Effects of familiarization, associative reaction time, and meaningfulness of response terms in forward and backward paired-associate learning

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The purpose of the present study was to determine the effect of familiarization of response terms on the forward and backward acquisition rate of a list of PAs, in which the response terms were rated on associative reaction time (RT) and meaningfulness (associative frequency–Mn). Thirty-two undergraduate Ss individually received 20 familiarization trials in which, for 16 of the Ss, the eight CVCVC units of the list were the response terms of a PA list which was subsequently learned. For the other 16 Ss, conditions were the same, except that the CVCVCs of the familiarization list were different from the units of the PA list. Both RT and Mn were significant response-term variables in the forward anticipation learning task, but Mn interacted with familiarization, while RT did not, i.e., familiarization increased the learning rate of low-Mn pairs but not of high-Mn pairs. In the backward learning task, high-Mn pairs were learned in fewer trials than low-Mn pairs, but neither RT nor familiarization had an effect.

The findings of recent studies of the effect of associative reaction time (RT) of response terms in paired-associate learning (PAL) have consistently demonstrated that within levels of equated meaningfulness (M), short-latency RT response terms are learned in fewer trials than long-latency RT terms (Ley, 1968; Ley & Anderson, 1969; Ley & Locascio, 1970). With respect to stimulus terms, however, the results of Ley & Locascio (1969) indicate that within levels of M, RT of stimulus terms has no effect on the forward anticipation learning of PAs, whereas M has been shown to be a significant stimulus-term variable as well as a significant response-term variable. In view of the high correlation ($r = -.80$) between Mn (associative frequency) and RT (Ley & Locascio, 1970), the singular finding is that within the same list of PAs, short-latency CVCVCs, as *response* terms, were learned in fewer trials than long-latency terms of equated M; but as *stimulus* terms, these same CVCVCs had no effect on acquisition rate. The reliability of this finding was supported by a replication of the experiment (Ley & Locascio, 1969), the results of which were completely consistent and almost identical to the first experiment, i.e., within levels of M, RT of stimulus terms had no effect on PAL, but M of stimulus terms did. However, a backward recall test following forward anticipation learning in the replication experiment resulted in a significantly greater recall of the short-latency stimulus terms (response terms in the recall test) than of the long-latency terms. Similarly, high-M stimulus terms were recalled more frequently than low-M terms.

The results of the studies cited are consistent with the general finding that M is a significant stimulus- and response-term variable. Within levels of M, however, it would appear that the effect of RT is limited specifically to response terms in forward anticipation learning and stimulus terms in backward recall, or, more generally perhaps, to that term of the PA which is required to be recalled. If the general case obtains, i.e., if within levels of M, the effect of RT is limited to the term to be recalled, it would be expected that the effect of RT of response terms, following forward anticipation learning, would have no effect on backward recall, whereas M would. The primary purpose of the present study was to test this hypothesis.

The secondary purpose of the present study was derived from two somewhat closely related interpretations of the role of M in PAL. Underwood & Schulz (1960) account for the facilitative effect of M through its high correlation with pronunciability, whereas Goss (1963) accounts for the facilitative effect of M through its high correlation with recognition latency. These hypotheses suggest that the more readily a given verbal unit can be pronounced or the faster a unit can be recognized, the sooner the unit can serve as a stimulus term and thus facilitate PAL. If M bears the same relationship to response terms as it does to stimulus terms, as Goss (1963) has suggested, and if, within levels of M, the role of RT is different from that of M, then variables which might conceivably affect pronunciability and/or recognition latency should have a greater effect on PA terms rated on M than on those rated on RT. Although research on the effects of familiarization has not provided clear and consistent results (Goss & Nodine, 1965), some evidence that familiarization interacts with M of response terms has been offered by Schulz & Martin (1964). If familiarization facilitates pronunciation, its effect should be greater on low-M terms than high-M terms, since high-M terms are closer to the maximal ease of pronunciability. Similarly, if familiarization decreases recognition latency, its effect should be greater on low-M terms, since high-M terms are closer to minimal recognition latency. Therefore, if, within levels of M, the role of RT is different from M, the predicted interaction between familiarization and M would not be expected between familiarization and RT, i.e., familiarization of response terms should have little or no effect on the forward PAL rate of short-latency (SL) and long-latency (LL) RT response terms. The secondary purpose of the present study was to test this hypothesis.

SUBJECTS

The Ss were 32 undergraduate paid volunteers (16 females and 16 males) from the State University of New York at Albany, naive with respect to prior experience in verbal learning studies.

MATERIALS

The materials used in the forward and backward PAL lists and in the practice list were the same as those used by Ley & Locascio (1970), viz, the response terms of the PA list for the forward task (stimulus terms in the backward task) were eight CVCVC verbal units selected from Taylor's (1959) list: four high-Mn terms (two with SL RTs and two with LL RTs) and four low-Mn terms (two with SL RTs and two with LL RTs). The stimulus terms on the forward PAL list (response terms on the backward list) were eight two-digit numbers selected on the basis of their approximately equal associative values (Battig & Spera, 1962). Four different forward PAL lists were constructed, each with an accompanying backward PAL list. These lists all contained the same stimulus and response terms, but paired in different combinations. Each of these lists was arranged for presentation on separate paper tapes for use on a memory drum. The arrangement was in four random orders, with the restriction that each of the eight PAs occupy a different position in each order and that no pair follow or precede another more than once.

The materials used in the familiarization treatment list were the same eight CVCVC verbal units that appeared on the PAL forward and backward lists. The eight CVCVCs used in the familiarization-control

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Table 1
Mean Number of Trials to the First Correct Backward Anticipation of Short- and Long-Latency Terms, Low- and High-Meaningfulness Terms by Familiarization Trials

		Familiarization Trials			
		0 Trials		20 Trials	
Meaningfulness	Reaction Time	Mean Number of Trials	SD	Mean Number of Trials	SD
Low	Short Latency	2.78	1.06	2.59	1.67
	Long Latency	3.06	0.75	2.90	1.70
High	Short Latency	1.88	1.30	1.84	0.50
	Long Latency	2.06	0.70	2.09	0.97

Table 2
Mean Number of Trials to the First Correct Forward Anticipation of Short- and Long-Latency Terms, Low- and High-Meaningfulness Terms by Familiarization Trials

		Familiarization Trials			
		0 Trials		20 Trials	
Meaningfulness	Reaction Time	Mean Number of Trials	SD	Mean Number of Trials	SD
Low	Short Latency	17.6	15.05	17.2	10.79
	Long Latency	25.5	14.80	17.5	11.32
High	Short Latency	13.2	6.79	14.2	7.58
	Long Latency	15.6	9.14	16.3	8.18

treatment list (irrelevant familiarization) were CVCVC verbal units different from those used on the PAL lists and formally dissimilar from the test list CVCVCs, but of approximately equal Mn and RT values.

PROCEDURE

The experimental procedure was the same for all Ss except that half of the Ss were assigned randomly to a familiarization treatment (20 presentations of each CVCVC response term of the PAL test list, in which Ss were required to pronounce each term aloud as it appeared) and half were assigned to a familiarization-control (irrelevant familiarization) treatment (20 presentations of CVCVCs which did not appear on the PAL test list, in which Ss were required to pronounce each term aloud as it appeared) preceding the PA forward and backward learning tasks. During familiarization trials the CVCVCs were presented in four random orders on a memory drum at a 2-sec rate (2 sec for each of the terms with a 2-sec interorder interval). Immediately following the familiarization trials, Ss were presented with the test list in the forward PAL task at a 3-sec presentation rate (1½ sec for the stimulus term alone, 1½ sec for the stimulus and response terms together, with a 3-sec intertrial interval) following the same procedures employed by Ley & Locascio (1970). The learning score for a given PA for a given S was the number of the trial on which S made the first correct anticipation of the PA. The learning score for a PA not correctly anticipated at the end of 50 trials was 51. The learning score for a given S on a CVCVC subsample (HM-SL, HM-LL, LM-SL, LM-LL) was the mean of the learning scores on the CVCVCs which comprised the subsample. Immediately following forward anticipation learning, Ss were presented with a second PA list containing the same PAs as on the forward list, but in a backward order of presentation, i.e., the CVCVCs were the stimulus terms and the two-digit numbers were the response terms. For the backward anticipation procedures, the rate of presentation and the method of scoring were the same as for the forward learning task.

DESIGN

The data from the forward and backward PAL tasks were analyzed separately, each in a mixed factorial ANOVA, in which familiarization (20 relevant trials or 0 relevant trials) was the between-Ss variable, and RT (SL and LL) and M (HM and LM) of CVCVC verbal units used as either response terms (forward PAL task) or stimulus terms (backward PAL task) were within-Ss variables.

RESULTS

The mean number of trials to the first correct backward anticipation for the short- and long-latency CVCVC response terms within levels of low and high M are given in Table 1. Consistent with the primary hypothesis of the present study, the difference between the mean number of trials to the first correct backward anticipation for the short- and long-latency RT PAs was not significant, $F(1,28) = 1.22$, $p > .05$, whereas the high-M pairs were learned in significantly fewer backward anticipation trials than the low-M pairs, $F(1,28) = 8.47$, $p < .025$. The 20 familiarization trials preceding forward anticipation had no effect on backward anticipation learning rate, $F(1,28) = 0.02$, $p > .05$; and familiarization did not interact with either RT, $F(1,28) = 0.01$, $p > .05$; or M, $F(1,28) = 0.08$, $p > .05$. The Familiarization by RT by M interaction was not significant, $F(1,28) = 0.01$, $p > .05$.

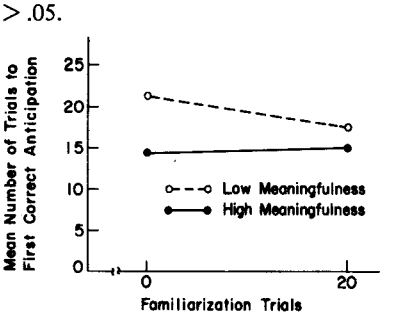

Fig. 1. Mean number of trials to the first correct forward anticipation for low- and high-meaningfulness response terms as a function of familiarization trials.

With respect to the secondary purpose of the present study, the mean number of trials to the first correct forward anticipation for short- and long-latency CVCVC response terms are given in Table 2. Consistent with the findings of previous studies (Ley, 1968; Ley & Anderson, 1969; Ley & Locascio, 1970), the short-latency RT response terms were learned in fewer trials than the long-latency terms, $F(1,28) = 3.12$, $p < .05$, and high-M terms were learned in fewer trials than low-M terms, $F(1,28) = 10.02$, $p < .005$. Although the main effect of familiarization was not significant, $F(1,28) = 0.40$, $p > .05$, the predicted M by Familiarization interaction was significant, $F(1,28) = 3.56$, $p < .05$. Figure 1, which is a plot of the mean number of trials to the first correct forward anticipation for low- and high-M response terms as a function of familiarization, clearly indicated that the difference between the PAL rate of high-M CVCVCs following 20 familiarization trials is almost identical to the PAL rate of high-M terms following irrelevant familiarization, i.e., the effect of familiarization is limited almost exclusively to the low-M terms. Of greater immediate importance, however, was the finding that the RT by Familiarization interaction was not significant, $F(1,28) = 1.26$, $p > .05$. The M by RT by Familiarization interaction was not significant, $F(1,28) = 0.46$, $p > .05$.

DISCUSSION

The results of the present study provide additional support to the hypothesis that within levels of M, the effect of RT in PAL is limited to the term of the PA which is required to be recalled. In the present study, RT of response terms, in forward anticipation learning, had a significant effect (i.e., short-latency RT terms were learned in fewer trials than long-latency RT terms), but in backward learning, RT of stimulus terms (response terms in forward anticipation learning) had no effect on PAL rate. Meaningfulness, on the other hand, was a significant variable in both learning tasks, forward and backward anticipation. These findings are compatible

with those of Ley & Locascio (1969), who found that within levels of M, RT of stimulus terms, in forward anticipation learning, had no effect on PAL, but in a backward recall test, RT of response terms (stimulus terms in the forward anticipation learning task) had a significant effect (i.e., short-latency RT terms were recalled more frequently than long-latency terms). Again, M was a significant variable in both learning tasks.

The Familiarization by M interaction provides additional evidence that within levels of M, the role of RT in PAL is different from that of M. Consistent with the predictions of the present study, learning the low-M response pairs was facilitated by familiarization trials (findings consistent with those of Schulz & Martin, 1964), whereas familiarization did not interact significantly with RT.

The results of the present study are consistent with the hypothesis put forth by Ley & Locascio (1969), viz, recognition or pronunciability or Martin's (1968) perceptual encoding are all indexed by M and are processes separate from recall. Further, since, within levels of M, the effect of RT is limited to the term of the PA that is required to be recalled, it is conceivable that RT, although highly correlated with M, is the variable underlying recall, i.e., short-latency RT units may be recalled more readily than long-latency RT units.

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Recognition memory for words presented at a slow or rapid rate*

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Fast presentation (about 1 word/sec) impairs subsequent recognition of both common and very rare words. This presentation rate, slow enough for accurate perception but probably too fast for much more elaborate information processing, also sharply reduces the variability of recognition memory scores.

In studies of the ability to recognize words recently seen, investigators have overlooked the importance of the rate at which the words are originally presented. They have chosen their rates more or less arbitrarily, so that a word's exposure duration almost always has fallen within the range of 2-5 sec. Over this range, later recognition performance seems to vary only slightly and unsystematically (Egan, 1958; Schulman, 1967; Shepard, 1967). It is as if normal processing of the words presented could be completed within 2 sec or so, additional exposure time being superfluous. If sufficiently less than 2 sec were allotted each word, however, performance in recognition memory would surely decline. Brief (but not tachistoscopic) exposures, long enough for accurate perception but too short for much more elaborate information processing, should impair recognition memory to the extent that this memory for recent experience depends upon such processing. Moreover, sufficiently brief exposures may be expected to curtail opportunities for idiosyncratic encoding and, consequently, to reduce variability among Ss. The present experiment shows that recognition memory indeed suffers and that variability is reduced when a suitably fast presentation rate is used.

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METHOD

Two presentation sequences were prepared. One consisted entirely of common English words, the other entirely of very rare English words. A group of Ss was confronted with one of these sequences, at either a slow or a fast rate, and then was tested for recognition. Two Kodak Carousel slide projectors were connected in tandem and externally timed to produce the fast rate, which exposed each word for 1.00 sec, or the slow rate, which exposed each word for 4.25 sec. There was about 0.75 sec of change-time between slides. Two hundred common words were drawn selectively from the 1,000 most frequently occurring English words, as listed by Thorndike & Lorge (1944); 200 rare words, a majority of which had probably never before been seen by any of our Ss, were drawn selectively from Cieutat (1963). Within each group of 200 words, structural similarity was avoided, and only words of two or more syllables were allowed.[1] Of the 200 words in each group, 100 at random were selected for the presentation sequence. These "old" words were then interspersed among the 100 remaining "new" words on the test of recognition memory that followed. The Ss knew that the presentation sequence was to be followed by a recognition test. Only a few minutes for instructions separated the two phases of the experiment. The recognition test was in booklet form, and S worked at his own pace. Alongside each of the 200 test words, S recorded his confidence, using a 6-point scale, that the word was "old." The 2 x 6 data matrix so determined—i.e., the six responses distributed over the event categories "old" and "new"—may be represented as pairs of increasing, accumulated proportions and plotted as points to which an operating characteristic (OC) may be fitted [see