Each condition used 40 sequences. Condition (*b*) used the same vocabulary as in (*b*) of the first experiment. In condition (*c*) every word in the entire test (200 words) was different, and all were common four-letter nouns or verbs drawn from the *AA* and *A* lists of Thorndike and Lorge[5].

The respective mean percentage correct sequences for the (*b*) and (*c*) conditions were 68·7 per cent and 43·4 per cent. These means are significantly different ($t = 4{\cdot}26$; $P < 0{\cdot}001$).

The result of Experiment 2 is compatible with an informational model of short-term memory. But the (*b*) conditions in the two experiments are identical (apart from the number of sequences presented), and the subjects are comparable. Furthermore, the difference between the (*b*) condition scores for the two experiments is not significant (Mann–Whitney test, $P > 0{\cdot}1$). One might therefore be justified in regarding condition (*b*) as a subject matching test, and so compare the mean scores of (*a*) and (*c*). In this case a Mann–Whitney test shows the difference to be highly significant ($P < 0{\cdot}001$). This result is not compatible with an informational model.

Taken together these results provide far more support for a memory span model based on probability of acoustic confusion than for one based on information theory. I have shown that, if vocabulary size is constant, memory span is a function of probability of acoustic confusion. I have further shown that varying the vocabulary size may lead to either greater or smaller memory span. It seems *a priori* that the 200-word vocabulary of condition (*c*) has a smaller probability of acoustic confusion than the (*a*) vocabulary, and a greater one than the (*b*) vocabulary, and that these are the relationships on which the results depend.

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[1] Pollack, I., *Amer. J. Psychol.*, **66**, 421 (1953).
[2] Miller, G. A., *Psychol. Rev.*, **63**, 81 (1956).
[3] Crossman, E. R. F. W., in *Information Theory* (Butterworth, London, 1960).
[4] Conrad, R., *Nature*, **193**, 1314 (1962).
[5] Thorndike, E. L., and Lorge, I., *The Teacher's Handbook of 30,000 Words* (Columbia Univ., New York, 1944).

Relationship between Degree of Learning and Retention

Underwood[1] has argued that the major factor determining retention is the previous learning experience of subjects. On the basis of data from a series of earlier experiments by many different workers he suggests that recall of verbal material is a function of the number of previous lists learned. The more lists previously learned, the lower is the recall score after 24 h. Underwood claims that this is due to an increase in proactive inhibition from each list learned. In this way proactive inhibition is considered to be the main causal factor affecting recall performance.

The following two experiments have attempted to assess the importance of proactive inhibition in the learning situation Underwood discusses. The first experiment used the same design as in the work cited by Underwood. Six lists of paired associate items were learned by the anticipation method. One list was learned to the criterion of a single correct trial on each of six successive days, and each list was recalled on the following day before learning of the next list commenced.

The percentage recall for each list is shown in Fig. 1 (Exp. 1). Although percentage recall declined over successive lists, this decline was not so great as Underwood's composite curve from previous experiments would suggest. It is felt that this is because Underwood's curve combines data from paired associate and serial learning tasks; recall of serial lists is expected to be worse than recall of paired associate lists.

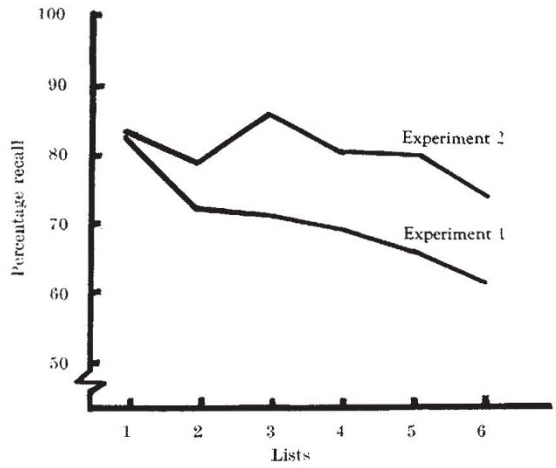

Fig. 1. Percentage recall after 24 h for six successive lists under two experimental conditions of learning

On the other hand, it was found that mean number of trials to reach the learning criterion declined steadily from 11·40 to 6·85 over the six lists. The average degree of learning of items declined in a similar fashion. Degree of learning is here operationally defined as the number of times an item is correctly anticipated during learning. The mean number of correct anticipations per item for list 1 was 5·90, and for list 6 this figure was 3·86.

The relationship between degree of learning of individual items and the probability of recall of those items was investigated for each of the six lists. It was found that probability of recall of items was directly dependent on degree of learning. It has been already reported that mean degree of learning of items in each list declined with each additional list learned. Since probability of recall is found to be dependent on degree of learning, it is felt that the observed decline in mean degree of learning provides a more economical explanation of the decline in recall scores than does an explanation invoking an additional concept, proactive inhibition.

A second experiment investigated the relationship between degree of learning and retention of items over the same six lists when trials to criterion were held constant for each list. Mean degree of learning of items was found to increase over the six lists. The recall performance is again shown in Fig. 1 (Exp. 2). It can be seen that no consistent decline in recall scores occurred in these conditions. As in the previous experiment, it was found that probability of recall was directly dependent on number of correct anticipations (that is, on degree of learning).

While the variations in degree of learning over the six lists are again taken to be the major determinant of recall score, it is however likely that an additional factor is affecting the results of the second experiment. There was a significant tendency for a given degree of learning to be associated with a lower probability of recall with each additional list learned. It is possible that this represents proactive inhibition, although other possibilities cannot be ruled out (for example, a decline in the amount of extra-experimental rehearsal of items). A similar tendency was observed in the results of the first experiment, but this was not statistically significant. If this second factor in the results of these two experiments is in fact proactive inhibition it clearly is not the main causal factor determining recall of items

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[1] Underwood, B. J., *Psychol. Rev.*, **64**, 1 (1957).