Paired-associate learning with homograph stimuli*

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Acquisition of a paired-associate list was compared for lists having adjective responses and either homograph or nonhomograph stimuli. The two sets of stimuli were equated for mean length, frequency, and image value. Acquisition of the list with homograph stimuli was significantly slower, a result consistent with Martin's encoding variability hypothesis.

Martin (1968, 1971, 1972) contends that the number of ways in which a stimulus can be encoded is a powerful determinant of paired-associate learning and transfer. He proposed that learning a paired-associate item involves making some encoding response to a stimulus, which results in a functional stimulus to which the overt response is learned. If, on any trial, the previous encoding response is not made, the S essentially fails to recognize the stimulus and cannot utilize previously accumulated associative strength (Martin, 1967).

Martin argues that the probability of encoding a stimulus differently is a function of the number of distinctly different encodings, so that rate of learning should decrease as encoding variability increases. One must distinguish between recodings on a qualitative basis. Under Martin's theory, each new response paired with a stimulus has associated with it an essentially unlimited number of possible encodings. These can be of two basic types: the functional stimulus can change subtly, in the sense of a variation on a theme, or substantially, as when there is a complete change of theme. For example, consider the stimulus BZR; B could continually be taken as functional stimulus, but encoded slightly differently each time. (Martin suggests that the response paired with BZR may determine the particular coloration B assumes.) Alternatively, the S could switch to Z, R, ZR, etc. The latter encodings are distinctly different, and it is this type of encoding variability which should retard learning.

To test his hypothesis, Martin (1968; Martin & Carey, 1971) used trigram-digit pairs in the A-B, A-Br negative transfer paradigm. Learning of the initial list was faster with high-meaningfulness (M) stimuli than with low-M stimuli, a result attributed to the greater encoding variability of low-M stimuli. Negative transfer, relative to an A-B, C-B control paradigm, was less for the low-M trigrams than for the high-M trigrams. Martin's interpretation holds that the greater number of distinct encoding possibilities for low-M trigrams permitted easier recoding in transfer, and that recoding functionally transformed the A-Br paradigm to the A-B, C-B paradigm. The fewer encoding possibilities for high-M trigrams inhibited recoding and increased the amount of negative transfer.

The experimental work generated by Martin's analysis (not all favorable; see Williams & Underwood, 1970) has thus far been characterized by the use of nonsense syllable stimuli or compound stimuli (Merryman & Merryman, 1971). Of course, the use of such stimuli is partially dictated by the theoretical analysis. Martin claims that encoding variability decreases as M increases; if a high-M trigram permits few distinctive encodings, words should allow even fewer opportunities. However, there is one important class of words which might be supposed to have high encoding variability: homographs (e.g., file, seal). The present study compared acquisition using homograph and non-homograph stimuli. We reasoned that the homograph stimuli would permit more possible encodings, and so predicted slower learning of the list for the homograph group.

METHOD

Subjects

Eighty-two Rutgers University undergraduate volunteers were tested separately. Two were eliminated from the study, one for failure to learn, one for equipment failure. The remaining 80 Ss, 76 male and 4 female, were assigned randomly to the two groups. Twenty-six of the volunteers received one credit toward fulfilling a course requirement; the remainder were paid.

Materials

Twelve ambiguous nouns (Set Aa) with approximately equiprobable interpretations were taken from Kausler & Kollasch (1970). Twelve unambiguous nouns (Set A) were matched in frequency (range, 1 to 1,772) with the homograph stimuli using the Kučera & Francis (1967) norms. Each set had a mean length of 4.2 letters per word. A separate group of Ss rated the Aa and A sets on image value, following the procedure of Paivio, Yuille, & Madigan (1968); mean ratings were 5.49 for Set A and 5.22 for Set Aa. Twelve two-syllable adjectives (frequency range, 3 to 97) were paired randomly (excepting obvious stimulus-response relationships) with the two sets of nouns.

Procedure

The lists were presented by slide projector at a 3-sec rate in a study-test presentation procedure. The study-test interval was 3 sec, and the test-study interval was 6 sec. There were three randomizations used on both study and test trials. Learning was carried to a criterion of one errorless trial.

RESULTS AND DISCUSSION

The mean number of errors per S is presented in Table 1, along with standard deviations. There was greater variability in acquisition scores for the homograph stimuli, which is consistent with the expectation of greater encoding variability, $F(39,39) = 1.78$, $p < .05$. There were reliably more errors committed on homograph stimuli, $t(39) = 2.59$, $p < .05$, even though the difference in variability

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Table 1
Performance as a Function of Stimulus Condition

	Total Errors		Trials to Criterion		Trial 1 Errors	
	Mean	SD	Mean	SD	Mean	SD
Homograph	30.05	18.56	7.15	3.17	9.73	1.84
Nonhomograph	21.02	13.92	5.95	2.43	8.15	2.68

necessitated halving the degrees of freedom. Table 1 also contains mean number of trials to criterion along with standard deviations. Again, there is greater (but not reliably) variability for homograph groups. The homograph stimuli required more trials to master, $t(78) = 1.89$, $.05 < p < .10$.

We have reported two analyses of the effects of homograph stimuli on first-list learning, and the significance level of both is uncomfortably close to .05. Since learning occurred rapidly, the effect of homography was probably diluted. If so, the first trial of learning should give a clearer picture of any inhibitory effects. Table 1 includes the mean number of errors per S on Trial 1 of the initial list. The nonhomograph groups had a lower mean error rate but more variability ($s^2 = 7.21$) than the nonhomograph groups ($s^2 = 3.38$). These variances were significantly different, $F(39,39) = 2.13$, $p < .05$. The reader might sense an inconsistency in the smaller variability for the homograph group, since we have predicted greater variability for this group in the earlier analyses. However, there is a ceiling effect at work for the homograph group on Trial 1, since Ss cannot achieve a score greater than 12. The distribution of error scores (see Table 2) is more skewed for the homograph group. The difference in number of errors was significant, $t(39) = 3.06$, $p < .005$, even with the reduction in degrees of freedom. On the basis of this analysis, which should be more sensitive than the earlier ones, we conclude that homograph stimuli significantly retarded acquisition.

Table 2
Frequency Distribution of Errors on the First Trial

Stimulus Condition	10-12	7-9	4-6	1-3
Homograph	26	12	2	0
Nonhomograph	14	18	5	3

To assess the generality of the effect across homographs, the total number of errors made on each homograph stimulus was compared with the total made on the matched (by frequency) nonhomograph stimulus. For 10 of the 12 comparisons, more errors were made on the homograph pair. Hence, the homography effect was not due to a small number of stimuli, but was rather general. Of course, one could argue that some aspect of the homograph stimuli other than their multiple meanings was responsible for the observed differences. However, the stimuli were equated for frequency, length, and image value; these controls certainly decrease the likelihood that the results are an artifact of some variable other than homography.

The increased duration and variability of the learning process for lists with homograph stimuli supports Martin's position and demonstrates that the notions of encoding variability are not applicable only to nonsense syllable and compound stimulus materials.

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