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Training delays reduce the choose-short effect with keylight, but not with food, duration samples in pigeons

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Abstract

Pigeons were trained to match 2- and 8-s food samples. The delay on training trials was either 0 s (group 0sF), 5 s (group 5sF), or varied between 2 and 8 s ($M = 5$ s, group 5sV). Testing at a delay that exceeded the training delay by 15 s in each group revealed a robust choose-short effect in each group. The same pigeons then reacquired a previously trained matching task involving 2- and 8-s keylight samples. Different comparison stimuli were used on food-sample and keylight-sample trials. The delay on training trials was the same on both food- and keylight-sample trials. Extended-delay testing revealed a robust choose-short effect in all three groups when the durations were conveyed by food presentations, but only group 0sF revealed a choose-short effect when the durations were conveyed by keylight presentations. Hence, training with a nonzero delay, whether fixed or variable, reduces the choose-short effect with keylight durations but not with food durations. It was concluded that at least some of the psychological processes mediating performance differ as a function of the event that conveys the duration.

Keywords: Timing; Memory; Matching-to-duration; Training delays; Choose-short effect; Pigeons

1. Introduction

Trials in the delayed matching-to-sample procedure begin with presentation of one of two or more stimuli as a sample stimulus. The sample is followed, typically after a delay interval that varies in duration across trials, by two or more comparison stimuli. Which comparison is correct (and hence pecking it is reinforced) on any particular trial depends upon which sample was presented at the beginning of the trial. Across trials, both the stimulus presented as the sample and the spatial position of the correct comparison stimulus are varied.

The symbolic or arbitrary delayed matching procedure has proven to be a particularly useful tool in the analysis of short-term retention in pigeons. Of particular relevance to the present research is the use of the symbolic matching procedure to study memory for the duration of an event. In the first such study, Spetch and Wilkie (1982) examined pigeons' memory for 2- and 10-s durations of food access and houselight illumination. Following training with a 0-s delay, pigeons were tested with delays ranging from 0 to 20 s. For both food and light samples, accuracy was greater for short samples than long samples after longer delays. That is, subjects showed a strong tendency to choose the comparison stimulus associated with the short sample after longer delays. This observed tendency was called the *choose-short effect*. The choose-short effect is a robust phenomenon and has been demonstrated in a large number of studies (e.g., Gaitan and Wixted, 2000; Grant, 2006; Grant and Kelly, 1996, 1998; Grant and Spetch, 1991, 1993, 1994; Grant and Talarico, 2004; Kraemer et al., 1985; Santi et al., 1993, 2003; Spetch and Rusak, 1989; Spetch and Wilkie, 1982, 1983; Talarico and Grant, 2006).

Spetch and Wilkie (1983) developed the subjective shortening account of the choose-short effect. The subjective shortening account is most readily conceptualized within the information processing model of timing developed by Church and associates (Church, 1978; Gibbon and Church, 1984; Roberts and Church, 1978). According to this model, an internal clock represents time as the accumulation of pulses emitted by a pacemaker. According to the subjective shortening account, the choose-short effect is produced by the shortening of this representation of time (e.g., loss of counts in working memory) during a delay interval greater than that of training. Hence, testing a pigeon immediately following termination of a long sample (i.e., at a 0-s delay) results in a high proportion of correct choices because the representation of the sample duration in working memory corresponds

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closely to the reference memory representation of a long sample established during training with a 0-s delay. Because the working memory representation is held to subjectively shorten, at longer delays (e.g., 10 and 20 s) the working memory representation of a long sample corresponds less closely to the reference memory representation of a long sample, and corresponds more closely to the reference memory representation of a short sample, thereby leading to an increased tendency to choose the short-associated comparison as delay increases.

Several studies have assessed memory for duration following training with a nonzero delay. Spetch (1987) used 2- and 8-s durations of food access as samples and training delays of 0, 10 and 20 s across three successive stages of training. Each training phase was followed by a retention test and each revealed a choose-short effect at a delay that was 10 s longer than the training delay, a result that was replicated using training delays of 0, 5 and 10 s by Spetch and Rusak (1992, Experiment 2a). Spetch and Rusak (1992, Experiment 2b) trained one group with a constant 5-s delay and a second with a variable delay ranging from 2 to 8 s in 2-s increments. The two groups did not differ either during acquisition or retention testing, and both demonstrated a strong choose-short effect at a 20-s delay. Kelly and Spetch (2000) also observed a choose-short effect at delays of 10 and 20 s after training with 2- and 6-s durations of food access and a constant delay of 5 s, and Spetch and Rusak (1989) observed a choose-short effect at delays longer than the 10-s training delay after training with either food or houselight durations. Finally, Grant and Kelly (1998) employed 2- and 8-s keylight samples and variable delays that ranged between 1 and 3 s during training and found a choose-short effect during retention testing at delays of 15 and 30 s.

Although the studies reviewed in the preceding paragraph suggest that the choose-short effect is affected little, if at all, by the use of a nonzero delay during training, other studies question that conclusion. For example, Dorrance et al. (2000) trained pigeons on an event duration task with 2- and 10-s samples of keylight and delays of 0, 1, 2 and 4 s. When tested at extended delays of 8 and 16 s, the typical choose-short effect was not found, although there was a trend in that direction. Consistent with the findings of Dorrance et al., Grant and Talarico (2004, Exp. 1) and Talarico and Grant (2006, Exp. 1) failed to find a statistically reliable choose-short effect after training with a variable delay ranging from 1 to 3 s. Moreover, Talarico and Grant (2006, Exp. 2) retrained these pigeons using a 0-s training delay and obtained a robust choose-short effect.

Recently, Grant (2006) compared the magnitude of the choose-short effect after training with a 0-s delay with that obtained after training with a nonzero delay. In all three groups, the samples were 2- and 8-s keylight durations and half of the pigeons in each group received color comparisons and the other half received line orientation comparisons. In both experiments, one group was trained with a fixed 0-s delay and two groups were trained with a nonzero delay, one with a fixed delay on each trial and the other with a variable delay the mean of which matched that of the fixed delay. In Experiment 1, the fixed nonzero delay was 2 s and the variable delays ranged from 1 to 3 s. In Experiment 2, the fixed nonzero delay was 5 s and the variable delays ranged from 2 to 8 s. Testing at extended delays revealed a stronger choose-short effect in the group trained with a 0-s delay than in either of the groups trained with a nonzero delay in both experiments. Moreover, the choose-short effect was statistically reliable only in the group trained with a 0-s delay in Experiment 2.

Grant (2006) proposed that the most obvious procedural difference between studies suggesting that training delays have little effect on the choose-short effect and those suggesting that training delays reduce the magnitude of the choose-short effect involves the event that conveys the duration. In particular, with the exception of Grant and Kelly (1998), studies that have obtained a robust choose-short effect after training with a nonzero delay (Kelly and Spetch, 2000; Spetch, 1987; Spetch and Rusak, 1989, 1992) have used different durations of houselight or access to food. In contrast, studies which have obtained a reduced or eliminated choose-short effect after training with delays (Dorrance et al., 2000; Grant, 2006; Grant and Talarico, 2004; Talarico and Grant, 2006) have used different durations of exposure to keylight. The lone exception was the study reported by Grant and Kelly (Experiment 1, 1998) in which a reliable choose-short effect was obtained at extended delays of 15 and 30 s after training with 2- and 8-s keylight samples and variable delays in the range of 1 to 3 s. The Grant and Kelly finding is perhaps not particularly surprising given Grant's (2006) finding that use of training delays reduces the choose-short tendency in relation to their length, but even a 5-s training delay did not entirely eliminate the choose-short tendency.

Although the literature is consistent with the conclusion that training with a delay reduces the magnitude of the choose-short effect when keylight durations are employed but not when houselight or food presentations are employed, all evidence has been between laboratory and, hence, necessarily between subjects. This author is unaware of any laboratory that has employed nonzero training delays and both food and keylight presentations. Because experimental protocols, equipment and laboratory procedures differ in often subtle and unspecified ways across laboratories, it is conceivable that one or more of these differences, rather than the nature of the samples, is responsible for between-laboratory differences in the magnitude of the choose-short effect after training with nonzero delays.

The present experiments sought more direct evidence in regard to the effects of a nonzero training delay on the choose-short effect as a function of the event that conveys the durations. To that end, the experiments reported in the present article provided a within-subjects and both between- and within-experiment comparisons of the effect of training delays on the magnitude of the choose-short effect with keylight and food durations. Sessions using keylight and food durations were as similar to each other as possible and, of course, the equipment, housing and handling conditions, etc. were identical.

2. Experiment 1

The three groups of pigeons that were employed in Grant's (2006) study served in the experiments reported in this article. In each group, the training delay was the same as in Grant