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COLLEGE OF LITERATURE, SCIENCE, AND THE ARTS
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Technical Report

The Effects of Familiarity on the Perceptual Recognition and Categorization of Verbal Information

EDWARD SMITH

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This report was also a dissertation submitted by the author in partial fulfillment of the requirements for the degree of Doctor of Philosophy in The University of Michigan, 1965.

The research reported here was initiated under the guidance of the late Professor Paul M. Fitts and completed and reported with the guidance of Professor Arthur W. Melton, Chairman, Assistant Professor Richard W. Pew, Professor J. E. Keith Smith, Associate Professor Ronald S. Tikofsky, and Professor Robert B. Zajonc.

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ABSTRACT

The effects of stimulus familiarity on the processing of stimulus and memorial information were investigated in two tasks: one which supposedly required only the perceptual recognition of each stimulus word (E task), and one which required a meaningful categorization of each stimulus word (C task).

The method commonly used to study recognition, the tachistoscopic recognition threshold procedure, possesses two liabilities: (1) it may confound stimulus and response familiarity; (2) it fails to measure the stimulus-response interval during which part of the perceptual information processing may be occurring, i.e., recognition may be considered a two stage process--formation of a stimulus representation followed by comparisons between this representation and memorial information--and these stages may occur during the unmeasured stimulus-response interval.

The method used to study familiarity's effect on recognition in this thesis (the E task) seems capable of measuring separately both stages of recognition and minimizing response biases. S was instructed to press a "YES" button if the stimulus word was a member of a predefined set of target words, and a "NO" button otherwise. The size of the set was either 1, 2 or 4 and S's response times (RTs) were recorded. The vertical displacement of the function relating mean RT to number of target words was assumed to reflect the formation of the stimulus representation while the shape of this function was assumed to reflect only the comparison process which underlies recognition. Target and nontarget words varied in familiarity, and the effects of this variable on the vertical displacements and the shapes of the RT functions for "YES" and "NO" responses were the important data.

In the C task S was instructed to press a "YES" button when the stimulus word was a member of any one of a predefined set of categories, and a "NO" button otherwise. The number of categories was either 1, 2 or 4 and the effects of stimulus familiarity on the functions relating RT to number of categories were the important data. In both tasks target stimuli were repeated.

The results showed that in both tasks: (1) all obtained RT functions were negatively accelerated; (2) the second occurrence of a word was responded to faster than its first occurrence, this facilitation being greatest for the 4-target and 4-category conditions. In the E task, "YES" responses were faster to familiar than to unfamiliar stimuli and this effect influenced only the vertical displacement of the RT function; "NO" responses were faster when the targets S was looking for were familiar than when they were unfamiliar and this effect influenced only the shape of the RT function. In the C task, familiar stimulus words were responded to faster than unfamiliar words, for both "YES" and "NO" responses. For "YES" responses familiarity affected only the vertical displacement of the RT function while for "NO" responses it affected both the vertical displacement and shape of this function.

A comparison of the data for the two tasks and a consideration of the slopes of the RT functions obtained in the E task indicated that these functions reflected a memory process that follows recognition, rather than the recognition process itself. It was this memory process, rather than recognition, which seemed to be sensitive to familiarity. In the C task it appeared that familiarity affected both the retrieval and testing of the stored information about the meanings of the stimulus words.

CHAPTER I

INTRODUCTION

The major purpose of this thesis is to investigate the effects of familiarity on the processing of stimulus and memorial information. In particular, a substantial portion of the present study is concerned with the processing of information involved in the perceptual recognition of verbal items. Since this thesis is process-oriented it necessarily stresses a method which is analytic with respect to the mechanisms that are assumed to be involved in recognition. The following review of the methodology commonly used in this area indicates the need for the development of more analytic methods.

In the past 15 years many experimenters have attempted to determine whether familiar verbal items are recognized faster than unfamiliar ones. The procedure most often used to assess this familiarity effect consists of comparing the average recognition threshold of a set of familiar items to that of a comparable set of unfamiliar ones. Such a procedure is ill-suited for investigating and interpreting familiarity effect for two reasons: (1) it may confound perceptual and response factors, and (2) it fails to control or measure the interval between stimulus presentation and response, an interval during which a great deal of the recognition process may be occurring.

Consider first the response bias criticism. Tachistoscopic recognition studies require the emission of verbal responses which, like the stimuli, vary in frequency or familiarity. Goldiamond and Hawkins (1958) have demonstrated that the differential effects of high and low word-frequency on tachistoscopic recognition thresholds can be obtained when response frequency is varied and stimulus frequency is maintained at a constant level. Specifically, they showed that pseudo-recognition thresholds, i.e., thresholds obtained in the absence of stimuli, decrease monotonically as the frequency of the "required" response is increased. Hence it is necessary to unconfound stimulus and response frequency if one wishes to attribute an obtained frequency effect to perception rather than to response factors.

In an attempt to separate these two factors, Zajonc and Nieuwenhuyse (1964) determined the relation between frequency and recognition thresholds (which reflects both stimulus and response frequency) as well as the relation between frequency and pseudo-recognition thresholds (which reflects only response frequency). They then assessed the contribution of perceptual factors, i.e., stimulus familiarity, by comparing the two frequency functions and concluded that the differences between them indicated that "... the role of response bias in the frequency recognition relationship is probably negligible when stringent recognition criteria are used" (Zajonc and Nieuwenhuyse, 1964, p. 285). However, these authors themselves note that this procedure is relatively indirect and cannot provide unequivocal evidence that increasing the frequency of occurrence of a stimulus reduces the time needed by the perceptual system to recognize it.

A more direct method for unconfounding stimulus and response frequency consists of eliminating the latter as a variable by requiring the same response to familiar and unfamiliar stimuli. On each trial several items are presented either simultaneously or successively and <u>S</u> is required to locate, either spatially or temporally, a predefined target item which is either high or low with respect to frequency. The dependent variable is accuracy of report if the stimuli are subthreshold, and search time if the stimuli are suprathreshold. Taylor, Rosenfeldt and Schulz (1961) specified a target word to their Ss and then exposed it and three other words simultaneously in a rectangular display for a brief duration. Eight different exposure durations were used and all four words in a display were either high-frequency or low-frequency words. The Ss were required to report the spatial position (upper-right, lower-right, upper-left or lower-left) of the target word. Accuracy of report was found to be greater when S had to locate a high-frequency target word in a set of four high-frequency words, than when he had to locate a low-frequency target word in a set of four low-frequency words.

However, in this experiment only 4 different sets of 4 words each were used, and each set was presented 8 times in the same rectangular order and an additional 24 other times in three other orders which were rotations of the first order. This procedure can lead to paired-associate learning between adjacent stimuli if S is given the opportunity to completely perceive the four different sets of words early in the experimental session. Such learning could aid S in his task as it would enable him to specify the target word's position if he identified either the target or a word adjacent to it. Since the method of constant stimuli was used with respect to the different exposure durations, it is quite possible that early in the session S was in fact exposed to each set at an exposure duration which was sufficiently long to permit complete perception of the four words and their positions. So frequency might have achieved its facilitative effect in this experiment via its influence on paired-associate learning, rather than through an enhancement of the perceptual process, since paired-associate lists containing high-frequency words as responses are learned faster than lists containing low-frequency words as responses (Winnick and Kressel, 1964).

Goldstein and Ratleff (1961) used the same method as Taylor *et al.* with three major exceptions: (1) each set of stimuli consisted of four nonsense syllables rather than four words, (2) differences in stimulus frequency were experimentally induced by varying the number of times each nonsense syllable was presented in a pretraining session, and (3) only one very brief (20 msec.) exposure duration was used, thus prohibiting complete perception of the words and their order early in the experimental session. No differential frequency effect was obtained. These authors also employed a temporal forced-choice method in which *S* had to specify the temporal position of a target nonsense syllable in a sequence of four nonsense syllables. Again stimulus frequency did not affect response accuracy.

Nonsense syllables also served as stimuli in studies by Portnoy, Portnoy and Salzinger (1964) and Smith and Egeth (in press). Portnoy *et al.* used a visual search technique in which *S* had to find a target syllable in a rectangular array of 50 nonsense syllables. Their manipulation of familiarity consisted of using as targets and nontargets, syllables of 0% and 100% association value (AV) as determined by Glaze's (1928) norms. There were four different experimental conditions in this study corresponding to the four possible combinations of high- or low-AV targets with high- or low-AV nontargets. The results indicated that search was faster when the target AV was high and when there was a difference in AV between the targets and the nontargets.

Smith and Egeth used this same visual search procedure except that the 50 nonsense syllables were placed in a single vertical column. Search time was found to be unaffected by AV but sensitive to the particular initial letters of the targets and nontargets. Specifically search was faster when the first letter of a target was never used as the first letter of a nontarget, than when the first letter of a target was frequently used as the first letter of a nontarget. These authors concluded that when nonsense syllables are used as stimuli in a search experiment, Ss may adopt strategies of letter search. If Ss look only for the initial letter of the target nonsense syllable we would not expect any effect due to the frequency or AV of the entire item (which is consistent with Goldstein and Ratleff's results as well as with Smith and Egeth's results), except in a situation where the rarity of the first letter of the target (with respect to the first letters of the nontargets) was confounded with frequency or AV variations. The latter was probably the case in the Portnoy et al. study in view of the limited population from which their nonsense syllables were drawn. Specifically, an inspection of Glaze's listing of 0% and 100% AV syllables suggests that, given the 16 target syllables used by Portnoy et al. and that their selection of nontarget syllables from Glaze's listing was random, the ordering of their four experimental conditions with respect to the opportunity for a nontarget syllable to start with the same first letter as a target syllable was exactly the same as the ordering of their four experimental conditions with respect to obtained search times. Thus the ordinal effects manifested in the Portnoy et al. data can be explained without recourse to variations in familiarity.

In summary, although the forced-choice methods have eliminated response biases they have introduced other artifacts, viz., paired-associate learning and letter searching strategies, into perceptual recognition experiments.

The second liability of experiments employing the tachistoscopic recognition method is based on a specific theoretical orientation and is concerned with the failure of these experiments to measure the entire recognition process. The information processing in such an experiment may be subdivided into two stages: first S extracts fragmentary information from the brief stimulus flash and forms a representation of it; he then rapidly searches through memory for information about the possible stimulus alternatives and attempts to find a match between the stimulus representation and the memorial information. In a tachistoscopic recognition study which uses repeated exposures these two stages--hereafter referred to as the read-in process and the memorial comparison process, respectively--may be repeated many times in the course of recognizing a single stimulus.

Many current theories of perceptual recognition endorse a two-stage process. For example, Bruner (1957) divides the recognition process into a search for stimulus cues and a matching of these cues with the stored specifications of certain categories, which correspond to the possible stimulus alternatives. Hick (1952) and Sternberg (1964) have proposed similar dichotomies for the recognition of stimuli in a choice reaction time task, while Neisser's (1964) theorizing about recognition in a visual search task implies a similar division of this perceptual process.

In tachistoscopic recognition studies the time to read in stimulus information is partially under the control of the E, since he regulates the physical duration of the stimulus. (By using a noisy post-exposure field E can gain further control over stimulus exposure, since the experiments of Sperling, 1960, and Averbach and Coriell, 1961, indicate that such a field interferes with the short-term visual trace.) But the memorial comparisons may well take place in the unmeasured interval between the nth stimulus presentation and the nth response, or even, when the ascending method of limits is used, in the interval between the nth response and the nth + 1 stimulus presentation. To complicate matters further, part of the read-in process may also occur in the uncontrolled stimulus-response interval, since the visual trace persists after stimulus exposure has terminated (Mackworth, 1962); and there seems to be no a priori reason why the memorial comparison process cannot at least begin during stimulus exposure. Thus a tachistoscopic recognition experiment may be unable to detect any effect that stimulus familiarity has on processes occurring during the stimulus-response interval since this interval is not measured, and unable to specify which part of the recognition process is sensitive to a variation in familiarity when such an effect is obtained.

What is needed is a procedure which is capable of measuring separately both stages of the recognition process, and at the same time, minimizing the occurrence of response biases, learning effects and letter searching strategies. Sternberg (1963, 1964) has recently developed a forced-choice classification task which, when modified, seems to have these characteristics. At the start of each trial a target set of elements is enumerated to S who is instructed to make a "YES" response (pulling a right-hand lever) if the test stimulus to be presented is a member of this target set, and a "NO" response (pulling a left-hand lever) otherwise. The latency of S's manual response is used as the performance index. Using this procedure, Sternberg (1963) has found that the mean reaction times (RTs), for both "YES" and "NO" responses, increase directly with the number of target elements. To account for the obtained monotonic function relating number of target elements to RT Sternberg (1964) proposes that when deciding whether or not a stimulus is a member of the target set, stimulus information is extracted and a representation of it formed; then this stimulus representation is compared sequentially to memorial representations of the targets. Hence the intercept of this RT function reflects the read-in stage (as well as the time needed to make a response), and the slope of this function reflects the rate at which the memorial comparisons are made.

Thus the conceptual distinction between the two stages of recognition can be made operational, and we may determine where in the recognition process a particular variable has its effect by ascertaining whether it is the intercept and/or the slope of the RT function which is affected by the experimental manipulation. For example, Sternberg (1964) has recently concluded that decreasing stimulus discriminability lengthens the duration of the read-in process since degrading the test stimulus affected mainly the intercept of the obtained linear RT function. It should be noted that such an inferred localization of a variable's effect rests on the assumptions that the duration of the read-in stage is unaffected by the number of targets, and that variations in the obtained RTs resulting from a variation in the number of targets reflect only that comparison process upon which perceptual recognition is based. In making this last assumption Sternberg (1964) follows Hick (1952) who also assumed that RTs increase when the number of alternatives increase because more time is needed to recognize each stimulus. Thus Hick (1952) and Sternberg (1964) implicitly argue that the traditional choice RT experiment is mainly concerned with the same process (recognition) that is studied in the traditional tachistoscopic recognition threshold experiment. There seems to be little doubt that early in practice RTs increase when the number of alternative stimuli is increased (Sternberg, 1963; Nickerson and Feehrer, 1964; Nickerson, 1965; Chase and Posner, 1965), but there has been no convincing demonstration that the time needed to categorize or classify a stimulus in a choice RT task involves only the recognition process

The present experiment utilizes the above operational distinction between the two stages of recognition (and the assumptions on which it is based) in investigating the role of familiarity in recognition. The number of target words and the familiarity of target and nontarget words are varied simultaneously in a modified version of Sternberg's recognition task. Since recent data indicate that the function relating RT to the number of target elements, though monotonic, is negatively accelerated rather than linear (Nickerson and Feehrer, 1964; Chase and Posner, 1965; Egeth and Smith, 1965) localization of any obtained familiarity effect will be based on the presence or absence of an interaction of this variable with the number of target words. That is, if familiarity affects the slope or shape of the RT function (as manifested by an interaction of familiarity with the number of target words) then we may conclude that familiarity affects the comparison process; while if the effect of familiarity on performance is manifested only in the vertical displacement of the RT function, then we may conclude that familiarity affects the read-in process.

This thesis also attempts to analyze the effects of familiarity in a task which requires that the stimulus words be comprehended as well as recognized. "Comprehending" a stimulus word in this task involved utilizing stored information about its meaning so that a decision could be made about its membership in a superordinate class. Though a great deal of research has attempted to demonstrate that experience with words, as inferred from population norms, can facilitate one's perception of them, there has been little concern about whether such experience can also speed one's comprehension of them. Yet the nature of the experience which is often presumed to lead to an increased familiarity with certain words, e.g., reading, speaking, writing, demands that the meaning of these words be determined. Since conceptual abilities seem to continue to develop long after perceptual abilities have reached a relatively proficient level, it is likely that familiarity plays a greater role in word comprehension than word perception when college level Ss are used.

To study word comprehension the "YES"-"NO" classification task is again utilized and Ss are instructed to make a "YES" response when the stimulus word is a member of any one of a predefined set of categories, e.g., colors or tools, and a "NO" response otherwise. Such a task must involve more processing of the stimulus word than is needed to recognize it. Stored information about the meaning of the word must be retrieved and tested or analyzed to determined if the word belongs to any of the relevant categories. An examination of the effect of stimulus word familiarity on the functions relating number of categories to RT and a comparison of these RT functions with those obtained in the recognition task should provide information about the nature and duration of these additional processes.

The general research strategy utilized in this study can thus be summarized as follows. To investigate the effects of familiarity on the recognition of stimulus words, (1) recognition is conceptualized as a two-stage process, (2) the duration of each stage is associated with a parameter of a RT function, and (3) the effects of stimulus familiarity on each of the parameters is determined and then these data are used to make inferences about which stage(s) of recognition was affected by familiarity variations. A similar procedure is employed to investigate the effects of stimulus familiarity on the comprehension of stimulus words. The effect of familiarity on the parameters of the obtained RT functions, as well as a comparison of these parameters with those obtained when the target sets are enumerated, is used to make inferences about the additional processes involved when a stimulus must be categorized on the basis of its meaning. This research approach should lead to a more analytic conclusion than: familiarity does (or does not) affect recognition or comprehension. Specifically, this approach should yield some conclusions about the effect of familiarity on the information processing mechanisms, involved in recognition and comprehension, which supposedly "grind away" in the latent period and eventuate in a categorizing response.

In both tasks the familiarity of each stimulus word is determined by reference to a set of population norms. Consequently any effect of this variable on performance is presumably mediated by repetitions outside the laboratory situation. It is thus of some interest to repeat target stimuli within an experimental session (at brief intervals) in both tasks, so as to determine how repetition in the experimental situation influences effects based on repetitions outside the experimental situation.

CHAPTER II

METHOD

Subjects

All Ss were University of Michigan undergraduates who volunteered for paid participation. Fifty Ss, 34 males and 16 females, served in a preliminary word rating experiment while 48 males and 48 females participated in the main experiment.

Procedure

The Ss were instructed to press a button labeled "YES" if the stimulus word was a member of a predefined set of target words, and a button labled "NO" otherwise. Two types of tasks, target sets defined by enumeration (E tasks) and target sets defined by category membership (C tasks), were combined factorially with three levels of size of target set, 1, 2 and 4 target words or categories. The six resulting conditions may be designated E1, E2, E4, C1, C2 and C4. Sixteen different Ss served in each of these conditions, half of them being exposed to one ordering of the stimuli and the other half to another ordering. Within each subcondition (which corresponds to a particular ordering of the stimulus words) sex and the assignment of response buttons to fingers were counterbalanced as follows: two male and two female Ss pressed the "YES" button with the forefingor of their preferred hand and the "NO" button with the forefinger of their nonpreferred hand, while two male and two female Ss had the opposite finger-button assignment. The familiarity of the stimulus words and whether a particular presentation of a target stimulus was the first or second occurrence of that stimulus word were the major within-S variables; these variations will be discussed in the section concerned with stimulus materials.

All Ss were instructed to respond as quickly and accurately as possible. The Ss in the C conditions were also provided with information about the relevant categories the first time each category name was used so as to minimize any differences in category familiarity. For example, when the relevant category was "furniture" Ss were told that instances of this category included any piece of furniture commonly found in the home. If S had any further questions about the nature of the category, E attempted to answer them, but no instances of the category were given as examples.

Also, in the C condition it was often the case that an S would not know the meanings of some of the stimulus words or that he felt that some of the words were ambiguous with respect to his "YES"-"NO" decision. Thus Ss in the C conditions were further instructed to push either response button if one of these situations occurred and to inform E of this immediately. These RTs were, of course, excluded from the data analysis. A total of 2.7% of the RTs obtained in the C conditions were excluded on this basis. Finally the data of any S in a C condition who did not know the meaning of as many as 10% of the stimulus words was discarded and a new S was run in that condition. This criterion resulted in the elimination of five Ss, two from the C2 condition and three from the C4 condition.

Apparatus

Stimulus words, as well as instructions which defined the target sets and which are hereafter referred to as target sets, were presented in one field of a Gerbrands Mirror Tachistoscope. They were typed on Esterline Angus record paper which was fed past a 4 5/16 × 7/16 in. window at a viewing distance of 23 in. from S. At the start of each trial a list of 1-, 2- or 4-target words or category names appeared simultaneously in a horizontal array in the viewing window. These items defined the target set for that trial. The S was permitted to study each target set until he judged he was sufficiently well acquainted with its contents to proceed. The S then said "Ready" and E immediately depressed a foot switch which resulted in the target set moving out of view and the stimulus word moving into position in the viewing window. This change required 50 msec. and at the end of this 50 msec. period a printing timer was started. The printing timer used was a Hewlett Packard digital recorder with a timing error of ±1 msec. The "YES" and "NO" response buttons were located on a panel in front of S at table height.

The depression of a response button simultaneously activated the printing timer which recorded S's latency to the nearest millisecond and removed the stimulus word from view. Thus the exposure duration of any stimulus corresponded to S's RT to that stimulus. The E monitored the printing timer and informed S whenever an error was made. The next trial began 1500 msec. after a response as the next target set moved into position in the viewing window. The inter-response interval was in part determined by the number of target words or categories since Ss studied larger target sets longer than smaller ones. However, in no condition was this interval less than about 3.1 sec. The total time taken by an S to complete the experimental session was also recorded.

Construction of Stimulus Lists

The stimuli were English words which were assumed (on the basis of criteria which will be discussed later) to be either familiar or unfamiliar to the Ss. Each experimental session involved 25 practice and approximately 200 test trials. In the course of an experimental session S was exposed to 225 target sets and 225 stimuli. The stimulus words were the same in all conditions but the nature of the target sets (1, 2 or 4 words or category names) depended on the particular condition. The stimulus words taken together with the target sets appropriate to a given condition define an experimental list.

For ease of exposition consider first the construction of a list for the E1 condition. Since 50 different target words were used and the target set (a single word) remained the same for an average of 4 consecutive trials, the E1 list consisted of 50 blocks of 4 trials. Two sample blocks are given below. (Note that any word which appears in a specification of a target set must be a target word while a word which appears as a stimulus may be either a target stimulus word or a nontarget stimulus word.)

Trial Number		Target Set	Stimulus	Correct Response
Block 1	1	table	TACIT (unfamiliar)	"NO"
	2	table	TABLE (familiar)	"YES"
	3	table	NOBLE (familiar)	"NO"
	4	table	TABLE (familiar)	"YES"
Block 2	5	black	BLACK (familiar)	"YES"
	6	black	TRACK (familiar)	"NO"
	7	black	BLOAT (unfamiliar)	"NO"
	8	black	BLACK (familiar)	"YES"

This example reflects the following characteristics of all 50 blocks of the E1 list: (1) Half of the stimuli were members of the target set and the other half were not. (2) Each target stimulus appeared twice on the average. However, a few blocks were included in which a particular target stimulus appeared only once or as many as three times in order to discourage S from anticipating the next stimulus. (3) The number of stimuli which intervened between the first and second occurrence of a particular target stimulus was varied. (4) Nontarget stimuli were never repeated, else S might start looking for them and then the number of words that S was looking for, i.e., the size of the target set, would no longer be under experimental control. (5) The nontarget stimuli always shared some letters with the target that S was looking for. Thus S was discouraged from looking at individual letters of the stimulus rather than at the entire word. (6) Half of the non-target stimuli were assumed to be familiar to the Ss and half were assumed to be unfamiliar.

Other important characteristics of the E1 list which are not discernible from the above example are: (7) Half of the target stimuli were assumed to be familiar to the Ss and half were assumed to be unfamiliar. (8) Stimulus words were always typed in upper case black letters while the target sets were always in lower case red letters. The purpose of using different colors and type for the stimuli and the target sets was to reduce recency effects which might obscure familiarity effects. That is, if each target stimulus was identical to one of the words specified in the target set, then the beneficial effect on performance of just having seen an unfamiliar target stimulus might sufficiently obscure any detrimental effect resulting from the word being unfamiliar.

Target sets for the E2 and E4 conditions were formed by combining, respectively, two or four of the single word target sets of the E1 condition. The target words that were combined to form a new set were always identical with respect to the familiarity variable, thus precluding the possibility that familiarity might influence performance by determining the order in which the memorial representations of the targets are compared to the stimulus representation. The above constraints necessitated that two target words and their associated nontargets from the E1 list, a total of five stimuli, be excluded from the E2 and E4 lists.

Using the example given above a target set for the E2 condition might be "table, black" and the stimulus words used in conjunction with it would be the eight stimuli in Blocks 1 and 2 in a new randomized order. For the E4 list stimuli from four blocks of the E1 list were combined and their order randomized to yield the stimuli to be used in conjunction with a target set. This procedure resulted in E2 and E4 lists which had the same eight characteristics as the E1 list. However, the number of stimuli which intervened between the first and second occurrence of a particular target stimulus varied directly with the size of the target set.

A similar procedure was used to construct the C lists. Twelve different categories were employed in the C1 list, each one defining a target set of words, namely the set of all words which were exemplars of that category. The number of target stimuli (exemplars of the category) actually used with any category was either 3, 4, 5 or 6 and all categories contained at least one familiar target stimulus and at least one unfamiliar target stimulus. The category remained the same for an average of 16 trials and so the C1 list consisted of 12 blocks of 16 trials. A sample block is:

Trial Number	Target Set	Stimulus	Correct Response
1	colors	BEIGE (unfamiliar)	"YES"
2	colors	BLACK (familiar)	"YES"
3	colors	TRACK (familiar)	"NO"
4	colors	MERGE (unfamiliar)	"NO"
5	colors	BEIGE (unfamiliar)	"YES"
-	-	-	-
-	-	-	-
-	-	-	-
16	colors	BLACK (familiar)	"YES"

Target sets for the C2 and C4 lists were defined by the combination of either two or four of the single categories used in the C1 list. The stimuli used in conjunction with these target sets were the stimuli which were associated with the component categories but in a new randomized order. The number of stimuli which intervened between the first and second occurrence of a target stimulus increased as the number of categories increased.

The eight characteristics of the E lists were also characteristics of the C lists. The Ss in both E and C tasks were informed of all eight characteristics, except those concerned with familiarity, before the experimental session began.

There are thus six basic lists corresponding to the six basic conditions which differ only with respect to (1) the nature of the target sets and (2) the order of the target sets and the stimuli associated with them. For each of these lists another list was constructed which differed from the original list only with respect to the order of the target sets and the stimuli associated with them. This permitted an examination of the effects of list order independently of the effects due to the different conditions.

Selection of Stimulus Words

Three different sources were used in selecting the 75 familiar words (25 targets and 50 nontargets) and the 75 unfamiliar words (25 targets and 50 nontargets). First the Cohen, Bousfield and Whitmarsh (1957) norms were used to obtain a pool of about 250 items which were instances of approximately 20 well-defined categories. The selected words were either very frequent or very infrequent associations to the category names.

Then the Thorndike-Lorge (1944) word count was consulted to determine the frequency of occurrence in English text of each of these 250 items. Only those words which were either both high-frequency associates to the category names and high-frequency words in general, or both low-frequency associates to the category names and low-frequency words in general were maintained. These remaining words were potential targets and the potential nontargets could then be selected. For each potential target a pair of potential nontargets was selected, each of which had at least two letters in common with the potential targets. One member of each pair was selected from the high-frequency words of the Thorndike-Lorge word count and the other member from the low-frequency group.

These two selection procedures resulted in a pool of 270 potential stimuli. To check the adequacy of the Thorndike-Lorge norms for University of Michigan undergraduates these 270 words were then given to a group of 50 such students who were instructed to rate the words "...with regard to your familiarity with them in written materials" and with regard to their evaluative meaning. Word value ratings were obtained in view of the Johnson, Thomson and Frincke (1960) findings that frequency of occurrence and rated value of words covary, and that good words are associated with lower recognition thresholds than bad words for a fixed frequency level. It is thus desirable to obtain a set of stimuli in which these two variables are not too highly correlated.

The Ss rated each word on a 7-point familiarity scale and on the good-bad scale of the semantic differential. On the basis of these results 50 target and 100 nontarget words were obtained. With only a rare exception, half of the targets had been rated high in all three frequency or familiarity norms (high-F words) and the other half had been rated low in all three of these norms (low-F words). Similarly, half of the nontargets had been rated high in both the Thorndike-Lorge word count and the student familiarity ratings (high-F words) and the other half had been rated low in both of these norms (low-F words). The characteristics of the four critical sets of words--high-F targets, high-F nontargets, low-F targets and low-F nontargets--are given in Table 1.

Table 1

AVERAGE CHARACTERISTICS OF STIMULUS WORDS

	High F Words		Low F Words	
	Targets	Nontargets	Targets	Nontargets
Cohen *et al.* rating	209.16		5.79	
Thorndike-Lorge rating	75.16	76.92	9.88	5.93
Familiarity rating	1.47	1.56	2.88	2.87
Value rating	2.79	2.84	3.29	3.68
Number of letters	5.20	5.10	5.20	5.20

Each entry in this table is an average based on either 25 or 50 words depending on whether the entry pertains to targets or nontargets respectively. The Cohen *et al.* rating for any one word is the total number of times that a group of undergraduate *Ss* gave this word as an instance of a particular category, this category being one of the 12 used in th[illegible] task. The Thorndike-Lorge rating for any one word is the total number of times that this word appeared in a sample of a million words. The familiarity rating or value rating for any one word is the mean rating of that word on a 7-point scale of familiarity or value, low numbers being associated with very familiar or highly valued words. Entries in the row labelled "Number of letters" simply indicate the average number of letters for each of the four critical sets of words.

A complete listing of all the stimulus words and their characteristics appears in Appendix A. The correlation between the Thorndike-Lorge ratings and the familiarity ratings was -.75 while the correlation between familiarity ratings and value ratings was .43.

In the E task dichotomizing the nontargets on the basis of high-F vs. low-F words is insufficient because the familiarity of the target words Ss are looking for may also be a relevant variable. (Note that this is not the case in the C task where S does not know the exact target words in advance and so cannot be influenced by their familiarity.) Thus the following four-way classification of nontargets was used in the E task: (1) high-F stimulus + high-F target set, (2) high-F stimulus + low-F target set, (3) low-F stimulus + high-F target set and (4) low-F stimulus + low-F target set. The characteristics of the stimulus words in classes (1) and (2) are approximately the same as those given for high-F nontargets in Table 1, while the characteristics of the stimulus words in classes (3) and (4) are approximately the same as those given for low-F nontargets in Table 1.

CHAPTER III

RESULTS

The dependent variable of interest is reaction time. When a representative sample of the latency data was examined for homogenity of variance, a dependence of variance, σ_i^2, on mean, $\bar{X}_i$, was observed, viz., $\sigma_i \stackrel{\sim}{=} \sqrt{\bar{X}_i}$. This dependence was corrected by taking square roots of all of the individual latencies (see Scheffe, 1960). When the standard deviations of the transformed scores are plotted as a function of the means of the transformed scores (this plot being made only for the above mentioned representative sample), there is no indication of any relation between the w Hartley's test for homogenity of variance (Winer, 1962) also failed to reject the hypothesis of homogenity of variance for the transformed scores in the representative sample. Thus transformed scores (of all latencies) were used in all statistical analyses. Graphic presentations of the results, however, are always based on untransformed scores since the actual times involved are themselves of interest. The number of individual observations contributing to any point on any of the graphs is never less than 350.

In all of the following analyses of variance sex, finger-response button assignment and list order were included as control factors so that the variance accounted for by these factors would not be added to the error terms. None of these variables produced a significant main effect in the E task. In the C task sex was a significant source of variance for "NO" responses only (males being faster than females), while finger-response button assignment and list order did not produce a significant main effect. The percentage of the total variance accounted for by these three factors and all interactions which include them varied from 25 to 31 in the statistical analyses performed. Since these three factors and their interactions, among themselves and with the other variables, have little relevance to the major concerns of this study they are not discussed further.

Results for the E and C tasks are presented separately.

Enumeration Task

Figure 1 presents the mean RTs for correct "Yes" responses as a function of number of targets with stimulus familiarity and repetition

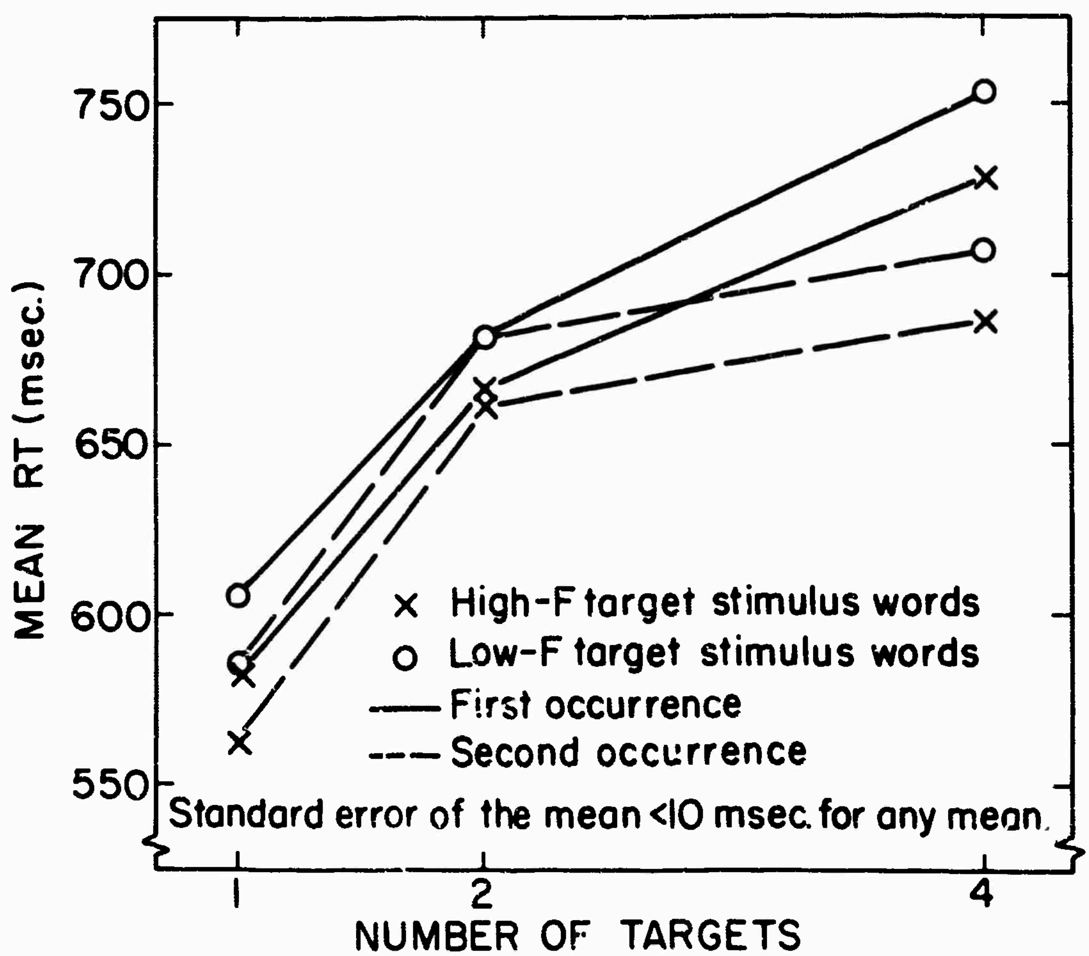

Fig. 1. Mean RTs for "YES" responses in Enumeration conditions as a function of number of targets, with stimulus familiarity and repetition as parameters.

(first vs. second occurrence) as the parameters, while Table 2 contains

Table 2

ANALYSIS OF VARIANCE OF CORRECT "YES" REACTION TIMES: ENUMERATION TASK

Source	df	MS	F	p
Between Ss				
T (Number of targets)	2	21978	7.62	<.01
Ss within groups	24	2882		
Within Ss				
R (Repetition)	1	1447	25.83	<.001
R × T	2	420	7.50	<.01
R × Ss within groups	24	56		
F (Familiarity)	1	1493	15.39	.001
F × T	2	10	<1	NS
F × Ss within groups	24	97		
P (Practice)	1	4791	48.39	<.001
P × T	2	18	<1	NS
P × Ss within groups	24	99		
R × F	1	1	<1	NS
R × F × T	2	6	<1	NS
R × F × Ss within groups	24	46		
R × P	1	65	1.76	NS
R × P × T	2	227	6.13	<.01
R × P × Ss within groups	24	37		
F × P	1	31	<1	NS
F × P × T	2	79	1.11	NS
F × P × Ss within groups	24	71		
R × F × P	1	48	1.23	NS
R × F × P × T	2	240	6.15	<.01
R × F × P × Ss within groups	24	39		

a summary of an analysis of variance of these latencies[1]. All four RT

[1] The reader may recall that five stimuli from the E1 list were excluded from the E2 and E4 lists. When the RTs associated with these five words are excluded from the results for the E1 condition, the mean RTs of the untransformed scores are never changed by more than 1 msec. Hence, all RTs obtained in the E1 condition were used in the graphic and statistical analysis.

functions are monotonic and show steeper slopes between 1- and 2-targets than between 2- and 4-targets. High-F words were responded to faster than low-F words on both the first and second occurrences of these words, and repetition within the experimental session did not reduce the magnitude of this familiarity effect (ca. 20 msec.). Moreover, for both first and second occurrences this effect is reflected only in the vertical displacement of the RT functions, as the RT functions for high- and low-F words are parallel for both first and second occurrences of these words. All of these statements are supported statistically (see Table 2) since F was a significant source of variance while the R × F, F × T and R × F × T interactions were not. (The significant R × P × T and R × F × P × T interactions will be considered later.)

Table 2 also shows that repetition significantly influenced RTs. Since the second occurrence of a stimulus appeared later in the list than its first occurrence it is possible that the repetition effect, averaged over the three levels of number of targets, is due to general practice in the task. Two considerations argue against attributing the repetition effect to general practice. First, the average number of items that intervened between the first and second occurrence of a stimulus word in the E task was three, and it is doubtful that a practice effect of sufficient magnitude to account for the repetition effect could manifest itself in just three trials. Second, practice (first vs. second half of the experiment) was included as a factor in the analysis of variance and although it significantly reduced RT scores, it did not interact with the number of targets while repetition did (see Table 2). In the first half of the experiment the mean RTs for correct "YES" responses for the E1, E2 and E4 conditions were 602, 687 and 738 msec., respectively, while in the second half of the experiment the three corresponding mean RTs were 564, 657 and 695 msec.

Figure 1 also indicates that repetition achieved its facilitative effect on performance primarily by shortening the latencies associated with the 4-target condition. Results from similar experiments (Neisser, Novick and Lazar, 1963; Egeth and Smith, 1965) also indicate that repetition of the stimuli (which was completely confounded with general practice in these other two studies) primarily affects RTs associated with multitarget conditions. It is therefore desirable to assess the effect of repetition on each of the two segments of the present RT functions. Table 2 shows a significant R × T interaction but this analysis is incapable of assessing the repetition effect for each segment of the RT function. To do this the factor T (number of targets) was partitioned into two components based on two orthogonal comparisons (see Winer, 1962). The first component, T(A), reflects RT differences between the 4-target condition and the mean of the 1-target and 2-target conditions ($T_4 - \frac{T_1 + T_2}{2}$), the coefficients for this comparison being -1, -1 and 2 for the 1-, 2- and 4-target conditions, respectively. The second components, T(B), reflects only RT differences between the 1-target and 2-target conditions ($T_1 - T_2$), the coefficients for this comparison being, 1, -1 and 0 for the 1-, 2- and 4-target conditions, respectively. It was now possible to determine the interactions of repetition, as well as of familiarity and of practice, with each of the components of the T variable. The results of this component analysis showed that repetition primarily affected the 4-target condition since the R × T(A) interaction was significant ($F(1, 24) = 11.22$, $p < .01$) while the R × T(B) interaction fell short of an acceptable level of significance ($F(1, 24) = 4.02$, $.05 < p < .10$). Familiarity and practice, which did not significantly interact with the gross T variable (see Table 2), also did not significantly interact with either component of this variable.

The results of repetition are more complicated than the preceding analysis may indicate. In Fig. 2 the magnitude of this effect is

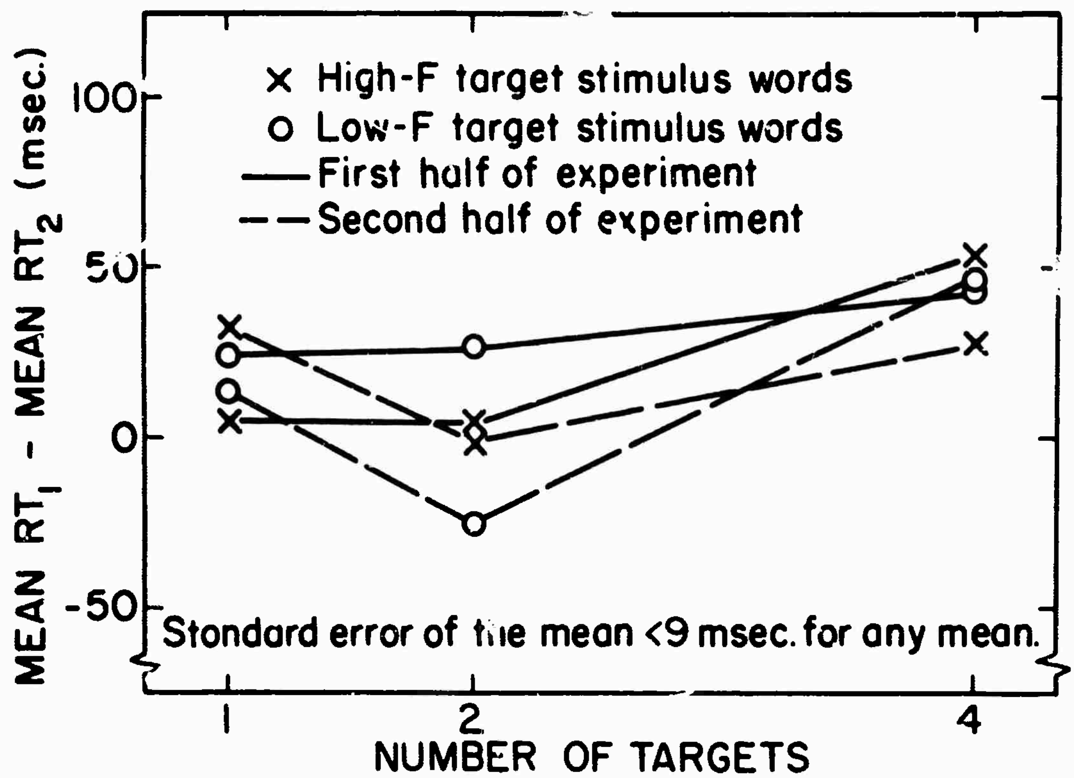

Fig. 2. Mean differences in "YES" RTs between first and second occurrences in Enumeration conditions as a function of number of targets, with stimulus familiarity and practice as parameters.

presented as a function of the number of targets, with stimulus familiarity and degree of practice as the parameters. Inspection of this graph reveals that in the second half of the experiment the repetition effect for the 2-target condition reverses direction, i.e., first occurrences are responded to faster than second occurrences. Figure 2 also shows that whether high- or low-F stimuli are benefited more by repetition depends on the degree of practice and the size of the target set. These two statements are reflected in the significant R × P × T and R × F × P × T interactions in Table 2.

Figure 3 presents the mean RTs for correct "NO" responses as a function of number of targets. In line with the four-way classifi-

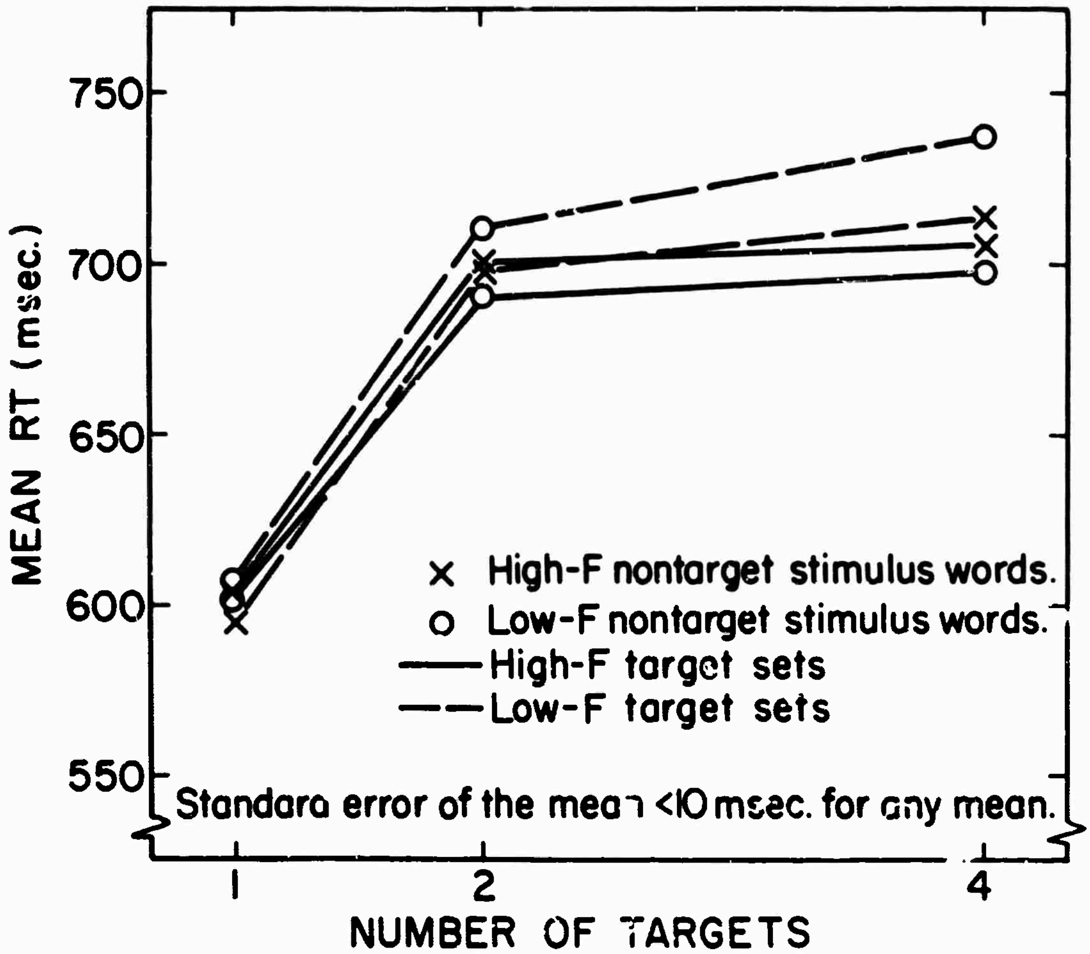

Fig. 3. Mean RTs for "NO" responses in Enumeration conditions as a function of number of targets, with stimulus familiarity and target set familiarity as parameters.

cation of the nontargets outlined earlier, stimulus familiarity and target set familiarity are the relevant parameters. Table 3 contains the summary of the analysis of variance for these latencies. Again, all four RT functions are negatively accelerated. Inspection of Fig. 3 and Table 3 indicates that nontarget stimuli were responded to significantly faster when S was looking for high-F targets than when he was looking for low-F targets, while the familiarity of the nontarget

Table 3

ANALYSIS OF VARIANCE OF CORRECT "NO" REACTION TIMES: ENUMERATION TASK

Source	df	MS	F	p
<u>Between</u> <u>Ss</u>				
T (Number of targets)	2	17606	7.90	<.[illegible]
<u>S</u>s within groups	24	2170		
<u>Within</u> <u>Ss</u>				
F (Familiarity of target set)	1	376	9.89	<.01
F × T	2	346	4.55	<.05
F × <u>S</u>s within groups	24	38		
W (Familiarity of stimulus word)	1	154	3.95	NS
W × T	2	10	<1	NS
W × <u>S</u>s within groups	24	39		
P (Practice)	1	2290	24.36	<.001
P × T	2	68	<1	NS
P × <u>S</u>s within groups	24	94		
F × W	1	420	9.13	<.01
F × W × T	2	40	<1	NS
F × W × <u>S</u>s within groups	24	46		
F × P	1	16	<1	NS
F × P × T	2	112	3.29	NS
F × P × <u>S</u>s within groups	24	34		
W × P	1	9	<1	NS
W × P × T	2	74	1.85	NS
W × P × <u>S</u>s within groups	24	40		
F × W × P	1	15	<1	NS
F × W × P × T	2	1	<1	NS
F × W × P × <u>S</u>s within groups	24	24		

stimulus was not a statistically significant source of variance. However, stimulus familiarity interacted with target set familiarity since nontarget stimuli were responded to faster when they differed from the relevant target set with respect to familiarity level than when they were the same. An examination of Fig. 3 indicates that this interaction obtains only for low-F nontarget stimuli, since the longest RTs are associated with responses to low-F nontarget stimuli when the target sets were also low-F, while the shortest RTs are associated with responses to low-F nontarget stimuli when the target sets were high-F. When the nontarget stimuli were high-F, it appears that the familiarity of the target sets did not affect RT.

The familiarity of the target set also interacted with the number of targets since the magnitude of this familiarity effect was proportional to the size of the target set (see Fig. 3). Again, this interaction seems to obtain only for low-F nontarget stimuli. When this interaction is partitioned into two components, corresponding to the two components of the T variable, both resulting interactions are significant (for the F × T(A) interaction $F(1, 24) = 4.63$, $p < .05$, and for the F × T(B) interaction $F(1, 24) = 4.95$, $p < .05$).

A comparison of Figs. 1 and 3 indicates that correct "YES" responses were faster than correct "NO" responses for the 1- and 2-target conditions but slower than correct "NO" responses for the 4-target condition. To determine whether correct "YES" responses were in general faster than comparable correct "NO" responses the results of the above three conditions were combined, and the latencies of correct responses to first occurrence of target stimuli were compared to the latencies of correct responses to nontarget stimuli which had the same familiarity level as the relevant target set. Although the resulting t ratio did not reach an acceptable level of significance ($t = 1.86$, $.05 < p < .1$), differential error rates (i.e., most incorrect responses were incorrect "NO" responses) must be taken into consideration in interpreting these results.

Other error rates must also be considered before drawing conclusions from the data for correct responses. Whenever an experimental variable results in one set of items being responded to faster than another set, it is possible that the effect of the variable was mediated by a decrease in Ss' accuracy criteria for the first set (see, e.g., Fitts, in press). To show that this is not the case it is sufficient to demonstrate that correct response latencies and error frequencies are not negatively correlated for the relevant comparisons.

The percentage of responses that were in error for the E1, E2 and E4 conditions were 2.8, 2.4 and 2.5, respectively, while the percentage of responses that were in error when S was looking for low-F targets (2.8) exceeded that when S was looking for high-F targets (2.4). Thus RT differences due to the number of targets and the familiarity of the target set cannot be attributed to changes in Ss' accuracy criteria but rather reflect differences in task difficulty. In fact, in the second comparison mean latency and error rate are positively correlated. This is also the case for the other major variables in the experiment since the percentage of S's responses that were in error was greater (a) when responding to low-F stimuli (2.9) than when responding to high-F stimuli (2.3), (b) when responding to the first occurrence of a target stimulus (4.0) than when responding to its second occurrence (3.3), (c) in the first half of practice (2.6) than in the second half (2.5), and (d) when making a "NO" response (3.4) than when making a "YES" response (1.8).

The latencies of the error responses are also pertinent to conclusions drawn from the data for correct responses. Since all statistical analyses were performed only on the latencies of correct responses, it is possible that the statistical results would be altered if the analyses were based on all responses and the latencies of the error responses did not show the same relations as the correct responses do. Although this possibility is remote since the overall error rate was only 2.6%, error latencies were examined and found to reflect the same relations as correct response latencies with respect to number of targets, target set familiarity, stimulus familiarity, repetition, practice and type of response (i.e., "YES" vs. "NO").

In addition to differences in RTs to stimuli as a function of the size of the target set, it was possible to obtain a rough estimate of differences in the time needed to study or memorize the target set as a function of its size. (Unfortunately, these "study times" were not directly measured, as they should be in future experiments of this type.) Since there were no interruptions between trials in the E task the total time needed to complete the task may be considered to be the sum of three components: (1) time spent memorizing target sets, (2) time spent responding to stimuli and (3) apparatus time which is assumed to be constant across conditions.

For each S the time spent responding to stimuli was determined by summing all his RTs in an experimental session; then this quantity was subtracted from his total time which had been recorded. These residual times reflect only memorization time plus a constant. Averages, across Ss, of these residual times for the 1-, 2- and 4-target conditions were then obtained. Table 4 contains the average total times, the average total responding time and the average residual times for the E1, E2 and E4 conditions. The entries of the fourth row of this table were obtained by dividing the average residual times by the total number of target sets that an S was exposed to in an experimental session. The entries in the last row of Table 4 are simply the differences between

Table 4

AVERAGES FOR TOTAL TIME, RESPONDING TIME AND RESIDUAL TIMES FOR THE ENUMERATION TASK

	E1	E2	E4
Total time (sec.)	720	780	990
Total responding time (sec.)	117	133	139
Residual time (sec.)	603	647	851
Residual time per target set (sec.)	3.015	3.318	4.364
Differences in residual times per target set (msec.)		303	1046

the residual times per target set for the E2 and E1 conditions and for the E4 and E2 conditions. These differences are estimates of the increases in memorization time per target set resulting from increases in the size of the target set. All entries in Table 4 are means based on 16 Ss.

Table 4 shows that the [illegible] residual times increased as the number of targets increased, indicating that the time taken to memorize a target set was directly related to its size. More interesting was the finding that the difference in memorization time between the 2- and 4-target conditions (1046 msec. per target set) was more than twice as great as the difference in memorization time between 1- and 2-target conditions (303 msec. per target set). This suggests that if these memorization times had been measured directly the function relating these times to number of targets would have been positively accelerated. It should be noted, however, that the above estimates of differences in memorization time are sensitive to S's confidence that he has the targets sufficiently accessible in memory. Thus differences in memorization time resulting from differences in the number of targets may reflect differences in the time actually required to memorize the targets, or differences in S's judgment of how much time he should spend memorizing the targets, or both.

Classification Task

In Fig. 4 the mean RTs for correct "YES" responses are presented as a function of number of categories with stimulus familiarity

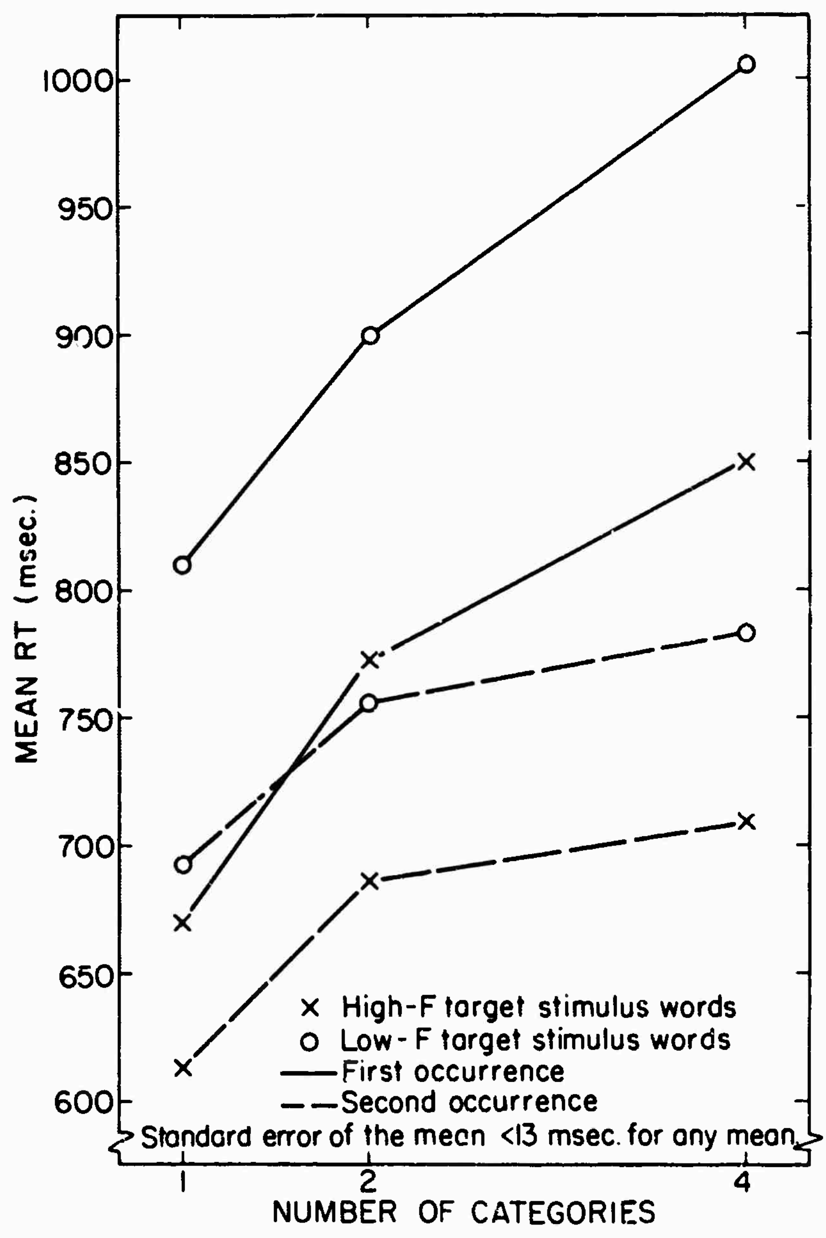

Fig. 4. Mean RTs for "YES" responses in Category conditions as a function of number of categories, with stimulus familiarity and repetition as parameters.

and repetition as the parameters, while the summary of the relevant analysis of variance appears in Table 5. Again, all RT functions are

Table 5

ANALYSIS OF VARIANCE OF CORRECT "YES" REACTION TIMES: CATEGORY TASK

Source	df	MS	F	p
Between Ss				
T (Number of targets)	2	19212	7.89	<.01
Ss within groups	24	2436		
Within Ss				
R (Repetition)	1	40506	285.25	<.001
R × T	2	1221	8.60	<.01
R × Ss within groups	24	142		
F (Familiarity)	1	32357	409.58	<.001
F × T	2	177	2.24	NS
F × Ss within groups	24	79		
P (Practice)	1	2047	7.44	<.05
P × T	2	857	3.12	NS
P × Ss within groups	24	275		
R × F	1	1667	24.88	<.01
R × F × T	2	15	<1	NS
R × F × Ss within groups	24	67		
R × P	1	1	<1	NS
R × P × T	2	65	<1	NS
R × P × Ss within groups	24	68		
F × P	1	1278	21.30	<.001
F × P × T	2	146	2.43	NS
F × P × Ss within groups	24	60		
R × F × P	1	114	4.07	NS
R × F × P × T	2	46	1.64	NS
R × F × P × Ss within groups	24	28		

negatively accelerated. Figure 4 shows that high-F words were responded to faster than low-F words on both the first and second occurrences of the words, and on both occasions the effect appears only in the vertical displacement of the RT functions. However, this effect of extra-experimental familiarity was substantially reduced after just one occurrence of a target stimulus in the experimental situation. These statements find statistical support in Table 5 as F and R × F were significant sources of variance while F × T and R × F × T were not.

The facilitative effect of repetition is obvious in Fig. 4. This effect cannot be attributed to general practice in the task since the proportion of the variance accounted for by the repetition factor was far greater than that accounted for by the practice factor (see Table 5). Figure 5 presents the magnitude of the repetition effect as

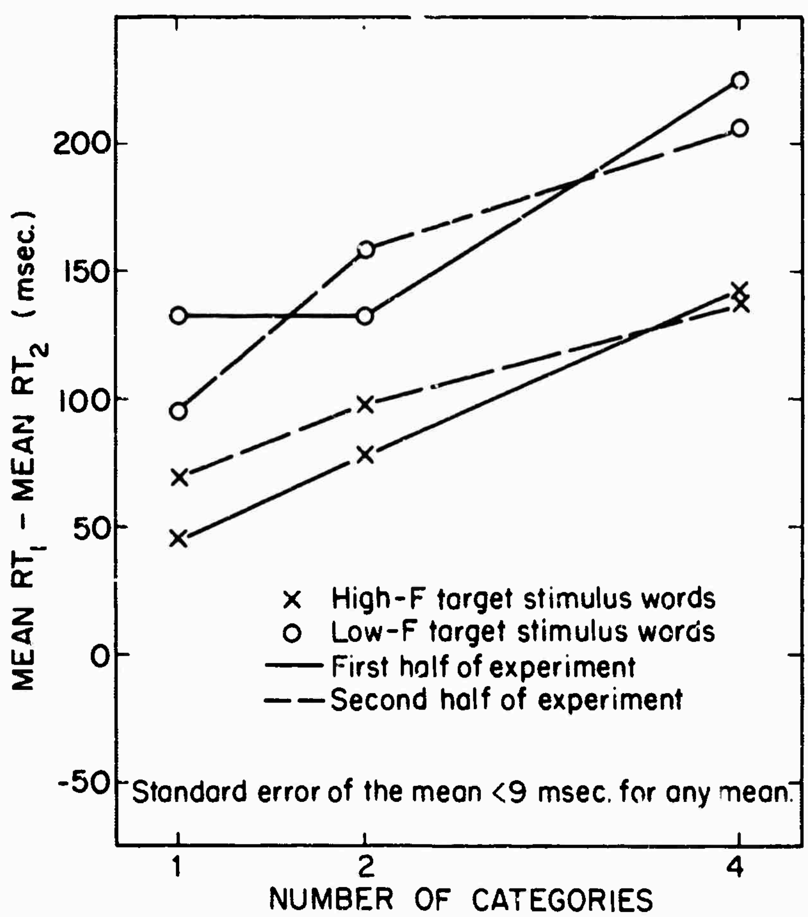

Fig. 5. Mean differences in "YES" RTs between first and second occurrences in Category conditions as a function of number of categories, with stimulus familiarity and practice as parameters.

a function of the number of categories with stimulus familiarity and degree of practice as the parameters, and clearly shows the invariance of the repetition effect over practice and the interaction of repetition and stimulus familiarity.

Figures 4 and 5 indicate that repetition interacted with the number of categories. This interaction seems to be due primarily to a disproportionate reduction of the RTs associated with the 4-category condition. A component analysis, identical to the one used for "YES" responses in the E task, indicated that the repetition effect was most pronounced in the 4-category condition as the R × T(A) interaction was significant ($F(1, 24) = 15.82$, $p < .001$), while the R × T(B) interaction was not ($F(1, 24) = 1.54$). Stimulus familiairty did not interact with either component of the T variable while practice interacted significantly with T(A) ($F(1, 24) = 6.34$, $p < .05$), but not with T(B) ($F(1, 24) < 1$).

In Fig. 6 the mean RTs for correct "NO" responses are presented as a function of number of categories with stimulus familiarity as the parameter, and in Table 6 the corresponding analysis of variance is summarized. The two RT functions show the same deviations from linearity which characterized the 12 functions already discussed. Figure 6 indicates that once again high-F words are responded to faster than low-F words and that stimulus familiarity interacted with the number of categories. Table 6 confirms both of these statements as both F and F × T were significant sources of variance.

A component analysis of the F × T interaction indicated that it was based mainly on the differences between RTs to high-F stimuli and RTs to low-F stimuli in the 4-category condition, the F × T(A) interaction being significant ($F(1, 24) = 6.25$, $p < .05$) while the F × T(B)

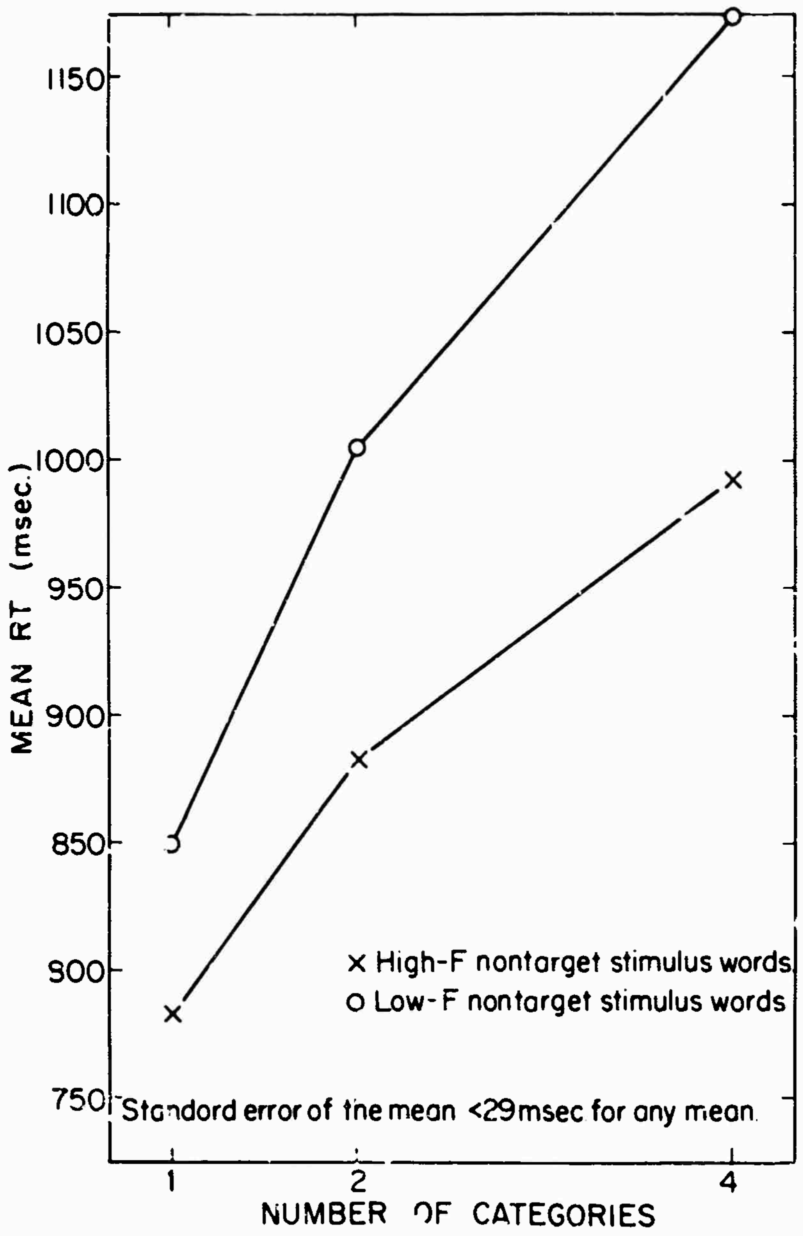

Fig. 6. Mean RTs for "NO" responses in Category conditions as a function of number of categories, with stimulus familiarity as the parameter.

Table 6

ANALYSIS OF VARIANCE OF CORRECT "NO" REACTION TIMES: CATEGORY TASK

Source	df	MS	F	p
Between Ss				
T (Number of targets)	2	27424	12.32	<.001
Ss within groups	24	2226		
Within Ss				
F (Familiarity)	1	17358	62.22	<.001
F × T	2	1109	3.97	<.05
F × Ss within groups	24	279		
P (Practice)	1	2836	16.20	<.001
P × T	2	887	5.07	<.05
P × Ss within groups	24	175		
F × P	1	24	<1	NS
F × P × T	2	11	<1	NS
F × P × Ss within groups	24	28		

interaction was not, $(F(1, 24) = 1.72)$. Practice also interacted significantly with T(A) $(F(1, 24) = 10.08, p < .01)$, but not with T(B) $(F(1, 24) < 1)$.

It is possible that the finding that high-F stimuli were responded to faster than low-F stimuli in the C task is due to an artifact of the experimental procedure. The Ss were instructed to press either button if they did not know the meaning of a stimulus word and to inform E of this immediately. These latencies were then discarded. The mean number of times that this occurred in an experimental session was 2.7 (all cases being low-F words), which is quite low considering how rare some of the words were. If on numerous occasions Ss did not know the meaning of a stimulus but did not inform E of this, then by chance half of these latencies would be added to the correct response latencies.

Since Ss were not attempting to respond quickly when they did not know what a word meant and since only low-F words were ever judged incomprehensible, the above would result in high-F words being responded to faster than low-F words.

To check this hypothesis three high-F stimulus words (the color names, BLACK, GREEN and YELLOW) and two low-F stimulus words (the color names BEIGE and INDIGO), which were never judged incomprehensible by any S in the experiment, were selected. Since it seems reasonable to assume that the meanings of these five words were always known by all Ss, then if the above artifact was indeed the source of the obtained familiarity effect there should be no difference between RTs to the two low-F color names and RTs to the three high-F color names. In point of fact the average difference between the low- and high-F color names (160 msec.) was of the same magnitude as that found when all stimuli were considered (140 msec.). Since these five words are all members of the same category (colors) this finding also indicates that the familiarity effect found in the C task can be obtained within a given category and thus is not dependent on differential category familiarity or difficulty.

A comparison of the two functions in Fig. 6 with the upper two functions in Fig. 4 clearly shows that correct "NO" responses took, on the average, about 100 msec. longer than correct "YES" responses. This comparison also indicates that the difference between "NO" and "YES" RTs increases with the number of categories for low-F words, but not for high-F words.

An analysis of the error frequencies indicated that the effect of the number of categories cannot be attributed to differences in Ss' accuracy criteria, as the percentage of responses that were in error for the C1, C2 and C4 conditions were 2.5, 3.6 and 4.0, respectively. A positive correlation between latencies and error rates also obtained for the other major variables in the experiment since the percentage of Ss' responses that were in error was greater (a) when responding to low-F stimuli (4.7) than when responding to high-F stimuli (2.3), (b) when responding to the first occurrence of a target stimulus (6.8) than when responding to its second occurrence (1.0), (c) in the first half of the experiment (3.6) than in the second half (3.1), and (d) when making a "NO" response (4.2) than when making a "YES" response (3.0). The latencies of the error responses again showed the same relations as the latencies of the correct responses with respect to all major variables.

Appendix B contains the mean RTs and error rates for all of the conditions represented in Figs. 1-6 discussed in this section.

CHAPTER IV

DISCUSSION

One of the major intentions of the present study was to utilize the RT functions obtained in the E task to localize the effect of familiarity within the recognition process. An effect of familiarity on the shape of these RT functions (i.e., an interaction of familiarity with the number of targets) was to be interpreted as an effect on the memorial comparison process, while an effect of familiarity on the vertical displacements of these RT functions was to be interpreted as an effect on the read-in process. Such a localization depends on the assumption that the obtained RT functions in the E task reflect only that comparison process upon which perceptual recognition is based. The following considerations, based on the data for both the E and C tasks, indicate that this assumption is not supported, and that the RT functions for the E task reflect a memorial comparison process which occurs after the stimulus has been recognized.

A comparison of the latencies of correct "YES" responses to first occurrences of high-F words in the E task (see Fig. 1) with the latencies of correct "YES" responses to first occurrences of high-F words in the C task (see Fig. 4) can be shown to lead to a contradiction, if it is assumed that the RT functions for the E task reflect only that comparison process which underlies perceptual recognition. Specifically, the mean RT for the C1 condition (669 msec.) is approximately the same as that for the E2 condition (666 msec.). This implies that the time needed to recognize a stimulus drawn from a set of two alternatives is equal to the time needed to recognize the same stimulus drawn from a larger set of alternatives (assuming that the number of perceptual alternatives for an S in the C1 condition must be greater than two) plus the time needed to categorize that stimulus on the basis of its meaning. This in turn implies (1) that recognition time is independent of the number of alternative stimuli, and (2) that the categorization process occurs simultaneously with recognition. The first implication is refuted by the RT function for correct "YES" responses to first occurrences in the E task which indicates that recognition time increases by approximately 45 msec. (one third of the difference between the mean RT for the E4 condition and the mean RT for the E1 condition) when the set of alternative stimuli is increased by one. The second implication can be refuted by the logical consideration that categorization cannot overlap with recognition since it is impossible for S to determine the meaning of a word before he has recognized it.

To resolve this apparent contradiction it must be assumed that the RTs for the E task reflect perceptual recognition plus an additional judgmental process, and that it is the latter which is responsible for the 45 msec. increase in mean RT concommitant with an increase of one in the size of the target set. This assumption can be justified by the following considerations. First, if the RT function for the E task truly reflected only differences in recognition time, then on the basis of the 45 msec. increase noted above we would be forced to predict that the time required to recognize correctly a word randomly selected from a set of 500 words would be greater than 20 sec. This extrapolation argument is weakened by the fact that all obtained RT functions are negatively accelerated, rather than linear. However, even if we consider only the second segment of the RT function (which is characterized by a shallower slope than the first) the estimate of the increase in recognition time resulting from an increase of one in the set of alternative stimuli is 31 msec., and the predicted time needed to recognize correctly a word randomly drawn from a set of 500 words would still be greater than 15 sec.

The second relevant consideration is that in studies by Pierce and Karlin (1957) and Conrad (1962) which required speeded identifying responses to suprathreshold verbal stimuli, i.e., reading lists of either nonsense syllables or random words, the increase in mean RTs which resulted from increasing the number of alternatives by one were as low as .17 msec. and .35 msec., respectively. These times, which are more than two orders of magnitude less than the comparable times obtained in the present study, would seem to be far more reasonable estimates of the perceptual system's sensitivity to the number of alternative stimuli.

However, these two reading rate experiments are not completely comparable to the present study since in these reading experiments S was exposed to a list of stimulus items, while in the present experiment S responded to a single stimulus word before the next one was presented. It is possible that when S has to name each item on a list in front of him, he can start to recognize items which follow the one he is currently naming, i.e., recognition of the nth + 1 stimulus may partially overlap the naming of the nth stimulus. This could result in underestimating the increase in recognition time per unit increase in the number of alternative stimuli. But naming RTs have also been obtained in an experiment by Fitts and Switzer (1962), in which a response was required to a single stimulus item (a letter or a numeral) before the next one was presented and a variation of the number of alternative letters or numerals was included. Estimates of the increase in recognition time resulting from an increase of one in the number of alternative letters or numerals were never greater than 5 msec., which is still approximately an order of magnitude less than the comparable estimates obtained in the present experiment.

Thus we may conclude that an additional judgmental process, which is far more sensitive to the size of the target set than is perceptual recognition, was involved in the E task. It is likely that this additional process is a memorial comparison process which occurs after the stimulus is recognized. That is, the stimulus is recognized (or labelled) and then this label is compared to labels of the targets stored in memory. It is on the outcome of these comparisons between labels that Ss' "YES"-"NO" decisions are based.

The above argument depends in part on the fact that the equivalence of the mean RTs for certain responses in the E2 and C1 conditions (viz., correct "YES" responses to first occurrences of high-F words) can lead to a contradiction. It is thus necessary to consider an alternative explanation of this equivalence which does not lead to such a contradiction. Specifically, it is possible that when a category name was presented in the C1 condition S implicitly enumerated or primed certain common instances of this category, and then was "set" only for these primed associations. If the number of associations that S primed varied between one and four from trial to trial, then a relatively high degree of accuracy could be obtained for "YES" responses to first occurrences of high-F words, and the corresponding mean RT should be in the range of the obtained mean RTs for "YES" responses in the E task. ("NO" responses or "YES" responses to low-F words in the C task might involve more processing of the stimulus information since the stimuli associated with these responses would not be likely to be primed. Thus mean RTs for "NO" responses and "YES" responses to low-F stimuli would not overlap with the mean RTs for the E condition.) If such associative priming did facilitate the RTs to high-F stimuli in the C1 condition, then the variability associated with these RTs should be greater than that associated with the comparable RTs for the E2 condition. This is because S supposedly primes a variable number of associations or items in the C condition while he always primes only two items (viz., the two targets) in the E2 condition. However, the standard deviation of the RTs to first occurrences of high-F stimuli in the C1 condition (157 msec.) was in fact less than the standard deviation of the RTs to first occurrences of high-F stimuli in the E2 condition (185 msec.), thus indicating that an associative priming interpretation of the obtained data is inadequate.

The present study's failure to measure only perceptual recognition in the E task cannot be attributed to the relatively long exposure durations used. In a similar experiment Sternberg (1964) determined RT functions for conditions in which each stimulus was exposed for 44 msec. and for conditions in which each stimulus was exposed until S made his response (ca. 400 msec.). The two obtained linear RT functions were virtually identical and both were characterized by slopes (35 msec. per target) which are far too great to be reflecting simply the influence of the number of alternatives on recognition.

It seems then that the process underlying the obtained RT functions in Sternberg's and the present experiment was a label comparison process rather than recognition. Similar experiments by Nickerson and Feehrer (1964), Chase and Posner (1956), Nickerson (1965) and Egeth and Smith (1965) also yield estimates of the increase in "recognition" time per unit increase in size of set. These estimates range from 25 to 65 msec. and so these four studies are also mainly concerned with a label comparison process. It may even be the case that all of the forced choice studies reviewed in the introduction also involved this process. However, since none of those studies both measured latencies and included a manipulation of the size of the set of alternatives, estimates like those cited above cannot be determined. When such estimates were obtained for the data of Pierce and Karlin (1957), Conrad (1962) and Fitts and Switzer (1962), they were too low to be indicative of this label comparison process.

In summary, all those studies which have varied size of set and required a "YES"-"NO" decision have yielded RT functions which are based on a memory process that follows recognition. That is, categorization of a stimulus in an RT task may involve more than just the immediate recognition of a stimulus. Consequently the "YES"-"NO" RT task, and possibly other forced-choice methods, may be of limited usefulness in investigating the effects of stimulus familiarity on recognition. Although reading rate or naming experiments seem to yield RT functions which do not reflect this memory process, such experiments require naming responses to verbal or alphanumeric stimuli; thus they cannot be used to study the effect of stimulus familiarity since they, like tachistoscopic recognition experiments, confound stimulus and response familiarity. However, these experiments are useful in determining an estimate of the perceptual recognition process' sensitivity to the number of alternative verbal or alphanumeric stimuli, since the stimuli must certainly be recognized before they can be named and since "...reading aloud attains the fastest rate at which a human being can be demonstrated to transmit information" (Pierce and Karlin, 1957, p. 492).

In view of the above what can be said about the nature of the obtained familiarity effect in the E task--is it due to a facilitation of perceptual recognition or of the subsequent memory process? For "YES" responses the familiarity of the targets affected only the vertical displacement of the RT function, while for "NO" responses the familiarity of the targets interacted with the number of targets, and affected only the shape the function. Since the nature of the familiarity effect depended c outcome of the label comparing process, it could not possibly be due to recognition which occurred before this process. (It should be noted that since judged familiarity and judged value were correlated, any effect attributed to familiarity may be due in part to value.)

This difference between the effect of familiarity on "YES" responses and its effect on "NO" responses suggests that its role in the label comparison process is a complicated one. One hypothesis that is consistent with most of the obtained data is that S responds faster when the target sets are high-F than when they are low-F because in the latter case S checks his decision. When the comparison process indicates that a "YES" response should be made, S checks only that one comparison which yielded a positive answer and thus the extra time taken to respond "YES" when the targets are low-F is independent of the total number of comparisons or targets; when the comparison process indicates that a "NO" response should be made, S checks all comparisons (targets) and thus the extra time taken to respond "NO" when the targets are low-F is directly related to the total number of comparisons or targets. However, if the time needed to check a single comparison is assumed to be the same for both of these cases, then the effect of familiarity in the 2- and 4-target conditions should be greater for "NO" responses than for "YES" responses, since more checks must be made for the former. An examination of Figs. 1 and 3 yields no support for this predication. Thus if the assumption of a differential check for "YES" and "NO" judgments is to be maintained, it must be further assumed that the time needed to make a single check is longer for "YES" judgments than for "NO" judgments. The assumption that low-F target sets are associated with longer RTs than high-F target sets because a check is necessary for the former, could be tested by varying the instructional emphasis on speed. If instructions are used which emphasize speed at the expense of accuracy, then the difference between the RTs to low- and high-F target sets would be expected to decrease.

Other characteristics of this label comparison process are also discernible from the present data. Since mean RT increases markedly with the number of targets, part of this process must be carried out sequentially. However, a strict serial model of this process seems inappropriate even for the first occurrences of stimuli, since the relevant RT curves show deviations from linearity, viz., the slope of these functions between 1- and 2-targets is steeper than that between 2- and 4-targets. This deviation from linearity might indicate that some parallel processing is occurring in the 4-target condition or that the extra time spent memorizing 4-word target sets results in a faster retrieval of the target labels.

These deviations from linearity are augmented by a single repetition of the stimuli. Previous research (Neisser et al., 1963; Egeth and Smith, 1965) has shown that practice in this kind of recognition task initially produces its greatest facilitative effect on the condition associated with the largets number of targets. Practice in these studies involved (1) repeated presentations of the stimuli, and (2) experience with the task and with the required responses. The present experiment permitted a separation of these two factors and indicated that in this study repetition of the stimuli was primarily responsible for the disproprotionate reduction of the RTs associated with the 4-target condition. However, there is some question of whether this result can be generalized to the Neisser _et al._, and the Egeth and Smith experiments, since the latter two studies used alphanumeric characters as stimuli while the present study used meaningful words.

As expected, stimulus familiarity had a great effect on performance in the C task. In order to make a response in this task _S_ had to recognize the stimulus word and then, based on an interrogation of stored information about this word, decide whether or not it was a member of any of the specified categories. In view of the results for the E task we can assume that familiarity did not influence recognition, and thus familiarity must have affected either the time needed to retrieve the memorial information or the time needed to test it.

Any attempt to specify whether retrieval or testing or both were affected by familiarity must be preceded by a consideration of how the relevant information is filed in memory. The use of the word "filed" indicates that the conception of memory storage which underlies the following is one that likens the organization of memorial information to the organization of a filing cabinet. The information that _S_ must interrogate before making a response is contained in one or more drawers of this cabinet, and this information is said to be filed under the name used to designate that drawer(s). The retrieval process consists of finding the appropriate drawer as quickly as possible.

If we hypothesize that the relevant information is filed under the category name then retrieval time as well as testing time must increase with the number of category names, assuming that _S_ retrieves and tests the information about one category before considering the next one. Since the RT differences due to familiarity are due to changes in either retrieval or testing time and since both retrieval and testing time increase with the number of categories, any obtained familiarity effect must appear in the form of an interaction with number of categories. This hypothesis about the organization of the relevant memorial information can be rejected on the basis of the data for "YES" responses alone which show a significant familiarity effect but no significant interaction of familiarity with the number of categories.

If we hypothesize that all the necessary information is filed under the stimulus word, then retrieval time is independent of the number of categories since once this source of information is located no further memory search is necessary. Therefore, testing time must be directly related to the number of categories sinc RTs in the C task were directly related to this variable. Thus if familiarity affects retrieval time the effect will appear in the vertical displacement of the RT functions for both "YES" and "NO" responses, while if it affects testing time the effect will appear in the form of an interaction of familiarity with the number of categories. The obtained data show that for "YES" responses, familiarity affected only the vertical displacement of the RT function while for "NO" responses, familiarity interacted with the number of categories and also affected the vertical displacement of the RT function. Consequently these data are consistent with the present hypothesis about the organization of memorial information, thus permitting the conclusion that familiarity affected both the retrieval and testing of this information. However, the effect of familiarity on the vertical displacement of the RT function was far greater for "YES" responses than for "NO" responses and familiarity interacted with number of categories only for "NO" responses. As was the case when considering the results for the E task, the different effects of familiarity on "YES" and "NO" responses is difficult to account for. The hypothesis that S checks his decisions about low-F words, and the check for "YES" judgments involves one test while the check for "NO" judgments involves as many tests as there are categories, is again a possibility.

The above qualitiative model of the processes involved in the C task has the same basic form as that proposed for the E task. In both tasks the response is contingent upon a decision which is based on memorial information, and so both tasks require recognition of the stimulus, retrieval of the relevant memorial information and a testing or comparison process which eventuates in a decision. This sequence of events which supposedly fills the latent period in both tasks may be represented as follows: Recognition → Retrieval → Testing → Response. (Note that checking a decision is part of the testing process.) Since the responses in all conditions in both tasks were identical, this study did not involve any manipulation of the response stage. Though an attempt was made to influence the duration of the recognition stage, it appears that variations in the duration of this process made a negligible contribution to the obtained variations in RTs. Thus the experimental variables within a task primarily affect the two intermediate stages of the above sequence--retrieval and testing.

The differences between the RT functions for the E and C tasks imply that there were substantial differences in the duration of the retrieval and testing mechanisms involved in these two tasks. For example, the RT functions for the C task were steeper than those for the E task, which indicates that the duration of the testing process is greater when S must categorize a stimulus on the basis of its meaning than when S must simply compare a label of the stimulus to a small set of labels stored in memory. Similarly, the vertical displacement of the RT functions for the C task were greater than those for the E task, particularly when the former are based on low-F stimuli. These differences may well be due to differences in the time needed to retrieve the necessary information. When a small set of target words is enumerated to S they may be held in a rapid access temporary storage and S's retrieval problem is somewhat trivial. However, in the C task, S did not know what memorial information he needed until the stimulus appeared, and thus a good deal of the latent period might have been consumed by the retrieval of this information.

Thus the research strategy of associating different parameters of the RT functions with different processes occurring during the latent period and investigating the effects of experimental variables on these parameters, has produced further information about the nature of these hypothesized processes. Classifying a stimulus on the basis of whether it was the same as or different from an item(s) stored in memory seemed to involve a memory process, which occurred after recognition and which was sensitive to the number of stored items and their familiarity. Classifying a stimulus on the basis of category membership seemed to involve the retrieval of stored information, which was sensitive to stimulus familiarity, and a testing process which was influenced by stimulus familiarity and the number of possible categories that the stimulus word could belong to.

CHAPTER V

SUMMARY

The effects of familiarity on the processing of stimulus and memorial information were investigated in two tasks: one which supposedly required only the perceptual recognition of each stimulus word (E task), and one which required a meaningful categorization of each stimulus word (C task).

An examination of the method commonly used to study perceptual recognition, the tachistoscopic recognition threshold procedure, indicates two liabilities of utilizing this method: (1) it may confound stimulus and response familiarity; (2) it fails to measure the stimulus-response interval, during which a great deal of the perceptual information processing may be occurring. A number of experiments have circumvented the first liability by controlling response familiarity, but these studies may have introduced other artifacts, viz., paired-associate learning and letter searching strategies. With regard to the second liability, perceptual recognition may be considered a two stage process--formation of a stimulus representation followed by a testing or comparison between this representation and memorial information--and these two stages may occur during the unmeasured stimulus-response interval in tachistoscopic recognition studies.

The method used to study the effects of familiarity on recognition in this thesis (the E task) was developed by Sternberg (1964), and seems capable of measuring separately both stages of perceptual recognition and minimizing the occurrence of response biases, learning effects and letter searching strategies. At the start of each trial a target set of words was enumerated to S who was instructed to press a "YES" button if the stimulus word to be presented was a member of this target set, and to press a "NO" button otherwise. The size of the target set was either 1, 2 or 4 and Ss response time (RT) was the performance index. The vertical displacement of the function relating RT to the number of target words was assumed to reflect the formation of the stimulus representation while the shape of this function was assumed to reflect only the comparison process which underlies perceptual recognition. Both target and nontarget stimulus words varied with respect to familiarity, and the effects of this variable on the vertical displacementsand the shapes of the RT functions for "YES" and "NO" responses were the prime data of conern.

To study the effects of stimulus familiarity on the processes involved in categorizing a stimulus on the basis of its meaning (C task), S was instructed to press a "YES" button when the stimulus word was a member of any one of a predefined set of categories, and to press a "NO" button otherwise. The number of categories was either 1, 2 or 4 and RT was again used as the performance index. The effects of stimulus familiarity on the vertical displacements and the shapes of the functions relating RT to number of categories for "YES" and "NO" responses were the important data. The exact same list of stimulus words was used in both the E and C tasks, and in both tasks the target stimuli were repeated.

The results showed that in both tasks: (1) all obtained RT curves were characterized by a steeper slope between 1- and 2-targets than between 2- and 4-targets; (2) the second occurrence of a word was responded to faster than its first occurrence, this facilitation being greatest for the 4-target and 4-category conditions. In the E task

"YES" responses were faster when the stimulus (and consequently the target set) was familiar than when it was unfamiliar, and this beneficial effect of familiarity influenced the vertical displacement of the RT function but not its shape. Repetition changed neither the magnitude nor the form of this effect. "NO" responses were faster when the target words S was looking for were familiar than when they were unfamiliar, and this effect influenced only the shape of the RT function. In the C task familiar stimulus words were responded to faster than unfamiliar words, for both "YES" and "NO" responses. For "YES" responses familiarity affected only the vertical displacement of the RT function while for "NO" responses it affected both the vertical displacement and the shape of this function. A single repetition of a stimulus word substantially reduced the magnitude of familiarity's effect on "YES" RTs.

A comparison of the data for the two tasks and a consideration of the slopes of the RT functions obtained in the E task indicated that these functions reflected a memory process that follows recognition, rather than the recognition process itself. Moreover, it was this memory process, rather than recognition, which seemed to be sensitive to the familiarity variation. In the C task it appeared that familiarity affected both the retrieval and testing of the stored information about the meanings of the stimulus words.

APPENDIX A

LISTING OF ALL STIMULUS WORDS AND THEIR CHARACTERISTICS

A Thorndike-Lorge rating of A indicates that the word's frequency of occurrence was 50 or more per million but less than a 100 per million, while a rating of AA indicates a frequency of 100 or more per million.

Target Stimulus Words:

Stimulus Word	Category	Cohen *et al.* Rating	Thorndike-Lorge Rating	Familiarity Rating	Value Rating
chair	furniture	392	AA	1.28	2.78
table		346	AA	1.32	2.34
divan		4	3	3.86	3.14
rocker		1	2	2.40	3.08
black	colors	62	AA	1.46	3.96
green		282	AA	1.34	2.32
yellow		222	AA	1.38	3.52
beige		1	1	2.62	3.10
indigo		-	5	2.74	2.48
tiger	animals	30	30	2.04	4.08
horse		209	AA	1.52	2.68
lynx		2	7	3.84	3.91
sloth		2	4	3.20	4.77
weasel		1	9	2.54	4.60
church	religious buildings	391	AA	1.34	2.34
vestry		2	2	4.22	3.29
abbey		1	11	2.94	2.96
hammer	tools	373	34	1.56	2.90
mallet		2	3	2.18	3.63
wedge		5	11	1.94	3.16

Target Stimulus Words (Continued):

Stimulus Word	Category	Cohen *et al.* Rating	Thorndike-Lorge Rating	Familiarity Rating	Value Rating
dress	clothes	123	AA	1.32	2.68
skirt		161	A	1.46	2.30
cape		1	34	2.06	3.22
cloak		1	28	2.57	3.67
train	vehicles	161	AA	1.58	2.58
truck		149	23	1.44	2.36
sleigh		1	7	2.08	2.26
buggy		3	7	2.09	3.24
window	building parts	220	AA	1.34	2.22
floor		126	AA	1.20	2.78
stair		54	A	1.60	2.92
alcove		1	3	3.32	2.87
foyer		1	1	3.84	2.68
arch		2	34	2.20	3.12
priest	clergymen	383	42	1.55	2.42
minister		328	A	1.78	2.96
bishop		93	40	2.24	2.46
vicar		4	3	3.24	3.04
rector		3	6	3.10	3.18
house	dwellings	359	AA	1.24	2.34
hotel		55	A	1.56	2.68
cabin		49	A	1.66	2.34
pueblo		5	2	3.18	3.44

Target Stimulus Words (Continued):

Stimulus Word	Category	Cohen *et al.* Rating	Thorndike-Lorge Rating	Familiarity Rating	Value Rating
knife	weapons	306	A	1.44	3.78
sword		111	A	1.89	3.87
lance		1	16	2.82	3.86
mace		1	3	4.62	4.15
head	body parts	220	AA	1.26	2.06
foot		134	AA	1.28	2.52
gland		1	5	2.14	2.90

Nontarget Stimulus Words:

Stimulus Word	Thorndike-Lorge Rating	Familiarity Rating	Value Rating
charm	A	1.62	2.12
noble	A	1.80	2.02
clean	AA	1.22	2.14
dinner	AA	1.28	2.14
track	A	1.68	2.90
grand	A	1.72	2.90
hollow	A	2.24	4.14
began	AA	1.78	3.06
indeed	AA	1.94	3.02
times	AA	1.54	3.18
honor	AA	1.44	1.86
land	AA	1.20	2.24
bond	A	1.62	2.78

Nontarget Stimulus Words (Continued):

Stimulus Word	Thorndike-Lorge Rating	Familiarity Rating	Value Rating
month	AA	1.20	2.48
wealth	A	1.44	2.28
above	AA	1.58	3.08
handle	A	1.76	2.84
manner	A	1.32	2.56
large	A	1.42	3.32
dream	AA	1.56	2.24
smart	A	1.44	2.30
cross	AA	1.64	2.94
score	A	1.74	2.90
rope	A	1.84	3.70
class	A	1.32	3.44
trade	AA	1.54	2.72
trail	A	1.74	2.86
slowly	A	1.36	4.14
built	AA	1.58	2.50
winter	AA	1.34	2.86
float	A	1.62	2.56
stamp	A	1.58	2.74
almost	AA	1.64	4.06
offer	AA	1.54	2.56
area	A	1.88	3.14
dead	AA	1.40	5.08
better	A	1.48	2.70
clear	AA	1.40	2.26

Nontarget Stimulus Words (Continued):

Stimulus Word	Thorndike-Lorge Rating	Familiarity Rating	Value Rating
reduce	A	1.82	3.40
season	AA	1.58	2.50
hours	AA	1.36	3.06
steel	A	1.94	2.24
grain	A	1.55	2.46
public	AA	1.32	3.14
known	AA	1.56	2.58
sweet	AA	1.56	2.52
price	AA	1.52	3.44
many	AA	1.14	2.70
help	AA	1.40	2.56
spot	AA	1.50	4.22
glass	AA	1.40	2.46
beach	A	1.54	1.86
chafe	5	3.10	4.59
tacit	1	3.92	2.69
harem	2	2.67	3.00
dirge	3	3.86	4.47
robust	4	2.46	2.56
bloat	1	2.80	4.68
graze	16	2.40	2.98
merge	6	2.18	3.12
indent	3	2.06	3.36
farce	5	2.54	4.24
lyre	6	2.78	2.60

Nontarget Stimulus Words (Continued):

Stimulus Word	Thorndike-Lorge Rating	Familiarity Rating	Value Rating
sloop	2	2.84	2.74
welter	2	4.66	4.56
cherub	4	3.46	2.53
paltry	3	3.70	4.48
abate	7	3.64	3.08
haggle	1	2.76	4.84
malady	6	3.08	4.88
wench	4	2.52	4.30
skull	12	3.36	2.06
carp	1	2.94	4.22
cask	5	3.32	3.37
freak	5	2.28	5.20
basin	25	2.46	3.04
tread	26	2.44	3.62
slcuch	3	2.30	5.08
seethe	5	3.98	3.61
bulge	5	2.14	4.46
winded	1	2.56	4.44
valor	8	2.02	2.40
flair	1	2.48	2.50
allege	12	2.78	3.95
forge	17	2.32	2.98
primal	1	3.64	3.63
mightily	2	2.08	3.12
bisect	1	2.14	3.22

Nontarget Stimulus Words (Continued):

Stimulus Word	Thorndike-Lorge Rating	Familiarity Rating	Value Rating
molar	1	2.38	3.24
recede	4	2.46	3.60
hoist	10	2.71	2.95
libel	2	2.58	5.36
cabal	1	5.62	4.05
knave	18	3.26	4.69
swirl	7	2.18	3.04
lice	1	2.56	5.10
hack	7	2.50	4.68
helm	13	2.74	2.58
foal	1	3.62	3.19
glaze	9	2.38	3.44

APPENDIX B

MEAN REACTION TIMES AND ERROR RATES FOR MAJOR EXPERIMENTAL CONDITIONS

Enumeration Task: Correct "YES" RTs and Error Rates

Condition	Mean RT (msec.)	Percentage of Responses in Error
1-target, high-F stimuli, first occurrence	582	2.8
1-target, high-F stimuli, second occurrence	562	2.6
1-target, low-F stimuli, first occurrence	606	4.2
1-target, low-F stimuli, second occurrence	585	3.1
2-target, high-F stimuli, first occurrence	666	1.8
2-target, high-F stimuli, second occurrence	663	3.9
2-target, low-F stimuli, first occurrence	681	3.9
2-target, low-F stimuli, second occurrence	681	3.3
4-target, high-F stimuli, first occurrence	728	4.2
4-target, high-F stimuli, second occurrence	686	3.9
4-target, low-F stimuli, first occurrence	753	6.8
4-target, low-F stimuli, second occurrence	708	3.0

Enumeration Task: Correct "NO" RTs and Error Rates

Condition	Mean RT (msec.)	Percentage of Responses in Error
1-target, high-F stimuli, high-F target sets	605	2.9
1-target, high-F stimuli, low-F target sets	594	1.0
1-target, low-F stimuli, high-F target sets	603	2.3
1-target, low-F stimuli, low-F target sets	606	2.8
2-target, high-F stimuli, high-F target sets	700	1.2
2-target, high-F stimuli, low-F target sets	698	1.5
2-target, low-F stimuli, high-F target sets	690	1.6
2-target, low-F stimuli, low-F target sets	711	2.2
4-target, high-F stimuli, high-F target sets	705	.7
4-target, high-F stimuli, low-F target sets	713	1.5
4-target, low-F stimuli, high-F target sets	697	.5
4-target, low-F stimuli, low-F target sets	737	.5

Category Task: Correct "YES" RTs and Error Rates

Condition	Mean RT (msec.)	Percentage of Responses in Error
1-category, high-F stimuli, first occurrence	669	1.8
1-category, high-F stimuli, second occurrence	613	0
1-category, low-F stimuli, first occurrence	810	6.8
1-category, low-F stimuli, second occurrence	692	1.1
2-category, high-F stimuli, first occurrence	773	4.5
2-category, high-F stimuli, second occurrence	686	1.4
2-category, low-F stimuli, first occurrence	899	10.4
2-category, low-F stimuli, second occurrence	754	2.2
4-category, high-F stimuli, first occurrence	851	7.0
4-category, high-F stimuli, second occurrence	709	0
4-category, low-F stimuli, first occurrence	1006	10.8
4-category, low-F stimuli, second occurrence	783	1.4

Category Task: Correct "NO" RTs and Error Rates

Condition	Mean RT (msec.)	Percentage of Responses in Error
1-category, high-F stimuli	783	1.6
1-category, low-F stimuli	849	3.5
2-category, high-F stimuli	882	2.0
2-category, low-F stimuli	1005	3.3
4-category, high-F stimuli	991	2 3
4-category, low-F stimuli	1176	4.6

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13. ABSTRACT

The effects of stimulus familiarity on the processing of stimulus and memorial information were investigated in two tasks: one which supposedly required only the perceptual recognition of each stimulus word (E task), and one which required a meaningful categorization of each stimulus word (C task).

A comparison of the data for the two tasks and a consideration of the slopes of the RT functions obtained in the E task indicated that these functions reflected a memory process that follows recognition, rather than the recognition process itself. It was this memory process, rather than recognition, which seemed to be sensitive to familiarity. In the C task it appeared that familiarity affected both the retrieval and testing of the stored information about the meanings of the stimulus words.

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
1. Perceptual recognition of verbal items						
2. Paired-associate learning						
3. Reaction times						
4. Stimulus familiarity						

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