# Effects of types of input structure upon recall and different clustering scores*

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A categorized word list was presented in a blocked, a random, or a systematically alternating sequence for free recall. Amount recalled and category clustering with the alternating input sequence were equivalent to the results with the random arrangement, and both of these types of sequences were significantly inferior to the blocked input. These results are consistent with predictions based upon the simple proximity of related items and are contrary to expectations based upon the degree of general sequential structure as defined by methods previously used with preceptual stimuli. All of the six clustering measures examined here showed exactly the same pattern of results.

Studies of input organization effects in free recall of categorized lists have usually involved comparisons of a blocked (BLK) order of presentation, in which all instances of a given category follow consecutively, with a random (RND) sequence, which is most often generated with the restriction that no word is ever followed directly by another word from the same category. In the present study, a systematically alternating (ALT) arrangement (e.g., ABCABC . . . .) was compared with the two more widely investigated input sequences.

Input organization is typically specified either by the number of instances where two successive words come from the same category (i.e., category repetitions) or by the average distance between members of the same category in terms of the number of intervening words from other categories. Both proximity measures show the organization of the BLK sequence to be greater than that of the RND and ALT orders. However, the ALT sequence involves an apparent sequential structure, or pattern, which is not reflected by the proximity measures, but which can be captured by the use of a sequential coding scheme similar to that used with perceptual stimili by Payne (1966a, b) and others. As shown in Table 1, this scheme involves abstraction of the largest possible sequential units, which are immediately repeated (i.e., the entities inside the parentheses in Table 1), and specification of the number of immediate repetitions of each unit (designated by the numbers following the parentheses). In terms of the simplicity of the codes, and hence the amount of potentially useful sequential structure, the ALT and BLK sequences are superior to the RND order.

Thus, the basic question was whether performance with the ALT input sequence would be similar to that of the RND order, as expected on the basis of the proximity measures, or whether it would be more similar to that of the BLK sequence, as suggested by the degree of sequential structure.

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## METHOD

A list of 15 numbers, randomly selected from those between 1 and 50, was used for practice. The experimental materials comprised 10 words from each of the categories of *animals*, *occupations*, and *vegetables*. These words were chosen from the lower frequency levels of the Cohen, Bousfield, & Whitmarsh (1957) norms, and were arranged according to the three types of presentation sequences. Their proximity and sequential structure values are shown in Table 1. The figure of 1.94, given as the average distance between members of the same category in the RND sequence, is the mean value over the 15 different RND lists. Alternatively, the sequential code is given for one specific RND sequence, whereas the mean number of units over all RND lists was 14.30. The order of appearance of the categories was counterbalanced across instances of the BLK and ALT sequences, and the order of words within categories was randomized across instances of all types of sequences.

The Ss were tested individually, using an electronically paced, manual presentation of the items on 3 x 5 index cards. The instructions emphasized that Ss could write remembered items in any order. The practice items were presented at a 2.5-sec rate, with a recall period of 2 min. The experimental lists were presented at the same rate, with a single recall period of 3 min duration. The Ss were 45 undergraduate students, who were paid for their services and who were assigned in an alternating fashion to input sequence conditions.

## RESULTS

Mean correct recall scores and results of analyses are shown in Table 2. No significant differences were found in practice list recall by the three groups. The mean experimental list recall was identical for the ALT and RND sequences, and they were both significantly inferior by about 2.5 words to the BLK sequence.

Observed clustering of words from the same category was specified by the number of instances where a word from any category was directly followed in recall by another word from the same category. The values of observed clustering are, to some extent, a function of parameters such as total number of words recalled, number of categories recalled, and distribution of recalled words across categories (e.g., see Dalrymple-Alford, 1970; Roenker, Thompson, & Brown, 1971). The proper interpretation of clustering is usually accomplished, therefore, by use of some derived score which expresses observed clustering relative to chance, maximum possible, etc. There is now a variety of scores available and no compelling basis for determining the

Table 1
Characteristics of the Three Types of Input Sequences

| Input Sequence | | Proximity Measures | | Sequential Structure |
|---|---|---|---|---|
| Type | Example | Number of Repetitions | Mean Distance | Simplest Code |
| BLK | AAA . . BBB . . CCC | 27 | 0.00 | (A)10 (B)10 (C)10 |
| ALT | ABCABC . . . . ABC | 0 | 2.00 | (ABC)10 |
| RND | CACABC . . . . BCB | 0 | 1.94 | (CA)2 (BCA)2 (B)1 (A)1 (B)1 (CA)2 (B)1 (A)1 (CB)2 (A)1 (B)1 (A)1 (CB)2 |

single best score. Consequently, the following scores were used in the present study: (1) Bousfield's (1953) ratio of repetition (RR); (2) the observed-minus-expected (O–E) deviation score of Bousfield & Bousfield (1966); (3) Roenker et al's (1971) adjusted ratio of clustering (ARC); (4) the $D_A$ index described by Dalrymple-Alford (1970); (5) the standardized deviation score of Hudson & Dunn (1969); and (6) the $D_N$ index presented by Dunn (1969). Means and results of analyses are shown for each measure in Table 2. The pattern of results in every case shows (as confirmed by Scheffé tests) no significant differences between the ALT and RND sequences, with both of these resulting in less clustering than the BLK sequence.

## DISCUSSION

The results show that, both in terms of amount recalled and degree of clustering, performance with the ALT arrangement was equivalent to that with the RND list and significantly poorer than with the BLK list. These results thus conform to the predictions based upon the simple proximity of items from the same category. This kind of proximity is an important factor in quite a few explanations of input organization effects. For example, it has been proposed that such proximity determines the amount of effective processing time (D'Agostino, 1969), the probability that related items will be in short-term storage together (Glanzer, 1969), the degree of priming of common mediating responses (Puff, 1966) or the availability of individual word representational responses (Wood & Underwood, 1967), while Wallace (1970) has asserted simply that associations are formed on the basis of input contiguity. All of these views are equally supported by the present results.

On the other hand, these results do not suggest any influence of the more general sequential structure of the input list, as defined by the simplicity of the possible sequential coding schemes, and are therefore less consistent with any view of input organization effects which stresses the utilization of such structure as a basis either for coding the material for storage or for developing an effective retrieval plan (e.g., see Bower, Clark, Lesgold, & Winzenz, 1969). These results also do not provide any evidence for the generalizability of such coding schemes from their original application for the definition of the complexity of perceptual stimuli. It thus appears that the categorical composition of the material is the primary structure. The order of presentation seemingly influences the ease of detecting the categorical structure, and is not by itself very useful as a basis for coding or developing retrieval plans. It seems entirely possible that Ss do not even perceive the sequential arrangement of the words accurately in a single trial except with the BLK list.

Table 2
Means and Results of Analyses of Recall Performance as a Function of Type of Input Sequence

| | Type of Sequence | | | |
|---|---|---|---|---|
| | BLK | RND | ALT | F |
| Recall Scores | | | | |
| Practice | 7.40 | 7.60 | 8.47 | 1.09 |
| Test | 13.87 | 11.33 | 11.33 | 5.80* |
| Clustering | | | | |
| RR | .64 | .40 | .46 | 10.49* |
| O-E Deviation | 4.56 | 1.11 | 1.95 | 13.50* |
| ARC | .60 | .18 | .32 | 8.74* |
| $D_A$ Index | .38 | .12 | .20 | 7.83* |
| Standardized O-E | 2.72 | .75 | 1.30 | 11.31* |
| $D_N$ Index | 2.65 | .85 | 1.38 | 12.11* |

*$p < .01$ with $df = 2/42$

The similarity of results with all of the different clustering measures makes it unlikely that the many previous findings of greater clustering with the BLK list represent statistical artifacts arising from the use of unsophisticated or inappropriate clustering measures. These results offer no help in narrowing the field to a single best measure and illustrate once again that in some circumstances the choice of measures is not very critical at all, though the present situation probably did not provide terribly much exercise for any of the measures.

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# Selective attention and dimensional learning: A logical analysis of two-stage attention theories*

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The argument of the present paper is that attention theories (e.g., Sutherland & Mackintosh, 1972) make logically independent assumptions of selective attention and dimensional learning. The separability of these assumptions is illustrated by a model that assumes dimensional learning but no selective attention. The model successfully predicts the results of discriminative shift studies (e.g., ID vs ED shift comparisons) and supports the conclusion that a selective attention mechanism is not necessary to explain the results of such studies.

Many transfer phenomena in discriminative learning are frequently alledged to support theories of selective attention. Included among these phenomena are dimensional learning (Shepp & Eimas, 1964), the overlearning reversal effect (Lovejoy, 1966), progressive improvement in serial reversal learning (Mackintosh, 1969), and the execution of reversal shifts in the optional shift paradigm (Eimas, 1969). Other related effects have beeen discussed by Lovejoy (1968), Sutherland & Mackintosh (1971), and Fisher & Zeaman (1972).

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The theories in question (Lovejoy, 1968; Fisher & Zeaman, 1972; Sutherland & Mackintosh, 1971; Zeaman & House, 1963) commonly assume that during solution of a discriminative task, attention to a relevant dimension is strengthened while attention to irrelevant dimensions is weakened. Thus, the models assume that Ss learn something about *whole dimensions* of stimuli in addition to learning something about the specific cues that appear in a single task. With only this assumption of dimensional learning, attentional theories have predicted the phenomena mentioned above and have described some of the conditions which either enhance or constrain the appearance of some phenomena (e.g., see Lovejoy, 1966). These successes of attention theory have led many investigators to conclude that a selective attention mechanism is responsible for these transfer phenomena and have led still other investigators to argue that some developmental or comparative differences in discriminative performance are due to differences in selective attention mechanisms (e.g., Tennant & Bitterman, 1972; Wolff, 1967). In the present paper, however, we suggest that while the results of these various transfer experiments do require some explanation in terms of dimensional control and learning, they do not necessarily imply selective attention.

An examination of two-stage attentional theories reveals at least two fundamental, but independent, sets