the horizontal line as a cue to forget.

EXPERIMENT 1

Birds were trained on a variation of the matching task that may be referred to as the ambiguous-sample task. As shown in Table 1, the procedure was composed of three main types of trials: single-sample trials, double-sample S2+ trials, and double-sample S1+ trials. On double-sample trials, both samples were presented successively and each was followed by a different postsample cue. Responding on the basis of the second sample was reinforced on half of the double-sample trials (denoted S2+), and on the remaining half responding on the basis of the first sample was reinforced (denoted S1+). In the absence of postsample cues, the task on double-sample trials is ambiguous, and performance should be at chance level. The postsample stimuli remove the ambiguity on double-sample trials in that the horizontal line follows the incorrect sample and the vertical line follows the correct sample. On control trials, the single sample, which was, of course, the correct sample, was followed by the vertical line.

Early in training, mean accuracy on S2+ and S1+ double-sample trials should be at

chance level (50% correct). However, as training progresses, accuracy on double-sample trials would exceed chance to the extent that the horizontal line came to function as a cue to forget. It should be noted, however, that although such a result would be consistent with the notion that the horizontal line functioned as a cue to forget, other interpretations are possible. Two alternative interpretations are considered in the discussion section of the present experiment and were evaluated empirically in the second experiment.

METHOD

Subjects. Six Silver King pigeons were maintained at 80% of their free-feeding weights. Sessions were conducted 6 days per week, and supplementary feeding of mixed grain was provided after each session, if necessary, to ensure maintenance of prescribed weights. On days when experimental sessions were not conducted, each bird was fed an amount of mixed grain sufficient to maintain its prescribed weight. Water and grit were always available in the home cage. Each bird had extensive prior experience in matching tasks involving red and green sample and comparison stimuli. None of the birds had served previously in any experiments involving directed forgetting.

Apparatus. The birds were tested in six identical chambers. Three pecking keys were mounted horizontally in a row 20 cm above the floor in each chamber. An Industrial Electronics, Inc., in-line projector was mounted behind each key and was used to project stimuli onto the pecking key. A grain feeder was mounted below the center pecking key. Each test chamber was enclosed in a sound- and light-attenuating enclosure. Masking noise was provided by an exhaust fan within the enclosure and by white noise delivered through a speaker in the testing room. The presentation of events in the chambers and the recording of data were accomplished using microcomputers.

Procedure. Sessions consisted of 96 trials separated by a 30-s intertrial interval. The six types of trials that occurred in each session are shown in Table 1. Within each session, half of the trials were single-sample trials and half were double-sample trials. Each of the two types of single-sample trials occurred 24 times in each session. Each of the four types of double-sample trials occurred 12 times in each session. The correct comparison stimulus was

presented equally often on the right and left keys within each of the six trial types. The order in which the trials were tested varied randomly from session to session. Training continued for 268 sessions.

Each trial began with the presentation of a black dot on a white background as a preparatory stimulus. The preparatory stimulus was presented on the center key and remained illuminated until a single response occurred or, in the absence of a response, for 5 s. On control trials, termination of the preparatory stimulus was followed immediately by the sample stimulus, which remained illuminated for 5 s. Termination of the sample stimulus was followed immediately by a 1-s presentation of a white vertical line on a black background. The sample and the vertical line were presented on the center key. Immediately following termination of the vertical line, red and green comparison stimuli were presented on the side keys. A single response on either side key darkened both keys and produced 3-s access to grain if the key illuminated by the matching comparison was pecked.

On double-sample S2+ trials, termination of the preparatory stimulus was followed immediately by the first sample, S1, which was presented for 5 s. Termination of S1 was followed immediately by a 1-s presentation of a horizontal white line on a black background. Termination of the horizontal line was followed immediately by the second sample, S2, which was presented for 5 s. S2 was followed immediately by a 1-s presentation of a vertical line. Termination of the vertical line was followed immediately by illumination of the side keys, one illuminated by red and the other by green. A single response to either comparison darkened both keys and produced a reinforcer only if the peck was directed toward the key illuminated by the comparison corresponding to S2.

Double-sample S1+ trials were identical to double-sample S2+ trials with two exceptions. First, a vertical line followed the first sample (S1), and a horizontal line followed the second sample (S2). Second, a response to the side key illuminated by the comparison corresponding to S1 was reinforced.

RESULTS

Mean percentage of correct responses on double-sample trials is shown in Figure 1. Accuracy on single-sample trials (not shown in

Table 2

Percentage of correct responses on double-sample trials early and late in training during Experiment 1.

Bird	Sessions 1-4			Sessions 265-268		
	S2+	S1+	Mean	S2+	S1+	Mean
1	83.3	25.0	54.2	79.1	77.1	78.1
2	62.5	37.5	50.0	85.4	63.2	74.3
3	60.4	45.8	53.1	83.1	62.9	73.0
4	62.5	34.4	48.5	63.5	63.5	63.5
5	78.1	18.7	48.4	65.6	66.6	66.1
6	41.7	62.5	52.1	82.3	84.4	83.4

Figure 1) remained close to 90% correct throughout training. Data from individual subjects are shown in Table 2.

During the first block (Sessions 1 through 4), 5 of the 6 birds displayed a tendency to respond to the comparison associated with the second sample on both types of double-sample trials. This resulted in above-chance accuracy on double S2+ trials and below-chance accuracy on double S1+ trials. Bird 6 tended to respond to the comparison associated with the first sample, and thus performed above chance on double S1+ trials and below chance on double S2+ trials. Importantly, mean accuracy on double-sample trials was at chance level for each bird. As expected, then, initial accuracy on double-sample trials in the ambiguous-sample procedure was at chance level.

In contrast, mean accuracy on double-sample trials during the final block of training (Sessions 265 through 268) was above chance level for each bird. All 6 birds demonstrated a marked increase in accuracy on trials in which they had initially scored below chance level. Three of the birds (2, 3, and 6) also demonstrated a marked increase on trials in which they had initially scored above chance level, whereas the remaining birds (1, 4, and 5) showed little change in accuracy level. In the three blocks immediately preceding the final block (Blocks 64, 65, and 66), accuracy on double-sample trials, collapsed across birds, ranged from 69.8% correct to 72.4% correct. Moreover, accuracy on double-sample trials, collapsed across birds, exceeded 60% correct in each block beginning with Block 11.

Individual birds differed considerably in the point during training at which accuracy on double-sample trials consistently exceeded 60%: Bird 1, Block 4; Bird 2, Block 13; Bird 3, Block 38; Bird 4, Block 63; Bird 5, Block 9; and Bird

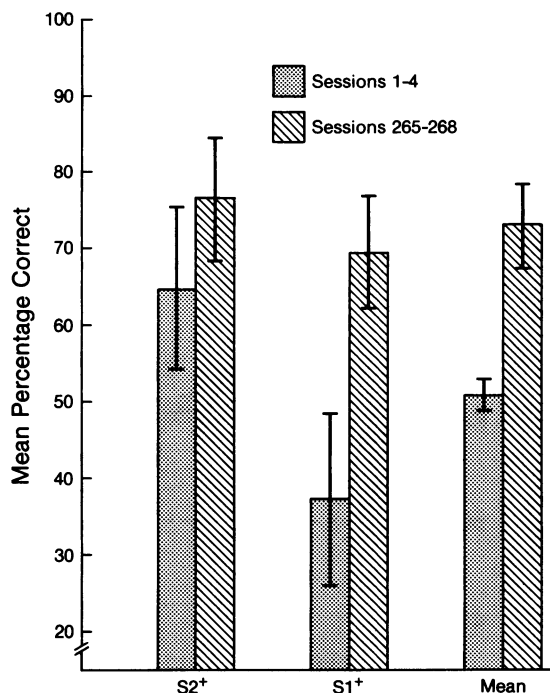


Fig. 1. Mean percentage of correct responses on double-sample trials early (Sessions 1-4, stippled bars) and late (Sessions 265-268, hatched bars) in training in Experiment 1. Error bars show ± 1 SD.

6, Block 11. In addition, the acquisition functions for individual birds, three of which are shown in Figure 2, were not characterized by a steady and consistent increase in accuracy on double-sample trials from one training block to the next. Rather, acquisition was characterized by plateaus at which accuracy remained constant for several blocks before eventually increasing. Moreover, there were some instances in which accuracy on double-sample trials decreased across three or more blocks of training.

DISCUSSION

The finding that each of the 6 birds learned to match at above chance level on double-sample trials reveals that one or both of the post-sample stimuli must have exerted control over matching. The question remains, however, as to the mechanism through which that control was exerted. One possible mechanism, of course, is that the horizontal line was established as a cue to forget and functioned to halt, or at least reduce, the postperceptual processing of the memory code activated by the immediately preceding sample stimulus.

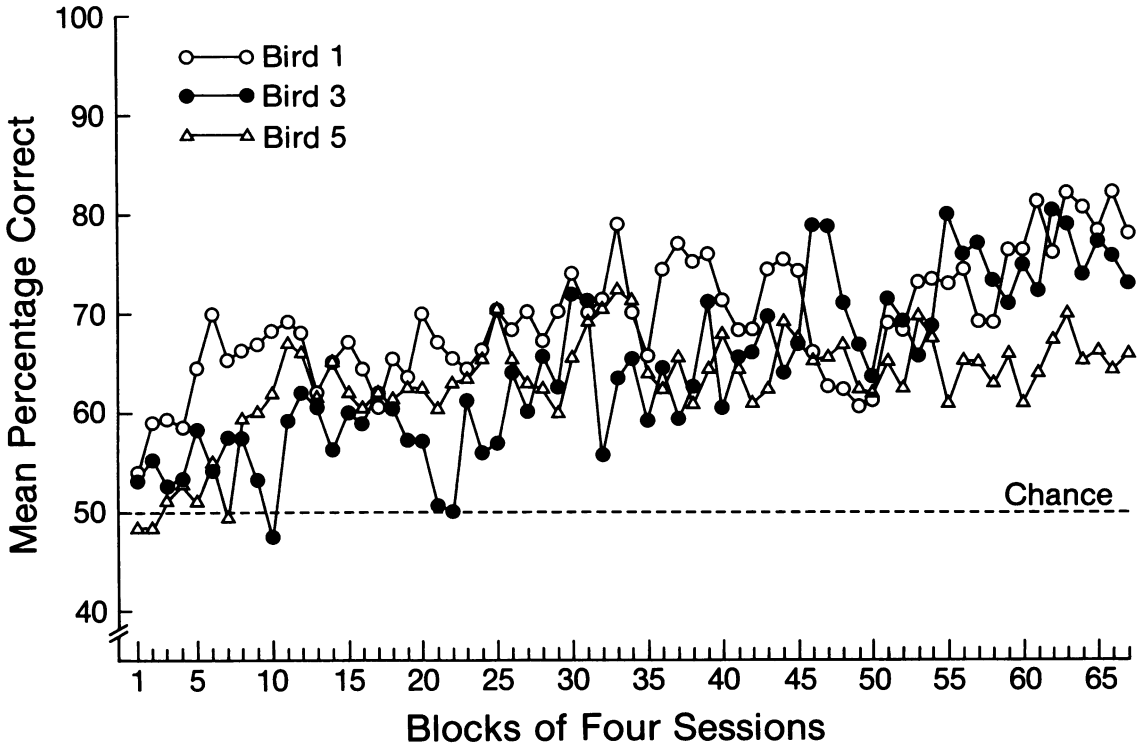


Fig. 2. Mean percentage of correct responses on double-sample trials as a function of blocks of four sessions of training in Experiment 1. Data shown are from 3 of the 6 subjects.

Alternatively, the postsample stimuli may have exerted control over the process of coding, rather than over the process of code maintenance. Notice that the sample–postsample pairs red–vertical and green–horizontal were presented only on trials in which responding to the red comparison was reinforced (see Table 1). On the other hand, the sample–postsample pairs red–horizontal and green–vertical were presented only on trials in which responding to the green comparison was reinforced. Given these contingencies, it may be that each of the four color sample–line postsample pairs caused activation of an instruction to peck either a red comparison (the pairs red–vertical and green–horizontal) or a green comparison (the pairs red–horizontal and green–vertical). Activation of instructional codes by sample–postsample pairs can be conceptualized in at least two ways.

First, it may be that the sample–postsample pairs, although presented successively, nevertheless functioned as compound samples. Ac-

ording to this view, the postsample stimulus is a component of the event (i.e., the color–line pair) that is coded. Indeed, Santi (1978) obtained evidence that vertical and horizontal lines, which were superimposed on color samples and were correlated with matching and mismatching (choose the nonmatching comparison) contingencies, were coded as part of a compound sample (i.e., color and line orientation). Although a line orientation was not presented until after termination of the color sample in the present experiment, it is possible that the color–line pairs functioned as a compound sample to activate an instructional code.

According to a second conceptualization, the postsample stimuli may not have functioned as a component of the event that was coded, but rather may have determined how the preceding event (i.e., the color sample) was coded. According to this view, the postsample stimuli exerted higher order or supraordinate stimulus control in that they determined the precise form of stimulus control exerted by the sample stim-

uli (see Nevin, 1973, and Sidman, 1986, for further discussion of higher order stimulus control in conditional discriminations). Zentall and his associates have obtained evidence that the level of houselight illumination, when correlated with matching and mismatching contingencies, can control the coding of color samples (Edwards, Miller, & Zentall, 1985; Edwards, Miller, Zentall, & Jagielo, 1987). Although the present procedure differed from that employed by Zentall and his associates in several aspects of potential importance, it is conceivable that the lines may have exerted higher order conditional control and determined which code was activated by the color sample. Applied to the present experiments, this view suggests that presentation of a vertical line caused a preceding red sample to be coded as "peck red" and a preceding green sample to be coded as "peck green," whereas presentation of a horizontal line caused a preceding red sample to be coded as "peck green" and a preceding green sample to be coded as "peck red."

A third account of the present findings holds that the postsample stimuli acted proactively and influenced the processing of the sample stimulus that followed the postsample stimulus. In particular, it could be argued that the postsample stimuli determined the extent to which the birds attended to the succeeding sample stimulus. Specifically, it could be maintained that the birds learned (a) to attend less strongly to sample stimuli that followed presentation of a vertical line (perhaps mediated by turning away from the center key) and (b) to attend more strongly to sample stimuli that followed presentation of a horizontal line (perhaps mediated by responding to the sample at a particularly high rate). The process identified in (a) above would result in an increase in accuracy on double-sample S1+ trials because the incorrect sample, S2, would be attended to weakly, or perhaps not at all. The process identified in (b) above would result in an increase in accuracy on double-sample S2+ trials because S2 would be attended to more strongly, and hence would be more likely to control choice responding, than S1.

Thus, increased accuracy on double-sample trials might be mediated by processes of directed forgetting, sample coding, or sample attention. The second experiment was conducted

to discriminate among these alternative accounts.

EXPERIMENT 2

Following the completion of Experiment 1, the birds were tested on single-sample probe trials on which the sample was sometimes followed by the vertical line, as in training, and was sometimes followed by the horizontal line. If the sample-postsample pair red-horizontal results in activation of the code "peck green" and the sample-postsample pair green-horizontal results in activation of the code "peck red," then performance on single-sample trials involving the horizontal line as the postsample stimulus should be below 50% correct. On the other hand, if the horizontal line functions as a cue to forget the preceding sample, then accuracy on single-sample trials involving the horizontal line as the postsample stimulus should be lower than on comparable trials involving the vertical line as the postsample stimulus, but should be at or above 50% correct. Finally, if the lines function solely to control the level of attention to a subsequent sample, then accuracy on single-sample trials should be unaffected by whether the sample is followed by a vertical line or a horizontal line.

METHOD

Subjects and apparatus. Same as in Experiment 1.

Procedure. Sessions were identical to those of Experiment 1 except that 16 single-sample probe trials were added to each session. The single sample was followed by the vertical line on eight probe trials and was followed by the horizontal line on eight probes. Except for the nature of the postsample stimulus, the two types of probe trials were identical. Single-sample probe trials involving the vertical line were identical to standard single-sample trials used throughout training and were included only to establish the reliability of data from probe trials.

The sample was red or green equally often on each type of probe trial, and the position of the correct comparison stimulus was balanced within sample color. A single-sample probe trial on which the vertical line followed the sample was presented on Trials 8, 22, 36, 50, 64, 78, 92, and 106 of each session. A

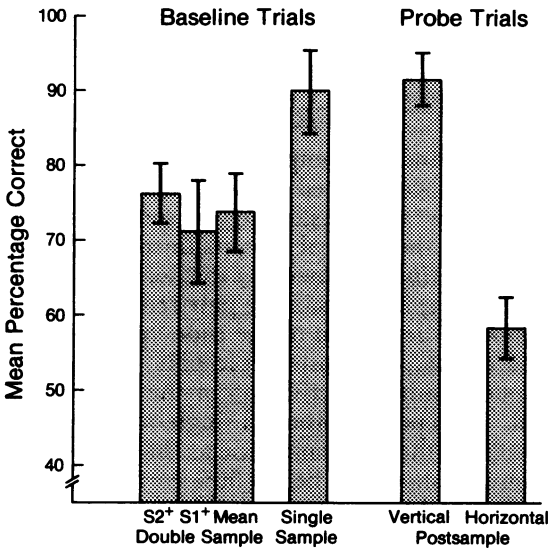


Fig. 3. Mean percentage of correct responses on baseline trials and on single-sample probe trials in Experiment 2. Error bars show ± 1 SD.

single-sample probe trial on which the horizontal line followed the sample was presented on Trials 6, 20, 34, 48, 62, 76, 90, and 104 of each session. The experiment consisted of four consecutive sessions of testing.

RESULTS AND DISCUSSION

Mean percentage of correct responses, collapsed across the four sessions of testing, is shown in Figure 3. The data from individual subjects are shown in Table 3. Performance on baseline trials, which were identical to the trials employed in Experiment 1, provides a replication of the major finding of Experiment 1: Accuracy on double-sample trials became stable at a level well above chance. Accuracy on single-sample probe trials on which the sample was followed by the vertical line was equivalent to that on baseline single-sample trials. This finding indicates that the 32 trials of testing per bird was sufficient to generate a reliable estimate of accuracy.

Accuracy on single-sample probe trials involving the horizontal line was reduced markedly relative to that on comparable trials involving the vertical line, and none of the 6 birds displayed below-chance accuracy on such trials. The former finding is inconsistent with the view that postsample stimuli act in an exclusively proactive manner and influence only the

Table 3
Percentage of correct responses in Experiment 2.

Bird	Baseline trials			Single sample	Single-sample probe trials	
	Double sample		Ver- tical post- sample		Hor- izontal post- sample	
	S2+	S1+	Mean			
1	81.3	75.0	78.2	92.2	93.7	56.3
2	78.1	58.9	68.5	87.5	93.7	50.0
3	76.0	81.3	78.7	96.3	93.7	62.5
4	64.9	69.8	67.4	86.9	93.7	56.3
5	76.0	64.2	70.1	80.2	81.2	62.5
6	81.6	78.1	79.9	96.3	93.7	62.5

extent to which the birds attends to a succeeding sample. The latter finding is inconsistent with the view that the horizontal postsample stimulus caused the activation of codes in accord with the contingencies of an oddity procedure. On the other hand, both findings are consistent with the view that the horizontal line functioned as a cue to forget the code activated by the preceding sample stimulus.

GENERAL DISCUSSION

Experiment 1 showed that pigeons can learn to match at an above-chance level of accuracy on double-sample trials in the ambiguous-sample task. This finding provides prima facie evidence that one or both of the postsample stimuli exerted control over matching behavior. The second experiment explored the mechanism through which that control was exerted. The data were consistent with the view that the postsample stimulus that consistently followed the incorrect sample functioned as a cue to forget the code activated by the immediately preceding sample stimulus.

Taken collectively, research concerned with the question of the conditions under which a postsample stimulus will come to function as a cue to forget suggests that two conditions are sufficient, although neither is necessary. The first sufficient condition is that a postsample stimulus is presented on trials in which attention to subsequent events and stimuli is not required (Rilling et al., 1984). In accord with this proposition, a postsample stimulus will come to function as a cue to forget if it is

associated with comparison omission or with a stimulus requiring nondiscriminative responding (e.g., Grant, 1981b; Maki & Hegvik, 1980; Maki et al., 1981), but will not function as a cue to forget if it is associated with a stimulus requiring discriminative, albeit sample-independent, responding (Kendrick et al., 1981; Maki et al., 1981).

The present findings, and those of Colwill (1984) and Grant (1986), suggest that a second condition is sufficient to establish a postsample stimulus as a cue to forget. Specifically, a postsample stimulus will function as a cue to forget if it is presented following a sample stimulus having the property that responding on the basis of that sample leads to nonreinforcement. Moreover, this condition is sufficient to establish a postsample stimulus as a cue to forget even though events subsequent to that postsample stimulus require attention.

An obvious question for further research is to determine whether the two conditions described above are exhaustive of those sufficient to result in a stimulus acquiring the capacity to function as a cue to forget. For example, as an extension of the present work, one could inquire as to whether a postsample stimulus that follows an irrelevant sample would be established as a cue to forget. This possibility could be evaluated by presenting a series of successive samples on each trial and then probing memory for one of the samples at testing. The test would consist of presenting one comparison associated with the relevant or target sample and one comparison associated with a sample not presented on that trial. Each of the nontarget or irrelevant samples would be followed by one postsample stimulus, and the target sample would be followed by the alternate postsample stimulus. An assessment procedure similar to that used in the second experiment reported here could be used to determine whether the postsample stimulus that consistently followed irrelevant samples was established as a cue to forget.

Somewhat further removed from the present research, one might inquire as to whether a stimulus that consistently follows each trial in insoluble simple discrimination tasks would be established as a cue to forget. This possibility could be evaluated by exposing pigeons to a series of two-choice simple-discrimination problems, some solvable and others insoluble. One posttrial stimulus would be presented fol-

lowing each trial of insoluble problems, and the alternate posttrial stimulus would be presented following each trial of solvable problems. Subsequently, the posttrial stimuli would be presented as postsample stimuli in a delayed matching-to-sample task to determine whether the posttrial stimulus associated with insoluble problems was established as a cue to forget.

The two conditions discussed above, although likely not exhaustive of those worthy of empirical investigation, are two of the more promising candidates for additional conditions that may result in the establishment of an effective cue to forget. A more complete specification of the conditions under which a stimulus acquires a capacity to function as a cue to forget should promote the development of more powerful theoretical conceptions of the avian information processing system.

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