Recall and clustering as a function of categorization and distance between related items*

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Lists composed of six pairs of categorically related associates (CA) and six pairs of categorically unrelated associates (UA) were presented to Ss for free recall. Presentation order was varied between groups by controlling the number of items (0, 1, 2, 3, or 5) intervening between associates. Recall and clustering were greater for CA words than for UA words, but only with noncontiguous presentation of associates. The locus of the recall effect was in the number of items recalled per pair rather than in the number of pairs represented in recall. The results were considered supportive of the hypothesis that in the absence of blocked presentation, categorically related items are more likely to be experienced contiguously (functional contiguity) than are categorically unrelated items.

In recent years, free recall organization has been the subject of considerable research. One form of such organization is clustering—the recall of related input items in adjacent output positions. Such clustering has been found with both taxonomically structured material (e.g., Bousfield, 1953) and associatively structured material (e.g., Jenkins & Russell, 1952). Two recent investigations (Bousfield & Puff, 1965; Marshall, 1967) have directly compared associative and category clustering. In both investigations, two sets of word pairs were equated in strength of intrapair associative relationships, with one set formed from pairs of taxonomically related words and the other set formed from pairs of taxonomically unrelated words. Both studies found higher clustering for taxonomically related associates, with Marshall's data also indicating higher recall for such items. In both studies, the presentation order was random, i.e., related words were not presented contiguously. It may be that in the absence of such nominal contiguity, categorically related items are more likely to be experienced contiguously (functional contiguity) than are associatively related items. Wallace (1970) has discussed a mechanism by which such functional contiguity might be accomplished. The purpose of this experiment was to compare the clustering and recall of the two types of items as a function of degree of contiguity.

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DESIGN

The design combined factorially five degrees of contiguity (number of items separating related items in the presentation sequence) with two types of interword relationships (taxonomic or associative). Item separation was manipulated as a between-groups variable and type of interword relationship as a mixed-list variable. In addition, to increase the generality of findings, three separate word lists were employed, with each S learning just one list.

MATERIALS

Three 24-word lists comprising 12 pairs of primary associates were selected from the Shapiro & Palermo norms (1968). As judged by the E, six pairs in each list were composed of taxonomically related words and six pairs were not; categorized (CA) and uncategorized (UA) pairs were matched closely in direct associative strength. Five sets of presentation orders were prepared for each list. The five sets differed in the number of items, zero, one, two, three, or five, intervening between associates. For example, in the Lag 0 orders, the sequence followed the pattern A-A'-B-B'-C-C', whereas in the Lag 2 orders, the sequence followed the pattern A-B-C-A'-B'-C'. Other order types followed similar patterns. Within each of the five set of item separations, three randomizations were prepared in which the member of the pair appearing first, its serial position, and its type (UA or CA) were permitted to vary.

APPARATUS

The Ss were tested individually in sound-isolated cubicles. The lists were presented via a standard Lafayette memory drum, and the Ss recorded their responses on blank recall sheets provided by the E.

SUBJECTS

A total of 180 undergraduate psychology students of both sexes served as Ss in partial fulfillment of course requirements at Fresno State College. Each S served in only one condition of the experiment. Assignment to groups was random, with the restriction that equal numbers serve in the five (Item Separations by Lists) groups.

PROCEDURE

The three randomizations were presented in immediate succession, with Ss pronouncing the words aloud as they appeared. A 2-sec presentation rate was employed with 4 sec between randomizations. Immediately following the third presentation, S was instructed to count backward aloud from 1,000 by threes and after 30 sec was instructed to write as many of the words as could be recalled in any order he found convenient. The recall test was terminated after 2 min.

RESULTS

A preliminary single-factor analysis of variance of the recall scores with lists as the independent variable revealed no significant differences, $F < 1$; hence, lists were ignored in subsequent analyses. Three recall measures were calculated: number of recalled words (R) of a given type, number of pairs represented by at least one member (P), and mean number of items recalled from represented pairs (IPP = R/P). Mean values of these three measures calculated separately both for UA and for CA pairs and for the five item-separation conditions are presented in Table 1. Standard deviations for these measures are presented in parentheses.

Word Recall

Overall, mean CA recall was 8.2 words and mean UA recall was 7.8 words. A two-factor analysis of variance treating categorization condition as a repeated measure indicated that this difference was reliable, $F(1,175) = 4.98$, $p < .05$. The main effect of item separation was only marginally significant, $F(4,175) = 2.06$, $.10 > p > .05$. In view of the significant Categorization Condition by Item Separation interaction, $F(4,175) = 4.90$, $p < .01$, simple tests of main effects were undertaken. These tests showed no significant effect of item separation on recall of CA words, $F < 1$, but there was a significant effect on recall of UA words, $F(4,175) = 5.92$, $p < .01$. Newman-Keuls comparisons indicated the source of this effect to be significantly better (at the .01 level) UA recall at Lag 0 than at any other level of item separation. Thus item separation did not influence recall of CA words but did influence recall of

Table 1
Means and Standard Deviations of UA and CA Recall Measures at Each Level of Item Separation

Item Separations	Recall Measures					
	R		P		IPP	
	UA	CA	UA	CA	UA	CA
0	9.19 (2.76)	8.14 (2.14)	4.67 (0.83)	4.15 (1.08)	1.97 (0.14)	1.96 (0.09)
1	7.36 (2.68)	8.28 (2.06)	4.41 (1.28)	4.55 (0.97)	1.67 (0.43)	1.82 (0.27)
2	7.94 (1.90)	8.22 (2.27)	4.67 (0.95)	4.69 (1.03)	1.70 (0.39)	1.75 (0.42)
3	6.83 (2.38)	8.28 (2.42)	4.38 (1.17)	4.72 (1.08)	1.56 (0.33)	1.75 (0.38)
5	7.50 (3.06)	8.03 (2.56)	4.60 (0.84)	4.54 (1.08)	1.63 (0.25)	1.77 (0.24)

UA words with Lag 0 (blocked presentation) leading to higher recall than did the other lag conditions. Simple tests of the main effect of categorization condition at each level of item separation revealed significantly better UA recall than CA recall at Lag 0, $F(1,175) = 6.22$, $p < .05$, and significantly better CA recall than UA recall at Lag 1, $F(1,175) = 4.69$, $p < .05$, and at Lag 3, $F(1,175) = 11.66$, $p < .01$. UA and CA recall did not differ significantly at Lag 2, $F < 1$, or at Lag 5, $F(1,175) = 1.56$, $p > .10$. Although the data are somewhat uneven, the implication is that UA recall is superior with contiguous (blocked) presentation of associates and CA recall is superior with noncontiguous presentation of associates.

Pair Recall

In the analysis of number of pairs represented in recall, neither the main effect of categorization condition, $F < 1$, nor of item separation, $F(4,175) = 1.07$, $p > .10$, was significant. Since the interaction between categorization condition and item separation was significant, $F(4,175) = 2.51$, $p < .05$, simple tests of main effects were again undertaken. Item separation did not significantly influence either UA pair recall, $F(4,175) = 1.36$, $p > .10$, or CA pair recall, $F(4,175) = 2.26$, $p > .10$; however, analysis of the effect of categorization condition revealed better UA pair recall than CA pair recall at Lag 0, $F(1,175) = 5.67$, $p < .05$. Comparisons at other item separations did not reach conventional levels of significance. Thus the only effect on pair recall was higher representation of UA pairs than of CA pairs with contiguous presentation of related items.

Items Recalled Per Pair

Mean IPP was 1.7 words for UA pairs and 1.8 words for CA pairs. Analysis indicated highly significant main effects both for item separation, $F(4,175) = 10.68$, $p < .01$, and for categorization condition, $F(1,175) = 34.88$, $p < .01$. The Categorization Condition by Item Separation interaction was also significant, $F(4,175) = 2.78$, $p < .05$, indicating a greater loss in IPP for UA words than for CA words with noncontiguous presentation of associates. Newman-Keuls comparisons revealed significant differences ($p < .05$) between IPP recall at Lag 0 and at Lags 2, 3, and 5, with the comparison between Lag 0 and Lag 1 barely missing significance. No other comparisons approached significance. The pair recall and IPP analyses taken together support the generalization that the superiority of UA to CA word recall at Lag 0 resulted from differential pair representation at that lag and that the greater CA than UA word recall at other item separations resulted from differential IPP recall at those lags.

Clustering

The clustering index used was the ratio of the number of words recalled in clusters to the total number of words recalled.[1] Means and standard deviations of the index for CA and UA pairs at each level of item separation are presented in Table 2. The overall mean index values for UA and CA pairs were .61 and .73, respectively. A two-factor analysis of variance performed on the arcsine transformations of the index showed this difference to be statistically reliable, $F(1,175) = 29.46$, $p < .01$. Examination of Table 2 makes it clear that this difference derived entirely from greater CA than UA clustering with noncontiguous presentation; with blocked presentation, UA and CA clustering were essentially equal. The main effect of item separation was also significant, $F(4,175) = 14.81$, $p < .01$, but the interaction of Categorization Condition by Item Separation was only marginally significant, $F(4,175) = 1.99$, $.10 > p > .05$. Subsequent Newman-Keuls comparisons revealed significantly greater clustering at Lag 0 than at Lag 1 and at Lag 1 than at Lags 2, 3, or 5; the latter did not differ significantly.

DISCUSSION

The present results clearly support the hypothesis that the disparity between associative and category clustering is dependent upon contiguity relations in the presentation order. Despite the marginality of the interaction between item separation and pair type, clustering of UA and CA pairs was equivalent with contiguous presentation but the overall difference between UA and CA clustering was significant, indicating that the superiority of category clustering is dependent upon noncontiguous presentation. It may be that superordinates are elicited as implicit associational responses (IARs) more frequently than are other IARs. If this were the case, establishment of a mediated link between noncontiguously presented members of a common taxonomic category (functional contiguity) would be more probable than establishment of a link between taxonomically unrelated associates.

Despite the overall consistency of these results with the preliminary hypothesis, several aspects of the data require special comment. The absence of an item separation effect for CA pairs is inconsistent with other reports (e.g., Cofer, Bruce, & Reicher, 1966). It is clear from the IPP analysis, however, that the effect of item separation is primarily upon the number of words recalled per category rather than on the number of categories recalled. Had larger categories been used, as in other investigations, the usual blocked-random effect would probably have emerged.

Although contiguous and noncontiguous presentation produced a difference in UA word recall, there was no differential effect for Lags 1, 2, 3, and 5. This contrasts with the monotonic function reported by Glanzer (1969) in a similar study. One

Table 2
Means and Standard Deviations of the Clustering Index for UA and CA Pairs at Each Level of Item Separation

Pair Type	Item Separations				
	0	1	2	3	5
UA	.93 (.18)	.61 (.33)	.51 (.34)	.52 (.34)	.49 (.29)
CA	.95 (.13)	.72 (.30)	.61 (.33)	.67 (.32)	.68 (.28)

of the differences between the two studies was in terms of the strength of intrapair associations. In the present study, only primary associates were employed (mean associative probability = .35), whereas in Glanzer's investigation, low-frequency associates (mean associative probability was less than .03) were employed. If this difference is responsible for the discrepancy in results, the implication is that item separation and the strength of intrapair association have an interactive effect on recall.

Perhaps the aspect of the present results requiring the most intricate explanation is the higher UA than CA pair recall at Lag 0. Assume that the first item of a two-item cluster is recalled by means of a contextual association, direct for UA pairs but mediated by the superordinate for CA pairs. Differential pair recall with blocked presentation may simply reflect the greater reliability of the direct contextual association than of the mediated contextual association. Presumably, with noncontiguous presentation, the greater likelihood of contiguous experience of CA words than of UA words offsets this advantage.

In summary, it would appear that greater clustering and recall of categorically related words occur only with noncontiguous presentation of related items. This is consistent with the hypothesis that category and associative clustering involve different types of associative relationships. Some have argued that distinguishing between category clustering and associative clustering is unprofitable (Cofer, 1965; Tulving, 1968; Wallace, 1970). However, the persistence of the empirical basis for the distinction makes its abandonment seem premature.

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NOTE

1. This ratio was selected in preference to one based on the number of clustering opportunities for the particular words recalled (e.g., Bower, Lesgold, & Tieman, 1969) because it was felt that the organization of the material in memory determines which words will be recalled as well as their output order.

Here we go again with another try at Notes & News. There will probably be more this month than at any other time, but we would like to have this a lively column and would appreciate your contributions to it.

Several people are on sabbatical or on leaves of absence this year. M. E. Bitterman is at the *University of Hawaii*, and William A. Calhoun is a NSF Science Faculty Fellow at *Indiana University*. Irving Biederman is at *Stanford University* and Gardner Lindzey, John C. Loehlin, and Frederick C. Newman are "thinking" at the *Center for Advanced Studies*.

Harold Babb has moved from the University of Montana to become Professor and Chairman of the Department of Psychology at the *State University of New York at Binghamton*.

Robert A. Baron and Dale W. Leonard are now at *Purdue University*, Baron moving from the University of South Carolina and Leonard from the University of Rochester.

Richard S. Bogartz has recently moved from the University of Illinois Urbana-Champaign campus to the *University of Massachusetts* where he is Professor of Psychology and Area Head of the Child Psychology Program.

Robert M. Boynton former Director, Center for Visual Studies at the *University of Rochester* has become Chairman of its Psychology Department.

Thomas S. Brown has moved from Michael Reese Hospital to *DePaul University*.

George C. Crampton is Professor in the Department of Psychology at *Wright State University*, moving from his position as Chief, Psychology Branch, Medical Research Laboratory, Edgewood Arsenal.

Also at *Wright State University* is A. C. McKinney, where he is Dean of Graduate Studies.

John S. Fletcher, after 20 years in the Army, is now holding a joint appointment in psychology and speech at *Memphis State University*.

Laird W. Heal has accepted the pasrtion of director for a project to evaluate the effectiveness of integrated management procedures for the treatment of cerebral palsied at *Northern Wisconsin Colony* and The University of Wisconsin at Eau Claire. He also holds the rank of associate professor in the Psychology Department.

Ronald R. Hutchinson is Director of Research at *Fort Custer State Home* but has kept his affiliation with *Western Michigan UNiversity*.

Arnold Hyman has recently become Assistant Professor at *Yale University*.

Harry Kaufman is Professor of Psychology at *Hunter College of the City University of New York*.

J. D. Keehn, for some years associated with the Addiction Research Foundation part time, has moved over to *York University's Atkinson College* full time.

Roy Lachman and Janet Mistler-Lachman were appointed Professor and Assistant Professor, respectively, at the *University of Kansas*. Roy formerly was Professor of Psychology at SUNY, Buffalo, where Janet Mistler received her PhD in 1971.

Joe Lewis has been appointed Assistant Professor at the *University of Texas in Arlington* replacing Frank Cheavens who has become Professor Emeritus.

Jared Jay Look has become Assistant Professor of Psychology at the *University of Connecticut in Waterbury*.

William A. Mason has moved from the Delta Regional Primate Laboratory to the Psychology Department and the National Center for Primate Biology at the *University of California, Davis*.

Michael M. Patterson has accepted the position of Assistant Professor of Physiology at the *Kirksville College of Osteopathic Medicine* in Missouri.

John R. Platt has moved from the University of Iowa to *McMaster University*, where he is Associate Professor of Psychology.

Oakley S. Ray has moved from Pittsburgh, Pennsylvania, to Nashville, Tennessee, where he is now Professor, Department of Psychology, Associate Professor, Department of Pharmacology, *George Peabody College*, and Chief, Psychology Service, *Veterans Administration Hospital*. He is training director of an interdepartmental graduate training program in neurobiology which emphasizes the field of psychopharmacology and animal developmental psychology.

Charles E. Rice has moved from the Stanford Research Institute to *Kenyon College* in Gambier, Ohio, where he is Chairman and Professor in the Department of Psychology.

T. T. Sandel is Chairman, Department of Psychology, *Washington University*.

Robert W. Schaeffer has gone from Florida State University to *Auburn University*, where he is Professor and Head of the Psychology Department.

Richard A. Schmidt Managing Editor of the *Journal of Motor Behavior*, has moved the editorial office to the Department of Physical Education, *University of Michigan*, where he is Associate Professor and Director of the new Motor Behavior Laboratory.

Kirk H. Smith has left Bell Laboratories in Murray Hill to become Associate Professor of Psychology at *Bowling Green State University*.

Ronald S. Tikofsky has moved from the University of Michigan to *Florida International University* where he will be Chairman of the Department of Psychology and Director of the Division of Social Sciences when that institution opens its doors in the fall of 1972. He is currently building a Psychology Department there.

Viejo Virsu, after several years in the United States and a year in England, is now back at the Psychological Laboratories at the *University of Helsinki*.

Morton M. Weir became Vice Chancellor for Academic Affairs at the Urbana-Champaign campus of the *University of Illinois* on November 1.