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Effects Of Constant And Varied Input Orders On Transfer Of Recall And Output Consistency

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EFFECTS OF CONSTANT AND VARIED INPUT ORDERS ON TRANSFER OF RECALL AND OUTPUT CONSISTENCY

BY

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B.A., Occidental College, 1975

THESIS

Submitted in Partial Fulfillment of the
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in the Graduate School of
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ABSTRACT

A transfer design was utilized to test differential predictions, derived from a one-process contiguity model and a two-process organizational model, concerning what is learned in the free recall situation under conditions of constant input order, in which the serial order of the list items remains the same for each presentation, and varied input order, in which the order is rescrambled for each presentation. Half of the subjects received constant input during training and half varied. In the test phase, half of the subjects in each of these two groups continued under the same condition received during training, while the other half were shifted to the complementary condition. Subjects shifted from constant to varied input showed negative transfer for both recall and output consistency, while the other three groups showed positive transfer for both measures. These results were interpreted as evidence for differences in what is learned under constant and varied input, and as support for the organizational model. The results were related to studies of the effects of constant and varied spatial groupings on coding processes.

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INTRODUCTION

In the typical multitrial free recall (MTFR) experiment, subjects are given several presentations of a list of stimulus items, and are instructed that they may recall those items in any order they wish. The serial order of the items is usually varied from presentation to presentation. In this situation, subjective organization is said to occur when a subject's output displays some degree of sequential consistency from trial to trial; such consistency is most commonly measured in terms of the number of pairs of items that occur in adjacent positions on each of two successive output trials (e.g., Tulving, 1962; for a review of such measures, see Sternberg & Tulving, 1977).

The typical MTFR procedure can be altered slightly by presenting the list items in the same sequential order on each trial while still allowing subjects to recall them in any order they choose. An important question arises as to whether the processes underlying the memorization and recall of list items are differentially affected by different conditions of input order. In essence, the issue is whether "what is learned" in the free recall situation is the same for both constant and varied input conditions. Previous data indicate that, with lists of unrelated words, keeping the serial order of items constant from trial to trial in the MTFR paradigm leads to superior recall than when the serial order is varied--at least when the conditions of input order are manipulated between-groups (Jung & Skeebo,

1967; Mandler & Dean, 1969, Postman, Burns, & Hasher, 1970); using a within-subjects design, Waugh (1961) found no difference in recall performance for constant and varied orders of input. In addition, when the input order of unrelated words is kept constant, subjects' recall protocols tend to show greater consistency from one output to the next, as well as greater correspondence to the input, as indexed by the intertrial repetition (ITR) measure (Bousfield & Bousfield, 1966) of output consistency.

The question of what is learned in the free recall situation under constant presentation vis-á-vis varied presentation is theoretically important for several reasons. Much of the impetus for the development of organizational theories of free recall arose out of a dissatisfaction with theoretical frameworks based on associationist principles such as frequency, contiguity, and the like. Tulving (1968), for example, maintains that Waugh's (1961) data argue <u>against</u> repeated, contiguous presentations as a means of facilitating the development of associations and thereby bringing about better memorial performance. At the same time, however, the method of constant presentation has presented what is apparently a sticky classificatory problem for organizational theorists, since subjects given a constant input order show a tendency to "seriate" (Mandler & Dean, 1969)--i.e., to adopt the input order as the basis for their output order. In the case of recall of unrelated

items, Tulving (1962, 1968), for example, has defined subjective organization as a consistent discrepancy between the input order of items and the subject's output order. Thus, for Tulving, seriation would not, by definition, qualify as a mode of subjective organization. On the other hand, Mandler (1969) prefers to regard seriation as a basic organizational process--and, therefore, one that is presumably fundamentally the same as other organizational processes. Similarly, Bower (1972) has included the principle of proximity, or contiguity, of items (temporally and/or spatially) as a major Gestalt law of grouping, and has emphasized the importance for memory of the process of "rote learning"--i.e., the association of events on the basis of their proximity relations. Bower comments, "I see no reason why 'organizational' memory theorists should shy away from recognizing such rote learning" (1972, p. 103).

Postman captured the essence of this problem when he pointed out that, while it is possible to maintain as Mandler (1969) has that seriation is simply the manifestation of a basic organizing process, "input-output correspondence is also grist to the mill of the contiguity theorist" (1972, p. 34). The thrust of Postman's comment seems to be that, if seriation is assumed to be a basic organizational process, then, when input order is constant, contiguity and organizational theories do not make differential predictions with respect to output consistency

performance. In this sense, then, it is true that

> as far as the specification of learning, and in particular free-recall learning, is concerned, the difference between exponents of association and organization appears to reduce largely to matters of language (Postman, 1972, pp. 40-41).

However, while it is perhaps the case that contiguity and organizational theories do not make different predictions concerning performance under constant input conditions, they do appear to make differential predictions concerning what is learned under these conditions.

For example, Wallace (1970) has developed an account of the consistency of output order observed between a subject's successive recall attempts that is based solely on the principle of contiguity. According to Wallace's hypothesis, items that are experienced together (e.g., during presentation, rehearsal, or recall) will tend to be recalled together. The contiguous recall of items is assumed to be a function of the associative strength among those items, which increases with repeated, contiguous experience of the items (e.g., "thinking" about items together). The contiguous experience of items can be influenced by such variables as nominal input order and functional input order. According to Wallace's formulation, a nominal input order that is constant, as opposed to varied, ought to increase the stability of rehearsal order and thus lead to more stable and consistent output orders across trials. At the same time, however, the same process of association-by-contiguity

ought to be operating under both methods of input order. In other words, what is learned (e.g., interitem associations) ought to be the same for both methods of input. If this is true, then subjects trained under one method and shifted to the other ought to show patterns of output consistency behavior similar to each other and to nonshift control subjects.

Predictions from organization theory concerning this situation are somewhat more complicated. When the input order is varied, subjects must develop their own consistent output order. It has been suggested that such stereotypic output orders may not necessarily represent the idiosyncratic inventions of each individual subject (Tulving, 1962); instead, varying the order of items from trial to trial may have the effect of allowing subjects to "discover" (Mandler, 1967; Tulving, 1962) or "detect" (Earhard, 1967) universal sources of organization inherent in the list. Several models of organization have been presented which postulate that organization is the result of two processes (Earhard, 1967; Mandler, 1967; Tulving, 1962). One process is essentially a discovery or detection process: each subject must first discover relations among the list items by which the items may be grouped. Such relations may be semantic, categorical, phonetic, etc. The second process involves the utilization of these relations--that is, subjects must actively group items according to the discerned

relationships among them. If varying the order of items from trial to trial has the effect of enabling subjects to discover underlying relations among items, then presenting the items in a constant order may have a prohibitive effect on the discovery process. If this analysis is correct, then it is conceivable that different processes may be operating under the two different methods of presentation: given varied input, subjects must first discover relations among items by which to organize the list, and then must use these discovered relations to group the items (Earhard, 1967; Mandler, 1967); given constant input, however, the discovery process may be obviated--or perhaps even actively interfered with.

The alternative possibility in this situation is that subjects are learning a more general skill (e.g., through a process of association by contiguity) that is not dependent on particular order-of-input conditions. Postman et al. (1970) have reported data that they interpret as evidence for such "nonspecific transfer" effects when subjects are shifted from a constant to a varied order of input on successive lists. In this study, half of the subjects were trained on two lists (List 1 and List 2) under a constant input condition and half under a varied condition. In the test phase, all subjects learned a third list (List 3) under the varied condition. Comparisons between the two were made on the basis of their absolute levels of performance

on List 3 alone, and no differences were found for either recall or ITR performance. On this basis, the authors concluded that the skills acquired during training under the constant condition were fully generalizable to the test situation where the input was varied. In other words, no evidence for differences in what is learned was obtained. However, analyses based on test list performance alone fail to take into account possible differences in the levels of performance attained by each of the experimental groups at the end of the training phase. In fact, subjects trained under the constant condition showed significantly higher recall and ITR performance on List 1 and List 2. When the constant condition subjects were then shifted to varied input in the test phase, they actually showed a decrease in both recall and output consistency from List 2 to List 3, while the subjects given varied input throughout showed a slight increase in both performance measures from List 2 to List 3.

The present experiment[1] replicated the constant-varied shift condition and varied-varied nonshift condition run in the Postman et al. (1970) study, and extended the design to include the complementary varied-constant shift group and constant-constant nonshift group. The basic design thus represents a 2 x 2 factorial transfer design with two levels of order of input (constant and varied) being manipulated orthogonally in the training and test phases.

Interest centers primarily on two related questions: (1) Are there transfer effects, as reflected in recall and/or organization performance, when subjects are shifted from a condition of either constant or varied input to the complementary condition, and (2) if so, are these transfer effects differentially affected by the conditions of input order? Since previous data (Mandler, 1969; Mandler & Dean, 1969; Postman et al., 1970) suggest that both the group given varied input in the training and test phases (Group VV) and the group given constant input in both phases (Group CC) will show improvement across lists--that is, learning-to-learn (LTL) effects--these two groups will be treated primarily as control groups. Special interest will focus on the group trained on a constant order and shifted to varied (Group CV) and the group trained on varied and shifted to constant (VC). In this situation, evidence for no differences in what is learned would be obtained if subjects who are shifted from one input condition in the training phase to the complementary condition in the test phase show changes in performance from List 2 to List 3 that are similar to subjects who are not shifted. With respect to output consistency performance, such a result could be taken as support for Wallace's (1970) single-process model of output consistency. Conversely, evidence for differences in what is learned would be obtained if shift subjects show patterns of transfer that are different from nonshift

subjects. Such an outcome for both output consistency and recall performance would be predicted by a two-process organizational model (e.g., Mandler, 1967).

In view of these differential predictions concerning the relationship of transfer performances between shift and appropriate nonshift subjects, comparisons were planned between Groups CC and VC and between Groups VV and CV. These comparisons conform to the logic of standard transfer paradigms (cf. Postman, 1970; Postman et al., 1970) of comparing groups trained on different tasks and tested on a common task.

FOOTNOTES

[1]A second experiment was run chronologically prior to the present one. Unfortunately, a lack of internal consistency in the results of the second experiment made conclusions based on it dubious. A report of the second experiment appears in Appendix II.

METHOD

Design

The subjects were 60 undergraduate student volunteers from the introductory psychology classes at the University of New Mexico, who received extra class credit for their participation. The experiment was conducted in two phases, training and test. In the training phase, there were two conditions of order of input of the words. Subjects in the constant input condition were presented a list of words in a random order on the first trial; this initial random order was then repeated on all subsequent study trials for that list. In the varied input condition, the order of presentation was randomized anew for each trial. In the training phase, half of the subjects were required to learn two successive lists (designated List 1 and List 2) under the constant condition while the other half learned both lists under the varied condition.

Following training, all subjects were transferred to a third list (List 3). For half of the subjects in each of the training conditions, the order of presentation of List 3 was constant on each trial while for the other half it was varied on each trial. Thus, there were four groups: a varied-varied (VV) group, a varied-constant (VC) group, a constant-constant (CC) group, and a constant-varied (CV) group.

Each of three stimulus lists appeared equally often as List 1, List 2, and List 3 for the four groups, and subjects were given six study-test cycles on each list. The design, therefore, consisted of a 2 x 2 x 3 x 6 factorial: Training Order of Input x Test Order of Input x Lists x Trials. Subjects were assigned to conditions on the basis of the order in which they appeared at the laboratory.

Materials

The stimulus items were taken from the Paivio, Yuille, and Madigan (1968) word lists. Each item was typed on clear plastic and mounted in a slide for display through a slide projector. A total of 90 nouns with A or AA Thorndike-Lorge (1944) frequency ratings were randomly selected. Three separate 30-item lists were constructed by randomly assigning each of the 90 words to one of three different lists. For each list, six different random orderings were then obtained, with the restriction that no word appear twice in the same serial position.

Procedure

The subjects were run in groups of 5-7. Each subject was given six study-test cycles in which to learn and recall each list of words. During study trials, the items were presented by slide projector at a rate of 2 sec/item. Prior to the presentation of each list, all subjects were instructed that they would be given several presentations of

a list of words, and that following each presentation they would be given 2½ min in which to write down as many of the words as they could remember. No explicit instructions were given regarding the order of presentation of the items, although subjects were told that they were free to recall the items in any order they chose. The subjects were required to learn a total of three lists in this manner, with an interval of 3-4 min between lists.

For a given list, varied-input subjects saw a different one of the six random orderings on each of the six study trials, while constant-input subjects saw the same ordering on each trial. In addition, for each list, three permutations of the six random orderings were obtained, and each of the three were used equally often in the varied conditions.

RESULTS

Both recall and output consistency measures were taken. The output consistency measure was a modification of the intertrial repetition (ITR) measure of Bousfield and Bousfield (1966), which counts the number of pairs of immediately contiguous items that are common to each of two successive trials, and then subtracts from this the value that could be expected by chance.

A preliminary analysis of variance was performed with the particular stimulus list appearing as List 1, 2, or 3 included as a factor. For the ITR data, this analysis revealed no statistically significant effects, largest F $(2, 112) = 1.94$, $p > .14$, $MS_e = 27.505$. For the recall data, the main effect of the stimulus list factor was significant, F $(2, 112) = 3.20$, $p < .05$, $MS_e = 4.417$. However, this factor did not significantly interact with the treatment factors. Thus, the data were collapsed across the factor of stimulus list for the analyses reported below.

Training Phase

Both trial-by-trial performance and total performance summed across trials for each list were analyzed. The analysis of the summed data will be presented first.

Mean total recall for each group on Lists 1 and 2 is depicted in Figure 1. As Figure 1 suggests, there were no differences in total recall on Lists 1 and 2 combined between subjects receiving varied input (Groups VV and VC) and those

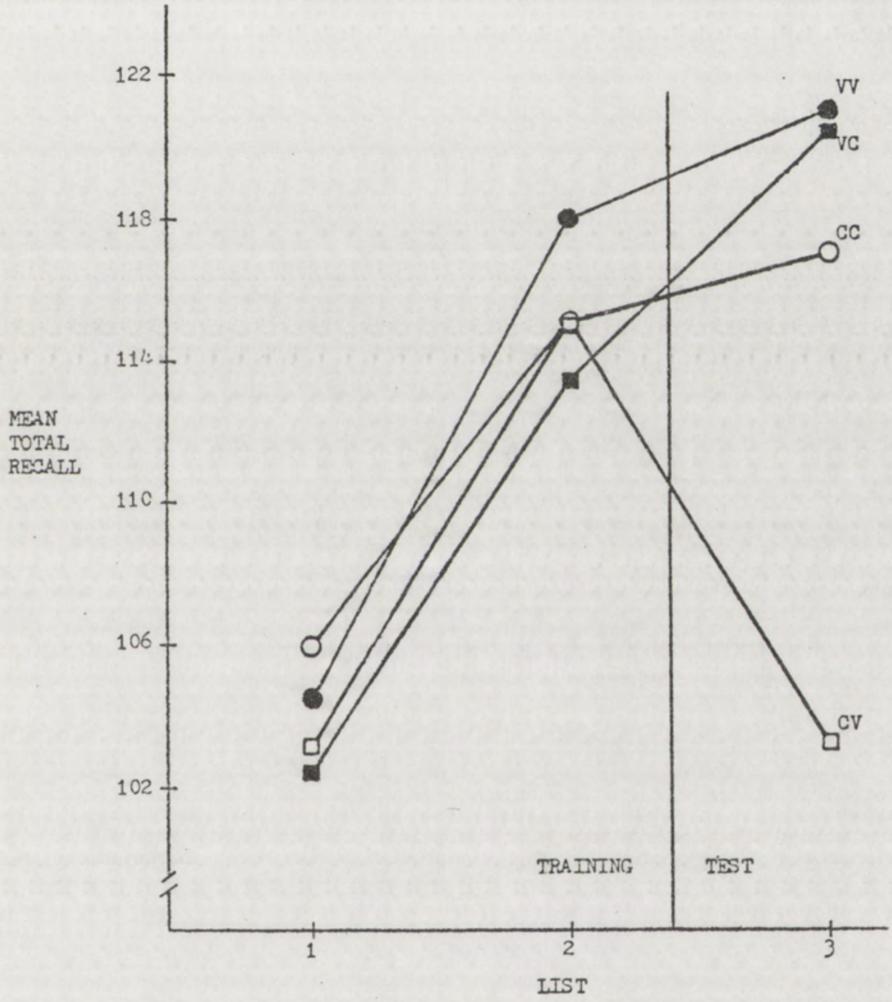

Figure 1. Mean total recall for Lists 1, 2, and 3 as a function of input condition.

receiving constant input (Groups CC and CV), $\underline{F}$ (1, 56) < 1, $\underline{MS}_e$ = 1245.768, and the improvement in recall from List 1 to List 2 was significant, $\underline{F}$ (1, 56) = 37.47, $\underline{p}$ < .001, $\underline{MS}_e$ = 209.320. The extent of this improvement was similar for both Training Input conditions, $\underline{F}$ (1, 56) < 1, $\underline{MS}_e$ = 209.320. Mean total ITR scores for each group on Lists 1 and 2 are graphed in Figure 2. As Figure 2 indicates, the pattern of results was essentially the same for the ITR data as for recall: no significant difference was observed between constant and varied input groups in overall ITRs on Lists 1 and 2 combined, $\underline{F}$ (1, 56) = 2.76, $\underline{p}$ > .10, $\underline{MS}_e$ = 226.846; also, the improvement for all groups in List 2 ITRs that is apparent in Figure 2 was significant, $\underline{F}$ (1, 56) = 45.09, $\underline{p}$ < .001, $\underline{MS}_e$ = 71.710. The degree of improvement for the CC and CV subjects did not differ from that of the VV and VC subjects, $\underline{F}$ (1, 56) < 1, $\underline{MS}_e$ = 71.710.

Figures 3 and 4 portray acquisition curves for recall and ITRs for each list. An analysis of the differences between List 1 and List 2 in linear and quadratic trends over trials for the recall data produced no significant effects of the treatment factors. This indicates that the rate of acquisition on List 2 was not significantly different from the rate on List 1. Thus, the improvement in recall on List 2 was fairly equally distributed across all six trials. For the ITR data, however, the increase in the slope of the linear trend from List 1 to List 2 was

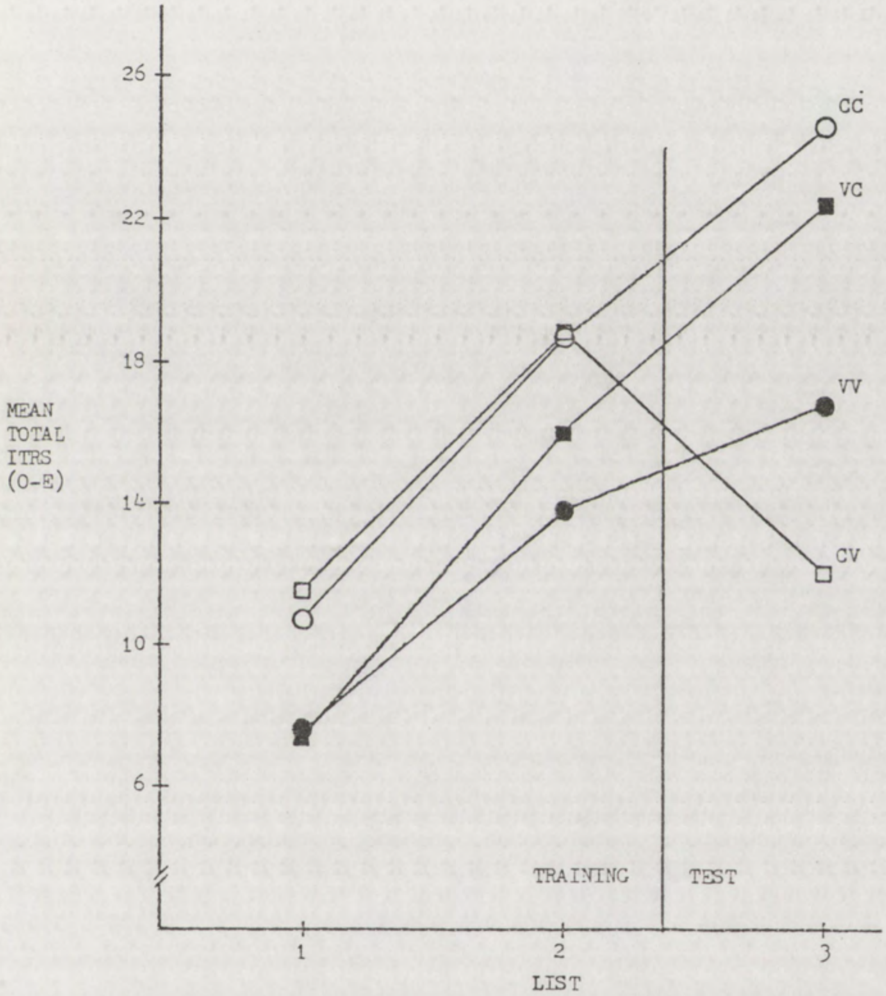

Figure 2. Mean total ITRs (observed minus expected) for Lists 1, 2, and 3 as a function of input condition.

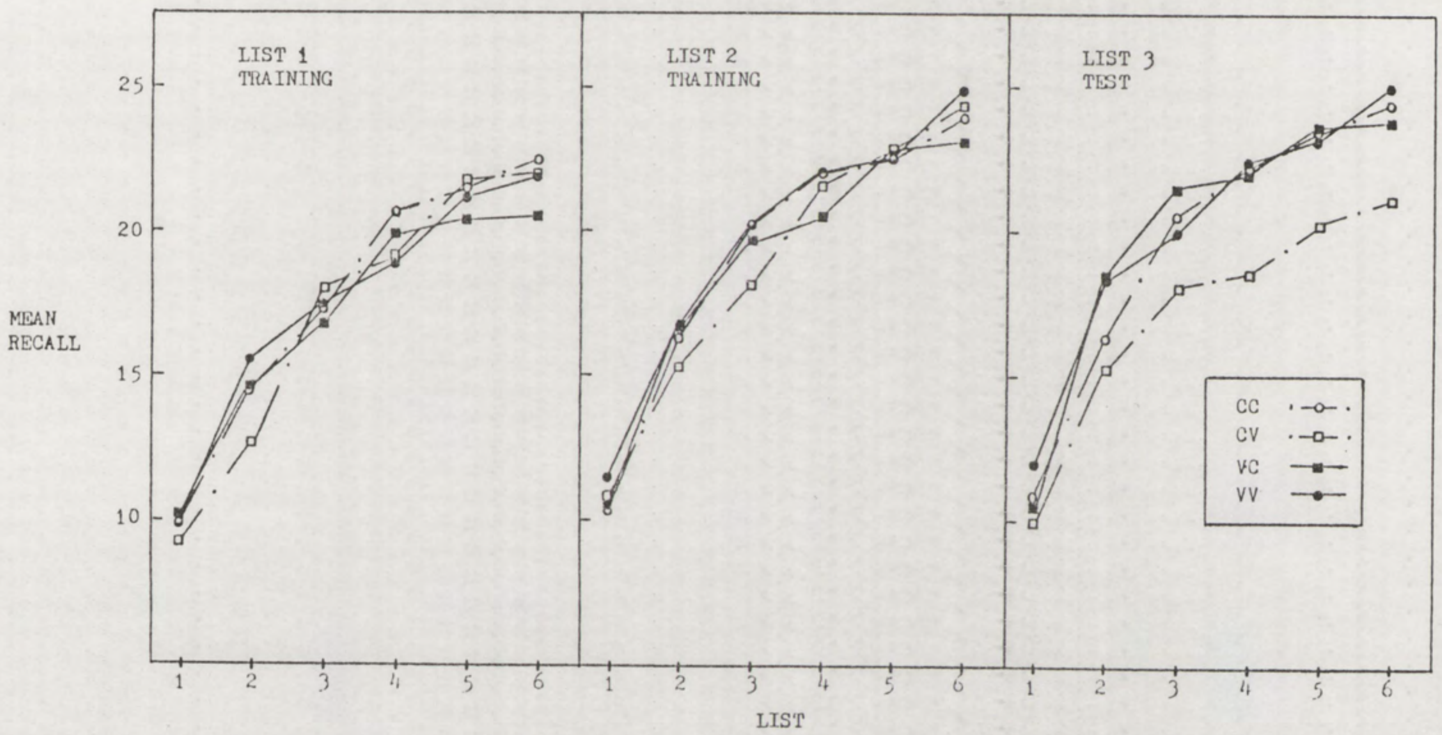

Figure 3. Mean recall over trials for Lists 1, 2, and 3 as a function of input condition.

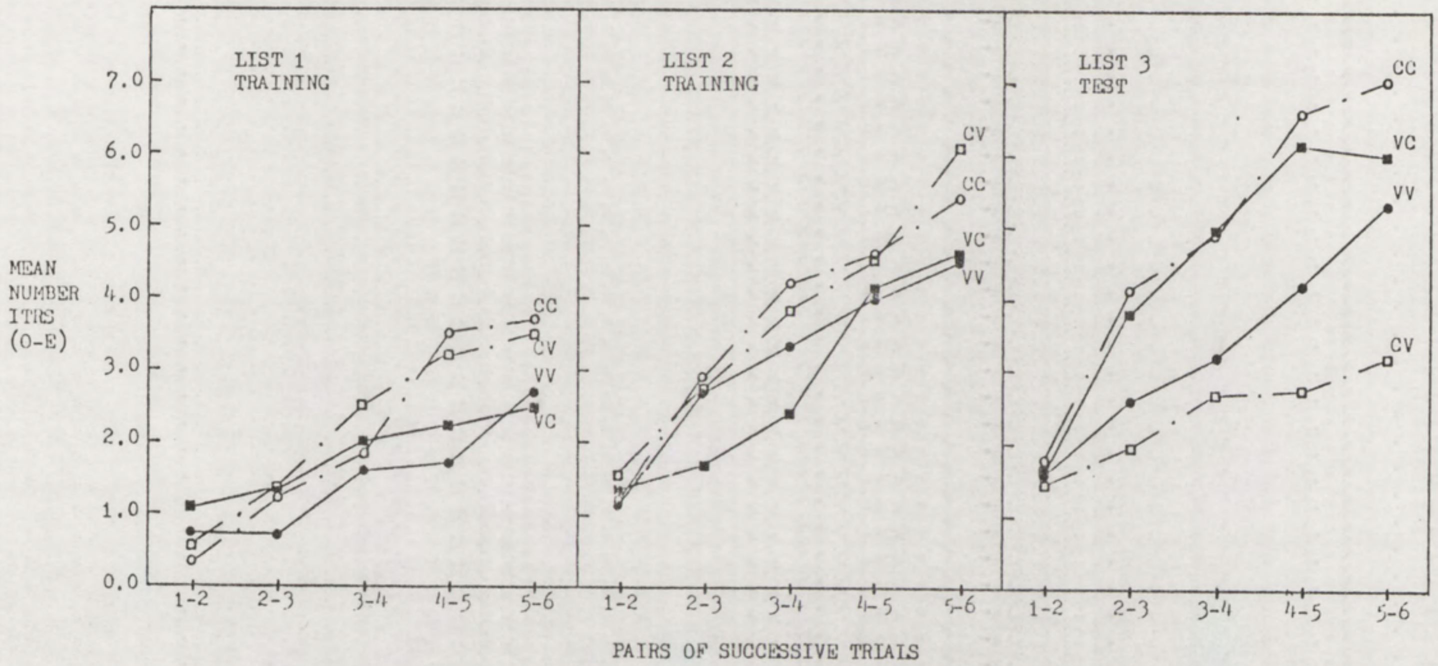

Figure 4. Mean number of ITRs (observed minus expected) between successive trials for Lists 1, 2, and 3 as a function of input condition.

significant, $\underline{F}$ (1, 56) = 6.323, $\underline{p} < .05$, $\underline{MS}_e$ = 84.305, reflecting the increase in the rate of ITR development on List 2 for all groups that is apparent in Figure 4. None of the other effects on ITR trends were significant.

Test Phase

Figure 1 depicts transfer performance from List 2 to List 3 for the recall data. There it can be seen that the recall of all groups continued to improve somewhat on List 3, with the exception of the CV group, whose recall showed a sharp decrease. An analysis of the mean differences between List 2 and List 3 recall revealed significant main effects of both Training and Test Input, $\underline{F}$ (1, 56) = 7.91, and $\underline{F}$ (1, 56) = 6.77, respectively, both $\underline{p}$s $< .01$, both $\underline{MS}_e$s = 179.609. The interaction of these two factors was not significant. The comparison of the CC and VC groups was not significant by either an a priori or post hoc criterion[1], $\underline{F}$ (1, 56) < 1, $\underline{MS}_e$ = 179.609; the CV subjects' mean recall difference, however, was significantly lower than the VV subjects' by both criteria, 1/3 $\underline{F}$ (3, 56) = 3.05, $\underline{p} < .05$, post hoc, $\underline{p} < .01$, a priori, $\underline{MS}_e$ = 179.609. The variance due to the latter difference accounted for 91% of the between-group variance due to the main effect of Training Input and the Training Input x Test Input interaction combined, and 54% of the total between-group variance.

Transfer performance of the four groups for the ITR data is depicted in Figure 2. The ITR performance of all

groups continued to improve on List 3, with the exception of the CV subjects' performance, which showed a marked decline. An analysis of the differences between List 2 and List 3 ITR scores produced a significant effect only for Test Input, $\underline{F}$ (1, 56) = 12.93, $\underline{p} < .001$, $\underline{MS}_e$ = 112.435. Neither the main effect of Training Input nor the interaction were significant, although the former approached a marginal significance level, $\underline{F}$ (1, 56) = 3.56, $\underline{p} < .07$, $\underline{MS}_e$ = 112.435. A comparison of Group CC and Group VC was nonsignificant, but the mean difference score for CV subjects was below that of the VV subjects, 1/3 $\underline{F}$ (3, 56) = 1.41, which is not significant by a post hoc criterion, but is significant by an a priori criterion, $\underline{p} < .05$, $\underline{MS}_e$ = 112.435. The variance due to the difference between these two groups accounted for 92% of the combined between-group variance contributed by the Training Input factor and the Training x Test Input interaction, and 24% of the total between-group variance.

Acquisition curves for Lists 1, 2, and 3 are presented in Figures 3 and 4. An analysis of differences in trends over trials for List 2 versus List 3 for the recall data, shown in Figure 3, revealed no significant main effects or interactions on differences in either linear or quadratic components between List 2 and List 3. Comparisons between the CC and VC groups and between the VV and CV groups were also nonsignificant for both trend measures. A similar

analysis of the ITR data, shown in Figure 4, indicated a significant main effect of Test Input on the difference in the slope of the linear trends between List 2 and List 3, $\underline{F}$ (1, 56) = 5.37, $\underline{p} < .05$, $\underline{MS}_e$ = 85.446, as well as a significant Training Input x Test Input interaction, $\underline{F}$ (1, 56) = 4.623, $\underline{p} < .05$, $\underline{MS}_e$ = 85.446. This interaction indicates that the pattern of linear trends exhibited by the four groups on List 3 differed from that exhibited on List 2 as a result of the particular combination of input received on those two lists. This difference can be seen in the middle and right panels of Figure 4. Looking at the middle panel, the slopes of the linear trends do not differ appreciably for the four groups. This is not the case for the linear slopes of the data plotted in the right panel. There it can be seen that, of the two constant Test Input groups (CC and VC), the group that received constant Training Input (CC) tended to acquire at a somewhat faster rate than the group receiving varied Training Input (VC); conversely, of the two varied Test Input groups (VV and CV), the reverse was true: the group receiving constant Training Input (CV) tended to acquire more slowly than the group receiving varied Training Input. For List 3, the simple main effect of Training Input and the simple two-way interaction were both nonsignificant; the linear slopes on List 3 did, however, differ significantly across levels of the Test Input factor, $\underline{F}$ (1, 56) = 5.36, $\underline{p} < .05$, $\underline{MS}_e$ = 76.340. This

result can be viewed in the far right panel of Figure 4 in the form of a divergence between those subjects receiving constant input in the test phase (Groups CC and VC) and those receiving varied input (Groups VV and CV).

Turning now to the planned comparisons, the test of the differences in linear and quadratic trends between List 2 and List 3 was nonsignificant for the comparison of Groups CC and VC, indicating that the relationship between these two groups in terms of their trends over trials did not change. Groups VV and CV differed on the linear measure, 1/3 F (3, 56) = 1.828, nonsignificantly by a post hoc criterion, but significantly by an a priori criterion, $p <$ .05, MS_e = 85.446. This result reflects the fact that the rate of development of ITRs tended to be faster for CV subjects than for VV subjects on List 2, but slower on List 3, as seen in the middle and right panels of Figure 4. The difference between these two groups was not significant for the quadratic trend difference measure.

FOOTNOTES

[1]All post hoc analyses were evaluated using Scheffé's post hoc criterion (Winer, 1971).

DISCUSSION

The improvement in recall and ITR performance from List 1 to List 2 for both constant and varied input conditions replicates the LTL effects previously reported for both of these measures (Mandler & Dean, 1969; Postman et al., 1970). On the other hand, the absence of a difference between constant and varied input groups in the training phase is at variance with the results of previous between-group studies using similar stimulus materials, which have reported advantages for constant input in both recall (Jung & Skeebo, 1967; Mandler & Dean, 1969; Postman et al., 1970) and ITR performance (Mandler & Dean, 1969; Postman et al., 1970). No difference in recall performance has, however, been observed when constant and varied input conditions are manipulated within-subjects (Waugh, 1961). Also, no difference has been reported between constant and varied input groups in recalling low-meaningful, three-consonant trigrams (Stimmel & Stimmel, 1967). One possible reason for these discrepant findings may lie in the nature of information given to subjects. In two of the studies (Mandler & Dean, 1969; Postman et al., 1970) reporting an order-of-input effect, pains were taken to inform the subjects of the nature of the input order of each list. Alternatively, neither of the studies reporting no difference between constant and varied input reported giving their subjects such information. The only study inconsistent with this

post hoc account is that of Jung and Skeebo (1967), which did not report informing subjects about input order, yet nevertheless found a facilitative effect on recall of constant input.

It is possible in this regard that subjects who are informed of the manner of input modify their memorization strategies accordingly. In this respect, such information might be more valuable for constant input subjects. On the other hand, uninformed subjects must discover the nature of input on their own, and it may take a number of repetitions before constant input subjects fully realize the constant nature of the input. Under these circumstances, the advantage for constant input might be mitigated by the possibilities that either: (1) uninformed subjects would not be able to take full advantage of the constant input of the list during early trials, and/or (2) by the time constant input subjects fully realize the nature of the input order, they may have adopted a strategy that is too well developed to be easily altered.

The data of major interest in the current study are the results of the order of input manipulations on transfer performance. With respect to output consistency, the essential question is whether the underlying mechanisms responsible for the grouping of items are different for constant and varied input, regardless of differences between the tasks in terms of the particular item relations on which

those groupings are based. As Postman et al. (1970) have noted,

> To the extent that grouping operations are specific, some decrement in performance would be expected when an experienced S encounters a change in the sequential characteristics of the learning task. The absence of such a decrement would indicate that grouping operations reflect a higher-order skill which is readily adapted to a new method of practice (p. 707).

It is clear from Figures 1 and 2 that shifting subjects from constant input in the training phase to varied input in the test phase (Group CV) had a very debilitating effect on both recall and ITR performance. The dissociation in ITR transfer performance between CV and VV subjects suggests that what is learned in terms of output consistency in the free recall situation under conditions of constant input is different from what is learned under conditions of varied input. This result militates against Wallace's (1970) contiguity model of output consistency, which asserts that output consistency is an increasing function of the associative strength among items, which increases with repeated, contiguous experience of those items. Items may be repeatedly experienced together in a number of ways--for example, during presentation, rehearsal, or recall. However, the model does not differentiate among the ways in which items are experienced together, asserting only that repeated contiguous experience of any kind will lead to greater output consistency. Subjects given constant input repeatedly experience items together during presentation,

while subjects given varied input obviously do not. The present data suggest that the manner in which items are experienced together may be important, since, for subjects tested under varied input, ITR performance continued to improve on List 3 only for those subjects who were also trained on constant input. In other words, according to Wallace's formulation, the cumulative effects of practice on Lists 1 and 2 should have been apparent in ITR performance on List 3. This was not the case for CV subjects.

The results of the transfer manipulation on recall and ITR performance support the two-process organizational model. According to this model, for subjects given constant input, the detection of underlying sources of organization should be to some extent obviated. Thus, subjects trained on constant input (Groups CC and CV) ought to experience LTL effects only for utilization, but not for detection, while subjects trained under varied input (Groups VV and VC) ought to experience LTL effects for both processes. Subjects subsequently shifted to the complementary condition in the test phase (Groups CV and VC), then, ought to show differential patterns of transfer performance: the transfer performance of CV subjects will suffer, since the conditions of input on the test list now require both detection and utilization, while the performance of VC subjects on the test list ought to continue to exhibit the beneficial effects of practice on Lists 1 and 2. As is apparent in

Figures 1 and 2, the results of the present experiment are in line with these predictions.

The conclusion that what is learned in the free recall situation is different under conditions of constant as opposed to varied input is directly opposite to that reached by Postman et al. (1970). However, as noted before, these authors based their conclusion on the fact that no differences were observed between CV and VV groups in terms of their absolute levels of performance on List 3. The CV group was, however, significantly higher than the VV group on the second list in both recall and ITRs. In fact, in the test phase, for subjects given standard free recall instructions, the patterns of transfer from List 2 to List 3 for both performance measures were similar to those obtained in the present experiment: VV subjects continued to improve somewhat from List 2 to List 3, while CV subjects actually showed a decrease. Thus, these results are in general accord with those of the present report, although the statistical significance of the former cannot be determined.

In summary, on the basis of the present data and previous, related results, the following conclusions may be drawn:

1. There appears to be evidence for differences in what is learned in the free recall situation for constant and varied orders of input in terms of both recall and

output consistency. This evidence is based on the divergence in recall and ITR performance between subjects shifted from constant to varied input and subjects continued on varied input throughout.

2. Under certain conditions, constant input appears to lead to enhanced recall and output consistency. This conclusion remains tentative, and, if valid, the exact conditions under which this occurs remain to be specified. One potentially important factor may involve informing subjects of the nature of the input order.

3. Varied input seems to allow for greater flexibility in adapting to subsequent input orders which may be of a different nature. This appears to be true at least for constant and varied orders.

The present data may also relate to the results of studies of the effects of spatial groupings on coding strategies. When trigram doublets (e.g., RUMWIG) are presented as spatially grouped letter sequences (e.g., RU MW IG), recall of these sequences is better if the groupings are varied on each presentation than if they remain constant (Ellis, Parente, Grah, & Spiering, 1975; Ellis, Parente, & Walker, 1974; Hunt, Parente, & Ellis, 1974). Furthermore, in this paradigm, subjects initially trained with varied input and then transferred to constant input on a test list continue to show facilitation of recall, whereas subjects initially trained with constant input and subsequently

transferred to varied input show impaired recall performance on the test list (Ellis et al., 1975; Hunt et al., 1974). This so-called "variability effect" has been interpreted in terms of a perceptual grouping hypothesis, which asserts that variation in the experimenter-imposed grouping structure for specific letter sequences will increase the probability that subjects will discover the pre-experimentally developed, underlying structure of the particular sequence (Ellis et al., 1974; Ellis et al., 1975). These results, in conjunction with those of the present report, suggest that memory performance depends not only upon the number of repetitions, but also upon the nature of those repetitions, and that the nature in which items are repeated may affect both encoding and organizational processes.

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APPENDICES

APPENDIX I

REVIEW OF THE LITERATURE

In 1953, W. A. Bousfield reported an experiment in which subjects were presented and asked to recall a list of sixty, randomly ordered words. The list was comprised of fifteen instances from each of four taxonomic categories. Bousfield observed that in recalling the words, subjects tended to group them on the basis of the four categories; he dubbed this phenomenon "clustering." With the subsequent developments of chunking (Miller, 1956) and subjective organization (Tulving, 1962), research and theory on the organization of memory have come to play a major role in the study of free recall from memory. Much of the impact of organizational interpretations of recall seems to have derived out of its antithetical stance toward the prevailing associationistic mode of theoretical thought (cf. Crowder, 1976). Indeed, much of the bulk of organizational theory and research seems to be aimed at developing accounts of recall phenomena which are based on theoretical principles other than the fundamental associational principles of contiguity, frequency, and recency. It might be said that one of the implicit goals of the organizational approach is to elevate these principles from primary to secondary ones--in effect, to explain why and how contiguity, frequency, and recency have the effects they do on free recall. For example, Tulving (1962) has argued that

it is not repetitions per se that lead to improved performance; rather, repetitions simply allow the subject to discover relations among items and to integrate (organize) several items into single, coherent units on the basis of these discovered relations. Thus, repetitions affect recall indirectly by allowing for increases in the amount and stability of organization. Tulving (1966) subsequently bolstered his argument by demonstrating that subjects given several repetitions on a list of items in an incidental learning situation show no savings under subsequent intentional learning conditions with the same list, relative to controls who had received no prior repetitions on the test list.

In the review that follows, organizational and associational factors are examined with respect to several major recall phenomena. These phenomena are divided into three major categories: the effects of structural variables, part-whole transfer, and constant and varied input effects.

The Effects of Structural Variables

Much of the early research on organization centered around investigations of the effects of various types of structured stimulus materials on recall. The classic example of this sort of experiment is the original clustering study (Bousfield, 1953). The clustering phenomenon could be explained from an associational point of view by

assuming that items from the same category are more strongly associated to one another than to items from other categories. The significance of Bousfield's experiment, however, lay in an alternative hypothesis which could also account for the data (Crowder, 1976). According to this hypothesis, each category was assumed to represent a higher-order unit into which the individual category instances had been organized. The notion is that the instances of a category have been integrated into a single, comprehensive memory representation. During recall, the subject first retrieves the higher-order category unit and then retrieves each individual item by "unpacking" the contents of that unit all at once, thus resulting in clustering. This formulation differs from a word-by-word associative model which posits individual representations of each item, with clustering being dependent on differential strengths of the connections among these representations. In fact, prior to Bousfield's experiment, Jenkins and Russell (1952) had already shown that subjects presented with a list of highly associated pairs of words in a scrambled order had a tendency to recall the associated pairs together. In this experiment, as in others, the strength of the association between the items was defined on the basis of the normative frequency with which one item elicited the other in free association tests. Subsequent research (Deese, 1959) revealed a direct relation-

ship between recall and interitem associative strength among the items on the list, defined as the average relative frequency with which each list item elicited the other list items in a free association situation. Three levels of interitem associative strength, High, Low, and Zero, were employed, and the result was a main effect on recall of interitem associative strength. In addition, associative strength correlated with recall at a value of 0.88.

In 1965, C. N. Cofer presented a review of a comprehensive research program aimed at investigating the effects of a number of structural variables on clustering. Cofer concluded that measures of associative strengths were better predictors of clustering than other measures of item relatedness such as category membership and synonym relations. In general, synonyms showed a low degree of clustering in free recall (Cofer, 1959). But the synonyms were also low in their degree of mutual associative overlap (i.e., interitem associative strength). Earlier results suggested a somewhat similar picture for category membership: greater clustering occurred for category instances that were high-frequency associates of the category names than for those that were low-frequency associates. The emerging picture seemed to suggest an associative interpretation of clustering in recall. However, there remained some findings that were problematic for an

account based solely on associative mechanisms. Marshall (1963) had presented subjects with a list of twenty-four items comprised of six categorized and six noncategorized pairs. In addition, the mutual relatedness (a variant measure of associative strength) of the pairs in a given list was varied over six levels. The result was an interaction: at higher levels of mutual relatedness there was no difference in clustering for the categorized and noncategorized pairs. However, at the lower levels, the categorized pairs showed greater clustering. The simple associative interpretation is further clouded by an apparently complex clustering-recall relationship that emerges when individual differences are taken into account. Using taxonomically categorized lists, Puff, Murphy, and Ferrara (1977) blocked subjects into High- and Low-Clusterers on a post hoc basis. When the stimulus list was made up of category instances that were low-frequency associates to the category names, no significant differences in recall were found for the High- and Low-Clusterers, despite a significant difference between the two in clustering scores. On the other hand, when the list was comprised of category instances that were high-frequency associates to the category names, significant differences were found between the two groups for both clustering and recall.

Taken as a whole, the data generally seem to favor an associative interpretation of clustering and recall, although

the relationship does not seem to be quite as simple as it may have first appeared. In general, the conclusion reached some years ago by Cofer (1965) still seems relevant: what is needed is an exhaustive study of situational, structural, and task variables in order to uncover the factors which facilitate or diminish clustering and recall.

Part-Whole Transfer

The part-whole transfer effect was first demonstrated by Tulving (1966). In Tulving's experiment, each of two groups learned two lists of unrelated words under multi-trial free recall (MTFR) conditions. The second list was the same for both groups and contained thirty-six items. The difference between the two groups concerned the nature of the first list: for the experimental subjects, the first list was comprised of half of the items that were to appear in the second list, while for the control group, the eighteen items on the first list were completely different from the items on the second list. Tulving had reasoned that if recall was a function of mere repetitions of items, then the experimental group ought to have an advantage in the learning of the second list, having already had a "head start" on half the items. If, on the other hand, recall depended on organization, then the experimental group ought to be at a disadvantage in learning the new second-list items, since the organization imposed on the first-list items would likely conflict with the optimal organization

of the total thirty-six items of the second list, thus producing interference. The result was that while the experimental subjects started with an initial advantage (owing primarily to recall of first-list items), they were eventually overtaken by the controls. Tulving concluded that the data supported the organizational account, and at the very least argued against a simple frequency hypothesis.

However, the results of subsequent research have considerably weakened Tulving's interpretation of the part-whole transfer effect. In a review of this literature, Sternberg and Bower (1974) have enumerated several problems with this account. First, when subjects are informed of the relationship between the first and second lists, the negative transfer disappears (Novinski, 1972; Wood & Clark, 1969), and in fact some positive transfer results (Wood & Clark, 1969). If interference from first-list organization is responsible for the negative transfer, it is difficult to see how simply informing the subjects of the relationship between the two lists could mitigate this interference. Secondly, the negative transfer also disappears if subjects are encouraged to write down as many items as they can remember during second-list recall, regardless of whether they are sure that those items occurred on the second list as well as the first (Slamecka, Moore, & Carey, 1972). From this result, Slamecka et al. concluded that the negative

transfer was due largely to the fact that subjects were editing some first-list items out of their second-list recall because they were not sure those items had actually appeared on the second list. Sternberg and Bower (1974) have presented a more formalized version of this notion known as the list discrimination hypothesis, derived from Anderson and Bower's (1972) associative model of free recall. According to this hypothesis, each time an item occurs, it is probabilistically given a "list tag." This tag identifies the item as having occurred on a particular list by recording the context present at the time of the item's occurrence. It is assumed that an item already possessing a number of first-list tags will more slowly acquire second-list tags, and therefore be more often rejected as having occurred on the second list. Thus, the part-whole negative transfer in recall should be due primarily to poor recall of first-list items. Sternberg and Bower (1974) report results confirming this prediction. In addition, the list discrimination hypothesis can successfully account for the other part-whole phenomena discussed above. When subjects are informed of the relationship between the lists, then each item with a first-list tag can automatically be assigned a second-list tag. In this case, the experimental group ought to show not negative but positive transfer, which it does (Wood & Clark, 1969). Finally, subjects who are encouraged to write down all of the items that they can

remember as in the Slamecka et al. study should not show negative transfer since they will be recalling items without regard to their list membership.

In summary, the negative transfer obtaining in the part-whole paradigm does not appear to be very good evidence for organizational processes in free recall. The thrust of Tulving's (1966) argument seemed to be that some of the second-list items are unavailable for recall due to the conflict between the first-list organization and the organization that would be optimal for the second list. This does not appear to be the case. Results from experiments employing modified free recall conditions in which subjects are instructed to recall as many items as they can regardless of the items' list membership suggest that there are no differences between experimental and control subjects with respect to the total number of available items (Slamecka et al., 1972; Sternberg & Bower, 1974).

Constant and Varied Input Effects

The third set of findings to be discussed involves constant and varied input effects in the MTFR paradigm. Here, constant input occurs when the serial order of items remains unchanged each time the list is presented for study. Varied input occurs when the serial order of the items is different each time the list is presented.

Reported effects of constant versus varied input present a conflicting array of results. In the earliest

reported study (Waugh, 1961) dealing with this effect, the input factor was manipulated within-subjects. Each subject learned eighteen lists, with varied input for six of the lists and constant for the other twelve. For six of the constant-input lists, subjects were instructed to try to recall the items in the order in which they were presented (serial recall instructions); for the other six constant-input lists, as well as for the six varied-input lists, the subjects were given standard free recall instructions. No difference was found between constant and varied input for the lists learned under free recall instructions.

Subsequent manipulations of constant and varied input have all been between-subjects, and the general finding has been significantly higher recall for constant input (Jung & Skeebo, 1967; Mandler & Dean, 1969; Postman, Burns, & Hasher, 1970). The latter two studies also reported a significantly higher consistency of output order across trials for constant input. However, Earhard (1967) reported in passing the results of a between-subjects pilot study in which no differences in recall were found between constant and varied input groups. In addition, Stimmel and Stimmel (1967) also reported no difference between constant and varied input groups for recall of three-consonant trigrams.

On the basis of the principle of contiguity, the studies reporting an advantage in recall due to constant input appear to be in accord with an associational view-

point (cf. Postman, 1972, p. 34), since the greater number of consistent, contiguous occurrences of items in the constant input condition ought to lead to a faster development of stronger associations among the items. Alternatively, the results seem to argue against an organizational account, since most organizational theories (e.g., Mandler, 1967; Tulving, 1962) assume that varying the order of the presentation of the items allows the subjects to discover underlying relations (e.g., semantic, categorical, etc.) among them. However, several theorists have argued that contiguity relations among items may also serve as bases for organization (e.g., Bower, 1972; Mandler, 1969), although the implication seems to be that such relations are not as effective as sources of organization (Mandler, 1969; Tulving, 1968). Thus, regardless of whether contiguity relations are assumed to be appropriate sources for organization, organizational theories do not appear to fare well with regard to the finding of facilitation of recall by constant input. At the very least it would seem that organizational theories would predict no differences in recall for constant and varied input, and at most an advantage for varied input conditions.

On the other hand, the findings of no differences in recall due to method of input could be taken as weak evidence for an organizational position while posing definite problems for any simple associational account. It is

possible that associationists could invoke some sort of interference notion to explain Waugh's (1961) within-subjects data, but the between-group results of Earhard (1967) and Stimmel and Stimmel (1967) would certainly be more problematic. However, at this point, it would probably be wise for both camps to withhold theoretical speculation until more is known about the exact conditions under which constant input does or does not facilitate recall.

Conclusions

The studies discussed in the preceding review do not appear to lend strong support to organizational theory. It appears that clustering and recall of structured material may be more parsimoniously and accurately predicted on the basis of associative strengths among items, or associative strengths between category instances and the category name, than on the basis of other relations among the items such as category membership per se. Similarly, part-whole transfer effects are better accounted for by associational assumptions which view the situation as a discrimination problem. However, although data apparently yield to an associational account, the explanatory capabilities of this account may not be as simple and complete as they at first appear. For example, the fact that clustering is related to associative strength between instances of a category and the category name does not follow directly from simple associative principles. Instead, an associational account of this relation

would seem to require the postulation of a hypothetical mediational process, along with additional assumptions about the effects of strong and weak associates to the mediator (category name). From an organizational viewpoint, alternative assumptions might be made concerning the relation between normative frequencies of associations to category names and the degree of coherency or integration of different items incorporated into a categorical unit which appear equally capable of handling the data. Which of the two theoretical processes will take us further remains to be seen. In addition, the results of studies of constant and varied input, taken as a whole, are not easily incorporated into either an organizational or associational interpretation.

Postman (1972) has noted that:

> as far as the specification of the products of learning, and in particular free-recall learning, is concerned, the difference between exponents of association and of organization appears to reduce largely to matters of language. However it is stated, the major endproduct of learning is the establishment of interitem dependencies (pp. 40-41).

The difference between the two formulations appears to lie in the specification of what is learned in terms of interitem dependencies. In view of this, assessments of organizational and associational accounts of free recall phenomena might best be made by empirically evaluating the predictions of each approach concerning what is learned in various free recall situations. In this regard, we agree with Postman

(1972) that, "when interest centers on the question of what is learned, measures of transfer are likely to provide a more definite answer than internal analyses of the characteristics of performance" (p. 40).

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APPENDIX II

EXPERIMENT 2

The logic and design of the second experiment were, in all essential respects, the same as in the first experiment. The primary difference between the two lay in the type of stimulus materials used: while lists of unrelated words were employed in the first study, the second used lists of taxonomically categorized items. The reason for this change was to investigate the possibility that varied and constant input orders have the same effect for both unrelated and structured lists. Mandler (1969) presented subjects with lists of scrambled, categorized words either in the same order or in a different order on each trial. All subjects were informed as to the nature of the list, and in addition were given the names of the four categories represented in the list prior to its presentation. Subjects' output protocols revealed that all subjects tended to organize or cluster their outputs on the basis of the categories regardless of the method of input order they had received. Moreover, subjects receiving a constant input order showed a greater degree of clustering than did subjects receiving varied input. Mandler suggests that varying the input order may introduce an interfering or confusing element--it may produce inadvertent clusters that are adopted and discarded from trial to trial until the categories are finally adopted as the major retrieval cues. It is of

interest to ask whether similar results will obtain for subjects not given information about the categorized nature of the list. It could be that an advantage in clustering for subjects given constant input will not appear if subjects are required to discover the categorized nature of the list on their own rather than being told beforehand.

Method

Design

The design of the second experiment was in all respects the same as that of the first, with the exception that the subjects received eight study-test cycles.

Materials

The stimulus items were taken from the Battig and Montague (1969) category norms. Each was typed on clear plastic and mounted in slides for display through a slide projector. A total of 90 category instances of relatively moderate frequency were selected in the following manner. For each of 30 arbitrarily selected categories, the frequency distribution of those words having a frequency count of ten or more were divided into quartiles. Only those words falling between the first and third quartiles were considered. From this pool, three words were randomly selected from each of the 30 categories. The following restrictions were observed: multiple-word items, hyphenated items, and ambiguous items (i.e., words appearing with a frequency count of ten or greater in more than one of the categories used) were not included.

Three separate lists were constructed by randomly assigning the three words selected from each category to one of three lists. Thus, there were three separate, 30-item lists, each consisting of ten, 3-item categories. For each list, eight different random orderings were obtained,

with the restrictions that in none of the orderings did two words from the same category appear contiguously, and that no word appeared twice in the same serial position.

Procedure

The procedure for the second experiment was in all respects the same as that of the first, with the following exceptions. Subjects were run in groups of 2-8, and were given eight study-test cycles to learn and recall each list of words. In addition, subjects were not given any prior information about the nature of the lists to be learned--that is, about either the nature of the input order or the categorized structure of the lists.

Results

Both recall and clustering measures were taken. Clustering was measured using the ratio of repetition (RR) (Bousfield, 1953). This measure counts the number of times two instances from the same category appear consecutively in a subject's output. This value is then divided by the total number of list items recalled on that output trial minus one, in order to adjust for different levels of recall.

A preliminary analysis of variance was conducted with the particular order of stimulus lists each subject received included as a factor. None of the interactions involving this factor were significant for either the recall or RR measure. Thus, it will not be discussed further.

Training Phase

Recall performance for Lists 1 and 2 is graphed in Figure 5. An analysis of mean total recall on Lists 1 and 2 produced no significant main effects or interactions, although the main effect of Training Input approached marginal significance, $F\ (1, 48) = 3.22$, $p < .08$, $MS_e = 1887.306$.

A test of the grand mean difference between List 1 and List 2 recall for the four groups combined was significant, $F\ (1, 48) = 17.78$, $p < .001$, $MS_e = 300.175$, indicating that the four groups as a whole improved on List 2. However, it is clear from Figure 5 that the extent of improvement was not equivalent for the four groups, and differed even for those receiving the same input order in the

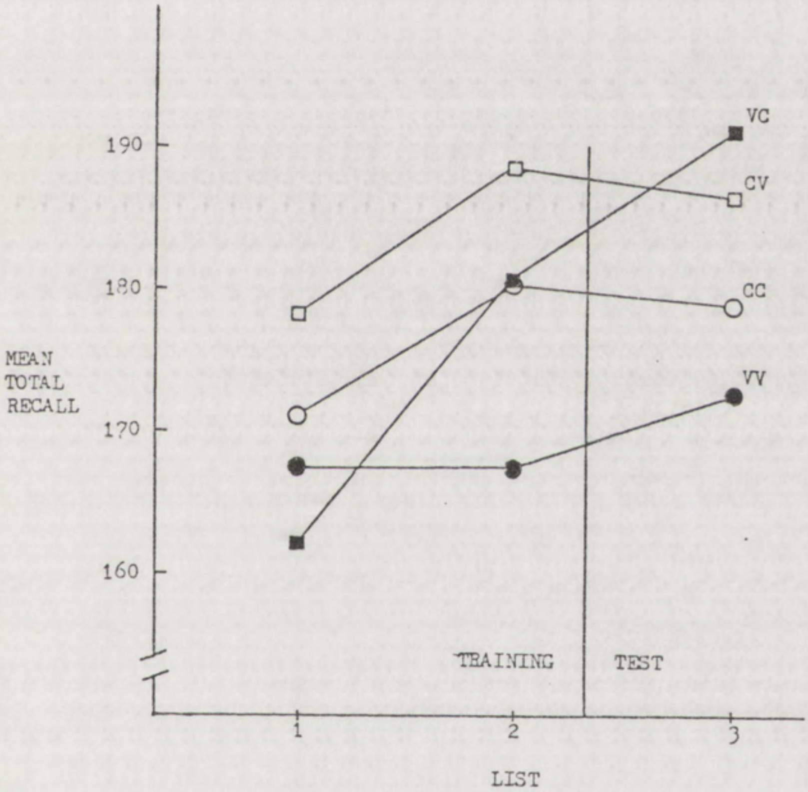

Figure 5. Mean total recall for Lists 1, 2, and 3 as a function of input condition.

training phase. This fact is substantiated by a significant Training Input x Test Input interaction, $\underline{F}$ (1, 48) = 4.73, $\underline{p} < .05$, $\underline{MS}_e$ = 300.175, effect on the mean difference scores between List 1 and List 2 recall. Subsequent analyses revealed that Groups CC and CV did not differ significantly on this measure, $\underline{F}$ (1, 48) < 1, $\underline{MS}_e$ = 300.175; however, VV subjects improved significantly more than VC subjects, $\underline{F}$ (1, 48) = 8.58, $\underline{p} < .01$, $\underline{MS}_e$ = 300.175. The CC and CV subjects showed significant improvement, $\underline{F}$s (1, 48) = 4.29 and 5.20, respectively, both $\underline{p}$s < .05, both $\underline{MS}_e$s = 300.175, as did VC subjects, $\underline{F}$ (1, 48) = 16.92, $\underline{p} < .001$, $\underline{MS}_e$ = 300.175; VV subjects, however, did not, $\underline{F}$ (1, 48) < 1, $\underline{MS}_e$ = 300.175.

The RR performance on Lists 1 and 2 can be viewed in Figure 6. Mean total RR scores for Lists 1 and 2 were significantly affected by the Training Input x Test Input interaction, $\underline{F}$ (1, 48) = 7.146, $\underline{p} < .01$, $\underline{MS}_e$ = 2.332. Further analyses showed that Groups VV and VC did not differ on this measure, $\underline{F}$ (1, 48) = 1.74, $\underline{p} > .10$, $\underline{MS}_e$ = 2.332, while the mean difference for CC subjects was significantly below that of CV subjects, $\underline{F}$ (1, 48) = 6.05, $\underline{p} < .05$, $\underline{MS}_e$ = 2.332.

A test of the grand mean difference between List 1 and List 2 RR scores indicated significant improvement for the four groups combined, $\underline{F}$ (1, 48) = 43.88, $\underline{p} < .001$, $\underline{MS}_e$ = 0.642. None of the other treatment factors nor their

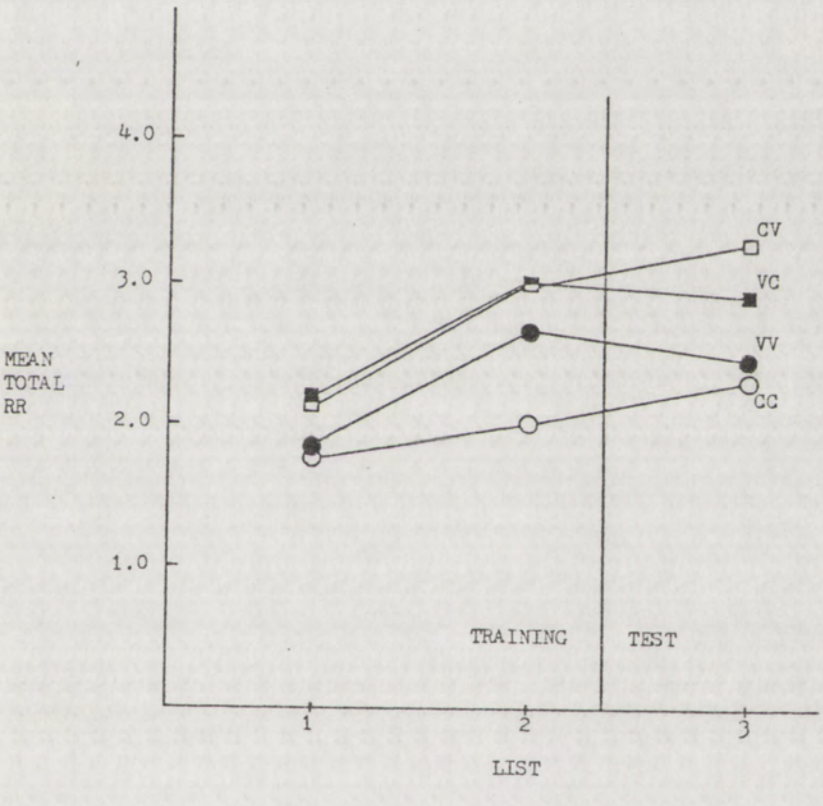

Figure 6. Mean total ratio of repetition (RR) for Lists 1, 2, and 3 as a function of input condition.

interactions had a significant effect on the mean difference scores.

Test Phase

Figure 5 depicts transfer performance for the recall measure. There were no statistically significant effects on the mean differences between List 2 and List 3 recall, although the main effect of Training Input was marginally significant, $\underline{F}$ (1, 48) = 3.565, $\underline{p} < .07$, $\underline{MS}_e$ = 385.133.

Transfer performance for the RR measure is portrayed in Figure 6. Training Input had a significant effect on mean differences between List 2 and List 3 RR performance, $\underline{F}$ (1, 48) = 4.55, $\underline{p} < .05$, $\underline{MS}_e$ = 0.651, indicating that transfer performance from List 2 to List 3 was primarily affected by the input condition received in training. Neither the main effect of Test Input nor the interaction approached significance.

Discussion

The differential performance in the training phase of groups receiving the same input conditions obviously casts doubt on any conclusions based on these data. The lack of improvement in recall on List 2 by VV subjects does not replicate previous learning-to-learn (LTL) effects demonstrated for varied input of categorized lists (Mandler, 1969), and is inconsistent with the significant improvement shown by VC subjects. Similarly, the differential RR performances on Lists 1 and 2 by CC and CV subjects is also inconsistent.

There is no ready explanation for the lack of internal reliability in the present data. All subjects were run under the same environmental conditions with the same apparatus and recall materials. Although subjects were run in groups of 2-8, complete experimental conditions were not run serially in time. Thus, the data cannot be accounted for on the basis of experimenter experience or time of semester. Also, there were no appreciable or consistent differences among the four treatment groups in the number and size of subject groups that had to be run to complete each experimental condition.

The possibility remains, of course, that the results are due simply to sampling error. In any case, differences in training phase performance of groups receiving the same input conditions invalidates any conclusions that might be

made concerning the experimental hypotheses.

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APPENDIX III

TABLES OF RAW AND SUMMARIZED DATA

TABLE 1

Number of Correct Recalls per Trial for Constant-Constant Subjects: Raw Data, First Experiment, Training Phase

	List 1 Trial							
Subject	1	2	3	4	5	6	Sum	Mean
1	12	16	15	23	23	19	108	18.0
2	12	18	19	18	24	25	116	19.3
3	8	13	17	17	19	22	96	16.0
4	8	14	15	18	19	19	93	15.5
5	12	15	20	23	26	21	117	19.5
6	8	14	18	20	21	24	105	17.5
7	9	16	20	24	22	27	118	19.7
8	8	12	17	22	23	25	107	17.8
9	10	16	21	25	24	24	120	20.0
10	9	13	16	20	18	24	100	16.7
11	11	17	17	23	24	27	119	19.8
12	13	19	22	26	26	28	134	22.3
13	7	8	12	13	15	14	69	11.5
14	10	14	17	19	21	20	101	16.8
15	10	11	13	18	18	17	87	14.5

Table 1 (con't)

	List 2 Trial							
Subject	1	2	3	4	5	6	Sum	Mean
1	14	22	24	26	24	28	138	23.0
2	10	18	25	22	25	27	127	21.2
3	8	9	12	11	13	13	66	11.0
4	9	16	21	21	24	26	117	19.5
5	16	22	23	26	25	25	137	22.8
6	9	16	21	25	26	24	121	20.2
7	6	13	15	20	19	22	95	15.8
8	12	16	20	23	25	27	123	20.5
9	15	18	23	22	25	27	130	21.7
10	10	13	20	23	25	25	116	19.3
11	9	18	23	26	28	27	131	21.8
12	11	19	25	26	25	27	133	22.2
13	6	10	14	14	13	14	71	11.8
14	8	16	18	22	21	22	107	17.8
15	12	17	19	22	22	24	116	19.3

TABLE 2

Number of Correct Recalls per Trial for

Constant-Varied Subjects: Raw Data,

First Experiment, Training Phase

List 1 Trial

Subject	1	2	3	4	5	6	Sum	Mean
1	9	14	20	18	22	23	106	17.7
2	8	14	22	24	25	27	120	20.0
3	7	10	13	14	20	16	80	13.3
4	10	12	16	19	20	25	102	17.0
5	12	17	20	21	25	21	116	19.3
6	9	11	12	17	18	17	84	14.0
7	11	16	22	21	25	24	119	19.8
8	13	14	23	22	26	21	119	19.8
9	8	14	21	16	21	21	101	16.8
10	8	10	17	22	20	22	99	16.5
11	6	9	14	15	18	19	81	13.5
12	8	9	15	21	23	23	99	16.5
13	11	13	19	19	22	25	109	18.2
14	10	13	18	23	22	26	112	18.7
15	9	14	19	18	20	21	101	16.8

Table 2 (con't)

List 2 Trial

Subject	1	2	3	4	5	6	Sum	Mean
1	13	16	20	22	21	25	117	19.5
2	14	21	23	25	24	24	131	21.8
3	8	12	20	19	22	23	104	17.3
4	11	13	19	21	19	22	105	17.5
5	14	22	23	27	27	24	137	22.8
6	8	12	14	16	19	19	88	14.7
7	9	19	20	21	27	26	122	20.3
8	11	22	20	24	21	26	124	20.7
9	10	17	19	23	21	28	118	19.7
10	10	14	15	16	21	22	98	16.3
11	13	7	16	17	21	25	99	16.5
12	13	22	23	23	28	27	136	22.7
13	8	10	17	23	22	25	105	17.5
14	11	16	22	22	23	24	118	19.7
15	9	16	22	25	27	26	125	20.8

TABLE 3

Number of Correct Recalls per Trial for

Varied-Constant Subjects: Raw Data,

First Experiment, Training Phase

	List 1 Trial							
Subject	1	2	3	4	5	6	Sum	Mean
1	6	12	16	18	18	18	88	14.7
2	9	13	12	17	15	19	85	14.2
3	10	10	16	17	20	20	93	15.5
4	10	11	15	19	22	25	102	17.0
5	11	16	18	23	22	25	115	19.2
6	8	12	21	22	22	27	112	18.7
7	8	10	9	10	13	14	64	10.7
8	5	8	15	13	11	13	65	10.8
9	15	21	23	27	25	28	139	23.2
10	14	21	18	25	20	18	116	19.0
11	11	18	24	25	27	25	130	21.7
12	9	14	13	19	23	21	99	16.5
13	10	14	14	17	25	23	103	17.2
14	13	22	19	26	26	15	121	20.2
15	14	18	18	21	16	17	104	17.3

Table 3 (con't)

List 2 Trial

Subject	1	2	3	4	5	6	Sum	Mean
1	6	12	17	23	25	24	107	17.8
2	11	17	23	20	22	24	117	19.5
3	10	14	21	20	24	24	113	18.8
4	15	19	21	21	25	24	125	20.8
5	12	19	23	17	22	26	119	19.8
6	14	23	26	23	26	25	137	22.8
7	7	10	10	11	9	15	62	10.3
8	6	10	7	10	5	7	45	7.5
9	12	23	27	25	28	28	143	23.8
10	12	21	23	24	27	26	133	22.2
11	12	18	21	22	27	26	126	21.0
12	7	15	16	22	24	27	111	18.5
13	11	18	17	24	27	26	123	20.5
14	13	21	24	23	28	26	135	22.5
15	9	13	19	22	24	19	106	17.7

TABLE 4

Number of Correct Recalls per Trial for

Varied-Varied Subjects: Raw Data,

First Experiment, Training Phase

	List 1 Trial							
Subject	1	2	3	4	5	6	Sum	Mean
1	10	12	17	14	17	20	90	15.0
2	10	12	14	16	13	16	81	13.5
3	11	17	19	15	19	16	97	16.2
4	9	15	14	16	21	24	99	17.7
5	9	16	18	18	21	24	106	19.5
6	11	15	16	21	24	25	112	18.7
7	11	17	20	20	25	24	117	19.5
8	8	15	15	15	15	15	83	13.8
9	8	14	21	24	27	28	122	20.3
10	8	16	19	24	25	24	116	19.3
11	9	13	13	18	19	22	94	15.7
12	16	24	25	26	26	24	141	23.5
13	7	12	12	14	21	20	86	14.3
14	10	16	18	22	23	23	112	18.7
15	10	18	20	19	21	24	112	18.7

Table 4 (con't)

List 2 Trial

Subject	1	2	3	4	5	6	Sum	Mean
1	9	15	19	22	26	28	119	19.8
2	9	17	23	21	20	21	111	18.5
3	15	13	21	20	20	23	112	18.7
4	10	16	19	22	23	24	114	19.0
5	12	15	18	19	24	23	111	18.5
6	10	15	21	26	25	26	123	20.5
7	11	21	19	24	22	27	124	20.7
8	8	16	14	15	12	17	82	13.7
9	12	19	22	23	23	27	126	21.0
10	13	22	20	25	23	26	129	21.5
11	10	17	20	22	22	26	117	19.5
12	19	25	29	27	28	29	157	26.2
13	12	15	19	24	27	28	125	20.8
14	11	18	24	23	29	28	133	22.2
15	12	9	14	18	15	20	88	14.7

TABLE 5

Number of Correct Recalls per Trial for Constant-Constant Subjects: Raw Data, First Experiment, Test Phase

	List 3 Trial							
Subject	1	2	3	4	5	6	Sum	Mean
1	9	22	23	22	22	22	120	20.0
2	11	12	19	23	24	27	116	19.3
3	4	8	13	15	17	20	77	12.8
4	6	13	15	19	20	23	96	16.0
5	15	21	23	21	24	20	124	20.7
6	10	19	20	22	24	23	118	19.7
7	13	24	22	26	27	27	139	23.2
8	15	18	26	29	30	30	148	24.7
9	8	16	23	27	28	30	132	22.0
10	15	20	23	24	25	28	135	22.5
11	10	18	24	27	25	28	132	22.0
12	9	13	20	23	29	29	123	20.5
13	6	7	10	12	13	10	58	9.7
14	12	15	23	21	20	22	113	18.8
15	15	18	24	23	29	26	135	22.5

TABLE 6

Number of Correct Recalls per Trial for

Constant-Varied Subjects: Raw Data,

First Experiment, Test Phase

	List 3 Trial							
Subject	1	2	3	4	5	6	Sum	Mean
1	12	17	24	17	21	23	114	19.0
2	10	19	19	19	22	23	112	18.7
3	9	13	13	19	18	20	92	15.3
4	9	11	18	13	17	22	90	15.0
5	13	19	25	25	19	24	125	20.0
6	8	10	14	17	15	17	81	13.5
7	12	18	23	18	24	23	118	19.7
8	15	19	19	18	18	19	108	18.0
9	10	15	16	19	17	16	93	15.5
10	9	13	15	14	18	17	86	14.3
11	8	14	13	18	21	16	90	15.0
12	7	9	20	20	23	22	101	16.8
13	7	13	16	19	23	24	102	18.2
14	9	17	15	21	22	25	109	17.0
15	12	21	22	22	26	26	129	21.5

TABLE 7

Number of Correct Recalls per Trial for

Varied-Constant Subjects: Raw Data,

First Experiment, Test Phase

	List 3 Trial							
Subject	1	2	3	4	5	6	Sum	Mean
1	12	15	16	17	23	25	108	18.0
2	10	22	26	27	24	22	131	21.8
3	10	17	22	23	25	26	123	20.5
4	10	16	24	22	21	23	116	19.3
5	10	14	17	17	19	24	101	16.8
6	14	24	26	23	22	25	134	22.3
7	6	10	12	13	13	13	67	11.2
8	8	8	8	9	11	8	52	8.7
9	17	24	27	28	28	26	150	25.0
10	6	17	23	25	29	28	128	21.3
11	9	25	26	28	27	28	143	23.8
12	9	21	26	26	28	26	136	22.7
13	11	23	25	29	29	28	145	24.2
14	20	24	27	27	30	30	158	26.3
15	10	16	18	18	26	26	114	19.0

TABLE 8

Number of Correct Recalls per Trial for

Varied-Varied Subjects: Raw Data,

First Experiment, Test Phase

List 3 Trial

Subject	1	2	3	4	5	6	Sum	Mean
1	12	18	19	21	23	22	115	19.2
2	18	20	25	26	26	28	143	23.8
3	14	18	15	17	21	23	108	18.0
4	8	13	16	18	21	22	98	16.3
5	9	19	17	18	21	21	105	17.5
6	7	16	22	26	25	27	123	20.5
7	14	17	19	24	23	27	124	20.7
8	11	17	16	15	18	18	95	15.8
9	13	21	22	21	21	22	118	19.7
10	11	17	16	22	23	26	117	19.5
11	10	18	24	25	25	29	131	21.8
12	17	26	27	29	30	30	159	26.5
13	11	19	20	25	23	28	126	21.0
14	15	20	23	27	27	28	140	23.3
15	11	16	18	23	22	24	114	19.0

TABLE 9

Number of Intertrial Repetitions (Observed-Expected) between Successive Pairs of Trials for Constant-Constant Subjects: Raw Data, First Experiment, Training Phase

	List 1 Trial Pairs						
Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	-0.44	1.65	0.36	3.71	5.17	10.45	2.09
2	0.17	2.60	-0.06	3.89	4.60	11.19	2.24
3	1.19	2.00	0.24	3.32	4.00	10.75	2.15
4	-0.54	1.47	1.33	0.23	0.50	2.99	0.60
5	0.38	0.96	3.96	1.73	2.88	9.90	1.98
6	1.46	1.43	0.99	1.13	5.79	12.80	2.56
7	1.58	3.86	4.13	6.70	7.72	24.00	4.80
8	-0.25	0.80	3.17	2.92	4.24	10.88	2.18
9	1.30	3.07	4.96	7.86	3.68	20.88	4.18
10	0.49	0.60	1.31	1.99	3.03	7.41	1.48
11	-0.77	0.61	3.07	6.62	4.44	13.97	2.79
12	1.27	1.00	2.53	6.50	5.21	16.52	3.30
13	-0.07	0.13	0.85	1.65	0.95	3.50	0.70
14	-0.80	-1.11	1.87	1.64	2.00	3.60	.72
15	0.64	-0.28	-0.77	0.32	1.28	1.19	.24

Table 9 (con't)

List 2 Trial Pairs

Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	2.29	4.70	3.38	3.65	2.49	16.52	3.30
2	2.00	3.79	6.01	6.62	4.50	22.92	4.58
3	-0.83	1.44	1.36	1.41	2.70	6.09	1.21
4	0.42	1.07	4.77	4.92	5.65	16.83	3.36
5	1.81	4.65	4.73	5.44	3.78	20.41	4.08
6	1.22	2.92	3.83	7.44	6.52	21.94	4.39
7	2.23	3.65	2.96	2.89	6.54	18.27	3.65
8	3.85	3.17	2.82	4.81	4.50	19.16	3.83
9	2.33	3.69	5.92	4.47	8.36	24.78	4.96
10	-0.46	1.31	2.82	6.54	4.52	14.72	2.94
11	1.11	4.69	5.60	9.35	18.41	39.16	7.83
12	4.14	3.85	8.58	5.71	5.63	27.91	5.58
13	1.00	1.71	2.88	2.21	2.79	10.59	2.12
14	1.13	1.54	4.45	2.52	2.52	12.16	2.43
15	2.12	1.32	2.85	1.59	1.84	9.52	1.94

TABLE 10

Number of Intertrial Repetitions (Observed-Expected) between Successive Pairs of Trials for Constant-Varied Subjects: Raw Data, First Experiment, Training Phase

List 1 Trial Pairs

Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	-0.48	1.89	2.27	-0.06	-0.50	3.11	0.62
2	1.46	2.82	3.84	3.73	5.50	17.36	3.47
3	0.66	-0.65	0.21	0.06	-1.31	-1.04	-0.21
4	1.50	1.25	0.80	-0.11	-0.37	3.08	0.62
5	1.12	2.93	2.26	-1.17	5.83	10.97	2.19
6	0.87	0.91	1.12	5.98	3.28	12.16	2.43
7	0.66	5.38	5.82	11.55	10.73	34.14	6.83
8	0.38	1.03	0.65	5.67	0.88	8.61	1.72
9	2.25	0.39	2.35	2.92	4.05	11.95	2.39
10	-0.50	0.51	2.29	2.91	0.05	5.25	1.05
11	-0.74	0.33	-0.69	-0.81	2.94	1.03	0.21
12	-0.33	-0.62	5.67	5.13	5.71	15.55	3.11
13	-0.78	0.27	2.84	4.00	3.76	10.08	2.02
14	0.35	3.06	5.84	4.65	4.53	18.43	3.69
15	2.33	1.01	1.77	3.67	6.37	15.15	3.03

Table 10 (con't)

List 2 Trial Pairs

Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	1.31	2.31	3.05	0.09	4.70	11.45	2.29
2	-0.06	5.01	4.81	7.60	6.54	23.90	4.78
3	1.13	2.90	1.57	2.85	2.65	11.09	2.22
4	1.22	1.27	2.95	1.80	1.85	9.08	1.82
5	0.99	1.92	3.51	4.35	4.30	15.07	3.01
6	2.13	2.69	1.20	3.97	4.49	14.48	2.90
7	2.35	2.89	6.70	8.66	11.43	32.03	6.41
8	3.26	4.05	1.87	3.79	6.61	19.56	3.91
9	1.94	3.70	6.90	6.01	10.57	29.12	5.82
10	0.71	2.47	1.25	0.35	0.09	4.87	0.97
11	0.34	-0.54	2.19	2.82	7.70	12.52	2.50
12	2.08	3.05	4.84	8.57	9.28	27.82	5.56
13	2.25	-0.66	1.93	4.65	5.62	13.78	2.76
14	1.98	2.11	6.74	4.79	5.89	21.51	4.30
15	2.00	7.97	8.32	8.50	10.43	37.21	7.44

TABLE 11

Number of Intertrial Repetitions (Observed-Expected) between Successive Pairs of Trials for Varied-Constant Subjects: Raw Data, First Experiment, Training Phase

	List 1 Trial Pairs						
Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	-0.33	2.06	1.08	3.88	0.04	6.73	1.35
2	-0.51	-0.38	-0.29	-0.33	-0.77	-2.29	-0.46
3	-0.60	1.47	1.59	1.22	3.95	7.64	1.53
4	-0.55	0.76	1.07	2.13	0.89	4.30	0.86
5	1.18	1.50	0.84	0.79	5.47	9.79	1.96
6	0.17	0.92	0.61	3.94	3.46	9.09	1.82
7	3.23	1.32	1.82	2.05	6.56	14.98	3.00
8	2.20	2.76	5.70	3.13	2.54	16.33	3.27
9	0.37	0.80	3.91	1.96	3.73	10.77	2.15
10	3.51	2.17	1.20	1.17	1.80	10.85	2.17
11	1.58	1.89	5.46	2.36	5.50	16.79	3.36
12	2.33	0.38	2.27	3.04	-0.27	7.76	1.55
13	-0.60	1.69	0.53	1.87	1.68	5.17	1.03
14	2.23	2.13	1.76	6.50	1.92	14.55	2.91
15	0.56	0.32	1.73	-0.08	1.34	3.80	0.77

Table 11 (con't)

List 2 Trial Pairs

Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	0.75	0.29	0.96	2.88	3.59	8.46	1.69
2	-0.75	-0.44	0.56	-0.11	-0.45	-1.20	-0.24
3	0.40	1.07	0.08	-0.01	-0.59	0.95	0.19
4	0.16	0.73	3.65	2.50	7.42	14.47	2.89
5	1.39	0.42	1.93	5.91	3.83	13.48	2.70
6	2.18	4.60	4.73	5.73	4.58	21.81	4.36
7	-0.34	-0.60	-0.02	1.39	-0.83	-0.40	-0.08
8	1.00	0.43	-0.57	0.76	0.89	2.50	0.50
9	4.35	4.51	2.50	4.42	8.21	23.99	4.80
10	5.95	3.87	5.62	9.57	9.43	34.45	6.89
11	0.33	1.73	5.82	9.44	7.56	24.89	4.98
12	0.20	0.08	1.11	4.84	9.57	15.81	3.16
13	1.09	3.98	2.11	3.57	6.56	17.31	3.46
14	2.86	6.33	7.62	9.57	9.21	35.59	7.12
15	0.28	-0.73	0.00	1.97	0.66	2.18	0.44

TABLE 12

Number of Intertrial Repetitions (Observed-Expected) between Successive Pairs of Trials for Varied-Varied Subjects: Raw Data, First Experiment, Training Phase

List 1 Trial Pairs

Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	0.00	0.29	0.53	0.39	-0.92	0.30	0.06
2	0.50	2.14	0.82	-0.40	0.60	3.66	0.73
3	-0.21	0.44	2.49	0.49	0.28	3.49	0.70
4	0.56	1.47	1.02	-0.08	5.05	8.00	1.60
5	2.00	-0.08	-0.30	1.04	1.79	4.44	0.89
6	1.64	0.53	3.67	3.64	1.86	10.74	2.15
7	0.55	3.08	4.64	2.91	6.46	17.65	3.53
8	2.50	0.36	1.63	1.73	2.02	8.24	1.65
9	-0.36	-0.61	3.05	4.57	4.28	10.93	2.19
10	-0.09	1.41	0.95	1.60	5.73	9.59	1.92
11	-0.10	-0.50	-0.36	0.09	-0.15	-1.02	-0.20
12	2.75	2.73	4.44	4.50	5.65	20.08	4.02
13	1.71	-0.78	0.93	1.76	0.00	3.63	0.73
14	0.48	0.38	0.33	2.79	4.56	8.54	1.71
15	-0.80	-0.87	1.04	0.95	2.64	2.97	0.59

Table 12 (con't) .

List 2 Trial Pairs

Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	0.61	3.07	3.01	2.00	2.86	11.54	2.31
2	0.70	2.07	2.00	1.80	6.48	13.06	2.61
3	2.26	1.19	0.26	2.45	2.09	8.25	1.65
4	0.88	2.97	3.70	3.79	1.76	13.10	2.62
5	0.20	0.84	0.77	2.66	2.48	6.95	1.39
6	1.04	1.16	3.88	5.44	6.44	17.97	3.59
7	1.52	7.09	7.66	3.84	5.72	25.82	5.16
8	1.13	2.82	0.47	0.38	1.59	6.38	1.28
9	0.37	3.70	4.50	3.71	2.51	14.78	2.96
10	1.23	4.91	4.78	3.54	3.73	18.18	3.64
11	1.51	1.22	1.91	2.74	3.80	11.18	2.24
12	3.99	5.48	9.34	11.18	13.27	43.22	8.64
13	1.00	1.91	5.66	11.57	10.28	30.42	6.08
14	1.43	2.89	1.01	2.61	3.27	11.22	2.24
15	-0.33	-0.89	0.76	2.19	1.12	2.84	0.57

TABLE 13

Number of Intertrial Repetitions (Observed-Expected) between Successive Pairs of Trials for Constant-Constant Subjects: Raw Data, First Experiment, Test Phase

	List 3 Trial Pairs						
Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	1.27	3.79	1.92	7.74	0.74	15.46	3.09
2	1.15	2.21	3.60	8.33	6.30	21.58	4.32
3	-0.13	2.19	0.87	1.78	4.59	9.30	1.86
4	1.49	-0.31	1.23	0.89	4.09	7.39	1.48
5	2.16	6.87	2.73	3.05	0.87	15.68	3.14
6	1.05	1.57	3.45	4.56	3.62	14.25	2.85
7	1.15	6.70	4.80	10.43	12.35	35.44	7.09
8	5.02	7.69	11.28	16.13	12.07	52.19	10.44
9	1.13	7.70	9.67	12.41	13.20	43.80	8.76
10	3.79	9.67	8.76	8.73	12.42	43.37	8.67
11	3.00	5.58	10.44	10.63	12.42	42.08	8.42
12	1.04	1.15	3.67	3.61	10.20	19.68	3.94
13	0.71	1.80	2.07	1.28	1.35	7.22	1.44
14	1.20	1.94	3.58	3.86	4.91	15.50	3.10
15	3.47	4.03	5.48	5.68	6.71	25.36	5.07

TABLE 14

Number of Intertrial Repetitions (Observed-Expected) between Successive Pairs of Trials for Constant-Varied Subjects: Raw Data, First Experiment, Test Phase

	List 3 Trial Pairs						
Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	1.12	2.67	2.97	3.82	4.73	15.31	3.06
2	0.24	-0.01	3.14	3.85	3.79	11.01	2.20
3	2.04	0.34	2.11	0.60	1.67	6.75	1.35
4	-0.40	3.27	0.23	0.19	1.03	4.31	0.86
5	3.11	1.56	2.52	0.99	2.08	10.26	2.05
6	1.25	0.97	6.89	3.14	2.96	15.21	3.04
7	3.33	4.99	4.25	1.89	7.76	22.21	4.44
8	1.23	1.39	-0.40	0.04	2.09	4.34	0.87
9	2.44	2.70	3.13	1.32	0.47	10.06	2.01
10	1.66	1.26	0.31	0.67	0.28	4.18	0.84
11	2.64	1.54	2.38	4.73	1.75	13.05	2.61
12	-0.33	0.53	2.09	1.67	1.79	5.75	1.15
13	1.27	2.78	4.84	4.68	5.62	19.18	3.84
14	0.34	1.13	2.13	4.43	3.48	11.52	2.30
15	1.95	3.96	4.01	9.38	8.37	27.67	5.53

TABLE 15

Number of Intertrial Repetitions (Observed-Expected) between Successive Pairs of Trials for Varied-Constant Subjects: Raw Data, First Experiment, Test Phase

	List 3 Trial Pairs						
Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	2.20	4.90	4.19	4.20	5.54	21.03	4.21
2	1.62	4.53	4.15	5.57	3.70	19.58	3.92
3	0.15	2.88	5.92	7.54	9.30	25.80	5.16
4	-0.25	2.19	5.70	6.52	6.58	20.75	4.15
5	-0.80	-0.47	-0.45	0.03	1.81	0.21	0.02
6	2.21	1.65	3.73	1.65	2.89	17.13	3.43
7	0.33	1.07	-0.92	-1.30	1.70	0.87	0.17
8	3.25	0.69	1.17	4.87	0.05	10.02	2.00
9	4.67	6.70	9.28	8.34	6.48	35.48	7.10
10	1.41	5.77	8.68	10.48	12.27	38.61	7.72
11	2.50	7.58	5.35	11.28	8.14	34.86	6.97
12	1.24	7.75	9.50	9.48	8.48	36.46	7.29
13	2.13	5.81	6.34	5.20	6.14	25.63	5.13
14	4.87	6.57	10.49	12.27	13.07	47.26	9.45
15	-0.70	-0.92	0.32	0.97	3.50	3.18	6.40

TABLE 16

Number of Intertrial Repetitions (Observed-Expected) between Successive Pairs of Trials for Varied-Varied Subjects: Raw Data, First Experiment, Test Phase

	List 3 Trial Pairs						
Subject	1-2	2-3	3-4	4-5	5-6	Sum	Mean
1	2.33	1.09	2.80	0.87	0.92	8.02	1.60
2	2.27	2.63	5.58	6.37	9.21	26.06	5.21
3	0.67	-0.41	-0.44	2.13	3.87	5.81	1.16
4	0.62	-0.69	0.92	-0.11	0.68	1.40	0.28
5	-0.84	-0.13	-0.02	0.56	2.45	2.02	0.40
6	0.64	5.81	6.80	9.58	9.50	32.33	6.47
7	2.89	4.32	5.08	3.76	4.51	20.56	4.11
8	0.23	1.85	1.40	0.19	1.32	4.99	1.00
9	0.38	3.96	1.82	1.91	2.09	10.16	2.03
10	1.49	1.19	1.97	1.65	2.73	9.03	1.81
11	2.20	3.74	4.73	6.52	10.48	27.67	5.53
12	3.29	8.56	9.34	14.13	14.07	49.39	9.88
13	1.31	4.04	4.91	4.81	4.57	19.64	3.93
14	3.96	1.82	3.65	8.49	9.41	27.32	5.46
15	1.18	1.08	-0.16	1.79	3.56	7.46	1.49

TABLE 17

Total Number of Correct Recalls and Ratio of Repetition (RR) Scores per List for Constant-Constant Subjects: Raw Data, Second Experiment

	Training Phase				Test Phase	
	List 1		List 2		List 3	
Subject	Recall	RR	Recall	RR	Recall	RR
1	179	2.84	194	3.01	190	2.84
2	160	1.48	177	3.79	183	2.28
3	159	0.39	163	1.58	153	0.55
4	190	2.49	203	3.64	204	3.04
5	205	1.52	203	0.76	186	1.29
6	174	2.94	204	2.81	218	3.56
7	143	1.40	126	1.74	159	1.80
8	159	2.78	162	1.17	159	3.65
9	162	1.84	182	2.49	175	2.48
10	162	2.56	173	1.64	185	2.70
11	173	0.89	181	1.75	167	2.20
12	204	1.37	213	0.50	199	1.59
13	152	1.28	156	1.15	148	1.81
14	176	1.53	190	1.97	166	2.11
15	172	1.05	174	2.07	181	3.16

TABLE 18

Total Number of Correct Recalls and Ratio of Repetition (RR) Scores per List for Constant-Varied Subjects: Raw Data, Second Experiment

	Training Phase				Test Phase	
	List 1		List 2		List 3	
Subject	Recall	RR	Recall	RR	Recall	RR
1	187	1.72	223	4.43	207	3.15
2	169	1.13	190	3.53	163	2.14
3	196	1.99	202	3.26	217	3.96
4	201	3.68	201	4.85	202	3.86
5	136	2.49	138	2.97	184	2.22
6	183	2.67	189	3.61	202	4.16
7	190	3.81	185	3.63	2.10	4.56
8	178	2.70	150	1.75	187	2.55
9	158	2.80	187	2.41	178	3.03
10	150	2.69	188	1.74	155	2.91
11	148	0.73	169	3.36	152	4.16
12	218	1.74	198	2.90	215	2.17
13	192	0.99	195	0.96	174	2.94
14	171	1.43	178	3.05	171	3.58
15	197	1.51	214	2.67	192	3.74

TABLE 19

Total Number of Correct Recalls and Ratio of Repetition (RR) Scores per List for Varied-Constant Subjects: Raw Data, Second Experiment

	Training Phase				Test Phase	
	List 1		List 2		List 3	
Subject	Recall	RR	Recall	RR	Recall	RR
1	137	2.08	158	4.17	172	3.24
2	163	3.36	196	4.59	189	3.53
3	170	1.09	175	1.45	230	0.31
4	193	2.67	220	3.62	221	3.06
5	173	1.63	196	4.33	212	4.33
6	123	2.42	115	2.31	162	0.15
7	144	2.06	151	1.38	159	1.09
8	199	4.44	220	4.23	213	5.00
9	176	4.11	208	4.33	204	5.18
10	138	0.72	141	1.91	146	0.79
11	169	1.62	211	3.73	210	4.38
12	162	1.68	169	2.02	196	4.35
13	196	1.45	201	2.19	185	1.84
14	140	1.71	159	2.70	188	4.40
15	164	1.86	192	2.47	181	2.11

TABLE 20

Total Number of Correct Recalls and Ratio of Repetition (RR) Scores per List for Varied-Varied Subjects: Raw Data, Second Experiment

	Training Phase				Test Phase	
	List 1		List 2		List 3	
Subject	Recall	RR	Recall	RR	Recall	RR
1	178	2.84	176	3.94	156	2.87
2	170	2.61	151	2.79	179	2.19
3	146	1.86	152	2.95	146	1.28
4	175	1.97	149	3.95	164	2.31
5	156	1.62	157	2.50	155	1.71
6	161	1.30	166	1.00	164	1.80
7	187	2.72	179	1.97	205	3.19
8	168	2.00	190	1.75	174	2.37
9	145	1.34	160	1.87	159	2.58
10	160	1.81	138	1.41	182	0.93
11	187	3.11	230	4.73	227	4.35
12	164	1.42	123	2.53	134	2.02
13	186	0.75	183	2.44	181	1.90
14	152	1.29	177	3.03	194	3.54
15	167	1.00	181	3.11	170	3.93

TABLE 21

Analysis of Variance Summary Tables for the First Experiment: Recall

Sum of List 1 and List 2 Recall

Source	df	MS	F
Training Input (TrI)	1	4.265	.00
Test Input (TeI)	1	56.076	.05
TrI x TeI	1	345.575	.28
Error	56	1245.768	
Total	59		

Mean Difference between List 1 and List 2 Recall

Source	df	MS	F
Training Input (TrI)	1	45.067	0.22
Test Input (TeI)	1	101.401	0.48
TrI x TeI	1	0.267	0.00
Grand Mean	1	7843.234	37.47***
Error	56	209.320	
Total	60		

Table 21 (con't)

Mean Difference between List 2 and List 3 Recall

Source	df	MS	F
Training Input (TrI)	1	1421.063	7.91**
Test Input (TeI)	1	1214.914	6.77**
TrI x TeI	1	385.065	2.14
Grand Mean	1	0.60	.00
Error	56	179.609	
Total	60		

Mean Difference between List 1 and List 2

Linear Trends over Trials

Source	df	MS	F
Training Input (TrI)	1	1179.261	1.05
Test Input (TeI)	1	153.599	0.14
TrI x TeI	1	1.667	0.00
Grand Mean	1	992.264	0.88
Error	56	1125.249	
Total	60		

Table 21 (con't)

Mean Difference between List 2 and List 3

Linear Trends over Trials

Source	df	MS	F
Training Input (TrI)	1	504.599	0.63
Test Input (TeI)	1	2666.658	3.23
TrI x TeI	1	1480.059	1.84
Grand Mean	1	1500.000	1.87
Error	56	804.290	
Total	60		

Mean Difference between List 1 and List 2

Quadratic Trends over Trials

Source	df	MS	F
Training Input (TrI)	1	17.066	0.03
Test Input (TeI)	1	437.398	0.71
TrI x TeI	1	326.664	0.53
Grand Mean	1	1179.256	1.91
Error	56	617.412	
Total	60		

Table 21 (con't)

Mean Difference between List 2 and List 3

Quadratic Trends over Trials

Source	df	MS	F
Training Input (TrI)	1	459.264	0.58
Test Input (TeI)	1	576.599	0.73
TrI x TeI	1	426.665	0.54
Grand Mean	1	405.600	0.51
Error	56	792.187	
Total	60		

**$p < .01$

***$p < .001$

TABLE 22

Analysis of Variance Summary Tables for the

First Experiment: Intertrial Repetitions (ITRs)

Sum of List 1 and List 2 ITRs

Source	df	MS	F
Training Input (TrI)	1	626.164	2.76
Test Input (TeI)	1	0.242	0.00
TrI x TeI	1	2.676	0.01
Error	56	226.846	
Total	59		

Mean Difference between List 1 and List 2 ITRs

Source	df	MS	F
Training Input (TrI)	1	22.928	0.32
Test Input (TeI)	1	29.836	0.42
TrI x TeI	1	40.262	0.56
Grand Mean	1	3233.554	45.09***
Error	56	71.710	
Total	60		

Table 22 (con't)

Mean Difference between List 2 and List 3 ITRs

Source	df	MS	F
Training Input (TrI)	1	400.155	3.56
Test Input (TeI)	1	1453.853	12.93***
TrI x TeI	1	118.582	1.06
Grand Mean	1	255.481	2.27
Error	56	112.440	
Total	60		

Mean Difference between List 1 and List 2

Linear Trends over Trials

Source	df	MS	F
Training Input (TrI)	1	68.523	0.81
Test Input (TeI)	1	4.256	0.05
TrI x TeI	1	96.419	1.14
Grand Mean	1	533.061	6.32*
Error	56	84.305	
Total	60		

Table 22 (con't)

Mean Differences between List 2 and List 3

Linear Trends over Trials

Source	df	MS	F
Training Input (TrI)	1	145.704	1.71
Test Input (TeI)	1	458.932	5.37*
TrI x TeI	1	343.776	4.02*
Grand Mean	1	0.032	0.00
Error	56	85.446	
Total	60		

Mean Differences between List 1 and List 2

Quadratic Trends over Trials

Source	df	MS	F
Training Input (TrI)	1	10.086	0.13
Test Input (TeI)	1	7.877	0.10
TrI x TeI	1	266.534	3.46
Grand Mean	1	4.396	0.06
Error	56	77.12	
Total	60		

Table 22 (con't)

Mean Difference between List 2 and List 3

Quadratic Trends over Trials

Source	df	MS	F
Training Input (TrI)	1	5.655	0.08
Test Input (TeI)	1	220.339	3.00
TrI x TeI	1	263.507	3.59
Grand Mean	1	107.040	1.46
Error	56	73.416	
Total	60		

* $p < .05$

*** $p < .001$

TABLE 23

Analysis of Variance Summary Tables for the

Second Experiment: Recall

Sum of List 1 and List 2 Recall

Source	df	MS	F
Training Input (TrI)	1	6080.227	3.22
Test Input (TeI)	1	216.604	0.12
Stimulus List Order (O)	2	3031.328	1.61
TrI x TeI	1	1995.263	1.06
TeI x O	2	1123.825	0.60
TrI x O	2	134.108	0.07
TrI x TeI x O	2	149.216	0.08
Error	48	1887.306	
Total	59		

Table 23 (con't)

Mean Difference between List 1 and List 2 Recall

Source	df	MS	F
Training Input (TrI)	1	5.400	0.02
Test Input (TeI)	1	1161.599	3.87*
Stimulus List Order (O)	2	36.317	0.12
TrI x TeI	1	1421.058	4.73*
TeI x O	2	136.550	0.45
TrI x O	2	333.148	1.11
TrI x TeI x O	2	338.114	1.13
Grand Mean	1	5339.242	17.79***
Error	48	300.175	
Total	60		

Table 23 (con't)

Mean Difference between List 2 and List 3 Recall

Source	df	MS	F
Training Input (TrI)	1	1372.814	3.57
Test Input (TeI)	1	126.150	0.33
Stimulus List Order (O)	2	644.464	1.67
TrI x TeI	1	93.751	0.24
TeI x O	2	20.600	0.05
TrI x O	2	89.867	0.23
TrI x TeI x O	2	117.599	0.31
Grand Mean	1	582.817	1.51
Error	48	385.133	
Total	60		

*$p < .05$

***$p < .001$

TABLE 24

Analysis of Variance Summary Tables for the Second Experiment: Ratio of Repetition (RR)

Sum of List 1 and List 2 RR

Source	df	MS	F
Training Input (TrI)	1	2.571	1.10
Test Input (TeI)	1	1.517	0.65
Stimulus List Order (O)	2	11.075	4.75*
TrI x TeI	1	16.664	7.15**
TeI x O	2	3.223	1.38
TrI x O	2	2.125	0.91
TrI x TeI x O	2	2.174	0.93
Error	48	2.332	
Total	59		

Table 24 (con't)

Mean Difference between List 1 and List 2 RR

Source	df	MS	F
Training Input (TrI)	1	1.067	1.66
Test Input (TeI)	1	1.423	2.22
Stimulus List Order (O)	2	12.131	18.89***
TrI x TeI	1	1.473	2.29
TeI x O	2	0.341	0.53
TrI x O	2	1.326	2.06
TrI x TeI x O	2	0.302	0.47
Grand Mean	1	28.174	43.88***
Error	48	0.641	
Total	60		

Table 24 (con't)

Mean Difference between List 2 and List 3 RR

Source	df	MS	F
Training Input (TrI)	1	2.961	4.55*
Test Input (TeI)	1	0.043	0.07
Stimulus List Order (O)	2	11.110	17.07***
TrI x TeI	1	0.018	0.03
TeI x O	2	0.281	0.43
TrI x O	2	1.093	1.68
TrI x TeI x O	2	0.959	1.47
Grand Mean	1	0.159	0.24
Error	48	0.651	
Total	60		

*$p < .05$

**$p < .01$

***$p < .001$