Coding strategies, perceptual grouping, and the "variability effect" in free recall

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Three experiments examined the effects of constant vs. varied input of letter strings on recall, and then examined the effects of such training in the learning of new lists of letter strings. Letter strings were constructed from pairs of trigrams spatially grouped, and were presented either consistently or with different spatial groupings on successive presentations. In Experiments I and II, varied input produced substantially greater recall than constant input. When transferred to a new list of letter strings, containing either the same general structure or a new scrambled structure, recall of the second list was determined primarily by conditions of first-list input, and unaffected by second-list structure. Although the "variability effect" did not appear in the training phase of Experiment III, Varied input led subjects to regroup or integrate the letter sequences more frequently and produced similar transfer effects as in Experiments I and II.

In a recent experiment, Ellis, Parente, and Walker (1974) reported that recall for letter sequences was enhanced when the sequences were variably grouped on successive presentations. The letter sequences were derived from trigram doublets (e.g., RUMWIG), and variability of nominal stimulus input was defined by different spatial/perceptual groupings of the letter sequences on successive visual presentations (e.g., RUMWI G, RU MW IG, R UMW IG, RU MWI G). Sequences presented in such a varied fashion were recalled at substantially higher levels than were the same letter sequences grouped consistently on successive presentations. These results established one restriction on any assumption that sheer repetition of nominal stimulus events maximizes recall. The general objective of this research is to explore the manner by which input variability, in the form of varied spatial groupings of letter sequences, facilitates recall as compared with conditions of input consistency or repetition.

The "variability effect" described above was interpreted in terms of a *perceptual regrouping hypothesis*, whose principal assumption is that variation in the E-imposed grouping rule or structure for specific letter sequences will increase the probability that subjects will discover the underlying structure (preexperimentally developed) of the particular sequence. In this instance, underlying structure refers simply to the pronounceable, highly integrated unit of the intact, unspaced letter sequence. Since the spatial grouping of the letter sequence, which is irrelevant to the subsequent recall task, changes on successive presentations, it is assumed that subjects are more likely to recognize the irrelevancy of the E-imposed grouping, and will therefore attempt to encode the letter sequence

in a unitary fashion which will enhance recall.

A restriction of the perceptual regrouping hypothesis is the assumption that varied stimulus input, in the form of altered letter groupings, will facilitate recall only when the sequence contains some minimal underlying structure. This assumption can account for the discrepancy between the findings of Ellis et al. (1974) and Bower and Winzenz (1969), who reported that memory for randomly generated digit series improved only as a result of consistent presentations of the series. When the temporal grouping of the digit series was varied on successive presentations, they found no improvement in recall. The digit series lacked, however, any evident structure which might be detected by subjects since they were random permutations of digits. In other words, a string such as 276,48,975 is no better a three-chunk set than is 27,6489,75, or vice versa, in the sense that there was no inherently better combination of the numbers for subjects to seek. Thus, when no overall structure is present, sheer repetition of the nominal stimulus event provides for maximum recall. There are additional differences between the experiments, however, which may also contribute to the divergent findings (cf. Ellis et al., 1974).

It must be emphasized that the perceptual regrouping hypothesis does assume that varied input will facilitate recall as long as there is some minimally obvious structure which, if discovered by subject, would facilitate recall, and when E-imposed grouping serves to mask the underlying structure with a less effective one. For example, Ellis et al. found that varied input aided recall of letter strings derived even from low-meaningfulness trigram doublets. It would appear that this effect does not occur only in the case of extreme lack of structure, e.g., random permutations of digit strings.

The purpose of the first experiment was to examine the effects of nominal stimulus variation on recall in

This research was supported by National Science Foundation Grant GB-27413X to the first author. Requests for reprints should be sent to Henry C. Ellis, Department of Psychology, University of New Mexico, Albuquerque, New Mexico 87131.

relation to a specific prediction of the perceptual regrouping hypothesis. The hypothesis assumes that if subjects are adopting an efficient encoding or organizational strategy as the result of attempting to learn a list of variably grouped letter sequences, this strategy will be transferred when subjects learn a new list of sequences regardless of the manner (varied vs. constant) in which the new list is presented. Specifically, if subjects are initially trained with sequences presented in varied fashion and if their tendency to look for and encode a higher order unit (the entire sequence) is established, then subjects should tend to transfer this strategy when shifted to a new list of sequences, regardless of whether they are grouped consistently or varied on successive presentations. This result was obtained by Hunt, Parente, and Ellis (1974). Moreover, subjects initially trained with constant input were impaired in their performance when transferred to a second list even when the second-list sequences were spatially varied. This latter finding does not obviously follow from the perceptual regrouping hypothesis since, in principle, subjects could overcome whatever detrimental strategy was established in the learning of the first list.

Experiment I examines the generality of the results reported by Hunt et al. (1974) and replicates these findings. Experiment II examines the effect of varied vs. constant input during training when subjects are transferred to letter groupings having minimal "higher order" structure; the experiment concerns the persistence of a presumably-established encoding strategy when the to-be-recalled (TBR) sequence is less readily unitized. Finally, Experiment III is designed to assess the nature of the recall task itself as a factor affecting the "variability effect," and to assess the role of encoding strategies when subjects are transferred to a new task consisting of variable vs. constant presentation of letter sequences derived from word phrases.

EXPERIMENT I

Method

Design. The subjects were 40 undergraduate summer student volunteers from the University of New Mexico. The experiment was conducted in two stages: training and transfer. In training, each subject received five study-test trials to learn and recall a list of eight letter sequences. Two methods of letter-sequence presentation were employed: a constant and a varied condition of presentation. Half the subjects were shown the sequences grouped in a consistent fashion (constant condition) on successive presentations, and the remaining half saw different perceptual groupings (variable condition) of each sequence on successive presentations. Interspersed between each study trial was a test which required subjects to recall the entire list of letter sequences in the order and sequence in which they were presented.

Following training, all subjects in each training condition were transferred to a second task in which they learned a new list of eight letter sequences, again presented in either a constant or

varied manner. Half the subjects trained with the constant input condition learned a new list in which the sequences were again grouped in a constant fashion, while the remaining half learned a new list in which the sequences were variably grouped on successive presentations. Similarly, half the subjects trained with the variable input condition learned a new list of letter sequences which were again grouped in a variable fashion, while the remaining half learned a new list in which the sequences were grouped in constant fashion. Thus, the first-list training conditions consisted of constant or varied input, and four transfer conditions were formed: constant input in training and constant input in transfer (C-C), constant input in training and variable input in transfer (C-V), variable input in training and variable input in transfer (V-V), and variable input in training and constant input in transfer (V-C).

Letter sequences. The stimulus items were letter sequences derived from trigram doublets constructed by combining two CVC (consonant-vowel-consonant) trigrams of 100% meaningfulness value (Archer, 1960) into a single doublet. For example, the two trigrams, ZIP and NOT, were combined to form the doublet ZIPNOT. Two eight-item lists were constructed in the above fashion. The items used were ZIPNOT, RIBHUT, BANCOW, MEDVAN, SUMKAY, RUMWIG, LAWSIR, JETRUG, PINSAP, WARBUT, JAMFOR, PALTEX, GASWEB, HADLOG, CUPNET, and DENGIT.

Each doublet was perceptually (spatially) arranged into three groupings of letters, the arrangement corresponding to a rule specifying the number of letters in a group. Four rules were used to separate the groupings of letters of a given doublet, these rules distinguishing the following grouping structures: 2,2,2 (e.g., ZI PN OT), 1,4,1 (Z IPNO T), 2,3,1 (ZI PNO T), and 1,3,2 (Z IPN OT). Four stimulus lists for each set of letter sequences were prepared, each list containing the eight stimulus sequences presented in a different serial order.

In the constant condition, a given letter sequence was presented in a consistently grouped fashion over successive presentations of the lists; however, four different structures were used, one for two sequences each. In the varied condition, the sequences were grouped according to a different rule (described above) over successive presentations of the four lists. For example, subjects trained with constant input saw the doublet ZIPNOT consistently grouped as ZI PN OT, whereas subjects trained with variable input saw the sequence grouped in four different ways. Thus, variation of the nominal stimulus was defined in terms of the application of a different grouping rule applied to the same letter sequences on successive list exposures. The intact trigram (e.g., ZIP or NOT) was never presented in either condition.

Training. All subjects were trained and tested individually in both input conditions. There were five study-test trials administered in each condition, a trial consisting of the successive presentations of four stimulus lists of the eight letter strings. Thus subjects received a total of 32 (four lists by eight letter strings) stimulus presentations per trial. Each sequence was exposed for a 2-sec interval, and subjects were instructed to remember the items as they would be tested for recall.

The subjects were given a recall task following each study trial which required them to recall the letters in the order and sequence presented. Subjects were given a test sheet containing eight horizontal arrangements of six adjacently spaced boxes corresponding to the eight sequences of six letters and were instructed to recall the letter sequences by filling in the boxes with the appropriate letters. They first recalled the letters with which they were confident and then guessed the remaining letters, making the procedure one of forced recall. Although the task required that the letters be placed in the order and sequence in which they were shown, subjects were allowed to free recall the letters in that they were allowed to enter the letters in any

temporal order. In all aspects, the features of the recall task were identical to those used by Ellis et al. (1974).

Transfer. The procedures in transfer were identical to those in training expect that subjects learned a new list of eight letter sequences. The lists in the training and transfer phases were counterbalanced, with the sequences reversed in the two phases for half the subjects.

Results

Training. The principal data from the training phase are presented in the left panel of Figure 1, which is a plot of mean correct recalls (all six letters in correct position) for the constant and varied input conditions. As the figure reveals, varied input produced superior recall throughout the training sequence, $F(1,38) = 13.9$, $p < .001$, $S_{\bar{x}} = .37$. Terminal recall probabilities for the varied and constant conditions were .70 and .35, respectively. Recall improved for both input conditions as a result of practice, $F(4,152) = 72.2$, $p < .001$, $S_{\bar{x}} = .16$. Moreover, the rate of improvement in recall was faster under the varied condition, as reflected in the significant Type of Training by Trials interaction, $F(4,152) = 4.6$, $p < .005$, $S_{\bar{x}} = .22$.

Transfer. Recall performance in the transfer phase of the experiment is presented in the right panel of Figure 1. This figure is a plot of the mean correct recalls of the letter sequences for the four training-transfer conditions. The figure shows that the training-input conditions overwhelmingly influenced recall during the transfer phase. Varied input in training led to superior recall in transfer regardless of the input conditions (varied or constant) to which these subjects were transferred. Similarly, constant input in training retarded performance in transfer despite the input conditions to which subjects were transferred.

The recall data were analyzed as a simple factorial (training input and transfer input) which allowed examination of the relative contribution of varied and constant input during first-list and second-list recall. Recall performance in the transfer task was determined by the conditions of first-list input, $F(1,36) = 18.9$, $p < .001$, $S_{\bar{x}} = .43$. In contrast, varied and constant input in transfer had no reliable effect upon recall, $F(1,36) = .18$, $p > .10$, $S_{\bar{x}} = .43$. In addition, input conditions of training and transfer did not interact reliably, $F < 1$. All groups obviously improved with practice, $F(4,144) = 67.48$, $p < .001$, $S_{\bar{x}} = .16$, and the rate of increase in recall was somewhat faster for subjects initially exposed to varied input, $F(4,144) = 2.51$, $p < .05$, $S_{\bar{x}} = .22$.

EXPERIMENT II

The results of the training phase indicate that the recall of letter sequences was substantially greater when the groupings were varied rather than constant on successive presentations. This finding replicates the

Figure 1. Recall of letter strings as a function of varied-constant input during training (left panel), and as a function of transfer to new lists and shifts in varied-constant input (right panel).

results of Ellis et al. (1974), and is of secondary interest here. More important is the finding that initial conditions of input, whether varied or constant, are powerful determiners of recall performance during the transfer phase. Subjects trained under varied input successfully transferred whatever encoding strategies or rules they achieved during first-list learning, regardless of whether they were shifted to varied or constant input during second-list learning. In turn, subjects trained under constant input appear unable to alter their strategies when shifted to varied input, and perform no better than subjects who learn a second list with constant presentation. In brief, recall performance during second-list learning was determined by the input conditions of first-list learning and was unaffected by input conditions of second-list learning.

The second experiment raised the question: What happens if subjects are shifted following varied input to new letter groupings which are derived from trigrams doublets having substantially less "higher order" structure? In effect, having presumably learned an efficient coding strategy under varied input, will they nevertheless continue to transfer this strategy when shifted to variable or constant input where the letter sequences are no longer derived from an easily recalled structure? The absolute level of recall is, of course, expected to decline if the letter sequences are now derived from obviously less well integrated structure such as ITNOPZ, as distinct from ZIPNOT. Structure is not eliminated with this new sequence, but it is otherwise less obvious. Even with this reduced structure, it is conceivable that recall performance in the transfer list will be affected primarily by the specific varied or constant condition experienced, and hence the predominant encoding strategy acquired, during first-list recall. It is not, of course, immediately obvious that subjects would necessarily transfer an efficient encoding strategy, achieved as a result of processing variable input,

when shifted to sequences more difficult to unitize; however, if they do, then this would add further support to the belief that subjects are indeed acquiring a unitizing strategy during varied input.

Method

Design. The subjects were 40 undergraduate student volunteers from the University of New Mexico. The design of Experiment II was identical to Experiment I with one exception. Although the same stimulus materials, consisting of letter sequences derived from highly structured, meaningful trigram doublets (hereafter referred to as *structured* materials) were used, a new set of *scrambled* or less *structured* materials were used in the transfer task. By scrambled material is meant letter sequences which are less meaningful or more difficult to unitize. Subjects in the training phase were randomly assigned to either a constant or varied training condition, as in Experiment I, and learned the same list of eight letter sequences. In the transfer phase, subjects were again transferred to either constant or varied conditions, but with scrambled letter sequences.

Letter sequences. Two types of stimulus items were used, structured and scrambled letter sequences. The structured sequences were the same as those used in Experiment I. The scrambled sequences were constructed by rearranging the structured sequences so as to form sequences which would be more difficult to integrate or unitize. First, the order of the letters in a given structured sequence was reversed. Second, two, three, or four of the letters were then repositioned. For example, the letters of the structured sequence ZIPNOT were initially reversed to form the sequence TONPIZ. The fifth letter (I) was then moved to the first position, and the second letter (O) was moved to the fourth position, forming the new letter sequence, ITNOPZ. Eight variations of each reversed sequence were constructed in the above manner forming a pool of 128 sequences (16 original sequences by eight variations), from which 16 scrambled items were randomly selected, with the restriction that one scrambled sequence was drawn from each set of eight variations of a given original sequence. The items used were ITNOPZ, UTHIBR, OWCNBA, NVAEDM, AYKUMS, IGUWRM, RSIWLA, GRGTJU, PSANPI, UTBRWA, ORAFMJ, EXTLPA, BWEASG, GLDAHO, ETNPCU, and TGNIDE. Each of the sequences was then grouped in a constant or varied fashion as in Experiment I.

Procedure. The study-test procedures in both the training and transfer phases of Experiment II were identical to those of Experiment I. Due to the structured/scrambled nature of the stimuli, a slightly modified counterbalancing procedure was employed: Two separate eight-item structured lists were used during training, with half the subjects learning one list and half the other. Likewise, all 16 scrambled versions of the stimuli were used in the transfer task. However, subjects trained with one eight-item structured list were transferred to the other eight-item scrambled lists, so that the training and transfer lists always consisted of different sequences.

Results

Training. The results of the training phase are presented in the left panel of Figure 2, which is a plot of the number of complete correct recalls for the constant and varied input conditions. Again, as in Experiment I, varied input produced superior recall throughout the entire training sequence, $F(1,38) = 14.32$, $p < .005$, $S_{\bar{X}} = .37$. Terminal recall probabilities for the varied and constant conditions were .94 and .65, respectively. (It

Figure 2. Recall of letter strings as a function of varied-constant input during training (left panel), and shifts to "scrambled" letter sequences in transfer (right panel).

will be noted that these recall results are substantially higher than those obtained in Experiment I, which used summer students, thus documenting the well known "Summer School Effect.") Recall improved for both input conditions as a result of practice, $F(4,152) = 102.13$, $p < .001$, $S_{\bar{X}} = .19$. Moreover, the rate of improvement in recall was faster under the varied input condition, as reflected in the reliable Type of Training by Trials interaction, $F(4,152) = 2.37$, $p < .05$, $S_{\bar{X}} = .27$. The general pattern of these results are, of course, entirely consistent with the training data of Experiment I.

Transfer. Recall performance in the transfer phase of the experiment is presented in the right panel of Figure 2, which is a plot of the mean number of complete correct recalls of the letter sequences for the four training-transfer conditions. The figure indicates that input conditions during training again determined recall during second-list learning, even when the second-list sequences were scrambled. Varied input in training led to superior recall in transfer, $F(1,36) = 9.92$, $p < .01$, $S_{\bar{X}} = .31$. In contrast, varied and constant input in second-list learning had no reliable effect upon recall, $F(1,36) = .58$, $p > .10$, $S_{\bar{X}} = .31$. Similarly, none of the interactions approached significance. All groups improved with practice, $F(4,144) = 75.96$, $p < .001$, $S_{\bar{X}} = .16$.

There is some suggestion from Figure 2 that the varied-constant condition recalled fewer sequences than the varied-varied condition, despite the insignificant overall F for the second-list conditions. A simple comparison, however, of these two conditions revealed no reliable difference, $F(4,72) = 2.00$, $p > .10$, $S_{\bar{X}} = .34$.

EXPERIMENT III

Experiment III was concerned with the characteristics of the recall task itself and with the nature of the transfer task materials. In Experiments I and II, a "box"

recall test was used which required subjects to recall the letters in adjacent boxes for a given sequence; this procedure, in some sense, forced subject to recall the sequences in an integrated form. In this experiment, the box test was not used; instead subjects recalled the letter sequences by writing them on a straight line with no constraints as to their grouping in recall. This procedure thus allowed subjects to write the sequences either with or without grouping, that is, with or without the spatial groupings that appeared in input, subject to the constraint that the letters were to be written in proper order. Moreover, it allowed the calculation of two recall measures, correct recalls of the entire sequences (as in Experiments I and II), and the probability that subject would write his recalled sequence in an entirely grouped or integrated fashion. The rationale of this second measure is based upon the assumption that if the function of varied input is indeed to induce subject to integrate (regroup) the letters into a unitized sequence, then this encoding strategy would reflect itself in subjects trained with varied input recalling the sequences in an integrated form more frequently. The use of a "straight line" recall test allowed a more direct test of the perceptual regrouping hypothesis, namely, that subjects experiencing varied input do tend to integrate the letter sequences more frequently than subjects receiving constant input.

A second purpose of Experiment III was to examine further the generality of the transfer effects using letter strings derived from word phrases in the transfer task. In brief, interest was focused on the persistence of encoding strategies when subjects are required to recall letter strings which can be organized and recalled as word phrases.

Method

Design. The subjects were 40 undergraduate student volunteers from the University of New Mexico. The design of Experiment III was identical to Experiments I and II with the exception that different types of sequences were used in both the training and transfer lists. Subjects were assigned to either a varied (V) or constant (C) training group in order of their appearance at the laboratory. Following training, the subjects in the V and C conditions were assigned to either a V or C transfer condition, resulting again in four transfer groups: C-C, C-V, V-V, and V-C, with the first letter identifying the training condition and the second letter identifying the transfer condition. Subjects in the training phase learned a list of eight letter sequences derived from trigram doublets. In the transfer phase, subjects were transferred to one of the four conditions described, but with letter sequences derived from word phrases.

Letter sequences: training. The training items were letter sequences derived from trigram doublets constructed by combining two CVC trigrams of 50% meaningfulness value (Archer, 1960) into a single doublet, as in Experiments I and II. Even with moderate-*m* and low-*m* levels, varied input was known to facilitate recall (Ellis et al., 1974). The items used were VIDCYR, POZJIS, LAHMOX, FOWQIN, KESHYL, DUHSYX, BEMWOH, and ROHGUK. Each of the sequences were then grouped into a constant or varied fashion as in Experiments I

and II.

Letter sequences: transfer. The transfer items were letter sequences derived from eight word phrases consisting of words of AA value from the Thorndike-Lorge norms. Each phrase contained a four-letter, three-letter, and five-letter word, respectively. The phrases were: THEY ARE WRONG, GIRL WAS YOUNG, HELP END FIGHT, MOVE OUR TABLE, OPEN THE DOOR, HAND OUT BOOKS, TELL HER STORY, and PLAN FOR TODAY. Four rules were used to separate the groupings of letters of a given phrase, these rules specifying the following grouping structures: 2,3,4,2; 3,3,2,4; 2,4,4,2; and 3,2,3,4. For example, the grouping structure 3,3,2,4 applied to the phrase GIRL WAS YOUNG yielded the letter grouping GIRLWA SY OUNG. For the constant input condition, two phrases each were fractionated according to one of these four grouping rules and were presented in that form on all successive presentations. In contrast, the varied input condition was presented with four different fractionated forms on each successive list. The order of the letter sequences derived from particular phrases was changed on each successive list.

Procedure. The study-test procedures in both the training and transfer phases of Experiment III were identical to those of Experiments I and II, except for the use of a "straight line" recall test. Subjects were presented a sheet of paper containing eight straight lines, and were instructed to write the 12 letters from each sequence. When subject could not remember all 12 letters from a phrase, he was instructed to guess, again making the procedure one of forced recall.

Results

Recall in training and transfer. The results of the training phase are presented in the left panel of Figure 3, which is again a plot of the number of complete correct recalls for the constant and varied input conditions. In contrast with the results of Experiments I and II, there was no reliable difference in recall between the constant and varied conditions, $F(1,38) = .40$, $p < .20$, $\bar{S}_x = .28$. Both conditions exhibited improved recall with practice, $F(4,152) = 52.03$, $p < .001$, $\bar{S}_x = .16$, and the Type of Training by Trials interaction was not reliable, $F(4,152) = .68$, $p > .2$, $\bar{S}_x = .22$.

Recall performance in the transfer phase of the experiment is presented in the right panel of Figure 3, which is a plot of the mean number of complete correct recalls of the letter sequences for the four

Figure 3. Recall of letter strings as a function of varied-constant input during training (left panel), and shifts to letter sequences derived from phrases (right panel).

training-transfer conditions. Despite the lack of difference in recall between the varied and constant conditions during training, varied input in training led to superior recall in transfer, $F(1,36) = 6.82$, $p < .025$, $S_{\bar{x}} = .51$. In contrast, varied vs. constant input in second-list learning produced no reliable effect upon recall, $F(1,36) = .35$, $p > .20$, $S_{\bar{x}} = .51$. All groups improved with practice, $F(4,144) = 57.87$, $p < .001$, $S_{\bar{x}} = .18$.

Recall integration. The fact that varied input did not lead to superior recall during training and yet led to superior recall when subjects were transferred to a second list is somewhat surprising and suggests that subjects were effectively transferring an encoding strategy which was not yet directly reflected in sheer recall performance. For this reason, the measure of integrating or grouping the letters in recall acquires particular interest. The results of this measure, the probability of integrating the letters in recall, are plotted in Figure 4. For the letter sequences presented during training, a sequence was scored as "integrated" if the intact trigram doublet was written without any spatial groupings. For the letter sequences during transfer, a sequence was scored as "integrated" if the three words constituting a phrase were, in fact, written as three separate words.

The left panel of Figure 4 shows the results for the training phase and indicates a higher level of integrating the letters for the varied condition, $F(1,38) = 4.12$, $p < .05$, $S_{\bar{x}} = .73$. Performance improved over trials, $F(4,152) = 3.06$, $p < .025$, $S_{\bar{x}} = .19$, and the Type of Training by Trials interaction was reliable, $F(4,152) = 5.01$, $p < .001$, $S_{\bar{x}} = .27$. Thus, despite the fact that no differences in recall per se appeared during the training phase, subjects in the varied condition were clearly showing greater evidence of integrating or grouping the sequences in recall.

The right panel of Figure 4 shows the results for the transfer phase and indicates that varied input in training led to a greater likelihood of integration probability in recall, $F(1,36) = 6.35$, $p < .025$, $S_{\bar{x}} = .81$. Again varied vs. constant input in second-list learning produced no reliable differences in integration probability, $F(1,36) = .08$, $p > .20$, $S_{\bar{x}} = .81$. Overall integration probability increased with practice, $F(4,144) = 4.318$, $p < .005$, $S_{\bar{x}} = .17$, and none of the interactions were reliable.

DISCUSSION

There are four principal findings of the experiments. The first concerns the results of all experiments which reveal that input conditions during training determine subject's performance during transfer. The interpretation of these results is reasonably straightforward and is based upon the general assumption that input conditions

Figure 4. Probability of integration of the letter sequences during training (left panel) and transfer (right panel).

during first-line recall affect the particular strategy that subjects are likely to achieve, and that once established this strategy is most likely to be applied during the learning of a second (new) list. The transfer results of Experiment I support this proposition in that subjects learning under varied input continue to perform equally well when transferred to a new list presented in either a varied or constant fashion. Similarly, subjects trained under constant input continue to perform equally poorly when shifted to either constant or varied input. Thus, in the former case "varied experience" provides a strong basis for positive transfer, while in the latter "constant experience" leads to transfer suppression.

The results of Experiment II also support the principle that encoding strategies established in first-list recall transfer to second-list recall even when the letter sequences of List 2 are structured quite differently from List 1. Even with the reduced (scrambled) structure in List 2, subjects trained with varied input show significantly greater recall when transferred to either varied or constant conditions. Similarly, subjects trained with constant input continue to recall fewer sequences regardless of the input conditions to which they are shifted. A comparable pattern of findings appeared in the transfer phase of Experiment III.

Although the varied-constant shift appears to produce poorer List 2 recall in Experiment II compared to the varied-varied shift, this effect was not reliable. Nevertheless, there may be some shift in strategy by the subjects in the varied-constant condition, in that they may adopt a mixed strategy or somewhat less efficient strategy during second-list recall. Mention of this seems warranted, although extensive speculation seems unreasonable given the nonsignificant difference.

The second finding of interest was the effects of varied-constant input on the probability of integration in recall. Despite the fact that in Experiment III the "variability effect" in the training phase did not occur, subjects in the varied input condition nevertheless showed a reliably stronger tendency to integrate or regroup the letters in recall with the "straight line" test.

Thus, although the varied condition was clearly inducing a strategy proposed by the perceptual regrouping hypothesis (Ellis et al., 1974), the tendency to integrate the letters was apparently yet insufficient to produce any reliable effect on correct recall of the letter sequences *per se*. It would clearly seem reasonable to expect that, after some point during training, subjects who integrated the letter sequences during training more frequently as a result of varied input would also begin to show superior free recall of the letter sequences as well.

The failure of the "variability effect" to occur with a straight line test raises, of course, the issue of the role of the recall test itself. Using letter sequences derived from moderate- (56%) and low- (12%) meaningfulness trigrams, Ellis et al. (1974) still found that varied input facilitated recall with a "box test." In Experiment III using letter sequences derived from moderate- (50%) meaningfulness trigrams, no variability effect appeared in free recall. Without the "box" test subjects may simply be less likely to detect a recallable structure in the letter sequence, or are less likely to detect a structure without extended practice. Other differences between the experiments preclude a resolution based upon a single factor. The overall low level of recall in Experiment III suggests perhaps the sequences are sufficiently difficult to learn to prevent a variability effect from appearing at this stage of practice. In any event, these results suggest that the nature of the recall test itself may be an important variable in affecting the role of variable vs. constant input on recall.

In addition, these results provide additional support for the findings of Ellis et al. (1974) and Hunt et al. (in press) with respect to the facilitating effect on recall of processing variably presented information. Most recently, Parente (1974) has extensively examined the role of constant-varied input with variations in degree of stimulus structure. Only with CCC (consonant-

consonant-consonant) trigram doublets of both low meaningfulness and low pronounceability did he find that constant input produced recall superior to varied input. Thus, using random permutations of consonant sequences, the results were comparable to those of Bower and Winzenz (1969) in the sense that facilitation was greater with consistent input; however, recall did improve over trials even with varied input, whereas Bower and Winzenz did not find improvement in this case.

Finally, it should be noted that the experiments reported here are related to the variability studies of Bevan and his colleagues (e.g., Bevan, Dukes, & Avant, 1966; Bevan & Dukes, 1967; Dukes & Bevan, 1967). Whereas Bevan has been principally interested in the effect of contextual variation on memory, our studies have focused on the effects of variation imposed on the entire sequence or event to be remembered.

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(Received for publication July 1, 1974;
revision received August 19, 1974.)