

# A QUANTITATIVE INVESTIGATION OF THE DELAY-OF-REINFORCEMENT GRADIENT<sup>1</sup>

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A number of animal learning experiments have been reported which involve a variable referred to as delayed reward or delayed reinforcement. This variable is usually characterized by a period of delay, spatial or temporal or both, between the occurrence of an instrumental response and the rewarding or reinforcing of that response. Examination of the results of the various experiments reveals striking differences in the degrees of learning which obtain with different lengths of reinforcement delay.

Watson (12) found that animals learn with equal facility to dig through a sawdust barrier to obtain food whether the food reward is given immediately upon successful completion of a trial or is delayed thirty seconds. Warden and Haas (11) found that a food-delay interval of five minutes does not retard maze learning. It is interesting to note that in both the Watson and the Warden and Haas experiments the animals were admitted to the feeding compartment immediately upon successful completion of a trial but that they were prevented from eating the food by the presence of a perforated lid covering the food dish. Experiments by Hamilton (3) and Wolfe (15) have demonstrated that animals learn a maze much less readily if they are detained *outside* the feeding compartment for one minute than if they are fed immediately on reaching the goal.

The fact that the Wolfe and Hamilton experiments obtained a decrement in learning with even a one-minute food delay is striking evidence of the presence of secondary reinforcement in the two earlier studies (11, 12). In other words, in the Watson study and in that of Warden and Haas the feeding compartment and the presence of the food itself served as reinforcing agents of a secondary nature, to such an extent that the delay of the primary food reinforcement (eating) did not impair learning.

With the Wolfe and Hamilton studies there remains the possibility that the delay compartment, because of its spatial and temporal

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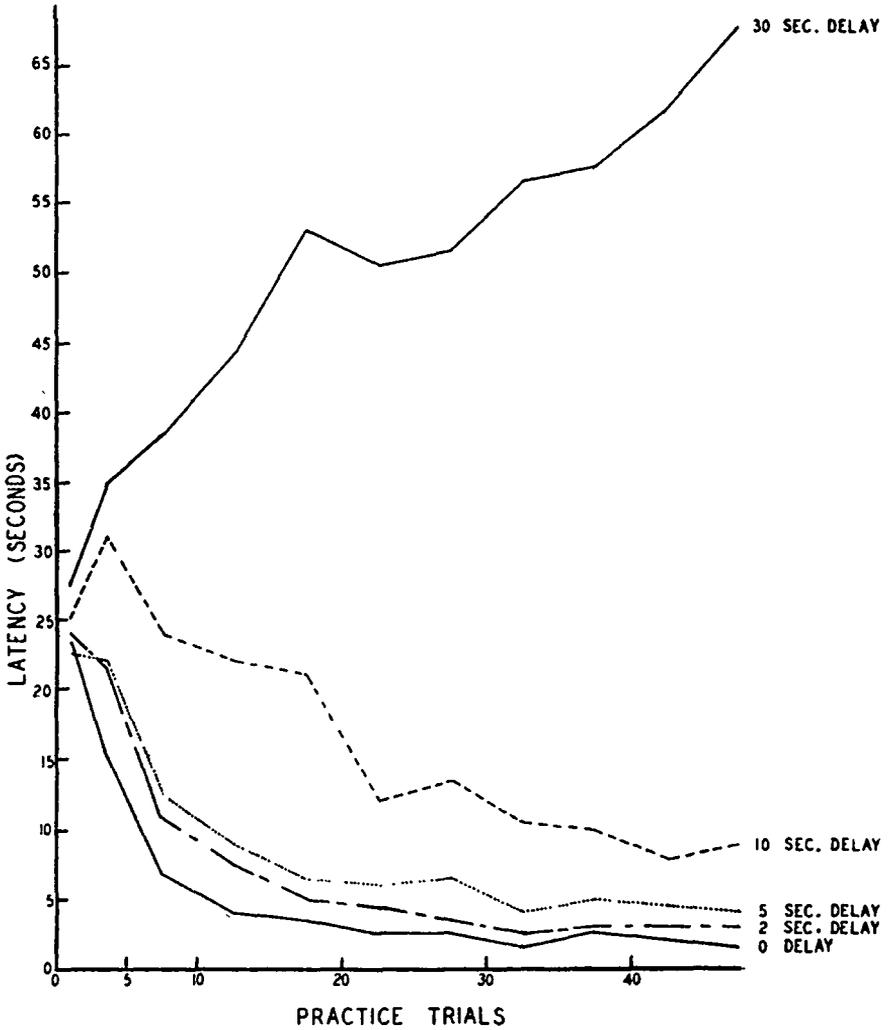


FIG. 1. Practice curves for the five experimental groups corresponding to the five conditions of delayed reinforcement. The curves for the 0, 2, 5, and 10-second delay groups are based on the results of 25 animals for each group, 16 animals comprising the 30-second group. Values represent the medians for pooled successive practice trials for all points except the first two points at the left of each curve. The first point on each curve represents the first trial only and the second point represents the median value for the 2-5 practice trials. Numerical values for the points are given in Table 2.

When a 2-second delay occurs between the response and the reinforcing state of affairs, the pooled curve for successive latencies resembles in form that for the 0-delay group. However, the rate of change appears to be somewhat less than that for the 0-delay group, and the median latency reached after 50 trials is longer than for the imme-