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STIMULUS FAMILIARIZATION
PRIOR TO PACED VERBAL PAIRED-ASSOCIATES LEARNING

by Hildegard Corbet

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CHAPTER I

REVIEW OF THE LITERATURE

1. Familiarization studied in relation to other attributes of meaningfulness

The subject of this thesis is the effect that frequent experience of a word has on the ease with which that now familiar word can be associated with other words.

In the tradition of associationistic psychology, it has become truistic to assume that a word or an object experienced frequently becomes familiar. Events following each other frequently in time or space are easily associated with one another. The effect of frequency on the strength of associations is seen in learning situations, as for instance when children learn the use of words, starting with the names of the objects most familiar to them (Mill, 1878). But apart from strengthening any association between events, or verbal items, the frequency with which any single item is experienced might also be thought to increase its "availability" (Thorndike, 1931). As Thorndike says, "the repetition of a situation does, of course, increase familiarity with it". Robinson (1932) suggests that "the act of reading or reciting a given syllable may ... influence the facility with which that act enters into new

associations". Carr (1925) points out that habit "increases the ease and readiness of the act and gives it coherence and stability". Waters (1939) tested Robinson's suggestion, but concluded, after having found no facilitation of subsequent tasks through familiarization of verbal material, that the concept of acquaintance may be a "logically separable factor, but cannot be experimentally isolated".

During the last few decades familiarity and other attributes of verbal material correlated with ease of learning have been studied intensively in the laboratory in order to establish valid and reliable correlational and experimental laws. Two laboratories in particular have been involved in these studies:

Noble (1953) regarded the familiarity of a verbal stimulus as some function of its frequency of occurrence in an organism's history, through "vision or audition, by means of speech (spoken or implicit) or by writing". Noble assumed, from his analysis of meaning (1952) that verbal stimuli acquire meaningfulness (m) value as some increasing function of frequency of experience (n). He used these premises to infer a positive correlation between familiarity (f) and m , through their postulated correlation with n . Frequency of experimentally induced stimulation with dissyllabic paralogues like "quipson" or "jetsam" and the judged familiarity with these 96 paralogues yielded a hyperbolic function (Noble, 1954). In these experiments, familiarity was defined as the frequency

with which the subjects "thought they had experienced the items", that is "seen, heard, used", and "come in contact with" them. Rated familiarity showed a correlation of .92 with Noble's meaningfulness (m). Proficiency in learning words as lists or pairs was found to vary directly with m or rated meaningfulness (m'). As m is related to n , differential familiarization through an increase in the number of experiences (n) with items prior to paired associate list learning should produce a difference in ease of learning. This supposition led to so-called "familiarization experiments".

Underwood and Schulz (1960) studied the correlates of the several factors that constitute meaningfulness, in order to be able to isolate the particular attributes of this complex that contribute most to differences in learning, and in order to test their hypotheses about the two-stage learning of lists of pairs of words. When subjects were asked to indicate what characteristics they had used to make their ratings concerning the ease of learning of verbal material, three characteristics were most frequently mentioned: the number of associations elicited, familiarity, and pronunciability. Judged familiarity was shown to be a direct "consequence of frequency" (Underwood and Schulz, 1960), that is of experience of the judged items. As a consequence of this, the effects of familiarization prior to paired-associate learning were tested.

Before the experiments on stimulus familiarization are mentioned, several terms which will be involved in their description need to be defined.

Verbal stimulus (S) refers to a complete verbal item to which a subject is asked to respond. It is recognized, however, that the functional stimulus (that aspect of the verbal stimulus to which the subject is momentarily attending) may be only part of this complex item (Underwood, 1963).

In a verbal paired-associates (PA) learning task, S is first presented alone to the subject, then the same S is presented again together with the verbal response (R) that is to be associated with it. The interval between the onset of the presentation of S to that of the pair is called the anticipation interval; the interval between the pair and the following S is the correction interval. The subject is asked to anticipate R when he sees the S presented singly, i.e. during the anticipation interval.

The formal similarity of verbal items in a list is said to exist to the extent that these items feature the same or closely similar letters or sounds in the same sequence.

Familiarization (F) refers to the experimental increase in experience of items for a number of times (n) prior to the instruction to associate the familiarized items with other verbal items in the paired-associates learning list. The familiarized item may be used as a

stimulus or a response in subsequent PA learning; these two procedures are called S familiarization (SF) and R familiarization (RF) respectively.

Meaningfulness (m) as defined by Noble refers to the number of associations a verbal item elicits per 60 seconds (the production method). Meaningfulness (a) as defined by Glaze (1928) is the number of subjects offering an association (the single unit method). Underwood and Schulz (1960) include in meaningfulness (M) both these definitions.

A CVC is a nonsense syllable (trigram) consisting of a vowel placed between two consonants.

Relevant familiarization refers to the presentation to the subject of verbal material which is used in a subsequent paired-associates test (criterion task). Traditionally, a control group is familiarized with irrelevant material, which does not occur in the subsequent task.

2. Early experiments with familiarization prior to PA learning

Familiarization of the response members has been found to be not facilitative to PA learning under certain conditions (De Bold, 1964, using pairs of syllables during F; Gannon and Noble, 1961, using 20 F trials and then pairs of pronounced dissyllables in PA learning; Goss et al., 1962 and 1965, using 4 to 60 F trials, and mixed lists of four pairs in the PA tasks). In a number of other experiments, RF did facilitate later learning of PA lists

(Underwood, Runquist and Schulz, 1959, using adjectives of high similarity of meaning; Saltz, 1961, using R members available during PA, with Underwood's material; Schulz and Martin, 1964, using aurally presented material and 30 F trials; Noble, 1963, using CVCs and from one to 64 spelling-familiarization trials). Underwood and Schulz, 1960, for their experiments I and II, used 1, 10, 20 and 40 F presentations of nonsense syllables of low similarity and low association value, and eight pair lists in PA learning, with trigrams as stimuli and trigrams or Noble's paralogues as responses. Irrelevant RF was the control. In these experiments, as in their experiment IV, when nouns or shapes were associated with the trigrams during F, the RF facilitated PA learning. Sheffield (1946) also reported facilitation effects. All experiments featured paced PA learning, in which the S is usually presented for two seconds and then followed by the paired presentation of S and R for two seconds. When unpaced conditions were tested (Runquist and English, 1964) no such effect existed.

Findings on effects of familiarization of stimuli have been mainly negative, although in the classical experiment by Winzen (reported in Gannon and Noble, 1961) later PA learning was facilitated with SF when S (with 0 F) and R (with 20 F), and S (with 20 F) and R (with 0 F) were compared. No control pairs seem to have been included. The pronounceable familiarized syllables had been presented to the subject 20 times on the day before PA learning.

Morikawa (1959, reported in Goss and Nodine, 1965) and Cieutat (1960, reported in Goss and Nodine, 1965) lend only slight support to Winzen's observations. Both used 2 x 2 orthogonal designs with S and R members of low meaningfulness. In both experiments the unfamiliarized S-R pairs needed more trials to criterion than the other three groups.

Battig's experiment (1964, reported in Goss and Nodine, 1965) suggests some facilitative effect of SF on PA learning. A discrimination-familiarization procedure was used. Turkish words (thus equivalent to words of low meaningfulness) and dissyllables were familiarized, by selecting a word from several arranged in a matrix. In the 3 x 3 matrices, four of the other stimuli differed from the stimulus to-be-familiarized by one letter, two other stimuli by two letters, and two by positions of two of the correct letters. Each of the stimuli used subsequently in the criterion task was placed in four different cells. Four different matrices were used. The subject chose the stimulus by saying the number which indicated the location of that stimulus in the matrix. A non-correction procedure was used. Familiarization was carried out to a criterion of one perfect trial or for a maximum of ten trials. The words were then paired with each other, or with unfamiliarized words of the same type to form 12-pair mixed lists, each combination being presented by three pairs. The means of errors per pair decreased with familiarization; for the

Turkish words there were 6.94 mean errors per pair for unfamiliarized S with unfamiliarized R pairs, 6.88 for familiarized S with unfamiliarized R pairs, 5.50 for unfamiliarized S with familiarized R pairs, and 4.58 for familiarized S with familiarized R pairs. For the dissyllables the same groupings also had decreasing mean errors per pair.

Although facilitation of PA learning through prior SF was suggested by the results of the three experiments reported above, the effects were statistically nonsignificant, and the experiments have, as reference level, a group with no familiarization. Thus warm-up, learning-to-learn, and other non-specific effects were not controlled.

Gannon and Noble (1961) used five-pair lists of dissyllables of low Noble m and frequency for PA learning. During the 20 F trials for S or R, the subjects had to pronounce the dissyllables aloud. S and R were also pronounced in the 17 trials of PA learning, in which anticipation and correction interval were two seconds each. The facilitative influence of S-term familiarization on the number of correct Rs in PA learning was statistically significant at the .001 level. Groups with irrelevant F were used as a baseline for the comparisons, so that non-specific F influences were controlled.

Schulz and Tucker (1962) tried to find an explanation

for the outcome of Gannon and Noble's experiment. They suggested that there might be a direct relationship between PA performance and length of anticipation interval. Overt pronunciation of S in PA learning varied with the effective anticipation period, practiced pronunciation increasing it.

The performance was compared of subjects who did, and those who did not, pronounce S in PA, after 0, 20, or 60 F trials with overt pronunciation. Gannon and Noble's dissyllables of low m were used. Under instructions of overt pronunciation in PA the mean number of correct responses over 17 PA trials increased with the number of prior F trials. The number of correct responses decreased with the number of F trials when the subjects did not pronounce the S during PA learning. For this group it was assumed that a conflict between overt pronunciation familiarization training and instructions for covert pronunciation inhibited the responses during the two-second anticipation interval. If the anticipation interval were to be longer, then facilitation or inhibition should be reduced or eliminated.

Their next experiment tested this assumption (Schulz and Tucker, 1962). A four-second anticipation interval was used, with the same design as in the previous experiment, but with 60 relevant or irrelevant articulated F trials only. As had been hypothesized, F neither facilitated nor inhibited when the mean number of correct responses during 17 PA trials were compared. Schulz and Tucker take this as supporting their hypothesis that the

effective length of the anticipation interval covaries with the amount of SF only when the absolute length of the anticipation interval is short.

Baker and Noble (1965) confirmed that 20 SF trials with material and method of Gannon and Noble were effective with a two second but not an eight second anticipation interval, over 25 trials of PA learning. SF and the anticipation interval are both significant variables in PA task performance using the S term articulation method.

The implication of the Schulz-Tucker hypothesis, that, as reported in Schulz and Martin (1964) "if neither familiarization nor PA learning involves articulation of stimulus units, stimulus familiarization should not affect PA performance" was tested by Schulz and Martin with aural PA learning. Three trigram F treatments involved 30 trials of relevant F, 30 trials of irrelevant F, and no F. During F the experimenter spelled the trigrams aloud, one every two seconds, while the subject listened. Free recall tests were given after 10, 20 and 30 F trials. PA lists consisted of eight pairs of trigrams of low similarity of four different levels of pronunciability as familiarized items and numbers as non-familiarized items in either S or R. The study recall method was employed for PA learning. The mean number of correct responses over 15 trials of PA learning did not differ with relevant and irrelevant SF.

Several studies give evidence of no effect or even a slightly inhibitory effect of SF on PA learning. Battig, Williams and Williams (1962) presented pairs of low M CVC trigrams during pretraining, in which one syllable was considered correct and had to be pronounced when the pair was shown. PA learning was not facilitated when the correct CVC trigrams were used.

Sheffield (1946) gave F for 10 or 20 trials. During F the subject was presented with the nonsense syllable and required to pronounce it. Then he had to find the syllable from a group of syllables. In a predifferentiation task, the subject had to make a unique response to the syllable, after having been trained like the first group. The familiarized members of the pair were 3-letter nonsense syllables, the non-familiarized ones common 3-letter words. S-familiarization was not facilitating PA learning.

Hakes (1961) replicated Gannon and Noble's experiment, omitting the control group. Neither SF nor RF were significantly effective. The experiment was reported in Goss and Modine, (1965).

In their experiments I to IV (1960) Underwood and Schulz tested their hypothesis that the rate of PA learning should be a function of F, M being correlated with n, where F or R should facilitate more than F or S, because M had been found to be more effective on the response side in PA tasks. Trigrams of low Glaze a-value (mean 17.12%)

with minimum similarity, were used in 8-pair PA lists in experiment I; trigrams as S and Noble's paralogues as R were used in experiment II to prevent interference from loss of differentiation between S and R. All subjects had the same total amount of F, either relevant or irrelevant, with the same kind of items. Thus they differed only with respect to relevant F. F in experiment I consisted of three study trials, where the subject spelled the items aloud, followed by a test trial in which an omitted letter had to be supplied by the subject, and then two study trials with a test trial on one day, and the same familiarization on the next day, followed by a three minute free recall. Test trials were to show any differences in R availability occurring through familiarization; they also "motivated the subject". In experiment II the subject spelled each item aloud at a two-second rate, the items were presented 40 times. The PA lists of eight pairs were learned in 20 anticipation trials at a 2:2 second rate. SF was not facilitative, but on the contrary slightly inhibitory to PA learning.

In experiment IV the S (or R) familiarization units were nonsense syllables of 0-20 % Glaze a-value, seen by the subject about 32 times, and spelled about 16-18 times. During predifferentiation-familiarization they were learned as responses to either nonsense forms or common English nouns. The non-familiarized R (or S) consisted of low M paralogues of 1.32 Noble m. Again, irrelevant F groups were

used as a control. Only RF facilitated test-list performance. Although the method of F was different from that in experiments I and II, there was slight inhibition of PA learning with SF. It seemed that in experiment IV the nouns used as S during F trials, when compared with forms as S, tended to intrude into the test-list learning. Also, the stimuli of the PA task had been responses during F trials, which might have inhibited performance. Bailey and Jeffrey (1958) did not find facilitation through stimulus familiarization during which they associated 1 to 3 responses to the stimulus.

Different types of stimulus familiarization were used in the cited experiments (listening, spelling, pronouncing, discriminating on matrices, study and recall and thus active learning, predifferentiation with shapes and nouns and thus increase in m), different numbers of pairs were used in the PA tasks (from 5 to 12), different numbers of F trials were given (from 1 to 64). Apart from the group of experiments in which practiced pronunciation of the dissyllables shortened the effective anticipation period during paced learning, no statistically significant facilitation through stimulus familiarization was found. The findings under various conditions might suggest that SF is not facilitative to verbal PA learning.

Apart from the paced learning conditions in PA learning, the experiments had in common the low meaning-

fulness of their items. Low meaningfulness implies low familiarity which should be expected to benefit more from familiarization than items of high meaningfulness; so this should have been a condition that would favour SF. Low interstimulus similarity was another attribute all lists had; this was probably chosen by the experimenters so that effects of similarity should not add to the effects of F within a stimulus.

Subjects questioned on the method they used to learn a trigram pair with a S of low M and a R of high M reported the conscious use of simple, one-step associations for 205 pairings out of 280 (Underwood and Schulz 1960). This is an example:

IGW - MAN W inverted looks like M, hence man
 IGW - MAN IG to IGnorant MAN

This illustrates that a part (as opposed to the whole) of a stimulus can successfully be used to elicit the R (Underwood, 1963); it suggests that, contrary to the R terms, for S terms there might not be any need for nor advantage in integrating the whole stimulus because S terms do not have to be produced whole to obtain the R. Any pronunciation, discrimination or recall of the whole nonintegrated low M stimulus might even be inhibiting later rapid associations with the R, because one or two letters from the whole S as a functional S might more freely assist associations with the correct R. In the usual three-letter nonsense syllables of low similarity

the first letter could often have served as functional S: in their experiment IV, for instance, Underwood and Schulz used XON, YIL, RUY, KIZ, JEC, QUG, VAK, MEQ, as S terms. As the single letters which might be used in their experiment as functional stimulus are easily discriminable from the beginning of the learning task, familiarization should not be expected to bring much facilitation.

If the subject could be forced to use the whole stimulus term, then SF might be facilitative to PA learning. For this purpose the arrangement of letters in a trigram would have to be such that the use of the first, or the second, or third letters would not yield satisfactory discrimination from other stimuli; no easy concept formation task should permit quick grouping of the stimuli so that the subject could not easily separate the stimuli with its help. The items in a list would then necessarily become formally fairly similar, with overlapping of several letters or sounds. Only a few experiments have been done with this type of verbal material. Description of these follows.

3. Familiarization experiments with stimuli of high formal similarity

Goss et al. (1962) combined % occurrence of R, high and low formal similarity, high and low M, and familiarization of S or R in their second experiment. They used 4 CVC trigram pairs per list. Irrelevant control groups were used for general familiarization effects. Familiarization, in four

or twelve trials consisted of seeing, and "responding" to each of the eight nonsense syllables in a list; future R-items in a PA list, underlined in red, had to be spelled aloud, future S-items were spelled by the subjects covertly, i.e. to themselves. The syllables were shown for two seconds each during F. Five subjects only were in each of the 64 combinations. Each pair was presented at a 2:2 second rate in the PA task. Acquisition was to a criterion of four perfect anticipations on a given trial. Between F trials and the PA task the subjects had four practice trials with a list of four PA units, whose S and R were to-digit numbers: this task might well have inhibited facilitation from F. SF did not increase the number of correct responses in the test trials.

In their experiment III, the possibility of inter-stimulus associations during F in experiment II was minimized; Goss now presented each syllable separately at a two second rate, 12 times, again with instructions to spell. Both S and R of a list were either "hard" (high similarity, low M) or "easy" (low similarity, high M).

Experiment IV extended F to 12 or 60 trials, with mixed lists, so that the subject was his own control. No facilitation of PA learning occurred. The syllables of high similarity and low M used by Goss were WUQ, QUW, WUH, HUW; JEX, XEJ, XEZ, ZEX. These two groups of four similar syllables each fall naturally into two subgroups (WUQ, and its reverse QUW) which should make elimination of already

presented items in a four-pair list very easy. It seems also that spelling during familiarization of pronounceable syllables (vowel between consonants) could not have been very facilitative.

Acquired discriminability and the effect of frequency of experience were intended to be separated by DeBold (1964) who, in the 20 F trials asked his subjects to pronounce (Group 1), and to pronounce and rate for difficulty of pronunciation (Group 2) pairs of CVC trigrams of high formal similarity (e.g. SIK, CIQ). The trigrams served as familiarized items in PA learning, with two-digit numbers as the other part of the six pairs. Control groups had irrelevant F training. Learning was very slow: at the end of 20 trials no group had mastered the list. Slight inhibition resulted from the familiarization of the syllables. Spear, Ekstrand and Underwood (1964) pointed out that inhibition might have arisen from associations between members of pairs established during F trials. It seems also that pronouncing or rating pronunciability of syllables like SIK and CIQ might emphasize their phonetic similarity rather than their difference when spelled.

Goss and Nodine (1965, experiment VI) combined formal similarity, and meaningfulness, with familiarization. Four-pair lists represented different subsets of similarity and meaningfulness of S and R. Twelve trials were given for either relevant or irrelevant SF, RF, or S-R familiarization. When means of correct responses during trials 1-12

of the PA task were compared, no facilitation of PA learning was obtained. The nonsense syllables of the four mixed pairs were of high and low Glaze M. F involved examining and reciting the CVC trigrams as they were exposed successively at a three-second rate by moving a card down columns of the 16 stimuli; and this might have resulted in inter-stimulus associations during F.

Battig and Brackett (1963) used pairs of stimuli during self-paced pretraining. The S terms were formally similar, (e.g. MER, MIR). F did not facilitate the PA task.

These mainly negative effects of SF on verbal PA learning make one wonder whether SF affects later PA learning at all.

4. Probable effects of stimulus familiarization

Within a verbal item

The number of times letters of a CVC trigram occur in the written English language has been found to covary with ease of learning, and with the meaningfulness of the syllable (Underwood and Schulz, 1960). If the syllable is not in the repertoire of a subject as an integrated item, then familiarization, through increased frequency of experience of the letters and sequences of letters, can integrate the syllable. Increase in integration becomes evident in the increase of the probability of a unitary, stable form of recognition responses. It makes the item

more easily available (Underwood and Schulz, 1960). This integration has been shown to be facilitative when the familiarized item served as a response which had to be pronounced and recalled as a unit. In the reported experiments it has not been facilitative when the familiarized item served as a stimulus, unless the S dissyllable was pronounced in the PA task. Several possible explanations for this noneffectiveness suggest themselves: 1. As part of the stimulus has been shown to be successfully used as a functional stimulus (Underwood and Schulz, 1960), integration into a unity during F need not be facilitative for PA tasks except when the total stimulus is needed as functional stimulus. 2. The pronunciation of items during F may insure a clear and unique recognition response of pronunciation, but this is not needed for the S in the PA task because the S is usually not pronounced. However, it might be an aid to covert rehearsal of whatever aspect of S is being isolated as the differentiating cue. Spelling during F seems to emphasize parts of the verbal item rather than the whole. 3. During F a type of coding response might have been requested by the experimenter from the subject which is not normally used during PA learning by the subject. Thus the switch from one coding response to another might negatively affect PA learning. But the question is, of course, to what extent all these different familiarization procedures contribute some facilitating common factor to the verbal item.

Although meaningfulness has been found to covary with frequency, an increase in frequency of the item by itself (i.e. not in association with other items) need not increase m (Schulz and Thysell, 1965; Riley and Phillips, 1959). Yet, just as frequency of pronunciation will increase the probability of one stable pronunciation of a syllable, frequency might - in the limited time available during familiarization - strengthen one association, so that it would be more unequivocally at the top of the hierarchy. (A shift in associations was suggested after familiarization towards more stereotyped associations (Schulz and Thysell, 1965).) Familiarization of a low M item, with the possible formation of an association, if only as a mnemonic device, should facilitate PA learning, if the other item of the pair in PA learning is fairly neuter (e.g. colours, motor responses, numbers, or perhaps even verbal items of very low M). It might also facilitate PA learning if the association happens to fit into the same concept as the other item of the pair. It might inhibit if the first experience of the pair of items to be learned in the PA list would have raised a stronger and more "fitting" association between the two items of the pair.

Between either S items or R items

If a S is similar to other stimuli in the list, this stimulus evokes the response to the other stimuli at a strength which depends on the grade of its similarity to the other stimuli. For formally similar stimuli this

"primary generalization" (Gibson, 1959) should not be too strong; the letters of the verbal material are discriminable from the beginning of the learning task for an adult, and "secondary generalization" through conceptualization is quickly available with adults. However, it has been shown that similarity does affect the ease of learning. Discrimination familiarization might orient the subject to the discriminable parts of the stimuli, to certain letters, and certain sequences. The coding of the sensory input (Lawrence, 1963), namely the sorting according to a particular aspect of a stimulus, has been shown to be strong. A switch should inhibit the speed of learning.

If the coding of the sensory input for one particular aspect of the stimulus is strong, then the irrelevant group might be "set", too; thus the difference between the relevant and the irrelevant group should not be great. The irrelevant control group might have to be modified.

If familiarization for formally similar low M items should evoke an association, these associations will probably be less similar than the items themselves, thus contributing to greater distinctiveness and possibly facilitating later PA learning. Predifferentiation familiarization with distinctive verbal responses associated to similar nonverbal stimuli has been shown to be effective when the nonverbal stimuli were later paired with motor responses

during PA learning (Cantor, 1955; Cantor, 1965; Gagné and Baker, 1950; Goss and Greenfield, 1958).

5. Theoretical formulations

Three theoretical formulations suggest possible facilitation of performance in PA tasks with prior discrimination familiarization of formally similar items.

1. Gibson (1940) considers the establishment of discrimination among the items to be learned a fundamental part of the learning process. A stimulus item, through generalization, tends to evoke responses appropriate to the other stimuli of the list. However, differential reinforcement during practice will increase differentiation. Gibson's postulate number 9 (page 207) specifies: "if differentiation has been set up among a number of stimulus items, it will be easier to differentiate them again later, even though they are paired with different overt responses than those learned when the original differentiation was set up". The subject learns to distinguish more clearly the cues which are already present; he discovers new aspects of the S situation rather than building up associations.

Lawrence (1949, 1963), assuming that all S-R connections are mediated, suggests that the properties of the sensory input are unspecified until a coding operation (implicit response) is determined. This coding operation orders the stimulus events with respect to some particular attribute. Previous discriminations can be transferred

to the new task even though new overt behaviours must be learned. "This is the result expected if learning is a two-stage process, one involving the establishment of a coding response and the other an association between its stimuli as coded and overt behaviours." (1963)

Kurtz (1955) also emphasizes the importance of the "observing responses" which direct the subject's attention to certain properties of the stimuli, thus increasing discriminability among the visual stimuli.

2. For Dollard and Miller (1950) the distinct response in pretraining is thought of as producing distinct interoceptive cues which become attached to the external S-compound and thus reduce interstimulus generalization. The result depends on the nature of the response. The usefulness, according to Dollard and Miller, of this functional definition, depends on the validity of two hypotheses: that learning of internal thought processes is governed by the same rules as external responses; that differential responses can be attached to the internal processes as to the external cues. This theory is based on Hull's notion of response-produced cue stimulation, which Dollard and Miller extended to apply to verbal responses.

3. Dollard and Miller (1950) also suggest that discriminative or observing and attention-paying responses made to the stimulus during pretraining carry interoceptive cues which might become attached to the external S.

For McAllister and Cantor (1962), also, the observing

response changes the stimulus by focusing on its discriminable aspects; it also produces its own cue. Attention to the discriminable aspects of the stimulus is thought to be the most potent change produced by the observing response.

Verbal stimuli of very low meaningfulness might be regarded as showing the transition between visual shapes of low meaningfulness and meaningful words; the two areas of study should converge here.

6. Suggestion of an experiment with stimulus familiarization on the basis of previous findings

In any experiment now designed to show the effects of SF, the following points should be considered:

1. The "coding operation" for the S terms should remain the same for the stimulus familiarization as for the PA learning, as it has been in most experiments on response familiarization. This coding operation is imposed on the subject by the experimenter for the familiarization trials. If the PA task is considered to demand that the subject recognize the stimuli and discriminate between them, recognition and discrimination should be the task during familiarization training. Relevant and irrelevant discrimination-familiarization groups should be compared with groups which had an equal amount of experience (n) with the stimuli but not the same coding operation.

2. The subject should be forced to attend to the whole of the stimulus; thus the choice of stimuli is critical. Stimuli that are fairly similar formally are suggested.

3. In order to minimize differential effects of various associations of the responses to the stimuli, and in order to maximize the possibility of isolating a stimulus discrimination stage even in as coarse a time measure as exists in paced paired-associates tasks, highly available responses are suggested. Numbers or colours should be available and fairly neutral in connotative substance.

4. In the attempt to find some stimulus familiarization effect in the shadow of the negative results of previous studies, the different familiarization conditions should be presented to different groups (Underwood, 1957); no other independent variable should be combined with them.

The present investigation was designed to test whether or not stimulus familiarization under the above limiting conditions facilitates subsequent verbal paired-associates learning when the required response is available and neutral.

The hypothesis was that the number of trials to criterion in paired-associates learning, in which stimuli of low M and high formal similarity are used, will be significantly lower when the stimuli are familiarized than when they are not familiarized.

CHAPTER II

METHOD

1. Subjects

120 male and female psychology students from the summer course of Introductory Psychology at Carleton University served as subjects. On appearing at the laboratory to be tested, each subject was assigned to one of five groups according to a prearranged random sequence.

2. Apparatus

A Patterson memory drum was used in both familiarization and paired-associates phases of the experiment. The verbal items appropriate to each phase and treatment group were typed on white tape in capital letters.

For familiarization procedures, timers were adjusted to pace the memory drum in a two-second by two-second interexposure sequence. In this fashion, each subject was presented with one of two lists of six CVC trigrams arranged in four random orders. During the interexposure intervals, the subjects had to look at CVC trigrams printed on white cards which were manually presented.

The memory drum tapes for paired-associates training contained one of two lists of six paired-associates arranged in four random orders. During the anticipation period stimulus members appeared in the left half of the presentation aperture; during the correction period

stimulus members appeared on the left, and response members on the right half of the aperture.

3.Design

Four groups of 24 subjects each were given, respectively, Relevant Stimulus Discrimination Familiarization (Group RSDF), Irrelevant Stimulus Discrimination Familiarization (Group ISDF), Relevant Stimulus Observation Familiarization (Group RSOF), and Irrelevant Stimulus Observation Familiarization (Group ISOF).

Following these familiarization procedures, all subjects in all groups were given paced paired-associates practice. A Control Group of 24 subjects learned the paired-associates task without any previous familiarization training (Group C).

4.Procedure

Discrimination Familiarization

Group 1, RSDF: Each subject sat facing the memory drum, with a pencil in his right hand. The experimenter sat to the subject's side, facing him. The subject was instructed (see complete instructions in Appendix 1) to look at the memory drum, where he would be shown a nonsense syllable every four seconds. He was told that the syllable would be exposed for two seconds, and that during the interexposure interval he should look quickly at the card in front of him (a card containing four words placed in a horizontal

line), choose from that card the word which he had just seen on the memory drum, and circle it with his pencil. While the syllable was being shown to the subject on the drum, the experimenter removed one card from a pile of 144 held in front of the subject. The periodic clicks of the memory drum enabled the experimenter to remove the cards at regular intervals. 24 trials (this number was determined by Pilot Study 1) were given to each subject. A trial was defined as one memory drum presentation of each of the six syllables from either List 1 or List 2. After the familiarization trials the subject was asked to write down all the syllables that he had seen on the memory drum in any order he liked.

Group 2, ISDF: The treatment of this group of subjects was identical to that of Group 1, except that this group was familiarized with syllables which did not appear subsequently in the criterion (PA) task.

Observation Familiarization

Group 3, RSOF: The treatment procedure for this group of subjects was identical to that of Group 1, except that instead of choosing the syllable presented on the memory drum from four syllables on a card, the subject was presented with only that drum-presented syllable on an otherwise empty card. This subject, also, circled the syllable with his pencil. The instructions, accordingly, required that he should look at the syllable presented on the drum, then

immediately look for the same syllable on the card and circle it.

Group 4, ISOF: The treatment of this group was identical to that of Group 3 with regard to procedure, and to that of Group 2 with regard to syllable material.

No Familiarization

Group 5, C: This group had no familiarization prior to paired-associates learning. It served as a control group for nonspecific familiarization effects such as warm-up, learning-to-learn, fatigue.

Paired-Associates Learning

All five groups were given the same paired-associates criterion task, using the paced anticipation method. The subject sat facing the memory drum. The experimenter sat to his side. The subject was instructed (Instruction in Appendix 1) about the criterion task and encouraged to guess the response if he was not sure of it, as soon as he saw the S item alone, and before the S-R pair was presented. As it was known (Schulz and Tucker, 1964; Baker and Noble, 1965) that the anticipation interval is important in producing familiarization effects in paired-associates learning, the intervals traditionally used in such experiments were employed in the present study in order to make the task and the resultant data comparable with those of previous experiments. The stimulus was presented for two seconds, appearing, alone, in the left window of the memory drum; then, immediately,

the S-R pair was presented for two seconds, with the stimulus appearing in the left window, and the response in the right. The intertrial interval was four seconds. All responses, including correct responses, incorrect responses and omissions, were recorded by the experimenter. Practice was carried out to fifty trials or until the subject gave correct anticipations on one complete trial. A trial was defined as one presentation of each of the six paired-associates.

After completion of the paired-associates task, the subjects were asked if, when trying to associate the responses with the stimuli, they had used any particular methods or associations, and if so which ones.

5. Materials

Two lists of six stimulus syllables each were used for the familiarization treatment and the paired-associates task of each treatment group. Each treatment group was divided into two equal subgroups, one using List 1 (the y-syllable set) in the criterion task, and the other being given another list, List 2 (the o-syllable set) in the criterion task. Subjects in one subgroup of each relevant stimulus familiarization treatment were familiarized with List 1 if they were assigned List 1 for the paired-associates task. The other half of the subjects in the same relevant treatment group were familiarized with List 2 syllables and learned responses to these same syllables in the paired-associates task. Subjects in one subgroup of each irrelevant stimulus

familiarization treatment were familiarized with List 1 syllables and given paired-associates training with List 2 syllables. The other half of the subjects in the same irrelevant treatment group were familiarized with List 2 syllables and were given paired-associates training with List 1 syllables. The relevant syllables are so called (McAllister, 1953) because they are the stimulus items subsequently to be learned on the paired-associates task; thus familiarization with these items is irrelevant (in specific stimulus terms) to test task learning. The verbal items of these lists are selected from a restricted range of CVC items of low association value (Glaze a-value 0-60%).

The formal similarity of the material is achieved by overlapping letters, and phonetic similarity within each list. The first letters within a list are of similar sound; the second letters are similar in that they are either front vowels (in the y-set) or back vowels (in the o-set), and the last letters of the CVC combination consist of three different plosives for each list. Six consonants and two vowels were used for each list instead of the twelve consonants and six vowels normally used for dissimilar lists. No letter of the o-set occurs in the y-set. Table I gives the lists of the stimuli used in the present experiment.

During the familiarization procedure of the RSDF and the ISDF groups, the to-be-familiarized CVC term appeared on a card together with three CVC terms similar to it. These

TABLE I

Syllables used as stimuli in
familiarization and paired-associates tasks

=====

<u>List 1</u> (o-set)		<u>List 2</u> (y-set)	
Syllable	Glaze a-value	Syllable	Glaze a-value
SOQ	47	WYB	20
SUK	60	WEP	53
ZOG	13	VYB	7
ZOQ	27	VEP	20
ZUK	0	VED	33
XUG	20	FYD	33

three items were not taken from the group of CVC terms constituting the two lists. Had they been, then discrimination and observation familiarization procedures could not have been compared validly, because the discrimination-familiarization groups would have seen the list items incorporated in the cards while scanning the cards for the CVC item to be discriminated, thus experiencing a number of presentations of all items different from that of the observation-familiarization groups. The three extra-list items per card came from an extra-list CVC Pool 1 for List 1, and from a corresponding Pool 2 for List 2. They were formed of the same letters as those in the lists. Within the three-extra-list items on each card, the first, the second and the third letter of the to-be-discriminated CVC term appeared at least once. The to-be-discriminated item appeared an equal number of times per subject in each of the four possible positions. The syllables of Pool 1 were:

SUQ SOG SOK SUG ZOK ZUQ ZUG XOG XOQ XOK XUK XUQ

and those of Pool 2:

WYP WYD WED WEB VYP VYD VEB FYP FYB FEP FEB FED.

The numbers 3-8 were used as responses during paired-associates learning. To control for possible serial position effects of the numbers (Ebenholtz, 1966) each syllable was paired with two numbers, one for each of two subgroups within each syllable set.

CHAPTER III

RESULTS

1. Number of trials to criterion

Total treatment groups

The paired-associates criterion task was found to be very difficult: 35 subjects out of 120 did not learn it within 50 trials (these 35 subjects will be referred to hereafter as 51+ subjects). Table II shows the distribution among the treatment and syllable groups of these 51+ subjects.

When the first subjects were tested and when the task proved to be unexpectedly difficult and the subjects showed increasing fatigue and frustration during the later part of the paired-associates learning, it was decided to stop the test for each subject after 50 trials if the criterion had not been reached. It would have been much more appropriate for statistical purposes to run the subjects to criterion as originally planned. All the subjects who did not reach criterion could not be included in any statistical assessment of the number of trials to criterion for each group. The irrelevant stimulus discrimination familiarization group had six 51+ subjects. Thus, in order to have an equal number of subjects in each group, all the other groups had to be reduced to the six best subjects, to be comparable with the irrelevant discrimination familiarization group. Unless mentioned to the contrary, all comparisons of trials to criterion therefore include the six best subjects of each group only.

TABLE II

Number of subjects not learning
the PA task within 50 trials
(51+ subjects)

=====

<u>Treatment Group</u>	<u>o-set</u>	<u>y-set</u>
Relevant Discrimination Familiarization	3	3
Irrelevant Discrimination Familiarization	6	1
Relevant Observation Familiarization	4	2
Irrelevant Observation Familiarization	5	3
Control	<u>5</u>	<u>3</u>
	23	12

The graphs showing the mean number of trials to criterion in the paired-associates task for the relevant and irrelevant observation and discrimination familiarization treatments for each syllable set (Figures 1 and 2) indicate that different treatment effects occur for the two syllable groups. Again, only data from the six best subjects are represented in each pictured mean.

Apparently, when y-syllables were used on the paired-associates criterion task, relevant and irrelevant observation familiarization and irrelevant discrimination familiarization were about equally effective, whereas relevant discrimination familiarization was markedly less effective than these (Figure 1). Indeed, compared with the performance of the control group which had received no familiarization at all, relevant discrimination familiarization appears to have produced a slight negative effect. The different effect of relevant familiarization on the observation group and on the discrimination group suggests some interaction between the kind of familiarization and the relevancy of familiarized stimulus materials.

No such interaction is shown in the graph which derives from the data of the paired-associates learning of onset syllables. Relevant familiarization and irrelevant familiarization do not differentially affect the observation and discrimination groups. The observation and the discrimination group are considerably better in performance after relevant familiarization than after irrelevant familiarization. When

Figure 1. Performance (trials to criterion) in the paired-associates task of the relevant (RF) and irrelevant (IF) familiarization groups of the y-syllable set after observation (OF) and discrimination (DF) familiarization (n per group = 6). Performance of the control group (C) is shown.

Figure 2. Performance (trials to criterion) in the paired-associates task of the relevant (RF) and irrelevant (IF) familiarization groups of the o-syllable set after observation (OF) and discrimination (DF) familiarization (n per group = 6). Performance of the control group (C) is shown.

the performance of the irrelevant familiarization groups is compared with that of the control group, hardly any difference between groups is seen.

As the data of Figures 1 and 2 imply, when the effects of relevant familiarization and of irrelevant familiarization in the two syllable groups are compared (disregarding the type of familiarization, observation or discrimination employed), an interaction is suggested between the effect of the relevancy of familiarization procedures and the differential effects of the two syllable sets. This interaction is shown graphically in Figure 3.

This graphical analysis of the data expressed in trials to criterion suggested that the statistical design applied to them should be such that the main effects of syllable set, relevancy, and type of familiarization, and their interactions could be isolated. A three-dimensional factorial design was deemed appropriate to this task. In accordance with the data of Figures 1, 2 and 3, the analysis was performed on the six best subjects of each group.

The Summary Table of the analysis of variance (Table III) shows that there is no significant triple interaction. However, the performance of the subjects learning the two different syllable sets proved to be statistically significantly different ($P < .01$; $F = 8.85$; $df = 1, 40$). The interaction between relevancy of familiarization and syllable list effects, evident from Figure 3, also proved to be statistically significant ($P < .05$; $F = 7.29$; $df = 1, 40$). Thus the

Figure 3. Performance (trials to criterion) in the paired-associates task of the relevant (RF) and irrelevant (IF) familiarization groups of the o- and the y-syllable sets (n per group = 12). The interaction suggests that the two syllable groups might have to be analysed separately.

TABLE III

Comparison between syllable groups, type of familiarization and relevancy of familiarization (trials to criterion).

Summary Table for the Analysis of Variance

=====

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
A (syllable groups)	623.5208	1	623.5208	8.85 +
B (relevancy of familiarization)	136.6875	1	136.6875	1.94
C (type of familiarization)	216.0208	1	216.0208	2.98
AB	513.5209	1	513.5209	7.29 ++
AC	26.0209	1	26.0209	.37
BC	26.0209	1	26.0209	.37
ABC	87.6874	1	87.6874	1.24
Within cells	2816.8333	40	70.4208	

+ P < .01

++ P < .05

effects of relevancy of familiarization had to be analysed separately for each of the two syllable sets.

Difference between o- and y-set

To find out for which of the treatments the y-set was markedly different from the o-set, the two syllable groups were compared in t-tests for each relevancy-group (i.e. the pooled irrelevant observation and discrimination group of the y-set compared with that of the o-set, and the combined relevant observation and discrimination group of the y-set compared with that of the o-set), and for the controls. The mean number of trials to criterion for each of these groups are given in Table IV. These differences were significant only for the irrelevant groups ($P < .01$; $df=22$; $t=4.2406$), and for the control groups ($P < .05$; $df=11$; $t=2.538$), whereas there was no reliable difference between the relevant familiarization groups.

Treatment effects on the y-set syllables

Figure 1 shows that while relevant and irrelevant familiarization had about equal effects on the performance of subjects given observation familiarization, the relevant discrimination training had a negative effect on criterion performance relative to the irrelevant discrimination training procedures.

Although, according to Figure 1, an interaction is suggested between relevancy and kind of familiarization, this interaction is shown in Table V not to be significant ($P > .2$;

TABLE IV

Treatment groups compared for
each syllable set
(mean trials to criterion)
=====

<u>Treatment groups</u>	<u>Syllable set</u>	
	<u>y</u>	<u>o</u>
Relevant	23.66	24.33
Irrelevant	20.45	34.25
Control	26.00	32.33

$F=1.5487$; $df=1,20$). The difference between relevant and irrelevant familiarization is not significant ($P>.2$; $F=.8270$; $df=1,20$). There is a suggestion of a difference between the observation and discrimination familiarization groups, but only at the .1 level ($F=2.9691$; $df=1,20$).

When the relevant familiarization group and the irrelevant familiarization group are compared with the control group, the mean trials to criterion for each group are as follows: relevant familiarization group (including the discrimination and the observation group) 23.66 mean trials; irrelevant familiarization group (including discrimination and observation group) 20.45 mean trials; control group 26.00 mean trials. A t-test revealed no significant difference between either of the two familiarized groups and the control group: for the comparison between the relevant familiarization group and the control group t was .5147 ($P>.5$; $df=16$); for the irrelevant familiarization group and the control group t was 1.625 ($P>.1$; $df=16$).

Treatment effects on the o-syllable set

Figure 2 shows that the performance of groups after relevant familiarization is considerably better than that after irrelevant familiarization for both observation and discrimination treatments.

Table VI supports this conclusion. A Factorial Analysis of Variance, applied to the data of the six best

TABLE V

Comparison between relevancy and type of familiarization
in the y-syllable set

Summary Table for the Analysis of Variance

=====

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	
A (relevancy of familiarization)	60.1667	1	60.1667	.8270	
B (type of familiarization)	216.0000	1	216.0000	2.9691	+
AB	112.6667	1	112.6667	1.5487	
Within cells	1455.0000	20	72.7500		
			+ P = .1		

TABLE VI

Comparison between relevancy and type of familiarization
in the o-syllable set

Summary Table for the Analysis of Variance

=====

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	
A (relevancy of familiarization)	590.04	1	590.04	8.665	+
B (type of familiarization)	26.04	1	26.04	.382	
AB	1.05	1	1.05	.015	
Within cells	1361.87	20	68.09		

+ $P < .01$

subjects in each group reveals an overall statistically significant difference between relevant and irrelevant familiarization ($P < .01$; $F = 8.665$; $df = 1, 20$). No reliable difference was shown between the observation and the discrimination conditions ($P > .2$; $F = .382$; $df = 1, 20$); nor was the interaction between relevancy and type of familiarization statistically significant ($P > .2$; $F = .015$; $df = 1, 20$).

Relevant familiarization groups, pooling the data for the discrimination and observation treatment groups, and the irrelevant familiarization group (including the six best subjects of the discrimination and the observation treatment groups), were then compared with the control. The mean trials to criterion in the paired-associates task for the three comparison groups were as follows: relevant familiarization group 24.33 mean trials, irrelevant familiarization group 34.25 mean trials, control 32.33 mean trials. In the t-test comparison of the relevant familiarization group and the control group, t was 4.8995 for df 16, which means that the probability of the difference between the two groups occurring by chance is less than 1%. When the irrelevant familiarization group was compared with the control group, no dependable difference between the two groups was found ($P > .8$; $t = .01481$; $df = 16$).

In summary, it can be said that with the o-syllable set, irrelevant familiarization did not facilitate paired-associates learning when the performance of the irrelevant

group was compared with that of the control group. Relevant familiarization, however, was shown to be significantly facilitative, when compared to either the irrelevant familiarization group or the control group.

2. Correct responses

Correct responses over nine trials

Most experiments on stimulus familiarization prior to verbal paired-associates tasks used the number of correct responses as dependent variable.

As the paired-associates task was stopped when subjects reached the criterion of one correct anticipation of all the responses in one trial, the correct responses over nine trials only can be compared.

Table VII shows the mean number of correct responses per subject over the first nine trials for each treatment group of the y- and the o-set. The consistently superior performance of subjects who learned responses to the stimulus syllables of the y-set supports the inference that o-set syllables were more difficult to handle in the paired-associates situation than y-set syllables.

Inspection of the data given in Table VII suggests that different familiarization effects occur for the observation and discrimination groups of the o-set groups. The graphs of Figures 4 and 5 indicate that there is an interaction between the relevancy of familiarization and

TABLE VII

Mean number of correct responses
over the first nine trials of the paired-associates task
(n per group = 12)

=====

<u>Treatment group</u>	<u>Syllable set</u>	
	<u>y</u>	<u>o</u>
Relevant Observation	16.67 (19.67) ⁺	14.92 (19.00)
Irrelevant Observation	16.83 (23.00)	12.08 (11.17)
Relevant Discrimination	15.42 (16.67)	11.42 (16.17)
Irrelevant Discrimination	16.42 (20.00)	12.00 (17.50)
Control	15.08 (14.33)	11.75 (14.00)

⁺For comparison, the mean number of correct responses of the six best subjects in each group is given in brackets.

Figure 4. Performance (mean number of correct responses) in the paired-associates task of the relevant (RF) and irrelevant (IF) familiarization groups of the y-syllable set after observation (OF) and discrimination (DF) familiarization (n per group = 6). Performance of the control group (C) is shown.

Figure 5. Performance (mean number of correct responses) in the paired-associates task of the relevant (RF) and irrelevant (IF) familiarization groups of the syllable set after observation (OF) and discrimination (DF) familiarization ($n = 6$ per group). Performance of the control group (C) is shown.

the type of familiarization in the o-set group (Figure 5), but not in the y-set group (Figure 4).

Analyses of Variance of a 2x2 Factorial Design (Tables VIII and IX) for the six best subjects of each syllable group confirm the graphical analyses of Figures 4 and 5. Neither difference in relevancy, type of familiarization, nor interaction was statistically significant for the treatment groups in the y-set (all Fs were below 1, $df=1,20$; $P>.2$). The same analysis for the data of the o-set showed the interaction between relevancy and type of familiarization to be statistically significant at the .05 level ($F=5.714$; $df=1,20$). Therefore the relevant familiarization groups of the o-set and the irrelevant familiarization groups of the o-set could not be pooled. To make them more easily comparable with the data of the o-set groups, the y-set groups were not pooled either.

When the treatment groups of the y-set were compared with the control group by t-tests, only the irrelevant observation group was significantly better than the control ($P<.05$; $t=2.6$; $df=10$). There was no reliable difference between treatment groups, when all twelve subjects were included into each treatment group.

Because of the interaction shown in the analysis of variance (Table IX) between relevancy and type of familiarization in the o-syllable set, the relevant and irrelevant observation groups, and the relevant and irrelevant discrimination groups were compared with each other and with

TABLE VIII

Comparison between type of familiarization
and relevancy of familiarization (number
of correct responses over nine trials)
of the y-syllable set

Summary Table for the Analysis of Variance

=====

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
A (relevancy of familiarization)	66.500	1	66.500	.889
B (type of familiarization)	53.500	1	53.500	.716
AB	.667	1	.667	.009
Within cells	1494.667	20	74.733	

TABLE IX

Comparison between type of familiarization
and relevancy of familiarization (number of
correct responses over nine trials) of the
o-syllable set

Summary Table for the Analysis of Variance

=====

<u>Source</u>	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>
A (relevancy of familiarization)	63.375	1	63.375	2.873 +
B (type of familiarization)	18.375	1	18.375	.833
AB	126.042	1	126.042	5.714 ++
Within cells	441.167	20	20.058	

+ $P > .1$.

++ $P < .05$

their control group. The relevant observation group was significantly better than the irrelevant observation group ($P < .05$; $t = 2.475$; $df = 10$); there was also a suggestion of a difference between the relevant observation group and the control group ($P > .1$; $t = 1.356$; $df = 10$); all the other comparisons of treatment groups, including also the comparisons of treatment groups with twelve subjects each, did not reveal any statistically significant difference.

Acquisition rate

A trial-by-trial comparison of the mean number of correct responses per group showed great variations and vitiated any possibility of inferring the general learning trends. It was decided, therefore, to block the acquisition data over four trials. This number of trials was chosen as the blocking category because four different random orders of the six paired associates had been presented to the subjects on test trials. Order differences should thus have a minimal effect on the variation in means from trial to trial.

Figure 6 (a-d) shows the acquisition trends over the first nine trials for each treatment group who learned responses to the y-set syllables: Figure 6 (a-b) compares the acquisition rates of treatment groups including twelve subjects each; Figure 6 (c-d) compares the performance of the six best subjects ("best" being defined by the least number of trials to criterion) in each group, which allows com-

Figure 6. Acquisition trends (mean correct responses) of the relevant (R) and irrelevant (I) familiarization groups of the y-syllable set, expressed as the moving average of 4. For the upper diagrams (a,b) n per group = 12; for the lower (c,d) n=6. Diagrams to the left (a,c) concern observation familiarization groups (O); those to the right (b,d) concern discrimination familiarization groups (D). Trends of the control group (C) are included.

Figure 7. Acquisition trends (mean correct responses) of the relevant (R) and irrelevant (I) familiarization groups of the o-syllable set, expressed as the moving average of 4. For the upper diagrams (a,b) n per group = 12; for the lower (c,d) $n=6$. Diagrams to the left (a,c) concern observation familiarization groups (O); those to the right (b,d) concern discrimination familiarization groups (D). Trends of the control group (C) are included.

parison with the groups which were analysed previously with regard to the number of trials to criterion. In the irrelevant discrimination group, where the number of trials to criterion was very small ($n=7$) for the best subject, this subject was assumed to have reached criterion again for the following two trials, until the second subject of the group had reached criterion; the resulting values in the graph are shown in brackets.

Constituted in this way, the functions of Figure 5 (a,b) show slight differences between the relevant and irrelevant observation groups, the relevant and irrelevant discrimination groups, and the control group comparable to those which already have been observed to hold when the response measure is numbers of trials to criterion. The irrelevant observation, and, after a few trials also the irrelevant discrimination group performed at a slightly higher level than the relevant observation and discrimination groups, and both of these treatment groups showed slightly faster rates of acquisition than the control.

Figure 6 (c,d) shows that the differences between the relevant and irrelevant observation groups and the control group were greater when the six best subjects in each treatment group were compared than when all twelve subjects were included in each group. The difference between the groups of six and of twelve subjects was not so marked in the discrimination familiarization groups (Figure 6 b,d).

Figures 7 a-c present comparable acquisition functions for groups of subjects learning responses to o-set syllables. The trend shown in the o-syllable group performances conforms with the findings with regard to trials to criterion of this group; differences between the irrelevant and the relevant observation groups becoming more marked as "slow" learners were eliminated (Figure 5 a,c). Thus, once again, the treatments seemed to act differentially on different subject strata within each observation treatment group. Again, as in the y-set, there is hardly any difference in trend between the relevant and the irrelevant discrimination groups whether performances concern twelve subjects or the six best subjects in each group.

A striking difference in both syllable groups is shown between the discrimination groups and the observation groups. The irrelevant observation group in the y-set, performs consistently better than the relevant observation group; it performs consistently worse in the o-set, this difference between relevant and irrelevant groups being clearly more marked in the groups including the six best subjects only. The relevant and the irrelevant discrimination groups start with relevant discrimination being slightly better than irrelevant discrimination for the y-set, then "crossing" over so that the irrelevant discrimination group, in later trials, is better than the relevant discrimination group. The same change occurs in the o-set, the irrelevant discrimination

group being slightly better than the relevant discrimination group for the first few trials, and then the relevant discrimination group becoming better in later trials.

Presumably, if all subjects had been run to twenty or twenty-five trials, these trends would have been much clearer.

In summary, the differences in the levels of performance and the trends of the acquisition rates for the relevant and irrelevant observation groups of both syllable sets seem to reflect the difference in trials to criterion in these groups. In both syllable sets these differences are clearly greater when the six best subjects of each treatment group are compared. In the discrimination groups, differences between relevant and irrelevant familiarization groups reflect the differences in trials to criterion only in the later trials, not in the first few trials.

Response rate

As the number of total errors increases with the number of trials needed to reach criterion, Underwood (1961), in his evaluation of Gibson's theory, advocates the ratio between trials to criterion and number of total errors to assess the difference between groups for generalized errors. As the generalization errors, i.e. the responses of one pair in the list incorrectly given to the stimulus of another pair, should include the omissions at the beginning of learning (because the responses were not forced), and as

hardly any response was given from outside the response numbers 3-8, all errors were included in calculating the error rate. The six best subjects of each treatment group were tested; the following error rate was found:

	Relevant Observa- tion	Irrelevant Observation	Relevant Discrimi- nation	Irrelevant Discrimination	Control
y-set	3.30	2.76	3.04	3.28	3.36
o-set	2.98	3.34	3.21	3.29	3.26.

In the y-set, the error rate in all familiarization treatments is lower than in the control group, with relevant observation showing a much higher error rate than irrelevant observation, whereas that of relevant discrimination is slightly lower than that of irrelevant discrimination.

The error rate in both irrelevant familiarization groups is higher than that of the control, in the o-set, and both relevant familiarization groups show a lower error rate than the control.

It is questionable whether the error rate as evaluation of generalization errors is appropriate if the differences in similarity affect the number of trials to reach criterion. Error rate would reflect decreasing generalization if the acquisition rate were not changed but the level of performance in the first trial raised; it would not necessarily reflect it if the acquisition rate were changed but the level of performance on the first trial were not changed. From the graph on Figures 6 and 7 both changes might be assumed to have occurred.

3. Associations and performance in the criterion task

The possibility existed that the number of associations evoked and reported might give a clue to the difference between syllable and treatment groups. Altogether only 33 associations were given to syllables in the y-set and 32 to those in the o-set, when the subjects were asked after the paired-associates learning if they had used any particular strategies or associations to learn the correct response to any of the stimuli. These associations included 14 associations to known words (e.g. wep = wept; suk = Suki, name of a cat; zuk = like the name of a chess player) or associations to known words such that the correct response was included (e.g. fyð = five year old; wep = Wednesday, 3rd day of the week). 43 associative "helps" concerned a formal part of the syllables in comparison with parts of a number (e.g. ved alphabetically before vep, as 3 before 7 in the number-sequence; xug - the x halved is the Roman numeral V; the Q of soq has a bar as has 4; zog = 7 and soq = 8, reversed alphabetical order with numerical order). The remaining eight "associations" were based on the Restorff effect: xug, or fyð were "unique", with "nothing else to confuse".

CHAPTER IV

DISCUSSION

The purpose of the present experiment has been to investigate the effects of two kinds of relevant and irrelevant stimulus familiarization of the paced verbal paired-associates learning of similar CVC trigrams, when the CVC trigrams were not pronounced or spelled in either familiarization or paired-associates tasks, and when the stimuli were constructed such that the subjects would have to use the whole of the stimulus to be able to give the correct response. The primary dependent variable was the number of trials to criterion.

Before describing the extent to which the objectives have been achieved, the way in which the results fit into our present knowledge and the possibility of further experiments, the main limitations of the experimental method will be considered.

The number of trials to criterion was chosen to be the dependent variable because Underwood (1953) had found that this measure was inversely related to stimulus similarity. As 35 of the 120 subjects, distributed differentially over the various treatment groups, did not learn the task within the set 50 trials and therefore had to be excluded from the data analyzed, and as the two employed sets of stimulus syllables had to be analysed separately,

the number of subjects in each group was reduced from the intended 24 to six.

In view of the negative results of previous stimulus familiarization experiments using verbal material, and on the assumption that stimulus familiarization would have a smaller effect on verbal than on visual shape material, the difference between treatments was expected to be small. As the number of subjects in each treatment is important in the F ratio, and as the probability of the type II error is smaller with larger groups of subjects, there should have been many subjects in each group, an objective which was not achieved. Indeed, the differences between the means of trials to criterion for the experimental groups proved to be small in relation to the variances within the groups. Thus the t -tests employed as analytic tools are minimally powerful.

The reliability of the experimental results would have been greater if the two syllable sets had been affected in the same facilitative way through familiarization, with comparable effects of relevant and irrelevant familiarization.

Unfortunately the subjects who reached criterion after fewer trials were not tested up to trial 20 or 25. Thus all analyses of numbers of correct responses per trial could only proceed as far as the trial on which the best subject had reached criterion.

Even within the two-second time allowance, it was evident that many subjects responded quickly to some syllables but slowly to others. Therefore it is felt that the

two-second paced paired-associates presentation was possibly too crude a measure to detect the effects of stimulus familiarization on paired-associates learning. Reaction time might provide a more accurate measure of familiarization effects although, because of individual differences, some baseline for each subject would first have to be determined.

A replication of the present experiment or further experiments of this kind should deal with a more homogeneous population than the one available for use here, which, apart from normal students, also included a great number of teachers, social workers and business employees of a wide age-range.

Having due regard to the limitations of the present experiment, the main conclusion to be drawn from it is as follows:

In the y-syllable set, all types of relevant and irrelevant familiarization with the exception of relevant discrimination familiarization facilitated paced verbal paired-associates learning when the six best subjects of each treatment group were compared. However, this observed facilitation was not statistically significant. There was a suggestion of a general and unspecific facilitation effect, because the relevant and the irrelevant observation groups performed at about the same level, in both cases higher than the control group which received no familiarization.

In the o-syllable set, the relevant familiarization groups were statistically significantly faster in the paired-

associates task than were either the irrelevant familiarization groups or the control group, when the dependent variable was trials to criterion. When the numbers of correct responses over the first nine trials were compared, the relevant observation group was significantly better than the irrelevant observation group. Again, these findings refer to groups which included only the six best subjects.

Discrimination familiarization did not facilitate paired-associates learning more than observation familiarization.

Considering the number of correct responses per trial for different treatment groups, there is a strong suggestion (which could not be shown when trials to criterion were compared because only the six best subjects per group could be compared) that familiarization affects the fast learners (defined by trials to criterion) much more than the slow learners. This is particularly clear when the observation familiarization groups are compared with their control group. A complicating factor is evident when the discrimination familiarization groups are compared. A considerable overlap of performance of the discrimination groups and the control group is found in the first few trials of the paired-associates task. If this were due to the inexperience of the subjects with paired-associates learning, the unexpected speed at which responses were demanded, or the difficulty to understand and apply the instructions, then the effects should show in the compari-

sons of the observation groups as well. The possibility exists that discrimination familiarization fatigues the subjects more than observation familiarization. Whatever the underlying variable may be, it must be some factor common to both relevant and irrelevant familiarization procedures. In no case does any discrimination familiarization group reach the number of correct responses that the best observation group reaches for the trials which were compared.

From the graphs of Figures 6 and 7 it seems justifiable to infer that, despite the different effects of relevant and irrelevant familiarization on the two syllable sets, the beginning of the functions for the irrelevant discrimination have in common a suggestion of some interference not obvious for the other treatment groups. It seems unlikely that this effect derives from greater habit strength through the discrimination procedure (as compared with the observation procedure), and consequently through the presence of a stronger interfering stimulus population than in the irrelevant observation groups. If this were so, then the relevant discrimination groups should perform better than the relevant observation groups. There is also the possibility that the extra-list syllables used in the discrimination groups interfere in the learning of relevant, and even more so in the learning of irrelevant stimulus material in the later paired-associates task. The stimulus population

dealt with by the subjects given discrimination familiarization is larger than in the observation familiarization groups, and perhaps also not so clearly defined.

It is obvious that discrimination familiarization, contrary to prediction, is not as facilitative to paired-associates learning as is observation familiarization, whether the performance measure used be the number of correct responses over a number of trials or the number of trials to reach criterion.

In previous experiments on the familiarization of formally similar stimuli the number of correct responses was the dependent variable (Gannon and Noble, 1961; Goss, 1962, 1965). No reliable facilitation of the paired-associates task had been found through relevant stimulus familiarization except in Gannon and Noble's experiment, in which the stimulus was pronounced during familiarization and during the test task. In the present experiment a significant difference between relevant and irrelevant stimulus familiarization was demonstrated for the observation group of the o-syllable set only, when those six subjects per group who needed least trials to criterion were compared.

Underwood (1953) found the number of trials to vary inversely with the formal similarity of stimuli, when three different degrees of CVC similarity were used. By inference, then, the experimental findings with the o-syllable set suggest that stimulus familiarization has operated to de-

crease the similarity of the stimuli. Reduced similarity, i.e. reduced generalization among the stimuli of the list, should also reduce the number of errors per trial in the familiarization groups. There are, in fact, fewer errors in the observation familiarization groups than in the control groups; also, the error rate (taking the number of trials per subject into account) is smaller for the relevant observation familiarization groups than for the control.

Gibson (1940) has considered differentiation of similar stimuli an essential part of learning. This differentiation was "a progressive decrease in generalization as a result of reinforced practice with Sa-Ra and the unreinforced presentation of Sb" (p.205). For her, the cues present in the stimulus are more clearly distinguished through differential reinforcement. In the present experiment, however, no overt dissimilar response was learned to the stimulus during familiarization training, and thus no overt differential reinforcement given. It seems that as long as general motivation is high enough for a student to "deal" with the stimulus material during familiarization, differentiation is likely to increase. As the letters of the stimuli were very familiar to each subject, the increase in differentiation should have occurred partly through the limitation of the letter population, and mainly through the attention to structure (i.e. for the syllables used: the letter sequence), unless it were possible to use the stimulus as a meaningful unit.

As overt pronunciation of the stimulus was not used in either familiarization or paired-associates tasks, overt pronunciation could not have affected facilitation or, consequently, the length of the anticipation period, as was suggested for the experiment by Gannon and Noble (1961).

Covert pronunciation was unlikely to contribute much to facilitation, because the syllables were arranged such that the use of covert pronunciation was more likely to increase the similarity between the syllables than to decrease it.

The number of overt associations reported to all syllables after the paired-associates task was minimal (65 out of a possible 516), and they were not differentially distributed over the various treatment groups. Thus, associations of the presented syllables with familiar words cannot have increased greatly during familiarization, although it had been thought that syllables like SUK and SOQ would easily be seen and reported as words and thus more quickly be associated with their responses. That hardly any association was easily available might well have been a factor conducive to forcing subjects to use the formal structure of the syllables. On the other hand, the use of number sequences as responses might have induced the subject to adopt the mnemonic device of using letter sequences.

Apart from nonspecific facilitation, irrelevant familiarization might be hypothesized to have evoked discriminative responses by directing the attention of the subjects to the most obvious differences between the syl-

lables, namely the different arrangements of the same letters; this was suggested by the way in which the subjects reconstructed the syllables which they wrote down after familiarization; some were recalled as a unit, others by first writing down a remembered letter and then filling in the possible combinations. If discriminative responses are evoked through irrelevant familiarization, then differences between the relevant familiarization and the irrelevant familiarization treatments should have been small, which in fact they were. Any subsequent experiment of this kind should therefore include a control group which uses the same group of letters (elements) in both the familiarization and paired-associates tasks, but in which the stimuli are distinguished by different obvious properties during familiarization (perhaps size or type of letters) from that during the paired-associates task. Thus any facilitation resulting from attention to the structure (in the present experiment: letter sequence) as opposed to the elements within the structure might be isolated. Kurtz (1955) showed that when figures were stimulus-items and colours were responses, the group of subjects having identical stimuli in familiarization and paired-associates tasks learned their paired-associates task in about the same number of trials as did the group with different stimuli which were, however, distinguished by the same property; that group which had stimuli in the paired-associates task

which were distinguished by a property different from that during familiarization needed statistically significantly more trials to criterion.

Familiarization procedures such as were employed in this study might be more effective when children are used as subjects. Young children should not be as familiar with the letters and letter sequences or CVC trigrams or words as college students are. Similar experiments might also be used to find out if reading difficulty in childhood is more connected with the child's difficulty in recognizing individual elements or in remembering correct letter sequences.

SUMMARY

1. The effect of stimulus familiarization on subsequent paced paired-associates learning at a 2:2 second presentation rate was examined. It was hypothesized that verbal material which would force the subject to use the whole of the stimulus as a functional unit should make stimulus familiarization facilitative to verbal paired-associates learning when the required response is neutral, i.e. when it does not elicit a particular group of meaningful associations.
2. The stimuli were two sets of six CVC trigrams, each of medium to low Glaze association value, used as controls for each other. The stimuli within each set were similar in sound (to minimize any facilitative effect of silent pronunciation) and of fairly high formal similarity. The responses were the numbers 3-8.
3. For each of the two syllable sets, there were five groups of 12 subjects each, which differed in the treatment administered to them prior to the paired-associates task: the relevant and irrelevant observation groups were familiarized, respectively, with the syllables occurring in the later paired-associates task and with syllables irrelevant to the later paired-associates task. Each of the stimuli was observed 48 times, in 24 double exposures. Relevant and irrelevant discrimination groups selected the syllables relevant or irrelevant to the criterion task from a group of four similar syllables in 24 observation-discrimination exposures such that the stimulus was observed 48 times, of which 24 observations were combined with discriminations. A control group had no

pretraining before the criterion task. As 35 of the 120 subjects did not reach the criterion of one correct trial within 50 trials, only the six best subjects per group could be included in comparisons of trials to reach criterion.

4. In the syllable group which proved to be the easier to learn (the y-set) familiarization did not reliably facilitate performance in the paired-associates task, although fewer trials to criterion were needed in the irrelevant and the relevant observation groups when they were compared with the control group.

5. In the other syllable group (the o-set) an analysis of variance showed an overall facilitative effect of the relevant familiarization treatment at the .01 level, when it was compared with the irrelevant familiarization treatment. Compared with the control group, the relevant familiarization groups needed statistically significantly fewer trials ($P < .05$) to reach criterion.

6. When the number of correct responses over the first nine trials was compared for the different treatment groups, a statistically significant difference was found between the relevant observation group and the irrelevant observation group of the o-syllable set.

7. There was a strong suggestion that familiarization affected different strata of subjects differentially, being mainly facilitative to the fast learners ("fast" being defined by the number of trials to reach criterion), and hardly facilitative at all to the slow learners. This was

suggested as one reason why stimulus familiarization had not previously been shown to be facilitative to subsequent paired-associates learning. The comparisons which yielded the significant effects of stimulus familiarization on the test task included only the six best subjects out of twelve in each treatment group.

8. The suggestion was offered that stimulus familiarization can decrease the similarity of stimuli of low meaningfulness without overt pronunciation of the stimuli in either familiarization or test task.

9. Conceivably, experiments with children as subjects might show more clearly the facilitating effects of stimulus familiarization.

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APPENDIX 1

INSTRUCTIONS TO SUBJECTS

Familiarization treatments

This is an experiment on the discrimination of nonsense syllables; neither your intelligence nor your personality will be tested. Syllables consisting of three letters will be presented to you, one every four seconds, in the left window of the apparatus in front of you. You will see the same syllables several times, but not in the same order.

Discrimination familiarization

As soon as you have seen a syllable, look at the card in front of you, find the syllable which you have just been shown and circle it with the pencil. So, when you see a syllable like this (shows a card with MAH on) in the window, find it quickly on the card and put a circle round it like this (card with circled MAH is shown). Ready?

Observation familiarization

As soon as you have seen a syllable, look at the card in front of you where you will see it again. Put a circle round it with your pencil. So, when you see a syllable like this (shows MAH) in the window, look at it on the card to your right and put a circle round like this (card with circled MAH is shown). Ready?

Paired-associates task

This is the second part of the experiment. It is a learning part. First you will see a syllable in the left window of the drum. Then the same syllable will appear again in the left window together with a number in the right window. When you have been shown all the syllables and pairs of the list once, I shall call out "Now". Then, as soon as you see a syllable in the left window, call out the number with which it had been paired during the first presentation of the list, before the pair appears in the windows. So, when you see, for instance, MAH in the left window (a card with MAH is shown) you quickly say "20" because previously you had seen MAH and 20 as a pair in the windows. You must say the number before the pair appears. The pairs are arranged in random sequence, so it is no use relying on the sequence. If you are not sure of the correct number to a syllable, guess it. Any questions?

APPENDIX 2

PILOT STUDY 1

This study, carried out before the main experiment, determined how many discrimination and observation familiarization trials had to be presented to the familiarization treatment groups before paired-associates learning so as to insure that the syllables were in the subject's repertoire. Five subjects were presented with treatment identical to that for the familiarization task of the experimental observation familiarization group. The syllables were presented at a four second rate on the memory drum (presentation of the syllable for two seconds, and then a blank space for two seconds), because this rate had allowed three previously tested subjects to select the familiarized stimuli from the cards during discrimination familiarization. The subjects in the pilot study were asked to recall the items after twelve double exposures of each syllable. The mean number of recalled syllables was 2.8. A new group of subjects was then presented with the same items for 24 familiarization trials, so that each stimulus was observed 48 times. Only 3.4 syllables were recalled on the average. However, it was decided not to increase the number of the familiarization trials, and to use 24 double exposures in the main experiment.