Repetition and serial learning

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A series of experiments were directed at assessing the role of repetition in serial learning. In each study, Ss learned one list by the traditional procedure of seeing the same items over and over again, as well as one in which all incorrectly anticipated items were replaced by new ones. Repetition invariably produced significantly faster learning, with fewer errors.

In a major theoretical paper, Rock (1957) seriously questioned the role of repetition in paired-associate learning. With one group of Ss, all incorrect items were replaced with new ones. This removed the factor of repetition by preventing the unlearned material from being seen on the following trial. Yet, there was no significant difference, in both trials to criterion and errors, between this group and one which learned in the traditional manner. Rock concluded that repetition plays no part in the formation of an association; i.e., a connection which is above threshold at the time of test.

EXPERIMENT 1

Many Ss tend to learn a paired-associate list piecemeal. That is to say, they silently rehearse a few easy pairs at a time, gradually adding new ones with each successive presentation. Since this is rather a common *modus operandi*, the paired-associate procedure may tend to obscure the beneficial effects of repetition.

Serial presentation would seem to provide a far more sensitive means of evaluating repetition, by preventing S from idiosyncratically picking and choosing items to commit to memory. In other words, the interdependence of items in an ordinal task precludes the possibility of selectively attending to certain portions of the list, while ignoring the balance.

Accordingly, the purpose of this study was to assess the role of repetition in serial learning.

Procedure

The experiment consisted of two conditions. In the first, S was required to learn a list of eight nonsense syllables by the method of anticipation. The syllables were taken from the Glaze Table of 40%, 47%, and 53% association value. They appeared in bold type on 3 x 5 in. index cards. The word START preceded the list, providing the stimulus for the first item. Three such lists were constructed, with one being randomly chosen for presentation.

The items were exposed for 2 sec. One immediately followed the other with no delay. There was a 6 sec intertrial interval. The same eight syllables were presented over and over again until S met the criterion of one perfect recitation. Thus, the factor of repetition was employed in the first condition.

In the second condition, unlearned syllables were dropped from the list, with new ones inserted in their place. The list was constructed of eight items randomly selected from a pool of 208. The remaining 200 syllables were used for replacement purposes. S was advised of the procedure in advance, so as to avoid undue confusion. Except for the replacement of incorrect responses, the second condition was identical to the first. For all intents and purposes, repetition was eliminated through the use of this substitution paradigm.

The order of the two conditions was counterbalanced over Ss, with a 5 min interval between lists.

Subjects

Four males and four females participated in this experiment. Ranging in age from 19-25, their mean age was 22.0 years. They were all students who were naive as to the purpose of this study.

Results and Discussion

While it took an average of 9.9 trials to reach criterion with repetition, a mean of 16.9 was required to learn the substitution list. This difference was significant according to the Wilcoxon signed-ranks test ($t = 1$, $n = 8$, $p < .02$). One S learned faster with substitution. However, she benefited from warming up on the repetition list, so that seven of the items were responded to

correctly on the first trial by the time the replacement list was presented. As a result, the substitution procedure was not overly disturbing.

The mean number of errors to criterion was 35.5 for the first condition, compared to 64.9 in the second. This difference was also significant according to the Wilcoxon test ($t = 3$, $n = 8$, $p < .05$).

These findings indicate that repetition seems to provide a decided advantage in a serial task.

EXPERIMENT 2

An objection may be raised against the first experiment, namely, that dropping an incorrect item also removes the stimulus needed for eliciting the next response in the series. Accordingly, it is really quite surprising that the substitution list was learned at all.

The following study was designed so as to take this argument into account.

Procedure

The procedure basically followed that of Experiment 1, except that a paired-associate was substituted for an incorrectly anticipated response in the second condition. The left hand member of the pair consisted of the missed item, thereby providing the stimulus for the next response. The right hand member was the replacement item to be anticipated on the following trial. If that replacement item were missed, S then would be shown a new pair; the old substitution syllable appearing on the left side with a new one on the right side. A chain of 25 such pairs was constructed for each of the eight positions in the list. The nonsense syllables employed in both conditions were of 80%-93% association value. The balance of the procedure was the same as in the previous study.

Subjects

Four males and four females participated in this study. Ranging in age from 20-24 their mean age was 22.0 years. They were all students who were naive as to the intent of the experiment.

Results and Discussion

The mean number of trials to criterion was 6.6 with repetition and 11.5 under the substitution procedure. The two conditions reliably differed according to the Wilcoxon test ($t = 3$, $n = 8$, $p < .05$).

A mean of 15.4 errors was found in the first condition, compared to 37.8 in the second. This difference was also significant ($t = 2$, $n = 8$, $p = .02$).

The results of the first experiment were confirmed in this study, as repetition again was found to generate a consistently large savings.

EXPERIMENT 3

Throughout the first two studies, Ss seemed to take particular notice of the position of various items within the substitution lists. Some openly counted the items, as they were presented one by one. It was as if they finally were able to ascribe some semblance of order to the substitution list by associating each syllable with its location in the series. This is supported by the finding that the replacement lists were learned in accord with the serial position curve when, in fact, the substitution design demanded that learning occur in a linear or progressive fashion. The strategy of transforming each item into a paired-associate enabled S to selectively learn some syllables, while avoiding others. This explains how the replacement lists were mastered with reasonable facility.

In the following study, the sequence of items was held constant, but their position in the list was varied from trial to trial. Accordingly, this experiment was directed at assessing the role of repetition in a pure serial chaining task.

Procedure

Since the previous studies produced similar results, the two substitution procedures were combined. Instead of being presented with a paired-associate, the incorrectly anticipated syllable was exposed for 2 sec. This furnished the stimulus for the next

response. Meanwhile, S was told, "Because you missed this item, it will be replaced by this one on the next trial." The substitution syllable was then presented for 2 sec. The nonsense syllables again were of 40-53% association value, but with 20 new ones added to the pool.

The location of the items, relative to the beginning and end of the list, was changed from trial to trial. This was accomplished, under both the repetition and substitution condition, by moving the items up one position for each new serial presentation. So, for example, if the series 1, 2, 3, and 4 were shown on the first trial, 2, 3, 4, and 1 would be seen on the second, 3, 4, 1, and 2 on the third, etc. Thus, S was confronted with the problem of connecting items within a series, regardless of their position. The balance of the procedure was the same as before.

Subjects

Eight females participated in this study. Ranging in age from 20-23, their mean age was 21.8 years. They were all students, naive as to the purpose of this experiment.

Results and Discussion

Four Ss failed to complete the substitution list, as the pool of cards became depleted within 28-29 trials. The remaining four met criterion in 13, 29, 34, and 36 trials, respectively. Everyone learned the repetition list within 18 trials. It took a median number of 9.5 trials to criterion. Learning was always faster with repetition. Therefore, the two conditions differed significantly according to the Binomial test ($p < .01$).

The repetition list generated a median of 17.5 errors, compared to 187.5 in the replacement condition. This difference was also significantly reliable according to the Binomial test ($p < .01$).

The substitution procedure was exceptionally stressful. As a result, Ss often became verbally abusive between trials. During each trial, they openly responded to the stimulus items. Their verbosity demonstrated something of major theoretical concern. When S appeared to be about halfway through the replacement task, old items—long since removed—began to intrude. S was unaware of ever seeing these syllables before and was unable to explain why they were being elicited. Their effect was to completely disrupt performance, forcing S virtually to start from scratch again. Every S experienced this phenomenon.

These data indicate that stimuli are connected on their very first presentation solely on the basis of contiguity. Although they may not be manifested verbally, they do express themselves in terms of generating interference. Repetition seems to play a most important role in bringing these weak associations above the threshold for verbal report.

Our findings strongly support continuity theory which, upon close examination, is truly a one-trial position. It differs from Rock's point of view only in that it refuses to arbitrarily reject the existence of associations which cannot be directly observed. Those who are so arrogant as to insist that the failure to verbalize a connection demonstrates its nonexistence, must uphold their contention by explaining such other phenomena as, the great amount of retroactive interference produced by partially learned lists and reminiscence.

REFERENCES

- ROCK, I. The role of repetition in associative learning. *American Journal of Psychology*, 1957, 70, 186-193.