Clustering of related but nonassociated items in free recall[1]

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Reliable category clustering was observed in the free recall of words which rhymed but which did not elicit one another as free associates. Intrusions were phonemically similar to list items.

In 1953, Bousfield demonstrated that words belonging to the same taxonomic category tend to be grouped in free recall. Bousfield attributed such "category clustering" to the action of a central mediating mechanism, a superordinate evoked in common by the words in a set. Other investigators (e.g., Jenkins & Russell, 1952) have shown that words which elicit one another as free associates also cluster in recall. Both Postman (1964) and Deese & Hulse (1967), among others, have pointed out that since words from the same taxonomic category tend to occur as free associates, it is possible that category clustering does not require a mediating construct for its explanation and is simply a special instance of associative clustering.

Whether category clustering exists as a phenomenon separate from associative clustering may be reduced to the empirical question of whether, in free recall, Ss cluster words which are, in some sense, related but which do not elicit one another as free associates. EAGLE and HAWK, for example, are "related" in that both are instances of a common taxonomic category. Since EAGLE, however, elicits HAWK as a free associate (Palermo & Jenkins, 1964), the clustering of these items in free recall does not necessarily mean that the grouping occurred because both terms evoke the superordinate BIRD. One approach to developing such materials is to employ phonemically related items. The words EAGLE and LEGAL, for example, are similar in phonemic structure, i.e., they rhyme, but LEGAL does not appear as a free associate to EAGLE (Palermo & Jenkins, 1964). The purpose of the present study, then, was to test the hypothesis that words which rhyme but which do not elicit one another as free associates will occur together in free recall.

MATERIALS

Sets of words rhyming with TACK, FURL, DEAD, and THROUGH, respectively, were presented on printed sheets to students attending introductory psychology classes. Each S was given four words, one from each phonemic category, and was asked to write down the first three words which each stimulus reminded him of. On each particular set of four items, 20 Ss supplied three associates per stimulus for a total of 60 associates per word. From this data, the words TACK, FLAK, SNACK, PACK, FURL, PEARL, SQUIRREL, SWIRL, DEAD, LED, WED, HEAD, THROUGH, NEW, RUE, and TWO were selected for inclusion in the free-recall task. Table 1 lists all of the associates which occurred with a frequency of 3 out of 60 or greater to each stimulus item. Two important features of the material in Table 1 should be noted: no stimulus item elicits any other stimulus item as a direct associate and no associate to a particular list word appears as an associate to any other list word.

PROCEDURE

The task consisted of orally presented sequences of words requiring written recall. Six randomizations of the 16 items were prepared with the constraint for each trial that one word from each of the four phonemic categories was represented once in each sequence of four items and no phonemically similar items were adjacent. Sixteen introductory psychology students (eight males and eight females) who had not participated in the gathering of the free-association norms were tested individually in a soundproof room. The equipment consisted of a Panasonic, Model RQ-156S tape recorder. From a prepared tape, S heard the word "Ready" followed 2 sec later by the first word in the message. The words were presented at the rate of one per second. The word "Recall" followed the last list item by 2 sec. Following the "Recall" signal, S was allowed 30 sec for recall followed by 10 sec until the next "Ready" signal. All Ss were given the same sequence of six trials. Prior to test, S was told that the same words would appear from trial to trial but that the order of the words would change, and that his task was to write as many words as he could recall in any order he wished.

RESULTS AND DISCUSSION

Three aspects of the data were examined: amount of item recall, the extent of category clustering, and the character of the intrusion errors. Item recall was a measure of amount of material retained with no value being attached to recall order. One point was allotted for each word correctly retrieved. The group's mean item recall scores for each trial are listed in Table 2. The increase in recall over trials proved to be highly reliable ($F = 25.53, df = 5/75, p < .001$).

Amount of clustering was indexed by the Bousfield & Bousfield (1966) "Stimulus category repetition" (SCR) scoring system. According to this scheme, S received, on each trial, a score representing his observed number of stimulus category repetitions, O(SCR), and a value for the amount of stimulus category repetitions expected by chance, E(SCR). If, for example, S's recall were TACK, PACK, WED, FURL, PEARL, NEW, LED, his O(SCR) score would be 2.00 for the adjacent SCRs TACK-PACK and FURL-PEARL and his E(SCR) value would be .70 (Bousfield & Bousfield, Formula II, p. 937). Intrusion and repetition errors were

Table 1
Most Common Associates to the List Items

TACK	**FLAK**	**SNACK**	**PACK**
board	planes	bar	sack
nail	war	eat	suitcase
point		food	trip
seat	**PEARL**		wolf
thumb	diamond	**SQUIRREL**	
tie	gem	acorn	**SWIRL**
	jewel	animal	around
FURL	necklace	brown	water
curl	oyster	furry	whirl
flag	ring	nut	whirlpool
fold	round	tail	wind
hurl	sea	tree	
throw	white		**HEAD**
		WED	body
DEAD	**LED**	bed	feet
alive	follow	girl	hair
funeral	lead	marriage	mouth
grave	leader	marry	neck
	pencil	together	nose
THROUGH			
by	**NEW**	**RUE**	**TWO**
door	brand	french	four
finished	car	regret	five
hole	old	sorry	love
in	young	street	number
into			three
tunnel			

not included in the analysis of SCR. Subtracting S's E(SCR) from his O(SCR) score yields a measure of SCR corrected for random responding. Thus, for each S there were six corrected SCR scores, one for each trial. From these measures, the group's mean O(SCR) – E(SCR) score was derived for each trial. These mean group scores are listed in Table 2 along with the t values resulting from comparisons of the group's mean O(SCR) vs mean E(SCR) scores for each trial. The t scores in Table 2 indicate that the general increase in amount of O(SCR) – E(SCR) over trials ($F = 4.01$, $df = 5/75$, $p < .005$) was due to greater-than-chance clustering on Trials 4, 5, and 6.

Given reliable category clustering, the nature of the intrusion errors assumes additional importance. As Deese & Hulse (1967, p. 272) point out, if items arouse a common superordinate which, in turn, mediates clustered recall, then imported items should also be category members. The present results support such a prediction. Of the 73 intrusion errors committed, 56 items, or 77% of the total, were words which rhymed with the list items (e.g., BLACK, TWIRL, FED, FLEW). Nine of these 56 rhymed intrusions were also associates to the list items (e.g., CURL, WHIRL). The remaining 17 intrusions, while not rhymes, were phonemically similar to list words (e.g., PECK for PACK, FURROW for FURL) and none of these 17 appear as free associates to the stimulus items listed in Table 1.

In short, the present findings that words which rhyme but which do not elicit one another as free associates occurred together in free recall, and that intrusions shared category membership but not, by and large, associative relationships with list items support the contention that at least one instance of category clustering does exist as a phenomenon separate from associative clustering.

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NOTE

1. The assistance of Mrs. Cheri Schwartz in preparing materials, testing Ss, and aiding in the scoring of the data is gratefully acknowledged.

Table 2
Mean Item Recall and O(SCR)–E(SCR) Scores for Each Trial

Score	Measure	Trials 1	2	3	4	5	6
Item Recall	M	5.50	7.62	8.94	9.00	9.44	10.00
	SD	1.15	1.26	1.06	1.97	1.63	1.71
O(SCR)-E(SCR)	M	.22	.19	.33	1.01	.91	1.58
	SD	.71	.93	.97	1.57	1.50	2.12
	t	1.22	.83	1.38	2.59*	2.39*	2.98**

**$p < .01$
*$p < .025$

The effect of information feedback and reference tones on d′ and L_x: A further analysis of Nash and Adamson's data

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A signal detection theory analysis of the data reported by Nash and Adamson leads to somewhat different conclusions. For example, sensory sensitivity (d′) is not altered by feedback in the no-anchor condition. The analysis also reveals that Ss chose a conservative response criterion (large value of L_x) when confronted with a combination of no feedback and no anchor stimuli.

A recent study by Nash and Adamson (1968) is of considerable interest since it appears to be the first in which the effect of both knowledge of results and of anchor (reference) stimuli on detection thresholds have been studied simultaneously. Ss were required to distinguish tone plus white noise from white noise alone. Separate analyses of the resulting hit and false affirmative rates led the authors to conclude that feedback improved performance under all anchor conditions (none, weak, and strong). They also found better discriminability with the strong-anchor ("suprathreshold") accessory stimulus than with the no-anchor (control) and weak-anchor ("subthreshold") stimuli. The weak anchor, in fact, was held to be without effect on sensory performance. The purpose of the present paper is to demonstrate that these conclusions may be extended and must be modified when the data are treated by signal detection theory.

The data of Nash and Adamson are valuable because they report both hit and false affirmative rates. This procedure makes it possible to determine when the experimental conditions influenced S's sensory sensitivity (d′), and when they influenced his response criterion (L_x). Signal detection theory (Green & Swets, 1966) treats S as a statistical decision maker who chooses a value of the likelihood-ratio criterion (L_x) to distinguish sensation from noise. The criterion reflects the psychological components of the traditional threshold, including the values and costs of right and wrong responses. Collection of these nonsensory factors in the form of the criterion measure makes it possible to isolate a relatively pure measure of sensory sensitivity, d′, which indexes Ss' accuracy, that is, ability to distinguish noise from signal-plus-noise. This method of analysis is