The effects of long intertrial intervals in probability learning

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The effects of past outcomes on prediction responses were investigated by comparing massed trials (10 sec intertrial interval) with widely spaced trials (48-72 h intertrial interval). Event-response and response-response dependencies were found with massed trials but not with spaced. It was argued that the lack of predictive power of independence-of-path models of probability learning (cf., Rose & Vitz, 1966) could be due to the use of massed trials in traditional probability learning experiments.

One assumption common to many models of probability learning (PL) is independence-of-path (Bush & Mostellar, 1955; Friedman, Burke, Cole, Keller, Millward, & Estes, 1964; Estes, 1964). Phenomena such as negative recency (Jarvik, 1951) and the ability of Ss to respond appropriately to one-trial-dependencies in the event sequence (Anderson, 1960) render this assumption suspect. Other investigations of PL have weakened the independence-of-path assumption and introduced models which allow Ss a memory of past events which can influence prediction responses (Restle, 1961, Ch. 6; Burke & Estes, 1957). While the success of these latter models (see Rose & Vitz, 1966) argues against the independence-of-path assumption it is quite likely that the lack of independence is related to the experimental situation and is not necessarily intrinsic to PL.

In the traditional PL experiment trials are run at a fairly rapid rate, usually about one every 5 sec. If, using Estes' original conception of PL, Ss are sampling stimulus elements on each trial, it is likely that the sampling is not random but favors stimulus traces from more recent trials. The test of this "artificial" trial-dependence would be to run a PL experiment with extremely long intertrial intervals. Information concerning the effects of spacing of trials is sparse. Most studies have been concerned with the effects of intertrial intervals on acquisition and asymptotic level (Grant, Hornseth, & Hake, 1950) and have not used intervals beyond 30 sec. Since the interest here is on trial dependencies and not necessarily on acquisition or asymptotic responding, we designed a simple experiment where the "learning" of the probabilities of the several events would be superfluous.

Method

Ss were required to predict which of two events would occur on each of a series of trials, specifically whether a coin would come up heads or tails. There were a total of 13 trials; one trial on each of five separate days and four trials on the sixth and seventh days. The Ss were students in an introductory psychology course and the experiment was conducted during the first few minutes

of each of seven successive class days. The intertrial interval for the spaced trials was then either 48 or 72 h; for the massed trials it was about 10 sec. Since the outcomes in coin tossing have a priori probabilities already associated with them and since most Ss have presumably had considerable prior experience with predicting such events, we favored it over the usual procedure of having Ss guess which of two lights will come on. Further, the use of a discrete physical event such as a coin toss should emphasize the independence of successive events. Admittedly, this procedure introduces a bias favoring independence that is not found in the traditional PL experiments where the events seemingly occur at the discretion of the E (Feldman, 1963). However, as will be seen below, even this was not sufficient to produce independence when trials were massed.

The number of Ss run each day differed owing to absenteeism and varied from 72 to 113; all results are thus given in proportions.

Results and Discussion

Table 1 gives the basic data. With spaced trials the probability of a "head" prediction (P_h) is seemingly not sensitive to the trial-by-trial outcomes; runs of two heads and two tails failed to produce differential effects. On days where four massed trials were run however, the effects were quite different. Here a run of two head outcomes produced a sharp drop in the probability of predicting a head down to .360, and a run of two tails increased P_h to .700.

Table 2 gives the individual response sequences for the four trial sequences of Days 6 and 7 (the only trials for which this information is available). The "predicted" values were generated using .544 for the probability of a "head" outcome rather than the a priori .500. The value .544 corresponds to the average P_h observed on the two days of massed trials weighted for the number of Ss run on each day. These data reveal strong response-response dependencies. A Kolmogoroff-Smirnov test showed a significant difference

Table 1 Proportion of "heads" responses (P_h) on each trial

Spaced trials (Days 1-5)		Massed trials (Day 6)		Massed trials (Day 7)	
Outcome	P_h	Outcome	P_h	Outcome	P_h
T	.657	H	.596	H	.590
T	.565	H	.528	T	.420
H	.597	T	.360	T	.520
H	.605	T	.629	T	.700
T	.606				

Table 2 Proportions of the several response sequences on the massed trials. Predicted proportions obtained by using $P_H=.544$ and assuming independence of responses.

Sequence	Pred.	Obs.	Sequence	Pred.	Obs.
TTTT	.043	.111	HTHT	.062	.042
TTTH	.052	.090	HHTT	.062	.048
TTHT	.052	.037	HTTH	.062	.106
THTT	.052	.026	THHH	.073	.016
HTTT	.052	.042	HTHH	.073	.026
TTHH	.062	.074	HHTH	.073	.106
THTH	.062	.032	HHHT	.073	.026
THHT	.062	.026	HHHH	.088	.190

between the predicted and the observed proportions ($D = .107$, $p < .05$).

It would seem rather clear that in the standard PL experiment with closely spaced trials the stimulus for each trial consists of recognizable traces from earlier trials and these traces are important in determining future predictions. Trial-by-trial dependencies are due, at least in part, to the massed trial techniques of traditional PL experiments.

An additional point of interest in the data is the overall level of P_H . The objective probabilities for the two events are .50 and in most two-choice PL experiments Ss initially predict the two events equally frequently. There obviously exists a bias for predicting "heads" that has persisted in spite of a great deal of experience reinforcing equal probabilities.¹ Nor has the experience of this experiment had any effect. On a day some four weeks later the Ss were again asked to predict the outcome of a coin toss. The P_H observed was .636, a value very close to that observed on the very first day of the experiment. This bias for "heads" has been previously documented. Schelling (1960, Chap. 1) asked Ss to guess what another person would predict on a coin toss. In a sample of 42 he found 36 replies of "heads." The bias then is obviously well known, even by the Ss themselves. With respect to coin tossing probability learning has clearly not taken place.

The use of an outcome probability of .50 does present some problems not encountered when one event is more likely than the other. Specifically, there is no optimal strategy, no way that the S can increase the probability of a correct response beyond .50. This situation has not been extensively studied and little is known about the extended behavior patterns that occur when the probabilities of the several events are all .50.

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Note

1. After the experiment was over each S was asked to approximate the number of times in his life he had guessed (predicted) the outcome of a coin-toss—less than 10, between 10 and 100, over 100. Thirty-four per cent replied over 100, 58% replied between 10 and 100 and only 8% replied less than 10 times.