

A SYSTEMATIC BIAS IN PIGEONS' MEMORY FOR FOOD AND LIGHT DURATIONS*

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(Received 4 January 1982)

(Accepted 3 May 1982)

ABSTRACT

Pigeons' memory for food-access duration and light duration was compared using a delayed symbolic matching to sample task. At very brief delay (retention) intervals (i.e., 0 or 1 sec) pigeons matched more accurately with food samples than with light samples, but at longer delays (i.e., 2 to 20 sec) this difference disappeared. These results suggested that food durations are more discriminable to pigeons than light durations, but not more memorable. It also was found that after long delays (i.e., 10 or 20 sec) the birds showed a strong tendency to choose the comparison stimulus associated with the short sample (i.e., a 'choose short' effect). The possibility that pigeons' memory for event duration might differ from their memory for other stimulus dimensions was discussed and it was proposed that the choose short effect might be due to subjective shortening of the representation of event duration over the course of longer retention intervals.

Key words: delayed matching to sample; duration as sample; food vs. light samples; retention intervals; bias for short duration.

Recently, Spetch and Wilkie (1981) reported that pigeons discriminate durations of food access more accurately than durations of light. They found that both the rate of acquisition and the asymptotic level of performance were better with food access as the signal than with light as the signal, regardless of whether the light signal

*This research formed part of M.L. Spetch's Ph.D. dissertation.

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consisted of illumination of a houselight, a feeder light, a pecking key, or a small, polarized light. Furthermore, the superior performance with food access as the signal was not specific to the task (i.e., go-no-go, right-left choice, or delayed matching sample) or to the type of reinforcer used (i.e., food or water).

These results have two important implications for the study of discriminative behavior. First, they suggest the possibility that biologically significant stimuli such as food may be more effective for the control of behavior than more 'neutral' stimuli such as light. Second, they suggest that the accuracy of animals' duration discrimination can be strongly influenced by the type of stimulus that signals the duration.

One purpose of the present study was to extend the findings of Spetch and Wilkie (1981) by comparing pigeons' ability to *remember* durations of food or light over various retention intervals. On the basis of pigeons' superior duration discrimination with food as the signal, it was expected that pigeons' memory for durations of food would be better than their memory for duration of light. Such a finding would be important because previous attempts to compare the memorability of food with more neutral stimuli have yielded inconsistent results (cf. Cohen, Nisbeto and Lentz, 1981), in spite of the long-standing assumption that biologically significant stimuli might be particularly memorable to a hungry animal (cf. Capaldi and Spivey, 1964; Pschirrer, 1972; Spetch, Wilkie and Skelton, 1981; Staddon, 1974; Wilkie, 1978).

A second purpose of the present study was to provide some information about pigeons' memory for time. Although there have been numerous studies of pigeons' memory for stimuli such as colors or line-tilts (e.g., Farthing, Wagner, Gilmour and Axman, 1977; Riley, Cook and Lamb, in press; Roberts and Grant, 1976; Wilkie and Spetch, 1978), little is known about pigeons' memory for event duration (cf. Cohen et al., 1981).

METHOD

Subjects

Three adult Silver King pigeons served as the subjects. Each was experienced at discriminating stimulus durations, but none had been exposed previously to delay interval manipulations. The birds were deprived of food until they were approximately 85% of their free-feeding weight and were maintained at this weight on mixed grain obtained during and after daily experimental sessions. The birds were housed in large individual home cages in which water and health grit were continuously available.

Apparatus

A BRS-Foringer Model PS-004 pigeon chamber was used. One wall contained a horizontal row of three plastic pecking keys; each required a force of about 0.2 N

to operate. An Industrial Electronics Engineers' Series 10 stimulus projector was mounted behind each key; these illuminated the keys with a uniform field of colored light. A Gerbrands Model G5610 solenoid-operated feeder that permitted timed access to mixed grain was centered below the keys. Grain presentations were illuminated by a 2.8-W lamp located within the feeder. The houselight consisted of two 2.8-W lamps mounted behind a transparent plastic reflector above the pecking keys; these lamps provided a diffuse illumination of the chamber.

Control of experimental conditions and collection of data were performed by a Data General NOVA 3 computer and the MANX software system (Gilbert and Rice, 1979).

Procedure

The baseline procedure was a variation of the delayed symbolic matching to sample (DSMTS) paradigm (cf. Spetch and Wilkie, 1981). Trials began with the presentation of a sample stimulus for either a short (2-sec) or a long (10-sec) duration. Food access (presentation of the raised illuminated grain-filled feeder from which the birds could eat) served as the sample stimulus on half the trials; on the remaining trials the sample was illumination of the houselight. Sample offset was followed immediately (0-sec delay) by illumination of the side pecking keys, one with a green and one with a red comparison stimulus. The position of red and green was varied randomly across trials. Correct choices (a peck at one color of key after short samples of either food or light or at the other color of key after long samples of either type) produced a 5-sec grain reinforcer, followed by a 30-sec intertrial interval (ITI). Incorrect choices terminated both comparison stimuli and initiated the ITI. Each session consisted of approximately 50 trials.

Each subject was trained under this baseline procedure with a 0-sec delay between the sample and comparison stimuli until matching accuracy appeared stable and asymptotic. The acquisition data from this phase of the experiment are reported in a previous study (Spetch and Wilkie, 1981). For the last ten days of this phase, matching accuracy was well above chance on both types of trials but was higher on food-sample trials than on light-sample trials for all birds.

Following baseline training, variations in the length of the delay between sample offset and comparisons stimuli onset (i.e., the retention interval) were conducted within sessions. Three series of delays were arranged. The first series consisted of delays of 0, 1, 2, 3, 4 and 5 sec; the second series consisted of delays of 0, 5 and 10 sec; and the third series consisted of delays of 0, 5 and 20 sec. During each series, the 0-sec delay occurred on half of the trials in each session; the longer delays occurred on the remaining trials with equal probabilities. Each bird was tested for 140 sessions (Series 1, 60 sessions; Series 2 and 3, 40 sessions each).

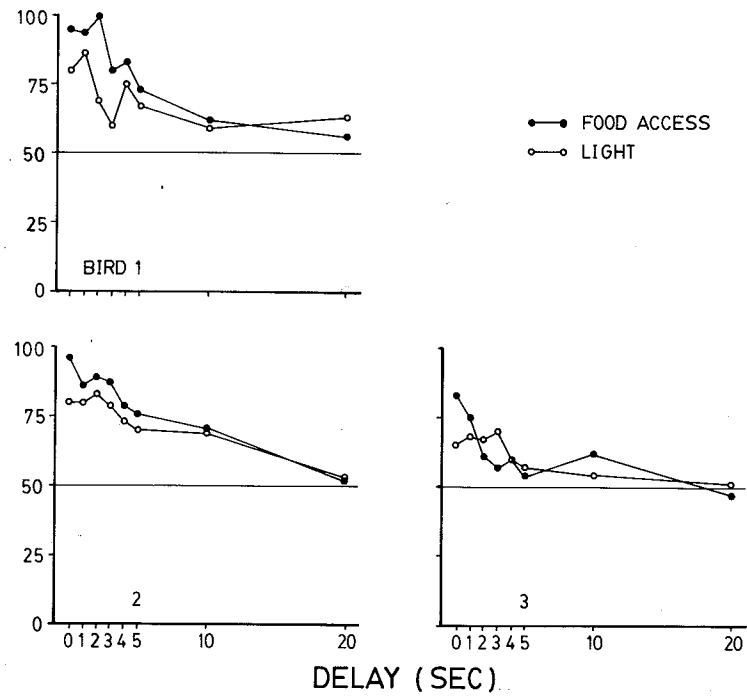


Figure 1. Matching accuracy (percent correct) with food access (●) and light (○) as the sample at each of the eight delays.

RESULTS

Figure 1 shows each bird's matching accuracy with food-access and light samples at each delay. (These data are collapsed across short and long durations of the sample.) Because performance at the 0- and 5-sec delays did not change significantly as a function of repeated testing, data points for the 0- and 5-sec delays were averaged over the three series of delay testing. Consistent with the results of previous studies (Spetch and Wilkie, 1981), matching accuracy was better with food-access samples than with light samples at the 0-sec delay. However, it is clear from Figure 1 that this difference between performance with food and light samples decreased rapidly as the delay interval was increased. A priori orthogonal comparisons between average matching accuracy on food and light trials at each delay confirmed that accuracy after food samples was significantly greater than accuracy after light samples at the 0-sec ($t(2) = 17.82, P < 0.05$) and 1-sec ($t(2) = 12.06, P < 0.05$) delays, but not at any of the longer delays (2 sec: $t(2) = 0.91, P > 0.05$; 3 sec: $t(2) = 0.52, P > 0.05$; 4 sec: $t(2) = 1.92, P > 0.05$; 5 sec: $t(2) = 0.99, P > 0.05$; 10 sec: $t(2) = 2.33, P > 0.05$; 20 sec: $t(2) = -2.29, P > 0.05$).

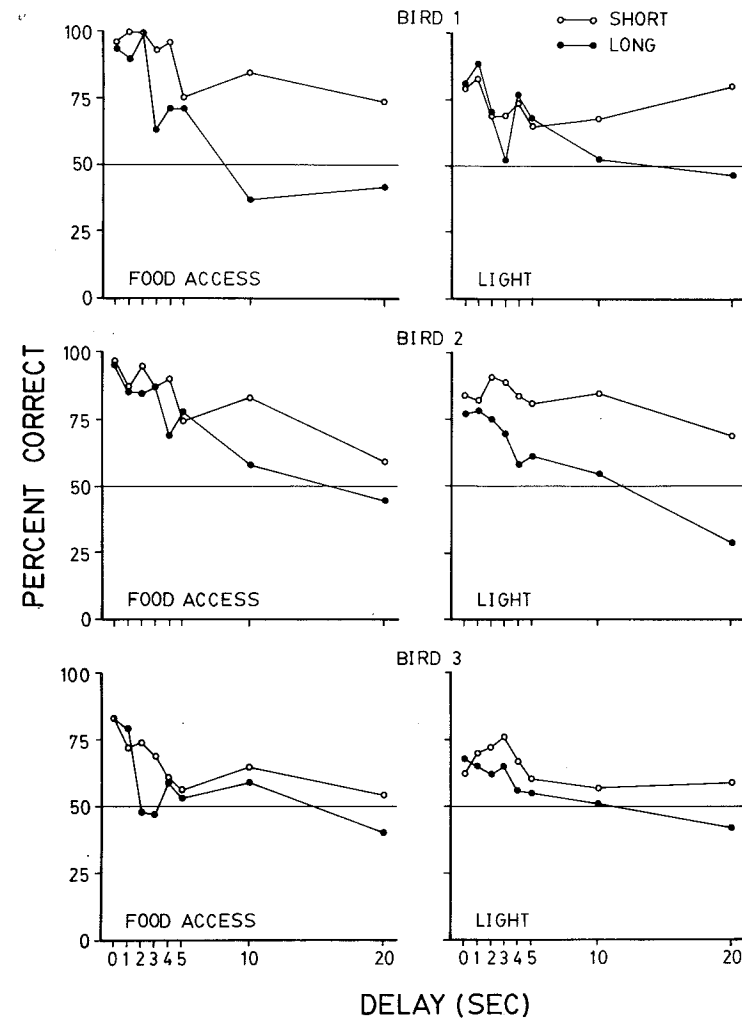


Figure 2. Percent correct after short (○) and long (●) samples at each of the eight delays, with food access as the sample (left panel) or light as the sample (right panel).

Figure 2 shows each bird's matching accuracy (i.e., percentage of correct choices) after short and long samples at each delay. (These data are shown separately for food and light samples.) At the short delays, the percentage of correct choices was approximately equal after short and long samples. However, at the longer delays accuracy after short samples clearly was greater than accuracy after long samples.

The effect of delays on accuracy after short and long samples was assessed by a four-way repeated measures analysis of variance, with the factors being delay, sample type, sample duration, and subjects. This analysis revealed that there were

nificant main effects of delay ($F(7,14) = 12.4, P < 0.05$), sample duration ($F(1,2) = 34.64, P < 0.05$) and subjects ($F(2,14) = 70.24, P < 0.05$). In addition, there were significant two-way interactions between delay and sample duration ($F(7,14) = 29, P < 0.05$), delay and subjects ($F(14,14) = 3.48, P < 0.05$), and sample type and subjects ($F(2,14) = 6.11, P < 0.05$). Finally, there were significant three-way interactions between delay, sample type, and subjects ($F(14,14) = 2.51, P < 0.05$), and between sample type, sample duration, and subjects ($F(2,14) = 10.03, P < 0.05$). No other effects were significant.

The interaction of delay with sample duration was analyzed further by a posteriori comparisons (Newman-Keuls, $P = 0.05$). These comparisons revealed that accuracy after short samples was significantly greater than accuracy after long samples at the 10- and 20-sec delays, but not at the shorter delays.

Thus, changes in the delay interval had two unexpected effects on the birds' performance. First, with delays greater than 1 sec, the significant difference between matching accuracy with food and light samples disappeared. Second, with long delays, the birds showed a strong tendency to choose the comparison stimulus associated with the short samples, as indicated by the significantly greater accuracy after short than after long samples. This tendency hereafter will be called the 'choose short' effect.

DISCUSSION

The results of this experiment replicate those of a previous study that showed that pigeons discriminate durations of food access better than durations of light (Spetch and Wilkie, 1981). However, the superior performance found in the present study with food samples was not maintained when there was a retention interval of more than 1 sec between the sample and comparison stimuli. These results suggest that food durations may be more discriminable than light durations, but not more memorable.

Although these results appear to contradict the idea that biologically significant stimuli such as food are more memorable than 'neutral' stimuli such as light (cf. Cohen et al., 1981; Staddon, 1974; Stubbs, Vautin, Reid and Delehanty, 1978), other interpretations of the data are possible. Food may in fact be more memorable than light, but only with respect to some dimension other than duration. For example, the identity or recency of food may be more memorable than that of light, and yet the duration of these events may not be differentially memorable. Studies that compare the memorability of food and light along more than one dimension may be useful in this regard.

Perhaps the most interesting result of the present study was the finding that accuracy at long delays was better after short samples than after long samples (i.e., the choose short effect). In contrast, a number of previous studies have shown that accuracy is better after long samples than short samples when wavelength or line

orientation are the dimensions along which the samples are to be discriminated (e.g., Roberts and Grant, 1967; Roitblat, 1980). Thus, it is possible that the processes underlying pigeons' memory for the duration of a stimulus differ from those underlying their memory for other dimensions of the stimulus.

Although a number of factors such as response biases (cf. Church, 1980) could be responsible for the choose short effect, a more interesting possibility is that pigeons' subjective representation of event duration in memory becomes systematically 'shortened' during the retention interval, so that after long delays the remembered duration of the long sample is more similar to the actual duration of the short sample. Such a 'subjective shortening' process would lead to more choices of the comparison associated with the short sample. In view of the potential importance of the choose short effect for understanding animal memory processes, and the paucity of research on animals' memory for event durations, further systematic investigation of the choose short effect is being conducted.

ACKNOWLEDGEMENT

This research was supported by the Natural Sciences and Engineering Research Council of Canada in the form of a Postgraduate Scholarship to M.L.S. and Operating Grant to D.M.W.

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