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# ON THE PREDICTION OF OCCURRENCE OF PARTICULAR VERBAL INTRUSIONS IN IMMEDIATE RECALL[1]

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In the past few years the author has published a series of experiments dealing with the frequency and order of emission of particular items in recall. These experiments demonstrate that both the order of emission of items in free recall and the occurrence of intrusions from other experimental lists may be determined by the context of a given list. If a list is learned by serial anticipation, most intrusions in serial recall, even after interpolation, come from other positions within the same list (Deese & Hardman, 1954; Deese & Marder, 1957). If, however, a list is organized into paired-associates, intrusions after interpolation are more likely to come from other lists, particularly if the same stimulus items are used in all lists (Deese & Hardman, 1954). In free recall, the order of emission of items within a list depends upon the strength of the serial organization in the list (Deese, 1957; Deese & Kaufman, 1957). Lists which have no serial or sequential organization are recalled in order of the associative strength of the items. Lists in which sequential organization is induced by statistical dependencies between items are recalled in serial order. Thus, sequentially organized lists in free recall behave much as do lists learned by serial anticipation.

Despite these and similar generalizations it has been impossible to describe completely the organization of lists in recall because of the "unpredictable" occurrence of extra-list intrusions. These are items which occur during recall but which come from none of the lists presented to *S*s. A plausible ex post facto account can be given for most extra-list intrusions after they have occurred, but heretofore no scheme has been developed for predicting their occurrence. The purpose of the present paper is to describe a technique for predicting the occurrence of such extra-list intrusions and to demonstrate that they are accounted for in terms of simple association, or, more specifically, the associative context of the lists presented to *S* for recall.

There are two problems inherent in the study of extra-list intrusions. These are (*a*) producing lists which reliably result in particular extra-list intrusions, and (*b*) finding variables which predict the relative frequency of occurrence of those intrusions. In the present experiment both of these problems have been solved by the use of the word-association technique, and, therefore, the present analysis demands the assumption that word-association norms may be used as indices of the strength of verbal stimulus-response associations in the population from which *S*s have been drawn. This assumption is justified to the extent that word-association norms are able to predict the occurrence of particular extra-list intrusions.

## METHOD

The experiment consisted of two parts. In one, the data on the occurrence of particular extra-list intrusions were gathered. In

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the other, word-association frequencies for the items used in the recall tests were obtained. Here the items from the recall lists served as stimulus items in a free association test.

In the study of immediate recall, 50 undergraduate students at Johns Hopkins University were used as *Ss*. All *Ss* were tested individually. Each *S* was tested on 36 lists of 12 words each. The *Ss* were instructed to listen carefully to each list and to recall orally the items from each list at the conclusion of the reading of the list. The lists and instructions for immediate free recall were presented by tape recording. The oral recalls from *Ss* were recorded by tape and transcribed later. Five different orders of lists were used; these were obtained by independent random assignment of the 36 lists to positions in testing. The assignment was made on the basis of tabled random numbers. All five orders were recorded at the outset of the experiment, and these were presented to *Ss* in rotated order as *Ss* were chosen from the available pool.

Each list consisted of the 12 highest frequency responses given to a particular stimulus on the Kent-Rosanoff word-association lists. The frequencies were obtained from the Minnesota norms for the Kent-Rosanoff items (Russell & Jenkins, 1954). The particular 36 lists are taken from Items 1, 2, 3, 5, 6, 7, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 33, 35, 36, 37, 38, 39, 40, 41, and 43 of the Minnesota norms. These particular 36 lists were chosen on the basis of preliminary observations which indicated that some of the lists very reliably produced the tendency for *Ss* to recall the stimulus word associated with the list (a word they had not heard in the list) and others of the lists never or very infrequently produced a tendency to recall the stimulus word. Thus a considerable range of tendency to emit an intrusion in recall resulted.

In order to predict the occurrence of these particular intrusions in recall it was necessary to obtain word-association norms with the words on the recall lists used as stimuli. Therefore, word association tests were administered to samples of *Ss* drawn from the same population as that used in the recall tests but consisting of different individuals. Since there were many items to be used in the word-association measurement, the items were divided into two groups and administered to two separate samples of 50 *Ss* each. There were 200 items on each test, including some filler items. These tests were administered in group form with the following printed instructions on the cover of the test booklet (these instructions were also read by *E*): "This is a free association test. On the next four pages you will find a list of words. Look at each word and write down in the column next to it a word that it makes you think of. Write only one association to each word. Sometimes you will think of a word that you have already given as a response to another stimulus word. Always write down this word; in brief, do not let your responses to earlier items influence how you respond to later items. Use only a single word. Do not skip any word."

The major data obtained from these word-association tests consisted of percentage frequency of occurrence of the Kent-Rosanoff stimulus word appropriate to a particular list as an associative response to words from that list. For example, "Chair" is the highest frequency response to "Table" on the Minnesota norms of the Kent-Rosanoff. In the present case the frequency with which "Table" occurs as a response to "Chair" was tabulated. For each list used in recall, the mean percentage frequency occurrence of the Kent-Rosanoff word as a response to all the items on the list was calculated for each list. These mean percentage frequencies constitute the independent variable in the present study.

Since the obtained association frequencies in the present study are based upon responses from only 50 *Ss*, a small number for word-association studies, it is fortunate that some indication of the reliability of these associations may be obtained by comparing them with the frequencies reported in the Minnesota norms for those stimulus items common to both the present lists and the Kent-Rosanoff. The Minnesota norms are based upon a sample of 1008, obtained from a population similar to that from which *Ss* for the present study have been drawn, so the obtained frequencies from the present study should correlate with those obtained from the Minnesota norms. There were enough common stimulus items between the lists such that there were 102 comparable associations which involved the critical items (responses which were the stimulus words for the 36 Kent-Rosanoff items). A number of these were zero frequency for both the Kent-Rosanoff and the present tables (e.g., while "man" occurs as a response to "short," "short" never occurs as a response to "man"). These common zero association frequencies were discarded in the comparison, however, on the grounds that they could

unduly inflate the obtained correlation. Consequently, a product-moment correlation was computed between the obtained percentage frequency of association for 88 different critical responses to stimuli common to both sets of data. The resulting $r$ was .778. The mean percentage frequency for these items on the Kent-Rosanoff norms was 16.0, and the mean percentage frequency from the present data was 15.4. Therefore, despite the comparatively small sample upon which the norms used in the present study are based, they seem to correspond well to those obtained from a much larger sample from a similar population. Since the average association score for each list used in the recall study is the mean percentage frequency with which the critical word occurs to 12 different stimulus items, even greater stability is achieved in the independent variable as the result of combination.

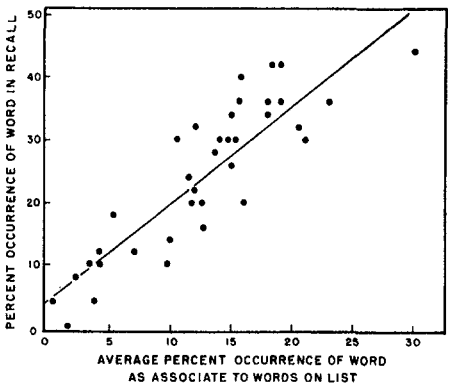


FIG 1. Percentage occurrence of a particular word as an intrusion in immediate free recall as a function of the mean association strength of that word to the words on the list.

## RESULTS

Table 1 shows the percentage frequency with which the Kent-Rosanoff stimulus word occurs as an intrusion in immediate free recall of the list composed of response items to that stimulus word. These vary from 0% for the stimulus word "Butterfly" to 44% for the stimulus word "Sleep." The problem in the present study is to determine the extent to which the tendency to emit these particular words as intrusions in recall is predictable from the frequency with which these words are given as associations to words on the list. Figure 1 shows the relationship between the percentage frequency occurrence of the stimulus word as an intrusion in recall and the mean percentage frequency of the stimulus word as an association to items on the list. As can be seen, there is an apparent regression between these variables. The product-moment correlation for these data is .873. With 35 *df*, it is significant well beyond the .1% level. If the obtained correlation is used as the best estimate of the true correlation, it follows that 76% of the variance in probability of intrusion is determined by variation in mean association strength.

TABLE 1

PERCENTAGE OCCURRENCE OF STIMULUS WORD AS INTRUSION IN IMMEDIATE RECALL ($N$ = 50)

| Stim. Word | % Intrusion | Stim. Word | % Intrusion |
|---|---|---|---|
| Table | 18 | Whistle | 4 |
| Dark | 10 | Cold | 34 |
| Music | 30 | Slow | 30 |
| Man | 32 | Wish | 12 |
| Deep | 14 | River | 20 |
| Soft | 40 | White | 16 |
| Mountain | 36 | Beautiful | 8 |
| House | 12 | Window | 30 |
| Black | 28 | Rough | 42 |
| Mutton | 4 | Foot | 36 |
| Hand | 22 | Needle | 42 |
| Short | 30 | Red | 24 |
| Fruit | 20 | Sleep | 44 |
| Butterfly | 0 | Anger | 34 |
| Smooth | 26 | Carpet | 10 |
| Command | 10 | Girl | 32 |
| Chair | 36 | High | 30 |
| Sweet | 36 | Sour | 20 |

Since the regression is apparently linear, a least-squares fit of the relationship was made. This yielded $Y = 3.7 + 1.63X$. The slightly positive origin suggests that intrusions

may have some "free" strength in the context of these lists. This is reasonable, since they are, on the average, words with high frequency of occurrence in English, and, as a consequence, one would expect them to turn up occasionally as intrusions, even when they have little or no association value to the items on the list.

The slope constant predicts that if the mean association strength for a particular word were increased to 60%, the probability of that word occurring as an intrusion would be 1.0. The author has tried to construct lists which would yield a particular word as an intrusion nearly always, but it does not seem possible to do so with the association norms currently available and if the lists are to be 12 items in length. It is very possible, however, that if association norms were available for a very large number of words, such a list could be constructed. If so, it would provide a definitive test of the linearity of regression of probability of intrusion upon association value.

It is possible to argue that the relationship described above is actually the result of other, uncontrolled variables. The most important of these are (*a*) the frequency of usage of the words predicted as intrusions and (*b*) the frequency with which these words occur in other prior lists. Both of these variables were examined as possible predictors of frequency of intrusion.

The L count from the Thorndike and Lorge (1944) word count was used as a measure of frequency of usage. The correlation between L-count frequencies and percent intrusions was .059. It might be argued that the correlation would have been higher if the L-count frequencies had been transformed logarithmically; however, both the highest and lowest frequency intrusions were among the very lowest L-count words. The low correlation is the result of scatter rather than curvilinearity in the plot. It is possible, however, that there would have been a genuine though small effect of frequency of usage if an adequate sample of words of different frequency of usage had been employed. In the present experiment only three of the predicted intrusions had L frequencies below 100, and none had L frequencies below 22. Therefore, while frequency of usage cannot account for the frequency with which intrusions occur, it is very possible that an investigation of frequency of usage itself would reveal a correlation between it and intrusion in recall. The investigation of this possibility awaits the development of word association norms which sample words adequately from a wide range of frequency of usage.

Some of the intrusions occur as actual items in other lists. This is true for 23 of the 36 predicted intrusions. Therefore, it might be argued that such intrusions were the result of a proactive effect. On general grounds this is unlikely, since the technique of a single presentation and a single immediate recall trial minimizes influences from list to list. However, the frequency of occurrence of each intrusion as an actual item in all prior lists was tabulated for each *S*, and the summed frequencies for all *S*s were correlated with the frequency of intrusion. The resulting $r$ was .162, which is not statistically significant. It is possible that proactive effects do exist, but they have not been satisfactorily demonstrated here, and they do not account for the obtained correlation between association frequency and frequency of intrusion.

In addition to the actually predicted intrusions in particular lists, the same words occasionally appear as intrusions in other lists, and, additional, unpredicted words also appear. These appear, however, very infrequently. The predicted intrusions occur, for all lists, with an average frequency of 24.2%, while the unpredicted intrusions occur with an average frequency of only 3.2%. Of these unpredicted intrusions, the word "girl" (a predicted intrusion for one list) occurs three times, each occurrence on a different list, and the word "music" (also a predicted intrusion for one list) occurs three times within one list, the list for which the intrusion "whistle" is appropriate. No other unpredicted word occurs as an intrusion more than twice, although for nearly every list at least one unpredicted intrusion occurs. The average frequency of 3.2% for these unpredicted intrusions agrees well with the value for the origin of the fitted curve in Fig. 1, if the possibility of occasional proactively determined intrusions and occasional unpredicted associations is taken into account.

## Discussion

The results of the present experiment indicate that the probability of a particular word occurring as an intrusion in immediate free recall of a list of words may be predicted from the tendency for the intruding word to occur as a response in free association to the items on the list. It is implicit that such association frequencies represented previously learned habits. Therefore, the present study has some implications for the influence of previous habits upon retention, an influence the importance of which has recently been pointed out by Underwood (1957).

The question immediately arises, may the results of this study be generalized to the occurrence of intrusions in recall at large? With the exercise of some caution, some generalizations may be made which, in turn, suggest some interesting hypotheses. The particular relationships reported in this paper are, of course, limited by the conditions of the experiment. The important point, however, is that the effect occurs, and, furthermore, for the data reported here it appears to be a linear effect. This implies that there is no interaction among the several words. The probability of intrusion is very well predicted by the simple mean, irrespective of distribution, of the associative tendencies for the intrusion to be elicited by the test words. Because of the very high proportion of variance predicted by the mean associative strength, relatively little variance could be predicted from any possible interactions. Therefore, the present data seem to warrant the hypothesis that the probability of occurrence of an intrusion in recall is proportional to the average association strength of that item in the context of the material being recalled and is relatively independent of the distribution of association frequencies among the various items on the list.

If this hypothesis has general validity, it provides an important mechanism for analysis and description of the kinds of elaboration in memory described by Bartlett (1932). It implies that in the process of recollection, words and concepts associated with remembered items will be added. Likewise, all other things being equal (ignoring, for example, serial position effects), items which are forgotten will be items which have low probabilities of being elicited by remembered items from the list. Thus, it may well be possible that some of the effects described as leveling and sharpening may turn out to be simply a matter of the strength of contextual associations to the items to be remembered.

With this in mind it is possible to interpret "clinically" some of the material presented by Bartlett (which, after all, is exactly what Bartlett did). For example, in the celebrated "War of the Ghosts" the word "war" appears four

times near the beginning of the story, but the words "battle" and "enemy" never appear. In one of the initial reproductions presented by Bartlett the word "war" appears, but also the words "battle" and "enemy" appear twice. In general, if the word "war" appears in recall, the words "battle" and "enemy" are added. These latter words are both high frequency associations to "war." Such an analysis proves nothing, of course, but it does suggest the possibility of constructing meaningful passages containing repeated words with known probabilities of eliciting other words as associations and then examining the reproductions for the frequency of occurrence of these associations as intrusions.

Even more intriguing is the possibility that some of the well-known experiments, the results of which are usually described as the effects of attitude and motive upon retention, may be predictable from the association frequencies to critical words yielded by the target populations. For example, one of the best known studies (Levine & Murphy, 1943) compared the retention of pro- and anti-communistic material in groups of *Ss* known to be either pro- or anti-communistic. The results of the present study suggest that at least some of the differences in kinds of material retained by such groups would be predicted from differences in association frequencies for critical words between the groups.

Thus, the hypotheses arising out of the empirical relationship found in this study suggest ways of interpreting a wide variety of problems of patterning and organization in memory in terms of elementary associative frequencies. At the very least, the results of this study suggest that experiments in which different groups of *Ss* are compared for their ability to remember specific items should either present data on association frequencies for the groups concerned or make certain that such association frequencies are well controlled.

## Summary

Lists consisting of 12 words each were presented to 50 *Ss* for a test of immediate recall. In the recall of these lists, particular words occurred as intrusions which varied in frequency from 0% for one list to 44% for another. Data gathered on word-association frequencies clearly showed that the probability of a particular word occurring in recall as an intrusion was determined by the average frequency with which that word occurs as an association to words on the list. The correlation between probability of intrusion and mean association value was .873. The regression, over the range examined, was linear, and this suggests the hypothesis that the probability of occurrence of a particular word as an intrusion in recall is proportional to the average association strength of that word to the words on the list.

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