FACTORS INFLUENCING THE DEVELOPMENT OF PARADIGMATIC AND SYNTAGMATIC ASSOCIATIONS IN SIMPLE ARTIFICIAL LANGUAGES

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ABSTRACT

FACTORS INFLUENCING THE DEVELOPMENT OF
PARADIGMATIC AND SYNTAGMATIC
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ARTIFICIAL LANGUAGES

By

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The present study contrasted two hypotheses proposed to account for the development of paradigmatic associations in natural language. One hypothesis, the intersubstitution hypothesis, suggests that paradigmatic associations result from the use of words by Ss in identical speech contexts. The intersubstitution hypothesis has been advanced by Deese, Horowitz, and McNeill, among others. A second hypothesis, suggested by Ervin (1961) and others, maintains that paradigmatic responses may result because of the simultaneous elicitation of several competing responses. This hypothesis has in its favor the dual explanation of both paradigmatic associations and so-called "Spoonerisms."

To investigate these two hypotheses in an exploratory way, 32 Ss were presented with nonsense figures that varied in size as well as form. These nonsense figures were assigned nonsense syllable labels which could refer to either form (noun) or size (adjective). A discrete word association test in which nonsense syllable elements

were presented as stimuli was administered after Ss reached a criterion of learning, and again after they reached a more stringent criterion. Both the associative response and its latency were recorded. Associative responses could be categorized not only as syntagmatic or paradigmatic, but also as contiguous, positional, or non-positional.

The major conclusions were as follows:

1. Subjects were able to learn artificial languages with relative ease, i.e., within a one hour session.

2. Classification of artificial language word association data in terms of grammatical class indicated that the majority of the associations were syntagmatic, and could be attributed to the contiguous appearance of the associates in artificial language sequences or contexts.

3. Two findings were taken as evidence that response interference had been generated as a result of artificial language training. First, the proportion of contiguous noun-adjective (N-Ac) word associations significantly exceeded ($p < .05$) the proportion of contiguous adjective-noun (A-Nc) associations; and the second, median A-Nc associative latencies were significantly slower ($p < .05$) than the median N-Ac associative latencies.

4. Under the conditions of the present study paradigmatic adjective associations could develop only as a means of resolving interference while certain paradigmatic

noun associations could develop as a result of intersubstitution. Statistical analysis indicated that within the framework of the artificial languages used, there was evidence ($p < .05$) that intersubstitution was involved in the development of paradigmatic noun associations.

5. There was evidence that interference and appearance in identical positions within different contexts did not interact in an additive manner to produce associations.

6. Associative symmetry of contiguous syntagmatic associations as measured by associative latencies was observed.

The relationship between paradigmatic association development and other variables such as ability to verbalize artificial language rules, amount of foreign language training, frequency of paradigmatic associations to English words, and type of artificial language training is discussed.

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CHAPTER I

INTRODUCTION

Empirical approaches to the study of word association began with the collection of normative data. Even a casual inspection of the norms indicates that stimulus words and response words are frequently of the same grammatical class. This observation raises questions since a frequency view of learning, with or without reinforcement, has become more widely accepted. With respect to natural language, the development of paradigmatic associations, i.e., associations between stimuli and responses of the same grammatical class, has generally been attributed to the use of words in identical speech contexts. This hypothesis has been called the intersubstitution hypothesis by McNeill (1963, 1966) and others. According to this view, words which appear in the same position within a sentence frame will become associates of each other. Another view of the association process would suggest that in the past a number of response words have been reinforced in the presence of a given stimulus word. Thus, considerable response competition would result if the given stimulus word were presented without sufficient contextual isolation.

In the present study, an artificial language situation, rather than a natural language setting, was employed to examine the factors operating in the development of paradigmatic associations. The Ss were given a word association test in which elements of a previously learned artificial language were presented as stimuli. The major purpose of the present study was to contrast the inter-substitution and interference hypotheses of paradigmatic association development.

Dependent Variables in the Word Association Studies

Before proceeding further, mention of the dependent variables involved in a discrete word association test should be made.

In a discrete word association situation a subject is typically instructed to respond with the first word that occurs to him when he sees or hears a stimulus word. Response latency or reaction time, and commonality are generally used as indices of the strength of the association between the stimulus and response. Commonality refers to the frequency of the associative response in a normative sample. It is assumed that the stronger the associative strength the shorter the associative latency and the greater the commonality. Schlosberg and Heiniman (1950) found a high (-0.80) correlation between the two associative strength indices. In a recent review of

English word association studies Jung (1966) pointed out "recently reaction time has been virtually replaced by commonality as the most widely used measure . . ." (p. 129). The commonality measure has been used almost exclusively in the current literature related to form class of word associations.

Literature Related to Form Class of Word Associations

The most common method of categorizing associations in terms of form class or grammatical class is patterned after Fries (1952). "In this analysis, all words which can occupy equivalent positions within English utterances are declared to be members of the same grammatical class" (Deese, 1965, p. 99). When word associations are classified according to such an analysis, it is observed that the form class of the associative response tends to vary as a function of the grammatical class of the stimulus word. The word associations of young children (under the age of six) tend to be "syntagmatic," i.e., responses are of a different form class than the stimuli. The associations of older children and adults are "paradigmatic," i.e., responses are of the same form class as the stimuli (Brown and Berko, 1960; Entwisle, Forsyth and Muuss, 1964, Ervin, 1961; Fillenbaum and Jones, 1965). However, Deese (1962a) has qualified the syntagmatic-paradigmatic findings as follows:

> The older generalization that adult associations are largely paradigmatic is unconditionally true only for nouns. Adjectives and verbs are about equally syntagmatic and paradigmatic; adverbs yield largely syntagmatic associations (p. 81).

Syntagmatic Association

"Syntagmatic associations are, in general, sequential elements or at least elements which usually occupy different positions within phrases or sentences" (Deese, 1965, p. 103). Thus, syntagmatic responses are generally contiguous with their stimuli in language sequences. "As in paired-associate learning, it is assumed that one factor critical to the formation of associative bonds is the experience of words in contiguity" (McNeill, 1966, p. 548). McNeill also suggested that the discrete word association test may be likened to the recall test in a paired-associate learning situation. If such a comparison can be made, certain observations related to paired-associate learning may also have some bearing on syntagmatic association development.

In paired associate learning situations recall in the forward direction has generally been found superior to recall in the backward direction (Ekstrand, 1966). However, Asch and Ebenholtz (1963) proposed that "when an association is formed between two distinct terms, *a* and *b*, it is established simultaneously and with equal strength between *b* and *a*." This "principle of associative symmetry" is hypothesized to operate under conditions in which both the stimulus and response elements are equally "available." Availability has been defined as an item's "accessibility to recall," or the proportion of Ss who recall an item correctly (Horowitz, Norman and Day, 1966). Horowitz, Brown and Weissbluth (1964) had subjects learn pairs of associates in which the "stimuli of some pairs were responses in other pairs; these stimuli became available during original learning" (p. 542). A free association test following traning indicated that "a backward association occurred as readily as a learned forward association if the PA stimulus was available" (Horowitz, et al., 1964, p. 541).

In summary, the development of associations between stimuli and responses which are of different form classes is generally attributed to the contiguous appearance of the associates in language sequences. There are data which indicate that syntagmatic associations do not necessarily develop only in a forward direction. Availability and associative symmetry may also influence syntagmatic association.

Paradigmatic Association

Traditional association theory has emphasized contiguity as the most potent factor operating in the production of word associations. Ordinarily words of the same form class do not appear in contiguity within sentences. Thus, it is difficult to posit contiguity as a variable in the development of paradigmatic association. However, Ervin (1961) hypothesized that words of the same form class could be placed into contiguity when a listener, trying to anticipate what he will hear next, makes an "erroneous anticipation." For example, if one hears "a cup of . . . ," and anticipates "coffee," but hears "tea," then the twc nouns are placed in contiguity. McNeill (1966) tested Ervin's "erroneous anticipation" hypothesis by presenting subjects:

> . . . pairs of nonsense syllables in sets of English sentence frames, with each pair appearing in a separate set. The members of pairs, substituting for one another equally often, formed idealized "grammatical classes" - that is, pairs of words that enjoyed identical privileges of occurrance . . . Ss were required to make overt anticipations of nonsense syllables upon presentation of sentence frames, a procedure that brings the process of erroneous anticipation to the surface (p. 549).

According to Ervin's hypothesis an increase in the frequency of anticipations should lead to an increase in the frequency of paradigmatic responses. McNeill's results did not favor the hypothesis that paradigmatic associations result from contiguity of erroneous anticipations of speech.

The most popular hypothesis concerning the development of paradigmatic associations is one which has been referred to as the "intersubstitution" hypothesis (Deese, 1962b, 1965; Ervin, 1961; Horowitz, et al., 1963;

Horowitz, Norman and Day, 1966; McNeill, 1963). According to the intersubstitution notion, "paradigmatic association results from the use of words in identical speech contexts" (McNeill, 1963, p. 250).

To investigate the intersubstitution hypothesis, McNeill (1963) again used a procedure in which nonsense syllables appeared in English sentence frames. Certain syllables appeared in adjective positions while others appeared in noun positions within the sentences. The Ss were given either 20, 40 or 60 training trials. Training was followed by a free association test in which noun syllables were stimuli, a recall test in which adjective syllables were stimuli, and a usage test in which Ss were asked to make up sentences with the syllables. McNeill (1963) found that:

> . . . the frequency of association between nonsense syllables presented as nouns in identical English contexts increased as a function of the number of presentations (p. 259). However, . . . there was no correlation between the frequency of paradigmatic association and the probability of using the artifical words in the same grammatical class as was imposed on them in training (p. 262).

Braine (1963; 1965) offered a version of the intersubstitution hypothesis and proposed that grammatical structure is acquired by "contextual generalization."

> For verbal learning, contextual generalization may be defined informally as follows: when a subject, who has experienced sentences in which a segment (morpheme, word or phrase) occurs in a certain position and context, later tends to

> place this segment in the same position in other contexts, the context of the segment will be said to have generalized, and the subject to have shown contextual generalization (1963, p. 323).

Thus, "'what is learned' are primarily the proper locations of words in sentences" (Braine, 1963, p. 324). Braine demonstrated contextual generalization by having children learn "miniature artificial languages with nonsense syllables as words" (Braine, 1963, p. 324). In one of Braine's "languages" "there were two classes of words, A words and P words, and sentences were always two words long and consisted of an A word followed by a P word" (Braine, 1963, p. 325). Language training consisted of sentence-completion problems in which two A words and two P words were used. Following initial learning, the Ss were given generalization problems in which a new A or P word was presented, and Ss were to supply an appropriate learned alternative word. On the basis of the results of the generalization test, Braine concluded that:

> . . . subjects who have experienced sentences in which words occur in a certain position and context tend to place these words in the same positions in new contexts. Such behavior indicates the learning of an association of words with their positions, the context generalizing (1963, p. 326).

Similar results were also obtained when more elaborate "languages" were used.

A theoretical explanation of paradigmatic association development which embodies the competing response notion has been largely ignored by most investigators in the area, with the exception of Ervin (1961). The competing response idea and its operation in the word association test situation has been described as follows:

> The stimulus word, through past experience, has become associated with many different response words and is capable of eliciting any of them. When the stimulus word is presented, the potential responses compete among themselves, and the strongest connection wins and governs the overt response. The frequency and speed with which a response wins out vary directly with the response's own strength, and inversely with the strength of its competitors (Woodworth and Schlosberg, 1954, p. 49).

The competing response or interference view can be applied as an explanation of paradigmatic association development. Assuming that a stimulus word is capable of eliciting several, equally strong, competing syntagmatic responses, a subject who is instructed to respond to the stimulus word as quickly as possible must resolve the existing interference. The alternatives available to the subject are: (1) to respond with a comparatively long latency with one of the competing responses, i.e., to give a syntagmatic response; (2) to respond with a Spoonerism, or a response which contains parts of two or more of the competing responses; or (3) to respond with a word outside of the competing response hierarchy. Such a word might be of the same form class as the stimulus word.

In the present study, interest is focused on the development of paradigmatic associations of nouns and adjectives. All hypotheses and interpretations stated from this point on are with respect to these two form classes only. Deese (1965) noted that "nouns are paradigmatic whether they are common nouns or rare nouns . . . common adjectives are somewhat more likely to be paradigmatic than are uncommon adjectives" (p. 106). The interference view would account for the finding that common adjectives tend to elicit paradigmatic responses by arguing that common adjectives would elicit many equally strong competing responses, while uncommon adjectives would elicit weak response competition. Thus the interference elicited by a common adjective would be resolved by responding paradigmatically. If an uncommon adjective elicits little or no interference, the strongest contiguous response or a syntagmatic association could be expected. The interference hypothesis would account for the observed paradigmatic responses to nouns by maintaining that through past experience a noun would elicit several associative responses. Responding paradigmatically with a word which is outside of the competing response hierarchy could resolve the existing interference.

In any study of natural language behavior, individual differences in previous verbal experiences represent a potent uncontrolled variable. A simple artificial language situation, such as that used by Braine (1963), would allow investigation of word association development with previous experience under experimental control. The use of a simple artificial language stems from early studies done by Esper (1933).

Esper Studies

Esper (1933) held that "language, in its fundamental, living form, consists of a system of verbal responses to (chiefly external) stimulus patterns . . . " (p. 347). Thus, a simple artificial language was designed in which nonsense figures (stimuli) were assigned nonsense names (responses). The conditions as described by Esper (1933) were as follows:

> (a) verbal responses were attached to a number of stimulus-objects which resembled one another in shape or size, but which were so selected that there was a certain asymmetry in the objective classes to which they belonged; and (b) additional objects were subsequently introduced which systematically resembled the original objects but for which no specific names had been learned. In both cases, the purpose was to provide conditions favoring varying degrees of instability in the stimulus-response relationship (p. 347).

Subjects were trained under various conditions for a total of eight consecutive months. One of the major conclusions made with regard to the associative process was that:

> Stimuli resulting from one verbal response become capable of eliciting a specific other verbal response whenever there is a frequent recurrence of environmental situations which tend to elicit both responses simultaneously or successively. An environmental situation might elicit such multiple responses either because it contains <u>both</u> of the objects <u>a</u> and <u>b</u> each of which tends to elicit its own specific response, or because it contains an object <u>a</u> which tends to elicit

> not only its own specific response but also the response specific to another (absent) object <u>b</u> (p. 376).

Esper's approach and findings have been virtually ignored in subsequent literature on the development of association. One probably reason for this is the long training period of the subjects. However, the use of simple artificial languages would allow experimental investigation of paradigmatic association development. The following rationale can be used to generate simple artificial languages. A single visual form can be verbally identified by a learned label, and such a label or shape name may be classed as a noun. If the visual form varied along a dimension such as size, a verbal unit may be assigned to each value of the size dimension. The verbal units used to signify size may be classed as adjectives. Thus, each instance of a visual form could be uniquely identified with two verbal units, one referring to form size and the other referring to form name. For example, a simple artificial language could be generated as shown in Table 1.

As in Esper's design, the stimuli are nonsense shapes. Each shape is associated with two pronounceable nonsense syllables. One of the syllables functions as an adjective, while the other syllable functions as a noun. In the arfitifial language in Table 1, the syllable "ged" appears as a part of the response only when either

TABLE 1.--A simple artificial language.

Size	Stimulus Nonsense Shape	Learned Response	
		Adjective	Noun
Size 1	A_1	ged	faw
Size 2	A_2	hib	faw
Size 1	B_1	ged	mep
Size 2	B_2	hib	mep

nonsense shape of Size 1 is presented, while the syllable "hib" appears only when either nonsense shape of size 2 is presented. Therefore, "ged" and "hib" serve as adjectives, while "faw" and "mep" serve as nouns. The adjective syllable "ged" appears in contiguity with the noun syllable "faw" and the noun syllable "mep." As training progresses, the syllable "ged" should be associated to an equal degree with both noun syllables, "faw" and "mep." Similarly, the adjective syllable "hib," which has appeared in contiguity with the noun syllable "faw" and the noun syllable "mep," should elicit both noun syllables with equal strength at the end of training. Assuming that backward associations do develop, each of the noun syllables should be associated to the same degree with each of the adjective syllables. Thus, once such a simple artificial language has been learned, it is hypothesized that a situation exists which is similar to that cited previously by Esper (1933, p. 376). In other words, paradigmatic associations would be expected to develop since the stimuli for each individual response element elicits two simultaneous or successive syntagmatic associates with approximately equal strength.

Pilot Work

Pilot studies indicated that Ss are able to learn simple artificial languages, such as that presented in Table 1, within an hour session. After learning the simple artificial languages to a predetermined criterion, Ss were given a discrete free association test in which each of the artificial language nouns and adjectives were presented as stimuli and the Ss were instructed to respond with the first nonsense word, of those that they had just learned, that they thought of. The associative responses and their latencies were recorded. Classification of the associative responses as paradigmatic (i.e., noun-noun or adjective-adjective) or syntagmatic (i.e., adjective-noun or noun-adjective) was made. It was found that although Ss gave a preponderance of syntagmatic responses, with adjective-noun (forward associations) occurring as frequently as noun-adjective (backward associations), some paradigmatic responses were also given.

In the simple artificial languages used in pilot studies, the nonsense syllable adjectives always appeared as the first element of the two syllable response to a nonsense shape, while noun syllables always appeared as the second element of the response. It could be argued that the development of any paradigmatic associations was based on intersubstitution, i.e., use in identical speech contexts, rather than associative competition or interference. In order to control for the possibility that two grammatically similar elements might become associated because they appear in a similar position within verbal contexts, it is necessary to design a simple artificial language in which some elements are of the same form class but do not occupy identical positions, and some are of the same form class and occupy identical positions.

A Simple Artificial Language to Compare the Effects of Interference and Intersubstitution on Paradigmatic Association Development

In the rationale suggested earlier for generating simple artificial languages, an adjective was described as a verbal unit which signified a particular value along some dimension, such as size. Acceptance of such a definition enables one to assume that there are no limitations on the position an adjective might occupy within a verbal utterance. Therefore, a possible paradigm of a simple artificial language in which verbal elements of the same form class do not appear in similar contextual positions appears in Table 2.

TABLE 2.--Paradigm of a simple artificial language in which adjective elements occupy different contextual positions.

Stimulus		Response
Size	Nonsense Shape	Nonsense Syllables
Size 1	W_1	Adjective 1 - Noun 1
Size 1	X_1	Adjective 1 - Noun 2
Size 2	Y_2	Noun 3 - Adjective 2
Size 2	Z_2	Noun 4 - Adjective 2

In the paradigm presented in Table 2, each adjective syllable should be associated to an equal degree with two noun syllables. It is maintained that only the response interference hypothesis would predict the development of any association between the two adjectives, while the intersubstitution hypothesis would predict the development of associations between nouns appearing in identical contexts.

Therefore, in a word association situation in which artificial language elements are presented as stimuli, S might respond with any one of the five remaining syllables. With reference to Table 2, when an adjective syllable is presented as a stimulus S might respond with: (1) the other adjective element (Adjective-Adjective paradigmatic association); (2) one of the two noun syllables which appeared contiguously with the adjective stimulus during training (Adjective-Noun contiguous syntagmatic association); or (3) one of the two noun syllables which had not appeared contiguously with the adjective stimulus, but had occupied the same contextual position as the adjective (Adjective-Noun positional syntagmatic association). When a noun syllable is presented as a stimulus in the word association test situation the S might respond with: (1) the other noun syllable which occupied the same contextual position and had also appeared contiguously with the same adjective syllable during training (Noun-Noun positional paradigmatic association); (2) one of the other two noun syllables which had not occupied the same contextual position as the stimulus noun (Noun-Noun non-positional paradigmatic association); (3) the adjective syllable which had appeared contiguously with the stimulus noun during training (Noun-Adjective contiguous syntagmatic association); or (4) the adjective syllable which had not appeared contiguously with the noun stimulus, but which occupied the same contextual position during training (Noun-Adjective positional syntagmatic association).

Major Hypotheses

During Artificial Language Training each adjective syllable appears with equal frequency in contiguity with two noun syllables. At the end of training a word association test is administered in which artificial language elements are presented as stimuli and the associative responses and their latencies are recorded. The appearance of a noun artificial language syllable in a word association test should elicit only one contiguous adjective syllable and response competition or interference. However, the appearance of an adjective syllable as a word association stimulus should elicit two equally strong contiguous noun associates and response interference.

Evidence of Interference

If response interference is generated as a result of training, the following word association test results are expected:

1. The proportion of noun-adjective contiguous syntagmatic associations should exceed the proportion of adjective-noun contiguous syntagmatic association. In other words, if interference is generated by the presentation of an adjective stimulus, rather than responding with one of the competing contiguous noun responses, *S*s would be more likely to resolve the interference by responding in some alternative fashion.

2. The average median latency of adjective-noun contiguous syntagmatic associations should exceed the average median latency of noun-adjective contiguous syntagmatic association. That is, if an adjective stimulus elicits response interference then *S*s should respond more slowly to an adjective than to a noun.

Interference vs. Intersubstitution

If interference rather than intersubstitution is the major factor involved in the development of paradigmatic association, the proportion of adjective-adjective associations should exceed the porportion of noun-noun positional associations. It is maintained that adjective-adjective associations would develop as a result of interference, while noun-noun positional associations would develop as a result of intersubstitution.

Evidence of Intersubstitution

If the development of paradigmatic associations is a result of intersubstitution, i.e., association as a result of appearance in the same context, then the proportion of noun-noun positional associations should exceed the proportion of noun-noun non-positional associations. Noun-noun non-positional associations would presumably be the result of chance.

Evidence of Interaction of Factors

Earlier it was stated that one manner in which interference might be resolved is by responding with an element which is outside of the competing response hierarchy. In the present study both adjective-adjective and adjective-noun positional associations illustrate this mode of responding. However, it is possible that associations develop between elements which have appeared in identical positions but within different contexts (Braine, 1963). An adjective-noun positional association is an example of such an association. Therefore, an adjective-noun positional association could be a result of interference, or a result of mediation in terms of position, or both. While an adjective-adjective association could develop only as a result of interference, a noun-adjective association, on the other hand, could develop only as a result of appearance in identical positions within different contexts. If the effects of interference and position interact in an additive manner, then it would be predicted that: (1) the proportion of adjective-noun positional associations should exceed the proportion of noun-adjective positional associations, and; (2) the proportion of adjective-noun positional associations should exceed the porportion of adjective-adjective associations.

The present study consists of two experiments. The results of Experiment I are used in constructing the artificial languages to be used in Experiment II.

CHAPTER II

EXPERIMENT I

Six pronounceable nonsense syllables were selected as artificial language elements: faw, ged, hib, jat, mep and zir. The Archer (1960) association value of these syllables is as follows: faw, 52%; ged, 36%, hib, 44%; jat, 41%, mep, 36%; and zir, 31%. It seemed possible that certain syllables might be associated with others prior to any exposure to the experimental situation. If associations were to be established through experimental training, any difference in pre-experimental associative strength would make data interpretation difficult. To determine the extent to which the syllables were associated with each other, a multiple-choice questionnaire was designed and administered to naive subjects. The multiple-choice format in which Ss are limited to a set of alternatives has been used in natural language word association tests (Crown, 1947; Kjeldergaard, 1962; Malamund, 1946; Maller, 1936; Terman and Mills, 1936; Wynne, Gerjuoy and Schiffman, 1965).

Method

Four counterballanced forms (Appendix A) of the twelve item multiple-choice test were given to a group of 421 undergraduate students in Introductory Psychology at Michigan State University. Along with the questionnaire, each S was also given an IBM Answer Sheet and a scoring pencil. The following instructions were read:

> You have been given a mimeographed sheet with twelve items. At the top of the sheet there is a Roman numeral I, II, III or IV. Please write this numeral on your IBM Answer Sheet. Please write your name on the IBM Sheet and at the top of the mimeographed sheet.

The E paused for a moment while the Ss carried out these instructions and then continued:

> If you look at the item labeled Sample at the top of the mimeographed sheet, it says, "The one word that seems to go best with dax is: (1) seb (2) paf (3) nij (4) tez (5) bip." If you thought that seb went best with dax, you would mark or fill in the one space on the IBM Answer Sheet; if you thought that paf went best with dax, you would fill in the three space; if you thought that tez went best with dax, you would mark the four space; or if you thought that bip went best with dax, you would fill in the five space on the IBM Sheet. Before you start, please say after me the words that you will be seeing in the twelve items.

The E then pronounced a syllable and the Ss repeated it. The same procedure was followed for the remaining syllables. Questions asked by Ss were answered by a repetition or paraphrasing of the instructions. The Ss were also urged to complete the questionnaire as quickly as possible. The entire procedure took approximately 30 min.

The questionnaires were constructed so that items 1-6 represented one random order of presentation of the six syllables as stimuli, and items 7-12 represented a second. Therefore, each S responded to each syllable twice. The number of Ss who responded with each of the five choices was tabulated for each item and for each of the four forms.

Results

These data indicated that the response did not vary as a function of questionnaire form (see Appendix B), therefore, the data were pooled. The number and percentage of the Ss giving the various syllable associations on presentations 1 and 2 are presented in Table 3. Each of the six syllables had frequency distributions of responses which differed significantly ($p < .001$) from chance distributions on both the first and second presentations. These data are presented in Table 4.

In all cases the syllables which Ss most frequently indicated as associates, i.e., those "seeming to go best with each other," were those which shared common middle vowels. The rank order of syllable associations according to the mean of the percentage of Ss on presentations 1 and 2 making the association is shown in Table 5.

Discussion

The percentage of Ss indicating that certain syllables "seemed to go best" with each other was used as index of associative strength. The syllable association highest in associative strength was "mep" and "ged," while

TABLE 3.--Frequency and percentage of associates to six nonsense syllable stimuli on presentations 1 and 2 of the syllable questionnaire.

		Presentation I		Presentation 2	
Stimulus	Response	Frequency	Per Cent	Frequency	Per Cent
faw	jat	156	37.2	151	36.3
	zir	110	26.3	111	26.7
	ged	73	17.4	70	16.8
	mep	51	12.2	49	11.8
	hib	29	6.9	35	8.4
ged	mep	177	42.2	170	40.7
	hib	77	18.4	66	15.8
	jat	66	15.8	83	19.9
	zir	55	13.1	50	11.9
	faw	44	10.5	49	11.7
hib	zir	151	36.0	150	35.9
	ged	95	22.7	102	24.4
	mep	67	16.0	63	15.1
	jat	63	15.0	62	14.8
	faw	43	10.3	41	9.8
jat	faw	128	30.5	121	28.9
	zir	98	23.4	101	24.2
	ged	90	21.5	110	26.3
	mep	54	12.9	48	11.5
	hib	49	11.7	38	9.1
mep	ged	200	47.7	178	42.6
	hib	80	19.1	60	14.3
	zir	49	11.7	63	15.1
	jat	47	11.2	56	13.4
	faw	43	10.3	61	14.6
zir	hib	146	34.8	128	31.0
	jat	103	24.6	101	24.4
	faw	73	17.4	87	21.1
	ged	66	15.8	59	14.3
	mep	31	7.4	38	9.2

TABLE 4.--Values of χ^2 obtained for the frequency distribution of responses to each of six nonsense syllables on presentations 1 and 2.

Syllable	Presentation 1	Presentation 2
faw	120.18	108.88
ged	136.47	120.26
hib	83.58	88.74
jat	51.11	68.40
mep	211.28	147.69
zir	88.80	59.83

TABLE 5.--Rank order of nonsense syllable associations according to mean per cent on presentations 1 and 2.

Rank	Stimulus	Response	Mean Per cent
1	mep	ged	45.2
2	ged	mep	41.4
3	faw	jat	36.8
4	hib	zir	36.0
5	zir	hib	32.9
6	jat	faw	29.7
7	faw	zir	26.5
8	zir	jat	24.5
9	jat	ged	23.9
10	jat	zir	23.8
11	hib	ged	23.6
12	zir	faw	19.2
13	ged	jat	17.9
14.5	faw	ged	17.1
14.5	ged	hib	17.1
16	mep	hib	16.7
17	hib	mep	15.5
18	zir	ged	15.1
19	hib	jat	14.9
20	mep	zir	13.4
21	ged	zir	12.5
22	mep	faw	12.4
23	mep	jat	12.3
24	jat	mep	12.2
25	faw	mep	12.0
26	ged	faw	11.1
27	jat	hib	10.4
28	hib	faw	10.0
29	zir	mep	8.3
30	faw	hib	7.6

the syllable association lowest in associative strength was "mep" and "zir." Using the indices of pre-experimental associative strength, two artificial languages were designed and appear in Table 6.

TABLE 6.--High and low adjective association--artificial languages

Stimulus		Response	
Size	Nonsense Shape	High Adjective Association	Low Adjective Association
1	W_1	mep zir	zir faw
1	X_1	mep faw	zir ged
3	Y_3	jat ged	jat mep
3	Z_3	hib ged	hib mep

One of the languages contained adjective elements in which the pre-experimental associative strength was high, i.e., mep and ged, while the other language contained adjective elements in which pre-experimental associative strength was low, i.e., mep and zir. An attempt was made to match the pre-experimental associative strength of an adjective syllable with each of the two noun elements with which it was to appear in the artificial languages.

CHAPTER III

EXPERIMENT II

Once the artificial languages were designed, Experiment II was run.

Method

Subjects

Thirty-two undergraduate students enrolled in the Introductory Psychology course at Michigan State University were used as *S*s. There were 20 females and 12 males. The students served as *S*s as part of the course requirements.

Two *S*s were replaced during the running of the experiment because they failed to reach criterion during Session 1.

Apparatus and Materials

The apparatus used was a combination tachistoscope and memory drum. The *S*s looked into the apparatus and viewed materials presented on an automatic card changer. The stimulus shapes were photographic copies of modified historical maps. Each of the four shapes was produced in three different sizes. The "small" size shapes were approximately 2.5 sq. in., the "middle" size shapes were approximately 3.75 sq. in., and the "large" size shapes were approximately 6.5 sq. in. The four small size shapes appear in Figure 1, the four middle size shapes appear in Figure 2, and the four large size shapes appear in Figure 3. Each of the shapes was mounted in the center of a bluegreen 8 1/2 x 11 in. Smead file-divider card. Four reproductions of each of the three sizes were mounted for each of the four shapes.

The nonsense syllables, "mep," "ged," "faw," "hib," "jat," and "zir" were printed in 1/2 in. black capital letters on 3 x 1 in. white gummed labels. Each one of the six syllables was printed on six different gummed labels. Each printed syllable was then mounted in the center of an 8 1/2 x 11 in. file-divider card.

The responses which were to be learned during artificial language training were printed on 6 x 1 in. white gummed labels. A total of four of each of the following responses was printed: "mep zir," "mep faw," "jat ged," "hib ged," "zir faw," "zir ged," "hib mep," and "jat mep." Each response was mounted in the center of an 8 1/2 x 11 in. card.

Procedure

Two paid undergraduate students assisted in running subjects. One of the assistants ran Ss 2, 6, 7, 11, 15, 16, 23, 24, 31 and 32 and the other ran Ss 3, 8, and 28. The author ran the remaining Ss.

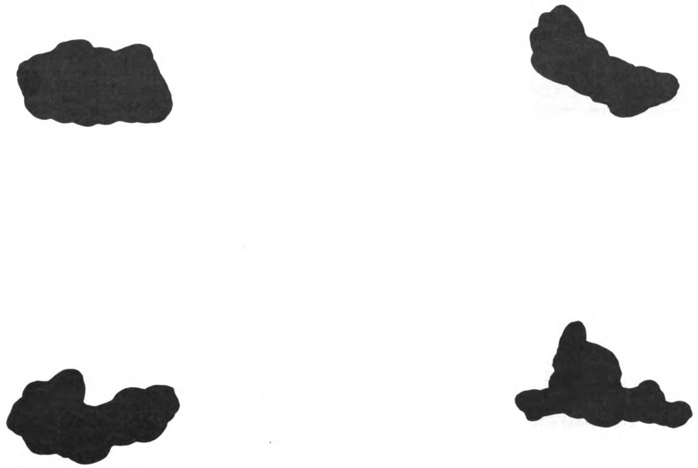

Figure 1.--"Small" Size Nonsense Shape Stimuli.

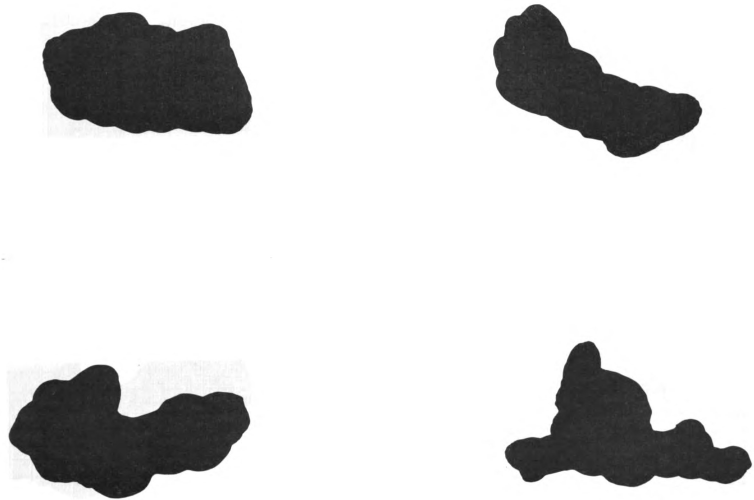

Figure 2.--"Middle" Size Nonsense Shape Stimuli.

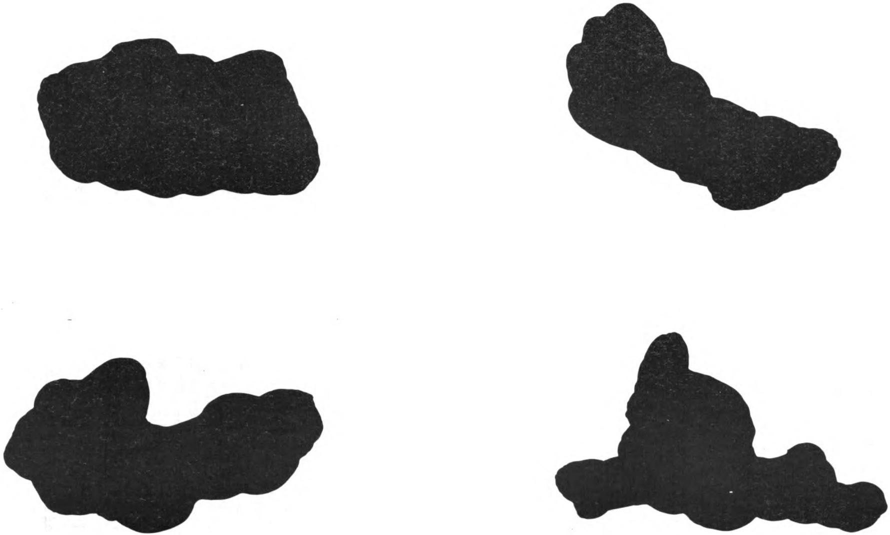

Figure 3.--"Large" Size Nonsense Shape Stimuli.

The Ss were run at the same hour on two consecutive days. The procedure consisted of seven phases.

Phase 1 - English Word Association Test 1

The main purposes of English Word Association Tests were to adapt S to the experimental situation, and to obtain the associative responses and latencies for natural language stimuli.

Once the S was comfortably seated in the darkened experimental room, the E read the following preliminary instructions:

> In front of you there is a scope-sight. I will be showing you things and timing how long it takes you to say something. During the experiment be sure to say only the one word you want to say, and try to keep your voice at the same level each time you say a word. For practice, look into the machine and say the word you see.

The E then presented the word CAT. After S had repeated the word, these instructions were read:

> From now on do not repeat the word you see in the machine. When you see a word in the machine, say the first word that you think of as fast as you can. Since I'm interested in the first word you say, and how long it takes you to say it, be sure to say just one word and say it as fast as you can. Remember, do not say the word you see in the machine, and try to keep your voice at the same level each time you say the first word you think of. Suppose I showed you the word CAT, (at this point E presented the word CAT) what is the first word you would think of?

During the remainder of the English Word Association Test the following twelve English word stimuli were presented to each S in the same random order: dark, slow, lamp, black, sour, salt, man, long, rough, sickness eagle, boy. Each stimulus word was exposed for two seconds. At the same time that a stimulus presentation began, a Hunter timer was started. The timer was stopped manually by _E_ when _S_ made a response. Although a voice key was used, it proved too cumbersome to use. Therefore, the associative latency measure, i.e., time between onset of stimulus word and _S_'s response, included _E_'s relatively constant reaction time. Between stimulus presentations while _E_ recorded the associative response and its latency, the _S_ was performing a button-pushing task. This task was introduced to prevent rehearsal by _S_ between stimulus presentations. Following the preliminary instructions, _S_s were then told:

> To make the task a little more difficult for you, I would like to have you press either of the buttons on your right or left. Do you see the buttons? Keep pressing the button and silently count the number of presses you make. I will ask you what number you are on, then I will say "Ready?" You will look into the machine and I will show you a word. As soon as you see the word, say the first word that you think of as fast as you can. After you have seen the word and said the first word you thought of, start pressing and counting again. In other words, the procedure will go like this: You press the button and count how many presses you make. I say, "How many presses?" You tell me how many presses you made. I say "Ready?" You look into the machine, see a word, and say the first word that you think of. Then you start pressing and counting again. Do you understand? Just to make sure that you are clear about what you will be doing, could you please tell me what you think your task is? (The _S_ described the procedure.) Please start pressing and counting now.

Phase 2 - "Noun only" Artificial Language Training for 16 Trials

It should be noted that in the artificial languages generated for the present study, the adjective nonsense syllables are part of the verbal response twice as often as the noun syllables. The possibility that a relationship between frequency of appearance of adjectives and frequency of paradigmatic association might operate in the artificial language situation prompted the use of a control for the frequency of appearance of adjectives in the present study. The control procedure constitutes the "Noun only" Training portion of Experiment II.

An item is defined as one stimulus (nonsense shape) and its appropriate verbal response. A trial is defined as the presentation of those four items which constitute the simple artificial language such as those designed for the present study. In a pilot study, it was found that Ss took approximately nine trials to learn simple artificial languages of the High and Low adjective Associations type. After consideration of (1) the number of times S would be exposed to adjectives as compared to nouns if he reached criterion immediately and (2) the number of trials to criterion required by the group of pilot Ss, sixteen trials were judged to be adequate to balance the frequency of appearance of the adjective and noun syllables. It was also reasoned that in learning a natural language Ss would ordinarily associate objects and their appropriate labels (nouns), and the elements associated with size (adjectives) would be learned afterward. Therefore, all Ss received sixteen trials of "Noun only" training following the initial English word association test. The stimuli in "Noun only" training, were those nonsense shapes appropriate to the particular artificial language S was to learn, but the stimuli were of middle size (Figure 2). The responses were appropriate noun syllables.

All Ss were given one "familiarization" trail in which the noun syllables appeared below the middle sized stimulus shapes. The Ss were read the following instructions:

> Now, let's try something new. I am going to show you some shapes, and each shape will have a nonsense word that goes with it. Your task is to learn the word that goes with each shape. In other words, I will show you a shape and you will say the word that goes with it as fast as you can. When I say "Ready?" you will look into the machine and see a shape and a word printed below the shape. Look at the shape and say the word that goes with it. "Ready?" (S viewed item 1). Look at this shape and say the word that goes with it. "Ready?" (S viewed item 2). Here is the next one. "Ready?" (S viewed item 3). Now look at this shape and say the word that goes with it. "Ready?" (S viewed item 4).

At the end of the "familiarization" trial the following instructions were read:

> From now on you will see only a shape and a short time later the word that goes with it. Try to say the word that goes with the shape before

> the word appears in the machine. If you make a mistake, or don't know the word, say the word when it appears. Every time you see a shape try to guess the word that goes with it. Even when you say the right word, say it again when it appears in the machine. I will say "Ready?" just before a shape appears. Do you have any questions? Just to be sure that you understand what your task is, please tell me what you think will be happening.

Each stimulus was presented for a two second interval, and approximately one second later the response was presented for two seconds. The inter-item interval was also two seconds. At the end of four trials the E had to stop for about two minutes to replace the stimulus and response cards on the card changer of the exposure device. Thus, the inter-trial interval varied from two seconds for four consecutive trials to approximately two minutes between every fourth and fifth trial. The S's response was scored as an error if (1) the appropriate syllable was not given, or if (2) the response was not made within the two second stimulus interval. The number of errors made during the sixteen trials of "Noun only" training was tabulated for all Ss.

Phase 3 - Simple Artificial Language Training

Following "Noun only" training, sixteen randomly assigned Ss were given training on the High Adjective Association Artificial Language, and sixteen randomly assigned Ss were given training on the Low Adjective Association Artificial Language. The languages learned by each S appear in Appendix C. All Ss were run to a criterion of three perfect trials. Again a response was scored as an error if (1) the correct two-syllable response was not given, or if (2) the response was not made within two seconds. The inter- and intra-trial relationships remained the same as those of "Noun only" training. Each S received a "familiarization" trial in which the appropriate responses consisting of two nonsense syllables appeared below the stimulus shapes, and was instructed as follows:

> Now let's try something new. I am going to show you some shapes, and each shape will have two nonsense words that go with it. Your task is to learn the two words that go with each shape. In other words, I will show you a shape and you will say the two words that go with it as fast as you can.
>
> When I say "Ready?" you will look into the machine and see a shape and two words printed below the shape. Look at the shape and say the two words that go with it. "Ready?" (S viewed item 1). Look at this shape and say the two words that go with it. "Ready?" (S viewed item 2). Here is the next one. "Ready?" (S viewed item 3). Now look at this shape and say the two words that go with it. "Ready?" (S viewed item 4).

At the end of the "familiarization" trial the following instructions were read:

> From now on you will see only a shape and a short time later the two words that go with it. Try to say the two words that go with the shape before the words appear in the machine. If you make a mistake or don't know the words, say the two words when they appear. Every time you see a shape try to guess the two words that go with it. Even when you say the two words correctly, say them again when they appear in the machine. I will say "Ready?" just before a shape appears. Do you have any

> questions? Just to be sure that you understand what your task is, please tell me what you think will be happening.

Once the S had demonstrated that he understood the instructions, the E began the presentation of the stimuli and responses. Presentation continued until S reached a criterion of three errorless trials. The number of errors and the number of trials to reach criterion were tabulated for each S.

Phase 4 - Artificial Language Word Association Test 1

After Ss had reached a criterion of three errorless trials, they were given a discrete free association test in which each one of the six nonsense syllables was presented as a stimulus. Each artificial language syllable was presented twice, once within each of two random blocks of six. The same syllable order, presented to each S, was as follows: hib, ged, faw, jat, mep, zir; followed by jat, mep, hib, zir, faw, ged. Between stimulus presentations the S performed a button-pressing task, as they had during the English Word Association Test, to prevent rehearsal. Each stimulus appeared for a two second interval, and Ss were instructed as follows:

> If you remember when you first came in I timed how fast you said the first thing you thought of when I showed you a word. We're going to do that again with the words you have been learning, that is, the words that went with the shapes. As you did before, press the button and count silently. I will ask you how many presses you made, then I

> will say "Ready?" and show you one of the words that went with the shapes. Say the first word you think of - one of the new words you learned - as fast as you can. Do you understand? Just to be sure, could you please tell me what you think will be happening?

The associative response and latency were recorded for each of the twelve syllable stimuli. After completing the Artificial Language Word Association Test, the Ss were reminded to appear at the same time the following day, and the first session ended.

Phase 5 - Continued Simple Artificial Language Training

At the start of the second session of the experiment, the Ss were given additional training in the simple artificial language. The procedure was the same as that of Phase 3 with two exceptions: (1) no "familiarization" trial was given; and (2) training continued to a criterion of six errorless trials. The number of errors and the number of trials to criterion were recorded for all Ss.

Phase 6 - Artificial Language Word Association Test 2

After Ss had reached the criterion of six errorless trials, they were given a discrete free association test in which each of the six artificial language nonsense syllables was presented as a stimulus. The order of presentation of syllables was as follows: faw, ged, jat, mep, zir, hib; followed by mep, jat, faw, zir, hib, ged. The procedure was identical to that used in the previous Artificial Language Word Association Test of Phase 4. The associative response and latency of each of the twelve syllable stimuli were recorded.

Phase 7 - English Word Association Test 2

Following the Artificial Language Word Association Test, all _S_s were given the same English Word Association Test as that of Phase 1. The _S_s were instructed as follows:

> Now, we are going to do the very same thing, except that the words I am going to show you are the English words. Press the button and count silently. I will ask you how many presses you have made, then I will say "Ready?" and show you an English word. Say the first word that you think of as quickly as you can. Any questions?

The associative response and latency for each of the twelve English words were recorded.

The _S_s were thanked for their participation, and dismissed. An explanation of the experiment was given to all _S_s during one of their class meetings after all data had been collected.

In summary, the procedure consisted of the following phases:

1. English Word Association Test 1.
2. "Noun only" Artificial Language Training for sixteen trials.
3. Simple Artificial Language Learning (Noun-Adjective) to a criterion of three perfect trials.

4. Artificial Language Word Association Test 1.

(End of Session I)

5. Continued Simple Artificial Language Learning (Noun-Adjective) to a criterion of six perfect trials.

6. Artificial Language Word Association Test 2.

7. English Word Association Test 2.

(End of Session II)

CHAPTER IV

RESULTS

Artificial Language Word Association Test

The Artificial Language Word Association Test was administered after each S reached a criterion of three errorless training trials, and again after each S reached a criterion of six errorless trials.

Since each artificial language contained six syllable elements, when presented with a single syllable stimulus, S might respond with any one of the five remaining syllables. When an adjective syllable was presented as a stimulus, S might respond with: (1) the other adjective element (Adjective-Adjective paradigmatic association); (2) one of the two noun syllables which appeared contiguously with the adjective stimulus during training (Adjective-Noun contiguous syntagmatic association); or (3) one of the two noun syllables which had not appeared contiguously with the adjective stimulus, but had occupied the same contextual position as the adjective (Adjective-Noun positional syntagmatic association). When a noun syllable was presented as a stimulus in the word association test situation the S might respond with: (1) the other noun syllable which occupied the same contextual position and had also appeared contiguously with the same adjective syllable during training (Noun-Noun positional paradigmatic association); (2) one of the other two noun syllables which had not occupied the same contextual position as the stimulus noun (Noun-Noun non-positional paradigmatic association); (3) the adjective syllable which had appeared contiguously with the stimulus noun during training (Noun-Adjective contiguous syntagmatic association); or (4) the adjective syllable which had not appeared contiguously with the noun stimulus, but which occupied the same contextual position during training (Noun-Adjective positional syntagmatic association).

The possible associations which could have been made by Ss in each of the Artificial Language Groups, and the classification of the associations in terms of paradigmatic or syntagmatic, as well as contiguous, positional, or non-positional appears in Table 7.

Within a single word association test, each nonsense syllable was presented twice. Therefore, Test I consisted of Presentations 1 and 2, while Test 2 consisted of Presentations 3 and 4. Data analyses were done in terms of Presentations rather than Tests, because of the possible influences of the first presentation on the second presentation within each test. Therefore, although data obtained on second presentations were analyzed and presented, the value of these data is limited. It should

TABLE 7.--Classification of associations made in artificial languages.

Group				Paradigmatic Associations						Group	Syntagmatic Associations							
High				Adjective-Adjective		Noun-Noun				High	Adjective-Noun				Noun-Adjective			
Sample Language						Positional		Non-positional			Contiguous		Positional		Contiguous		Positional	
Stimulus		Response		S	R	S	R	S	R		S	R	S	R	S	R	S	R
Size	Shape			mep	ged	zir	faw	zir	jat		mep	zir	mep	jat	zir	mep	jat	mep
1	W_1	mep	zir	ged	mep	faw	zir	jat	zir		mep	faw	mep	hib	faw	mep	hib	mep
1	X_1	mep	faw			hib	jat	zir	hib		ged	jat	ged	faw	jat	ged	faw	ged
3	Y_{3-}	jat	ged			jat	hib	hib	zir		ged	hib	ged	zir	hib	ged	zir	ged
3	Z_3	hib	ged					faw	jat	Low	zir	ged	zir	hib	ged	zir	hib	zir
								jat	faw		zir	faw	zir	jat	faw	zir	jat	zir
								faw	hib		mep	hib	mep	ged	hib	mep	ged	mep
								hib	faw		mep	jat	mep	faw	jat	mep	faw	mep
Low																		
Sample Language																		
Stimulus		Response		zir	mep	hib	jat	ged	hib									
Size	Shape			mep	zir	jat	hib	hib	ged									
1	W_1	zir	ged			ged	faw	jat	ged									
1	X_1	zir	faw			faw	ged	ged	jat									
3	Y_3	jat	mep					faw	hib									
3	Z_3	hib	mep					hib	faw									
								faw	jat									
								jat	faw									

be noted that results obtained on the first presentations are the major basis of interpretations made in the remainder of the study. The associative latencies and classifications of Ss' associative responses to stimuli presented during the Artificial Language Word Association Tests are presented in Appendix D.

On a single Presentation, each of the six nonsense syllables was presented once. Thus a single syllable stimulus could theoretically elicit one of the five remaining syllables as a response. If an adjective syllable was presented as a stimulus, the theoretical probability that S would respond with the other adjective syllable was one-fifth. However, the theoretical probability that S would respond with one of the two contiguous nouns was two-fifths. Therefore, the theoretical probability of an Adjective-Adjective (A-A) association was 0.20, of an Adjective-Noun (A-Nc) contiguous association was 0.40, and of an Adjective Noun positional (A-Np) association was 0.40. Similarly, the theoretical probability of a Noun-Noun positional (N-Np) association was 0.20, of a Noun-Noun non-positional (N-Nnp) association was 0.40, of a Noun-Adjective contiguous (N-Ac) association was 0.20, and of a Noun-Adjective positional (N-Ap) association was 0.20.

With reference to adjective associations, within each Artificial Language Group, the observed proportions on Presentations 1, 2, 3 and 4 were obtained by: (1) counting the number of Ss responding to each adjective stimulus with (a) the other adjective syllable, (b) a contiguous noun syllable, or (c) a positional noun syllable; (2) combining the frequencies of the tallies made for the two adjective syllables; and (3) dividing the frequency of (a) adjective responses, (b) contiguous noun responses and (c) positional noun responses by the total number of responses made to adjectives on that Presentation.

With reference to noun associations, within each Artificial Language Group, the observed proportions on Presentations 1, 2, 3 and 4 were obtained by: (1) counting the number of Ss responding to a particular noun stimulus with (a) a positional noun, (b) a non-positional noun, (c) a contiguous adjective or (d) a positional adjective syllable; (2) combining the frequencies of the tallies made for the four noun syllables; and (3) dividing the frequency of (a) positional noun responses, (b) non-positional noun responses, (c) contiguous adjective responses and (d) positional adjective responses by the total number of responses made to nouns on each Presentation.

A similar procedure was employed to find the average median latency of each associative class. The observed proportion and average median latency of each type of association on Presentations 1, 2, 3 and 4 for the High and Low Language Groups appear in Table 8.

Observed Proportions Tested Against Theoretical Proportions

A series of *z*-tests were run in which the observed proportions of each of the associative classes were tested against the appropriate theoretical proportions. The results of these *z*-tests appear in Table 9.

Interpretations of the significance tests presented in Table 9 must be made with caution since on each Presentation the sum of the proportions of associations made to adjectives was 1.00, and the sum of the proportions of associations made to nouns was 1.00. In other words, a high proportion of one class of associations to either a noun or an adjective would reduce the possible proportions of the remaining noun or adjective associative classes, i.e., the marginals were fixed.

The results of the *z*-tests of Table 9 may be summarized for paradigmatic associations as follows: first, the observed proportions of A-A associations did not differ significantly from the proportions of A-A associations expected to occur by chance alone; second, the observed proportions of N-Np associations were significantly less ($p < .01$) than the proportion expected to occur by chance; and third, the observed proportions of

TABLE 8

Observed proportions and average median latencies in seconds of associations of Artifical Language Word Association Tests for High and Low Artifical Language Groups.

			PARADIGMATIC											
			A-A				N-Np				N-Nnp			
	Test	Presen-tation	No. of Ss giving R	No. of R	Prop. of R	Lat. of R	No. of Ss giving R	No. of R	Prop. of R	Lat. of R	No. of Ss giving R	No. of R	Prop. of R	Lat. of R
High	1	1	2	2	0.062	1.38	2	2	0.032	1.12	5	7	0.129	1.85
		2	1	2	0.062	1.36	3	4	0.064	1.44	3	4	0.064	1.61
	2	3	4	6	0.188	1.68	2	2	0.032	1.08	2	4	0.064	0.97
		4	5	6	0.188	1.60	2	3	0.047	1.10	2	4	0.062	1.16
Low	1	1	5	6	0.194	1.71	3	3	0.048	3.70	5	10	0.159	1.82
		2	4	4	0.129	1.87	0	0	0.000	0.00	5	5	0.082	1.51
	2	3	1	2	0.062	1.17	2	2	0.032	2.16	1	1	0.016	1.09
		4	5	5	0.156	1.56	0	0	0.000	0.00	1	1	0.016	2.93

SYNTAGMATIC

			A-Nc				A-Np			
High	1	1	16	26	0.812	1.58	4	4	0.125	1.84
		2	15	23	0.719	1.36	7	7	0.219	1.78
	2	3	13	20	0.625	1.42	5	6	0.188	1.53
		4	14	24	0.750	1.26	1	2	0.062	0.96
Low	1	1	15	21	0.677	1.62	4	4	0.129	2.07
		2	15	22	0.710	1.58	5	5	0.161	1.68
	2	3	15	30	0.938	1.61	0	0	0.000	0.00
		4	16	26	0.812	1.55	1	1	0.031	2.22

SYNTAGMATIC

	N-Ac				N-Ap			
High	15	49	0.774	1.41	4	4	0.064	1.72
	15	49	0.762	1.30	6	6	0.111	1.55
	15	55	0.887	1.20	1	1	0.016	1.45
	14	56	0.875	1.15	1	1	0.016	1.20
Low	15	45	0.714	1.38	5	5	0.079	1.56
	16	52	0.852	1.51	4	4	0.065	1.96
	16	55	0.873	1.31	4	5	0.079	1.46
	16	56	0.889	1.29	4	6	0.095	1.71

TABLE 9

Summary of z-tests for observed proportions of associative classes vs theoretical proportions

Paradigmatic:			A-A(P=1/5)		N-Np(P=1/5)		N-Nnp(P=2/5)	
			z	p	z	p	z	p
	Test	Presentation						
High	1	1	-1.94	.0524	-3.30	.0010	- 4.36	<.0001
		2	-1.94	.0524	-2.71	.0068	- 5.45	<.0001
	2	3	-0.18	.8572	-3.30	.0010	- 5.39	<.0001
		4	-0.18	.8572	-3.06	.0022	- 5.51	<.0001
Low	1	1	-0.09	.9282	-3.02	.0026	- 3.91	<.0001
		2	-0.98	.3270	-3.91	.0001	- 5.07	<.0001
	2	3	-1.94	.0524	-3.34	.0008	- 6.20	<.0001
		4	-0.62	.5352	-3.97	.0001	- 6.20	<.0001

Syntagmatic:			A-Nc(P=2/5)		A-Np(P=2/5)		N-Ac(P=1/5)		N-Ap(P=1/5)	
			z	p	z	p	z	p	z	p
High	1	1	4.76	<.0001	-3.18	.0014	11.30	<.0001	-2.67	.0076
		2	3.68	.0002	-2.09	.0366	11.14	<.0001	-1.76	.0784
	2	3	2.60	.0094	-2.45	.0142	13.52	<.0001	-3.62	.0004
		4	4.04	<.0001	3.89	.0001	13.50	<.0001	-3.69	.0002
Low	1	1	3.16	.0016	-3.08	.0020	10.20	<.0001	-2.39	.0168
		2	3.52	.0004	-2.72	.0066	12.74	<.0001	-2.62	.0088
	2	3	6.21	<.0001	-4.62	<.0001	13.35	<.0001	-2.39	.0168
		4	4.76	<.0001	-4.26	<.0001	13.66	<.0001	-2.10	.0358

N-Nnp associations were also significantly less ($p < .0001$) than the proportion expected to occur by chance. These conclusions held for both language groups on each of the four Presentations. These data indicate that very few paradigmatic associations were given by Ss.

Turning to syntagmatic associations: first, the observed proportions of A-Nc associations were significantly greater ($p < .01$) than the proportion expected to occur by chance alone; second, the observed proportions of N-Ac associations were significantly greater ($p < .0001$) than the proportion expected to occur by chance; and third, the observed proportions of both A-Np and N-Ap associations were significantly less ($p < .05$) than the proportions expected to occur by chance. Again, these conclusions held for both Artificial Language Groups on each of the four Presentations. The major conclusion which can be drawn from these tests is that Ss tended to respond mainly with contiguous syntagmatic responses.

Evidence of Interference

If an adjective stimulus elicited response interference as a result of Artificial Language training, the following results were expected: (1) a greater proportion of N-Ac associations than A-Nc associations; and (2) longer median latencies of A-Nc associations than of N-Ac associations.

<u>Proportion of N-Ac Associations vs. Proportion of A-Nc Associations</u>

On a single presentation within an Artificial Language Word Association Test, the theoretical proportion of A-Nc associations was 0.40, and of N-Ac associations was 0.20. Therefore, in order to test for the difference between the observed proportion of A-Nc associations and N-Ac associations, the appropriate null hypothesis for a two-tailed test was $P_{A-Nc}P_{N-Ac}=0.20$. The McNemar test for the difference between two correlated proportions assumes the null hypothesis is $P_1-P_2=0$. Since the McNemar test is not appropriate in light of the null hypothesis of the present comparison, *z*-tests were run according to the procedure presented in Guilford (1956, p. 191). The *z*-tests for the difference between the observed proportion of A-Nc and N-Ac associations on each Presentation for the two Artificial Language Groups are presented in Table 10.

With reference to Table 10, in all cases the difference between the observed proportions was less than the difference of 0.20 expected to occur by chance alone, which indicated that the proportion of N-Ac associations exceeded the proportion of A-Nc associations. The difference between the two proportions was significant ($p < .05$), with the exception of the High Group on Presentation 1, on both word association tests. On the basis of these tests, it can be concluded that there is evidence supporting the hypothesis of response interference.

TABLE 10.--Summary of z-tests for difference between observed proportion of A-Nc and N-Ac associations on word association tests 1 and 2 for High and Low groups.

		z(t)	P_z	P_t	$\hat{P}_{A-Nc}-\hat{P}_{N-Ac}$
High Group (N-16)					
Test Presentation					
1	1	-2.12	.0340	<.10	.0625
	2	-2.25	.0244	<.05	0
2	3	-3.96	<.0001	<.01	-.1250
	4	-4.88	<.0001	<.01	0
Low Group (N-16)					
Test Presentation					
1	1	-2.25	.0244	<.05	0
	2	-4.04	<.0001	<.01	-.0625
2	3	-4.04	<.0001	<.01	-.0625
	4	*	<.0001	<.01	0

*Undefined - very large

Median Latency of A-Nc Associations vs. Median Latency of N-Ac Associations

Longer latencies of A-Nc associations as compared to N-Ac associations were expected if language training generated interference. Both A-Nc and N-Ac associations could have been either forward or backward in direction. The artificial languages were designed with the assumption that the latencies of forward and backward associations would be equal. Before any test of the hypothesis that A-Nc median associative latencies differed from N-Ac median associative latencies, it was therefore necessary to determine if there was a difference between forward and backward associative latencies. The average median latencies of forward and backward contiguous syntagmatic associations for the High and Low Groups on Presentations 1, 2, 3, and 4 appear in Table 11.

TABLE 11.--Average median latencies in Secs. of forward and backward contiguous syntagmatic associations for High and Low groups on tests 1 and 2.

Test	Presentation	Associative Direction	
		Forward	Backward
		High Group	
1	1	1.41	1.48
	2	1.29	1.31
2	3	1.27	1.27
	4	1.15	1.15
		Low Group	
1	1	1.46	1.42
	2	1.50	1.51
2	3	1.42	1.36
	4	1.39	1.28

An analysis of variance on the median latencies of forward and backward contiguous syntagmatic associations on each of the four Presentations was run for the High and Low Groups, and appears in Table 12.

TABLE 12.--Analysis of variance of median latencies of forward and backward contiguous syntagmatic associations for High and Low groups.

Source	df	Mean Square	F
Groups (G)	1	0.9988	3.625
Error (a)	30	0.2755	
Direction (D)	1	0.0099	0.164
Presentations (P)	3	0.4887	8.104*
G x D	1	0.0859	1.424
G x P	3	0.1427	2.366
D x P	3	0.0183	0.303
G x D x P	3	0.0107	0.177
Error (b)	210	0.0603	

*$p < .01$

In the analysis of variance presented in Table 12, the Error (a) was used as the denominator in the F ratio to test the main effect of Groups. The Error (b) was used as the denominator in the F ratio to test the main effects of Direction and Presentations, and the interactions. The analysis of variance on latencies of forward and backward contiguous syntagmatic associations, indicated that there was no significant difference between the average median latencies of forward and backward associations, and that latencies tended to decrease over presentations.

An analysis of variance was next performed on the median latencies of A-Nc associations and N-Ac associations on Presentations 1, 2, 3, and 4 of the word association test for the High and Low Groups. A summary of the analysis appears in Table 13.

TABLE 13.--Analysis of variance of median latencies of A-Nc and N-Ac associations for High and Low groups.

Source	df	Mean Square	F
Groups (G)	1	1.4013	3.143
Error (a)	30	0.4458	
Associative Class (AC)	1	2.0953	21.339**
Presentations (P)	3	0.3952	4.028*
G x AC	1	0.0922	0.939
G x P	3	0.1556	1.586
AC x P	3	0.1077	1.098
G x AC x P	3	0.0138	0.133
Error (b)	210	0.0981	

**$p < .01$

*$p < .05$

In the analysis of variance presented in Table 13, the Error (a) was used as the denominator in the F ratio to test the main effect of Associative Class and Presentations, and the interactions.

The analysis of variance on latencies of A-Nc associations and N-Ac associations indicated that the main effect of Associative Class was statistically significant ($p < .01$). An examination of the average median latencies of A-Nc and N-Ac associations on Presentations 1, 2, 3, and 4 for the High and Low Groups (Table 8) indicates that the average median A-Nc associative latencies were consistently longer than the average median N-Ac associative latencies. The main effect of Presentations was also statistically significant ($p < .05$). Again, examination of Table 8 indicates that the average median latencies for both associative classes tended to decrease over presentations.

Since the median A-Nc associative latencies were found to be significantly slower than the median N-Ac associative latencies, again there appeared to be evidence supporting the hypothesis of response interference.

Interference vs. Intersubstitution

The two artificial languages of the present study were designed using indices of pre-experimental associative strength between the nonsense syllable elements. A "syllable questionnaire" was administered to 421 naive Ss, and the indices of pre-experimental associative strength were the percentage of Ss indicating that certain syllables "seemed to go best" with each other. One of the artificial languages was then designed with adjective elements ("mep" and "ged") which had the highest pre-experimental associative strength (High Adjective Association Artificial Language), and the other artificial language was designed with adjective elements ("zir" and "mep") which had low pre-experimental associative strength (Low Adjective Association Artificial Language). It was maintained that if A-A associations were exhibited in the Artificial Language Word Association Tests, and if these associations were occurring with chance frequency, i.e., simply as a result of pre-experimental associative strength, then the incidence of A-A associations in the High Group should exceed that of the Low Group. If there was no difference between the two groups in the incidence of A-A associations, it would seem that Artificial Language Training was potent enough to establish new associations which were stronger than those existing pre-experimentally. According to Table 9, the incidence of A-A associations did not differ significantly from the frequencies expected by chance alone, for either the High or Low Adjective Association Artificial Language Groups. It might be argued that in the

High Group, the pre-experimental associative strength and the possible effects of interference are confounded with reference to the production of A-A associations. However, if both pre-experimental associative strength and interference were producing A-A associations in the High Group, these effects would be expected to be additive and result in: (1) a greater incidence of A-A association than that expected to occur by chance; and/or (2) a greater incidence of A-A associations in the High Group as compared to the Low Group. As pointed out previously, according to Table 9, the incidence of A-A associations in the High Group did not differ significantly from that expected by chance. A series of Fisher's exact tests (Appendix E) indicated that there was no significant difference between the number of Ss giving A-A associations in the High and Low Groups. A series of χ^2 tests (Appendix F) on the frequency of A-A associations to the two adjective syllable stimuli for the High and Low Groups, on each of the four presentations, also indicated no significant difference between the two groups. Although there were no statistically significant differences between the two groups, the data of both groups were considered, but not pooled, in tests dealing with the influence of interference in the production of paradigmatic associations.

It was hypothesized that if interference rather than intersubstitution, i.e., association attributed to the use of words in identical contexts, was the major factor involved in the development of paradigmatic association, then the proportion of A-A associations should exceed the proportion of N-Np associations.

Proportion of A-A Associations vs. Proportion of N-Np Associations

The difference between the observed proportions of A-A and N-Np associations were tested according to *z*-tests. The results of the *z*-tests of the difference between the correlated proportions for the two Artificial Language Groups on each of the four presentations appear in Table 14.

According to the *z*-test results presented in Table 14, none of the differences between the observed proportions of the High Group were significantly greater than the difference of zero expected to occur by chance alone. Although two of the tests for the Low Group were significant ($p < .05$), both significant values were for the second presentation within each of the word association tests.

On the basis of the results presented in Table 14, the overall trend suggests that there was no difference between the proportion of A-A and N-Np associations, and no conclusion can be made about the hypothesized influence of interference as compared to intersubstitution on paradigmatic association development.

TABLE 14.--Summary of z-tests for difference between observed proportion of A-A and N-Np associations for High and Low groups.

Test	Presentation	z(t)	Pz	Pt	$\hat{P}_{A-A}-\hat{P}_{N-Np}$
		High Group			
1	1	0	1.0000	-	0
	2	-1.03	.3030	-	-.125
2	3	0.83	.4066	-	.125
	4	1.19	.2340	-	.188
		Low Group			
1	1	0.72	.4716	-	.125
	2	2.31	.0208	<.05	.250
2	3	-0.58	.5620	-	-.062
	4	2.69	.0072	<.05	.312

Evidence of Intersubstitution

It was hypothesized that the development of paradigmatic associations as a result of intersubstitution, i.e., association as a result of use in identical contexts, would be manifested by the proportion of N-Np associations exceeding the proportion of N-Nnp associations.

Proportion of N-Np Associations vs. Proportion of N-Nnp Associations

The appropriate null hypothesis was $P_{N-Nnp} - P_{N-Np} = 0.20$. If the proportion of N-Np associations exceeded the proportion of N-Nnp associations, then the difference between the two observed proportions would have to be less than 0.20. The *z*-test results obtained in testing for the difference between the observed proportions of the two associative classes on each of the four presentations for the High and Low Groups are presented in Table 15.

TABLE 15.--Summary of *z*-tests for difference between observed proportion of N-Np and N-Nnp associations for High and Low groups.

Test	Presentation	z(t)	Pz	Pt	$\hat{P}_{N-Nnp}-\hat{P}_{N-Np}$
		High Group			
1	1	- 0.13	.8966	NS	.1875
	2	- 1.6	.1074	NS	0
2	3	- 4.88	<.0001	<.01	0
	4	-14.28	<.0001	<.01	0
		Low Group			
1	1	- 0.43	.6672	NS	.1250
	2	0.97	.3220	NS	.3125
2	3	- 2.45	.0142	.01<p<.05	-.0625
	4	- 2.25	.0244	.01<p<.05	.0625

According to the results presented in Table 15, on Presentations 1 and 2, the difference between the proportions of N-Nnp and N-Np associations for both groups did not differ significantly from what was expected to occur by chance. However, on Presentations 3 and 4, the difference between the proportions of the two associative classes was significantly less (High, $p < .01$; Low, $p < .05$) than the difference expected to occur by chance alone. In other words, in both groups, following additional training, there was an increase in the incidence of N-Np associations as compared to that of N-Nnp associations.

On the basis of the results presented in Table 15, it could be concluded that the development of paradigmatic associations as a result of intersubstitution was exhibited after additional training.

Evidence of Interaction of Factors

It was hypothesized that an A-A association could only develop as a means of resolving interference, while an N-Ap association could only develop as a result of appearance in identical positions within different contexts. However, an A-Np association could be attributed to either resolution of interference, appearance in identical positions within different contexts, or an interaction of the two factors. If these factors interacted in an additive manner then: (1) the proportion of A-Np associations should exceed the proportion of N-Ap associations; and (2) the proportion of A-Np associations should exceed the proportion of A-A associations.

Proportion of A-Np Associations vs. Proportion of N-Ap Associations

The theoretical proportion of A-Np associations on a single presentation within an Artificial Language Word

Association Test was 0.40, and the theoretical proportion of N-Ap associations was 0.20. If the proportion of A-Np associations exceeded the proportion of N-Ap associations, then the difference between the two observed proportions would have to be greater than 0.20. The *z*-test results obtained in testing for the difference between the observed proportions of A-Np and N-Ap associations on each of the four presentations for the High and Low Groups are presented in Table 16.

TABLE 16.--Summary of *z*-tests for difference between observed proportion of A-Np and N-Ap associations for High and Low groups.

Test	Presentation	z(t)	Pz	Pt	$\hat{P}_{A-Np}-\hat{P}_{N-Ap}$
		High Group			
1	1	-2.60	.0094	$.01<p<.05$	0
	2	-0.83	.4066	NS	.0625
2	3	0.36	.7188	NS	.2500
	4	-2.25	.0244	$.01<p<.05$	0
		Low Group			
1	1	-1.89	.0588	NS	-.0625
	2	-0.84	.4010	NS	.0625
2	3	-4.17	.0001	$<.01$	-.2500
	4	-2.94	.0032	$.01<p<.05$	-.1875

The results of the *z*-tests (Table 16) indicated that the proportion of A-Np associations was not significantly greater than the proportion of N-Ap associations. In fact, there was a trend in the opposite direction with a greater proportion of N-Ap associations than A-Np associations.

These results did not support the notion that the effects of interference and position within different contexts interact in an additive fashion.

Proportion of A-Np Associations vs. Proportion of A-A Associations

It was held that evidence of an interaction of factors in an additive manner would be indicated if the proportion of A-Np associations exceeded the proportion of A-A associations. If the proportion of A-Np associations exceeded the proportion of A-A associations, then the difference between the two observed proportions would have to be greater than 0.20. The *z*-test results obtained in testing for the difference between the observed proportion of A-Np and A-A associations on each of the four presentations for the High and Low Groups are presented in Table 17.

According to the *z*-test results presented in Table 17, both the High and Low Groups exhibited a significantly higher ($p < .05$) incidence of A-A associations than A-Np associations on Presentation 1. However, on Presentation 2, both groups had a higher proportion of A-Np associations than A-A associations, although the difference between the two proportions was not statistically significant. On Presentations 3 and 4 the Low Group again had a significantly higher (p < .01) incidence of A-A associations than A-Np associations, while this result was found for the High Group on Presentation 4.

TABLE 17.--Summary of z-tests for difference between observed proportion of A-Np and A-A associations for High and Low groups.

Test	Presentation	z(t)	Pz	Pt	$\hat{P}_{A-Np}-\hat{P}_{A-A}$
		High Group			
1	1	-2.17	.0310	.01<p<.05	-.1250
	2	1.17	.2420	NS	.3750
2	3	-0.74	.4592	NS	.0625
	4	-3.21	.0014	<.01	-.2500
		Low Group			
1	1	-2.14	.0324	.01<p<.05	-.1875
	2	-0.84	.4010	NS	.0625
2	3	-4.30	<.0001	<.01	-.0625
	4	-3.21	.0014	<.01	-.2500

On the basis of the results presented in Table 17, it could be concluded that the proportion of A-A associations tended to exceed the proportion of A-Np associations, and once again there was support for the hypothesis that the factors involved in association development, i.e., interference and appearance in identical positions within different contexts, do not interact in an additive manner.

Although the results obtained in the Artificial Language Word Association Tests were of primary interest, data were also collected for Artificial Language Training and English Word Association Tests.

To determine whether there were differences in ease of learning the High and Low Adjective Association artificial languages, statistical analyses of errors and trials to criterion during the various stages of training were made.

Artificial Language Training

"Noun-only"

All Ss were given 16 trials of Noun-only Training. The number of errors per trial for each S appears in Appendix G. The number of errors made by Ss over the 16 trials was totaled. In the High Adjective Association Group the mean of the total number of errors made over the 16 trials by each S was 17.4 with a standard deviation of 11.4; while in the Low Adjective Association Group the mean was 14.2 with a standard deviation of 7.7. No statistically significant difference was found between the means of the two groups. It could therefore be assumed that performance of the two groups was not significantly different at this stage of learning.

Simple Artificial Language Training

All Ss were given Artificial Language Training to a criterion of three perfect trials during Session 1 and continued Artificial Language Training to a criterion of six errorless trials during Session 2. The number of trials to each criterion and the total number of errors per trial for each S appears in Appendix H. The mean number of trials to the criterion of Session 1 training was 8.3 with a standard deviation of 5.02 for the High Group, and 8.6 with a standard deviation of 4.76 for the Low Group. The difference between the means of the two groups was not statistically significant. The mean number of trials to the criterion of Session 2 training was 1.5 with a standard deviation of 1.67 for the High Group and 2.7 with a standard deviation of 2.07 for the Low Group. The difference between the means of the two groups was not significant.

In the High Group the mean of the total number of errors to the criterion of Session 1 training for each S was 14.1 with a standard deviation of 11.78, while in the Low Group the mean was 15.6 with a standard deviation of 10.77. There was no significant difference between the means of the two groups. The mean of the total number of errors to the criterion of Session 2 training for each S of the High Group was 1.6 with a standard deviation of 1.50, and 3.5 with a standard deviation of 1.86 for the Low Group. No statistically significant difference was found between the means of the two groups.

In summary, Ss learned simple artificial language with relative ease, as indicated by the error and trials to criterion data. Furthermore, no statistically significant differences were observed between the two artificial language groups during training which implies that the two languages were of similar difficulty.

English Word Association Tests

The associative responses and latencies of each S to the word stimuli of the English Word Association Test are presented in Appendix I. A summary of these data is presented in Appendix J. The Ss tended to give predominately popular paradigmatic associations to both noun and adjective stimuli. The English Word Association data of primary interest are the associative latencies. If there was no difference between the associative latencies to English words and the latencies to Artificial Language stimuli, it could be assumed that the same underlying principles governed discrete free association in both test situations. The median latencies of each S's associations in the English and Artificial Language Word Association Tests were determined and appear in Appendix K. The average median latencies and standard deviations for the Word Association Tests appear in Table 18.

Since more stable latencies were expected on the second presentation of the Word Association Test, an analysis of variance was run on the data of English Association Test 2 and Artificial Language Association

Test 2. The results of the analysis are presented in Table 19.

TABLE 18.--Average median latencies in seconds and standard deviations of associations to English Word Association Tests 1 and 2 and Artificial Language Association Tests 1 and 2.

	English		Artificial Language	
	Test 1	Test 2	Test 1	Test 2
Average Median Latency in Sec.	1.40	1.20	1.44	1.27
Standard Deviation	0.21	0.20	0.24	0.24

TABLE 19.--Analysis of variance for median associative latencies on English and Artificial Language Association Tests 1 and 2.

Source	df	MS	F	P
Language Tests	1	0.0812	5.41	$.05 < p < .10$
Subjects	31	0.0851		
Residual	31	0.0150		

The main effect of Language Tests approached significance ($p < .10$). These results suggest that the same underlying principles may not apply in both the English and Artificial Language Word Association Test situations.

CHAPTER V

DISCUSSION

One of the purposes of the present study was to examine discrete free association data in terms of grammatical classes. With respect to natural languages, the development of syntagmatic associations, i.e., associations between stimuli and responses which are of different grammatical classes, is generally attributed to the contiguous appearance of the associates in language sequences or contexts. The word associations of young children (under the age of six) to adjectives tend to be largely syntagmatic. However, the associations of adults to nouns and common adjectives tend to be largely paradigmatic, i.e., associations between stimuli and responses which are of the same grammatical class.

A simple artificial language situation was employed rather than a natural language setting to examine associations categorized in terms of grammatical class. A discrete word association test, in which artificial language nonsense syllable elements were presented as stimuli, was administered after _S_s reached a criterion of three errorless Artificial Language training trials, and again after _S_s reached a criterion of six errorless trials. The associative response and its latency were recorded. The associations were then categorized not only as syntagmatic or paradigmatic, but also as contiguous, positional, or non-positional. The median latencies of each associative class were also determined.

The present study was primarily interested in the factors influencing paradigmatic association development. In the current literature, paradigmatic association development has generally been attributed to the use of words in identical speech contexts, i.e., intersubstitution. An alternative hypothesis viewed paradigmatic association development in terms of resolution of response interference elicited by a stimulus word.

Interference vs. Intersubstitution in Paradigmatic Association Development

In the present study the artificial languages were designed so that each syllable defined as an adjective appeared with equal frequency in contiguity with two syllables defined as nouns. It was hypothesized that the appearance of an adjective artificial language syllable in a word association test would elicit two equally strong, competing, contiguous noun associates, hence response interference. The appearance of a noun syllable would elicit only one contiguous adjective associate and hence no response interference. Since the artificial languages had been designed so that the two adjective elements did not occupy the same contextual position, nor were the two adjectives ever used in identical contexts, an adjective-adjective association should develop only as a mode of resolving response interference. The presentation of a noun syllable stimulus was not expected to elicit response competition, and if the intersubstitution position was tenable then paradigmatic associations would develop between nouns which appeared in the same position in identical contexts. Furthermore, if interference were the more potent variable in paradigmatic association development, the proportion of adjective-adjective associations would be expected to exceed the proportion of noun-noun positional associations. A statistically significant difference was not found between the latter two proportions. It is possible the effect of interference in the development of adjective-adjective associations equaled the effect of intersubstitution in the development of noun-noun positional associations. However, according to the statistical analyses, all that can be validly concluded is that there was no evidence that factors other than chance were involved in producing any differences between the proportions.

In light of these findings, i.e., the comparison of interference and intersubstitution, the following questions became important:

1. Was there any evidence of the effects of response interference?
2. Was there any evidence of the effects of intersubstitution?
3. Was there any evidence of an interaction between effects of appearance in identical positions within different contexts and effects of interference?

Evidence of Interference

If adjective elements elicited interference, the generated interference would be reflected by: (1) a greater proportion of noun-adjective contiguous associations than adjective-noun contiguous associations; and (2) longer median latencies of adjective-noun than noun-adjective contiguous syntagmatic associations. Statistical analyses indicated that (1) the proportion of noun-adjective contiguous associations was significantly greater than that of adjective-noun contiguous associations, and (2) average median latencies of adjective-noun associations were significantly greater than the average median latencies of noun-adjective associations. Therefore, there was evidence that the presentation of an adjective element generated interference.

Evidence of Intersubstitution

Two types of paradigmatic noun associations were possible in the present study. A noun-noun positional association was attributed to appearance in identical contexts, i.e., intersubstitution, while a noun-noun non-positional association was not. It was hypothesized that the influence of intersubstitution on paradigmatic association development would be manifested by the proportion of noun-noun positional associations exceeding the proportion of noun-noun non-positional associations. Statistical analyses indicated that although there was not a significant difference between the proportions on the first word association test, there was a significant difference between the proportions on the second test. The fact that there was no significant difference between the two proportions in the first test might be attributed to the influences of "Noun only" artificial language training. During "Noun only" training, Ss recieved 16 trials in which noun syllables were responses to middle size shapes. It is possible that associations formed between the noun syllables during these 16 trials. When artificial language training began, there was an equal probability that these noun-noun associations existed between those nouns appearing in identical contexts as between those nouns which did not. As artificial language training progressed, the operation of intersubstitution would be expected to increase the probability of noun-noun positional associations. However, the effects of intersubstitution may not have been potent enough at the end of initial training to yield a greater proportion of noun-noun positional than noun-noun non-positional associations. The statistical analyses indicated that only with additional training did the effects of intersubstitution on paradigmatic association development become detectable.

Evidence of Interaction of Factors

According to the results discussed thus far, it was concluded that certain word associations were influenced by the operation of interference, while other word associations were influenced by the operation of intersubstitution. It was hypothesized that associations could develop between elements which had appeared in identical positions within different contexts. Presumably, a noun-adjective positional association could only develop in this manner. It was held that an adjective-adjective association could only develop as a means of resolving interference. However, an adjective-noun positional association could be attributed to either appearance in an identical position within different contexts, or resolution of interference, or an interaction of the two factors. Therefore, if these two factors interacted in an additive manner then: (1) the proportion of adjective-noun positional associations would exceed the proportion of noun-adjective positional associations, i.e., associations attributed to position alone; and (2) the proportion of adjective-noun positional associations would exceed the proportion of adjective-adjective associations, i.e., associations attributed to interference alone.

Statistical analyses indicated that the proportion of adjective-noun positional associations was not significantly greater than the proportion of noun-adjective positional associations. In fact, the trend of the data was in the opposite direction with the proportion of noun-adjective positional associations exceeding the proportion of adjective-noun positional associations. These results did not support the view that the effects of two factors involved in association development, i.e., interference and identical position within different contexts, would interact in an additive fashion. The fact that noun-adjective positional associations, i.e., those attributed only to appearance in identical positions, were observed to occur more often than adjective-noun positional associations, seems to indicate that the response interference was not likely to be resolved by responding positionally.

Statistical analyses indicated that the proportion of adjective-noun positional associations was not significantly greater than the proportion of adjective-adjective associations. Again the trend of the data was in the opposite direction with the proportion of adjective-adjective associations exceeding the proportion of adjective-noun positional associations. These results were consistent with the previous finding that two factors involved in association development did not interact in an additive manner.

The fact that adjective-adjective associations, i.e., associations attributed only to resolution of interference, were observed to occur more often than adjective-noun positional associations supports the interpretation that response interference was not likely to be resolved by responding positionally.

In summary, it can be concluded that, when an adjective stimulus was presented, response interference was generated. If Ss resolved interference by giving a response outside of the competing response hierarchy, there was a greater probability that the response would be an adjective, than that the response would be a positional noun. When a noun stimulus was presented no interference was generated. If Ss gave a paradigmatic response, there was a higher probability that the response would be a noun which had appeared in an identical context than that the response would be a non-positional noun. It appears that there is evidence that both interference and intersubstitution operate in the production of paradigmatics. In the present study the artificial languages had been designed so that the two adjective elements did not occupy the same contextual position, nor were the two adjectives ever used in identical contexts. Paradigmatic adjective associations could only be attributed to interference. The presentation of noun element was not expected to elicit response competition, but rather paradigmatic noun associations were attributed to appearance in the same position in identical contexts, i.e., intersubstitution. Therefore, under the conditions of the present study, paradigmatic adjective associations were attributed to interference, while paradigmatic noun associations were attributed to intersubstitution.

Contiguous Syntagmatic Associations

In testing the observed proportions of each of the associative classes against the appropriate theoretical proportions, the most striking finding was that the observed proportions of contiguous syntagmatic associations were significantly greater than the proportions expected to occur by chance. In other words, when presented with any syllable stimulus, *S*s tended to respond with a syllable which had appeared in contiguity with the stimulus syllable during Artificial Language training. This predominance of contiguous syntagmatic associations was observed even after additional training had been given. Therefore, the *S*s in the present study seemed to give artificial language word associations comparable to the English word associations given by children under age six. It seems probable that Ss tended to give largely contiguous syntagmatic associations because the word association test was interpreted as a paired-associate recall test, i.e., a test of how well they knew the "other" syllable which had appeared with the stimulus during training.

Associative Direction of Contiguous Responses

It had been suggested that the present study should provide evidence concerning the associative direction of syntagmatic responses. During artificial language training, responses to stimulus shapes consisted of two nonsense syllables. As in a paired-associates situation, the two syllable elements appeared in contiguity during training. Presumably, the elements presented in contiguity were available, i.e., conditions were met for the development of associative symmetry. In the word association test situation, if the first syllable elicited the second, the direction of the association was forward; while if the second syllable elicited the first, the direction of the association was backward. "If the two associates are equally available, their two directions of recall should have equal latencies" (Horowitz, et al., 1966, p. 8). Statistical analyses indicated that there was no significant difference between the median latencies of forward and backward associations. Thus, it could be suggested that associative symmetry of contiguous syntagmatic associations was observed.

Suggested Research

Under the conditions of the present study, the observed number of paradigmatic associations was small. If paradigmatic association development can be attributed to interference and/or intersubstitution, it should be possible to experimentally increase the relative potency of these factors. One manner in which the influence of these factors might be increased is by lengthening artificial language training. That is, more stringent criteria and extended training sessions might lead to increased paradigmatic responding.

It is also possible that the S's set toward both training and the word association test might play a role in the type of associations that develop in a simple artificial language situation. If Ss interpret the language training as some sort of recall test, as hypothesized to be the case in the present study, the likelihood of paradigmatic associations would be depressed.

Instructions designed to counter a recall test set could be given to the Ss at various times during the experimental session. That is, there may be a difference in the effects of instructions given prior to language training and instructions given prior to the artificial language word association test. Therefore, a four group design could be used. Group L receives instructions to approach artificial language learning as the learning of a foreign language. Group R receives instructions which stress the fact that there is no such thing as a "right" response to a syllable stimulus. Group L-R receives instructions designed to reduce a recall test set prior to learning and prior to recall, i.e., Group L and Group R instructions. Group C receives standard instructions. If set influences the number of paradigmatic associations in an artificial language situation, then Group C should give fewer paradigmatics than the experimental groups. The importance of the stage at which instructions designed to reduce the recall test set are given could be ascertained by comparing the number of paradigmatics given by the experimental groups. For example, if Group R gives more paradigmatics than Group L, it could be concluded that recall test set may be more effectively reduced when given prior to the association test than when given prior to language training. Also if Group L-R gives more paradigmatics than either Group R or Group L, it might indicate that recall-test set is reduced most effectively when instructions are given both prior to learning and prior to the word association test.

A criticism which could be justifiably leveled at the present study is that Ss could have gone through artificial language training without being aware of the relationship between the adjective element and the stimulus shape size. That is, two shapes were always large while two different shapes were always small, and at no time did the same shape appear in two different sizes. The Ss may have learned the appropriate responses to the stimuli without ever noting the variations in stimulus size. In order to investigate the possible effect of this variable on the frequency of paradigmatic associations alternative languages could be developed (Table 20).

TABLE 20.--Simple artificial languages in which the same stimulus shapes appear in different sizes.

Size	Stimulus Nonsense Shape	Response	
1	W_1	a_1	n_1
1	X_1	a_1	n_2
2	W_2	n_1	a_2
2	X_2	n_2	a_2

The language in Table 20 would satisfy the requirements that S discriminate size in order to make the appropriate verbal response.

Using the basic paradigm of the artificial language employed in the present study, the number of competing responses elicited by an adjective could be manipulated and the influence on paradigmatic association frequency examined. For example, a language could be constructed in which one adjective would be expected to elicit many competing contiguous noun associates, while the other adjective would be expected to elicit few competing contiguous noun associates. If the strength of interference can be manipulated in this way, then the probability that an adjective response would be made to an adjective stimulus that elicits many competing responses should be greater than the probability that an adjective response would be made to an adjective that elicits few competing responses.

Other problems which could be investigated within the simple artificial language situation are the following:

1. Is there any relationship between S's ability to verbalize the artificial language rules and frequency of paradigmatic associations? That is, Ss could be questioned at the end of the experimental session regarding their awareness of the nature of the simple artificial language. If knowledge of some grammatic rule facilitates formation of paradigmatic associations, then those Ss who can describe the artificial language element

relationships should exhibit a higher frequency of paradigmatics than those Ss who are unable to describe the artificial language element relationships.

2. Is there any relationship between the amount of foreign language training and frequency of paradigmatic associations? Again Ss could be questioned at the end of the experimental session regarding the amount of foreign language training or experience they have had. It is possible that previous language learning may facilitate the formation of paradigmatic associations. Subjects could be classified in terms of amount of foreign language training and a comparison made of the frequency of paradigmatics of Ss of the various classes.

3. Is there any relationship between frequency of paradigmatic associations to English words and frequency of paradigmatic associations to artificial language elements? The Ss could be classified in terms of the frequency of paradigmatics on the English word association test. It is possible that the same Ss who give a high frequency of paradigmatic associations to English stimuli may also give a high frequency of paradigmatic associations to artificial language stimuli.

4. Is there any relationship between type of artificial language training and development of paradigmatic associations? Would the frequency of paradigmatic associations increase following training in which

artificial language elements are used in English sentence frames? It is possible that procedures similar to those used by Braine (1963) and McNeill (1963, 1966) in which Ss are required to complete artificial language or English sentences with appropriate artificial language elements may facilitate paradigmatic association development.

Finally, in the present study, interference was elicited by an adjective element. Subsequent research might focus on the influence on paradigmatic associations between noun elements which elicit interference. For example, the language which appears in Table 21 is analogous to the simple artificial language used in the present study.

TABLE 21. Simple artificial language in which noun elements occupy different contextual positions.

Stimulus		Response	
Size	Nonsense Shape	Nonsense Syllables	
1	W_1	a_1	n_1
2	W_2	a_2	n_1
3	X_3	n_2	a_3
4	X_4	n_2	a_4

In the language in Table 21 four adjective elements and two noun elements are employed. If the grammatical class of the element eliciting interference does not influence the development of paradigmatic associations, then results similar to those obtained in the present study would be expected for the language in Table 21.

CHAPTER VI

CONCLUSIONS

The conclusions indicated by the present study are as follows:

1. Subjects are able to learn simple artificial languages with relative ease.
2. Classification of artificial language word association data in terms of grammatical classes indicated that the majority of the associations were syntagmatic, and could be attributed to the contiguous appearance of the associates in artificial language sequences or contexts.
3. There was evidence that response interference had been generated as a result of artificial language training.
4. Under the conditions of the present study, there was evidence that intersubstitution was involved in the development of paradigmatic noun associations.
5. There was evidence that interference and appearance in identical positions within different contexts did not interact in an additive manner to produce associations.

6. Associative symmetry of contiguous syntagmatic associations as measured by associative latencies was observed.

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APPENDICES

APPENDIX A

FOUR COUNTERBALANCED FORMS OF THE MULTIPLE-CHOICE TEST OF EXPERIMENT I

Form I

<u>Sample</u>. The one word that seems to go best with dax is:
(1)seb (2)paf (3)nij (4)tez (5)bip

1. The one word that seems to go best with zir is:
(1)ged (2)hib (3)faw (4)jat (5)mep

2. The one word that seems to go best with faw is:
(1)jat (2)mep (3)zir (4)hib (5)ged

3. The one word that seems to go best with jat is:
(1)zir (2)hib (3)faw (4)ged (5)mep

4. The one word that seems to go best with mep is:
(1)faw (2)ged (3)zir (4)hib (5)jat

5. The one word that seems to go best with hib is:
(1)jat (2)zir (3)mep (4)ged (5)faw

6. The one word that seems to go best with ged is:
(1)mep (2)jat (3)hib (4)faw (5)zir

7. The one word that seems to go best with jat is:
(1)hib (2)mep (3)zir (4)faw (5)ged

8. The one word that seems to go best with zir is:
(1)jat (2)mep (3)ged (4)hib (5)faw

9. The one word that seems to go best with hib is:
(1)zir (2)ged (3)faw (4)jat (5)mep

10. The one word that seems to go best with ged is:
(1)mep (2)zir (3)faw (4)hib (5)jat

11. The one word that seems to go best with faw is:
(1)ged (2)mep (3)jat (4)zir (5)hib

12. The one word that seems to go best with mep is:
(1)ged (2)hib (3)jat (4)faw (5)zir

Form II

<u>Sample</u>. The one word that seems to go best with dax is:
(1)seb (2)paf (3)nij (4)tez (5)bip

1. The one word that seems to go best with zir is:
(1)mep (2)jat (3)faw (4)hib (5)ged

2. The one word that seems to go best with faw is:
(1)ged (2)hib (3)zir (4)mep (5)jat

3. The one word that seems to go best with jat is:
(1)mep (2)ged (3)faw (4)hib (5)zir

4. The one word that seems to go best with mep is:
(1)jat (2)hib (3)zir (4)ged (5)faw

5. The one word that seems to go best with hib is:
(1)faw (2)ged (3)mep (4)zir (5)jat

6. The one word that seems to go best with ged is:
(1)zir (2)faw (3)hib (4)jat (5)mep

7. The one word that seems to go best with jat is:
(1)ged (2)faw (3)zir (4)mep (5)hib

8. The one word that seems to go best with zir is:
(1)faw (2)hib (3)ged (4)mep (5)jat

9. The one word that seems to go best with hib is:
(1)mep (2)jat (3)faw (4)ged (5)zir

10. The one word that seems to go best with ged is:
(1)jat (2)hib (3)faw (4)zir (5)mep

11. The one word that seems to go best with faw is:
(1)hib (2)zir (3)jat (4)mep (5)ged

12. The one word that seems to go best with mep is:
(1)zir (2)faw (3)jat (4)hib (5)ged

Form III

<u>Sample</u>. The one word that seems to go best with dax is:
(1)seb (2)paf (3)nij (4)tez (5)bip

1. The one word that seems to go best with mep is:
(1)ged (2)hib (3)jat (4)faw (5)zir

2. The one word that seems to go best with faw is:
(1)ged (2)mep (3)jat (4)zir (5)hib

3. The one word that seems to go best with ged is:
(1)mep (2)zir (3)faw (4)hib (5)jat

4. The one word that seems to go best with hib is:
(1)zir (2)ged (3)faw (4)jat (5)mep

5. The one word that seems to go best with zir is:
(1)jat (2)mep (3)ged (4)hib (5)faw

6. The one word that seems to go best with jat is:
(1)hib (2)mep (3)zir (4)faw (5)ged

7. The one word that seems to go best with ged is:
(1)mep (2)jat (3)hib (4)faw (5)zir

8. The one word that seems to go best with hib is:
(1)jat (2)zir (3)mep (4)ged (5)faw

9. The one word that seems to go best with mep is:
(1)faw (2)ged (3)zir (4)hib (5)jat

10. The one word that seems to go best with jat is:
(1)zir (2)hib (3)faw (4)ged (5)mep

11. The one word that seems to go best with faw is:
(1)jat (2)mep (3)zir (4)hib (5)ged

12. The one word that seems to go best with zir is:
(1)ged (2)hib (3)faw (4)jat (5)mep

Form IV

Sample. The one word that seems to go best with dax is:
(1)seb (2)paf (3)nij (4)tez (5)bip

1. The one word that seems to go best with mep is:
(1)zir (2)faw (3)jat (4)hib (5)ged

2. The one word that seems to go best with faw is:
(1)hib (2)zir (3)jat (4)mep (5)ged

3. The one word that seems to go best with ged is:
(1)jat (2)hib (3)faw (4)zir (5)mep

4. The one word that seems to go best with hib is:
(1)mep (2)jat (3)faw (4)ged (5)zir

5. The one word that seems to go best with zir is:
(1)faw (2)hib (3)ged (4)mep (5)jat

6. The one word that seems to go best with jat is:
(1)ged (2)faw (3)zir (4)mep (5)hib

7. The one word that seems to go best with ged is:
(1)zir (2)faw (3)hib (4)jat (5)mep

8. The one word that seems to go best with hib is:
(1)faw (2)ged (3)mep (4)zir (5)jat

9. The one word that seems to go best with mep is:
(1)jat (2)hib (3)zir (4)ged (5)faw

10. The one word that seems to go best with jat is:
(1)mep (2)ged (3)faw (4)hib (5)zir

11. The one word that seems to go best with faw is:
(1)ged (2)hib (3)zir (4)mep (5)jat

12. The one word that seems to go best with zir is:
(1)mep (2)jat (3)faw (4)hib (5)ged

APPENDIX B

RAW DATA FOR EXPERIMENT I: NUMBER OF *S*s RESPONDING WITH EACH OF THE FIVE CHOICES FOR EACH ITEM FOR THE FOUR COUNTERBALANCED FORMS

Stimulus	ZIR									
Response	ged		hib		faw		jat		mep	
Presentation	1	2	1	2	1	2	1	2	1	2
Form I	14	13	35	30	10	16	31	28	7	9
II	24	19	34	32	19	22	23	25	8	9
III	17	15	41	33	17	24	24	24	9	9
IV	11	12	36	33	27	25	25	24	7	11
Σ	66	59	146	128	73	87	103	101	31	38
%	15.8	14.3	34.8	31.0	17.4	21.1	24.6	24.4	7.4	9.2

Stimulus	MEP									
Response	ged		hib		faw		jat		zir	
Presentation	1	2	1	2	1	2	1	2	1	2
Form I	45	39	12	12	13	13	14	17	13	16
II	43	39	26	17	10	19	15	13	14	19
III	51	49	20	13	15	16	9	15	13	15
IV	61	51	22	18	5	13	9	11	9	13
Σ	200	178	80	60	43	61	47	56	49	63
%	47.7	42.6	19.1	14.3	10.3	14.6	11.2	13.4	11.7	15.1

Stimulus	PAW									
Response	ged		hib		zir		jat		mep	
Presentation	1	2	1	2	1	2	1	2	1	2
Form I	22	22	11	11	16	16	30	32	18	15
II	26	22	6	8	25	28	41	36	10	14
III	16	16	4	9	26	31	46	42	16	9
IV	9	10	8	7	43	36	39	41	7	11
Σ	73	70	29	35	110	111	156	151	51	49
%	17.4	16.8	6.9	8.4	26.3	26.7	37.2	36.3	12.2	11.8

Stimulus	HIB									
Response	ged		zir		faw		jat		mep	
Presenta-tion	1	2	1	2	1	2	1	2	1	2
Form I	18	28	38	34	15	15	11	9	15	11
II	27	29	34	34	13	12	14	14	20	18
III	24	25	40	44	10	9	20	17	14	13
IV	26	20	39	38	5	5	18	22	18	21
Σ	95	102	151	150	43	41	63	62	67	63
%	22.7	24.4	36.0	35.9	10.3	9.8	15.0	14.8	16.0	15.1

Stimulus	GED									
Response	zir		hib		faw		jat		mep	
Presenta-tion	1	2	1	2	1	2	1	2	1	2
Form I	19	15	18	13	9	11	14	19	37	39
II	19	16	22	19	14	12	19	21	34	39
III	13	11	19	15	13	16	13	18	50	48
IV	4	8	18	19	8	10	20	25	56	44
Σ	55	50	77	66	44	49	66	83	177	170
%	13.1	11.9	18.4	15.8	10.5	11.7	15.8	19.9	42.2	40.7

Stimulus	JAT									
Response	ged		hib		faw		zir		mep	
Presenta-tion	1	2	1	2	1	2	1	2	1	2
Form I	17	25	5	5	32	28	28	25	15	14
II	29	35	13	6	29	27	25	27	12	12
III	19	19	15	18	37	37	23	25	14	9
IV	25	31	16	9	30	29	22	24	13	13
Σ	90	110	49	38	128	121	98	101	54	48
%	21.5	26.3	11.7	9.1	30.5	28.9	23.4	24.2	12.9	11.5

APPENDIX C

ARTIFICIAL LANGUAGES LEARNED BY EACH

S

HIGH ADJECTIVE ASSOCIATION ARTIFICIAL LANGUAGE GROUP

Shape	Size	S1	S2	S3	S5	S8	S11	S13	S16
A	1	mep zir	mep faw	mep zir	hib ged	jat ged	mep faw	hib ged	jat ged
B	2	mep faw	mep zir	mep faw	jat ged	hib ged	mep zir	jat ged	hib ged
C	3	jat ged	hib ged	hib ged	mep zir	mep faw	jat ged	mep faw	mep zir
D	3	hib ged	jat ged	jat ged	mep faw	mep zir	hib ged	mep zir	mep faw

Shape	Size	S18	S21	S22	S24	S26	S27	S29	S32
A	3	mep zir	mep faw	mep zir	hib ged	jat ged	mep faw	hib ged	jat ged
B	3	mep faw	mep zir	mep faw	jat ged	hib ged	mep zir	jat ged	hib ged
C	1	jat ged	hib ged	hib ged	mep zir	mep faw	jat ged	mep faw	mep zir
D	1	hib ged	jat ged	jat ged	mep faw	mep zir	hib ged	mep zir	mep faw

LOW ADJECTIVE ASSOCIATION ARTIFICIAL LANGUAGE GROUP

Shape	Size	S4	S6	S7	S9	S10	S12	S14	S15
A	1	hib mep	jat mep	zir faw	hib mep	jat mpe	zir faw	zir ged	zir ged
B	1	jat mep	hib mep	zir ged	jat mep	hib mep	zir ged	zir faw	zir faw
C	3	zir ged	zir ged	hib mep	zir faw	zir faw	jat mep	jat mep	hib mep
D	3	zir faw	zir faw	jat mep	zir ged	zir ged	hib mep	hib mep	jat mep

Shape	Size	S17	S19	S20	S23	S25	S28	S30	S31
A	3	hib mep	jat mep	zir faw	hib mep	jat mep	zir faw	zir ged	zir ged
B	3	jat mep	hib mep	zir ged	jat mep	hib mep	zir ged	zir faw	zir faw
C	1	zir ged	zir ged	hib mep	zir faw	zir faw	jat mep	jat mep	hib mep
D	1	zir faw	zir faw	jat mep	zir ged	zir ged	hib mep	hib mep	jat mep

APPENDIX D

RAW DATA: ARTIFICIAL LANGUAGE WORD ASSOCIATION TESTS

High Group

Stimulus: mep (adj.)

			Test 1						Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
1	faw	Nc	1.01	faw	Nc	1.29	ged	A	2.37	ged	A	1.39
2	ged	A	1.50	ged	A	1.40	ged	A	1.30	ged	A	1.08
3	faw	Nc	1.06	faw	Nc	0.97	faw	Nc	1.14	faw	Nc	1.11
5	zir	Nc	1.94	zir	Nc	1.63	jat	Np	0.93	hib	Np	0.99
8	faw	Nc	1.09	faw	Nc	0.97	faw	Nc	1.02	zir	Nc	0.95
11	zir	Nc	2.34	zir	Nc	1.08	faw	Nc	1.51	faw	Nc	2.05
13	ged	A	1.27	faw	Nc	1.89	zir	Nc	1.27	faw	Nc	1.11
16	faw	Nc	1.43	zir	Nc	2.20	faw	Nc	1.56	faw	Nc	1.30
18	zir	Nc	4.31	zir	Nc	1.50	zir	Nc	1.57	zir	Nc	1.50
21	zir	Nc	1.56	zir	Nc	1.31	ged	A	1.83	zir	Nc	0.95
22	faw	Nc	1.44	faw	Nc	0.98	zir	Nc	1.76	faw	Nc	1.06
24	faw	Nc	1.05	faw	Nc	1.00	faw	Nc	1.06	faw	Nc	1.26
26	faw	Nc	1.31	faw	Nc	1.14	faw	Nc	0.98	faw	Nc	0.93
27	faw	Nc	1.08	hib	Np	2.08	faw	Nc	1.50	faw	Nc	1.24
29	faw	Nc	0.95	zir	Nc	0.92	faw	Nc	0.96	faw	Nc	0.93
32	zir	Nc	1.48	zir	Nc	1.49	hib	Np	2.36	zir	Nc	1.81

Stimulus: mep (adj.)

Low Group

	Test 1								Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
4	jat	Nc	5.95	jat	Nc	1.40	jat	Nc	2.29	jat	Nc	1.87
6	zir	A	2.26	zir	A	2.91	jat	Nc	2.07	jat	Nc	1.86
7	jat	Nc	1.32	hib	Nc	1.24	jat	Nc	1.55	hib	Nc	1.58
9	jat	Nc	0.72	jat	Nc	1.32	jat	Nc	1.32	hib	Nc	1.63
10	"jib"	Other	1.39	hib	Nc	0.95	jat	Nc	0.98	hib	Nc	1.01
12	hed	Np	2.88	zir	A	2.06	jat	Nc	2.05	zir	A	1.17
14	hib	Nc	0.99	hib	Nc	1.90	jat	Nc	2.28	hib	Nc	1.33
15	zir	A	1.00	hib	Nc	2.33	hib	Nc	1.65	zir	A	1.26
17	zir	A	2.89	faw	Np	2.65	jat	Nc	1.88	hib	Nc	1.28
19	ged	Np	1.94	"zed"	Other	1.90	zir	A	1.21	zir	A	1.66
20	ged	Np	2.01	ged	Np	1.52	jat	Nc	0.96	ged	Np	2.22
23	ged	Np	1.45	jat	Nc	2.34	jat	Nc	2.45	jat	Nc	2.05
25	zir	A	1.76	faw	Np	1.41	jat	Nc	1.67	zir	A	2.17
28	hib	Nc	1.31	hib	Nc	1.00	jat	Nc	0.97	hib	Nc	0.96
30	hib	Nc	1.64	hib	Nc	1.64	jat	Nc	2.12	hib	Nc	1.22
31	hib	Nc	2.29	jat	Nc	1.51	jat	Nc	1.51	jat	Nc	1.66

High Group

Stimulus: ged (adj.)

			Test 1						Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
1	hib	Nc	1.59	jat	Nc	1.79	hib	Nc	1.92	hib	Nc	0.95
2	hib	Nc	1.62	mep	A	1.31	mep	A	1.25	mep	A	1.43
3	zir	Np	1.44	hib	Nc	1.22	hib	Nc	1.15	hib	Nc	1.11
5	hib	Nc	1.16	faw	Np	1.42	faw	Np	0.94	zir	Np	0.94
8	hib	Nc	1.19	hib	Nc	1.51	mep	A	1.31	hib	Nc	1.03
11	hib	Nc	1.60	zir	Np	1.46	hib	Nc	1.07	mep	A	2.37
13	hib	Nc	1.60	hib	Nc	1.95	hib	Nc	2.76	hib	Nc	1.67
16	hib	Nc	1.75	zir	Np	1.88	zir	Np	1.52	hib	Nc	1.39
18	jat	Nc	4.37	jat	Nc	0.97	zir	Np	1.50	mep	A	1.11
21	hib	Nc	1.47	zir	Np	1.94	mep	A	1.71	hib	Nc	0.76
22	faw	Np	2.20	zir	Np	2.45	jat	Nc	1.75	jat	Nc	0.98
24	hib	Nc	1.21	hib	Nc	1.29	jat	Nc	1.33	jat	Nc	1.15
26	faw	Np	1.63	faw	Np	1.25	faw	Np	1.33	jat	Nc	1.81
27	hib	Nc	1.07	hib	Nc	1.35	hib	Nc	1.35	hib	Nc	0.99
29	hib	Nc	1.25	jat	Nc	0.87	jat	Nc	0.91	hib	Nc	0.96
32	zir	Np	2.08	hib	Nc	1.83	jat	Nc	1.59	mep	A	1.88

Low Group

Stimulus: ged (noun)

	Test 1								Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
4	zir	Ac	1.55	zir	Ac	1.52	zir	Ac	1.52	zir	Ac	1.41
6	zir	Ac	2.09	jat	Nnp	1.94	zir	Ac	1.61	zir	Ac	1.29
7	zir	Ac	1.68	zir	Ac	1.34	mep	Ap	1.60	zir	Ac	1.26
9	zir	Ac	1.69	zir	Ac	1.86	faw	Np	2.32	zir	Ac	1.22
10	"meb"	Other	0.91	zir	Ac	0.92	mep	Ap	0.93	zir	Ac	0.92
12	zir	Ac	1.55	mep	Ap	1.86	zir	Ac	1.28	zir	Ac	1.41
14	zir	Ac	1.62	zir	Ac	1.83	zir	Ac	0.93	zir	Ac	1.08
15	jat	Nnp	1.25	zir	Ac	1.53	zir	Ac	1.23	mep	Ap	1.39
17	jat	Nnp	1.28	zir	Ac	2.03	zir	Ac	1.72	zir	Ac	2.84
19	zir	Ac	1.21	zir	Ac	1.38	mep	Ap	0.98	zir	Ac	1.25
20	zir	Ac	1.04	zir	Ac	1.28	zir	Ac	0.98	zir	Ac	1.30
23	mep	Ap	1.59	mep	Ap	2.64	zir	Ac	2.03	mep	Ap	2.04
25	zir	Ac	2.06	zir	Ac	1.78	zir	Ac	0.92	zir	Ac	1.17
28	faw	Np	1.45	hib	Nnp	1.06	hib	Nnp	1.09	zir	Ac	0.91
30	zir	Ac	0.98	zir	Ac	1.29	zir	Ac	0.98	zir	Ac	0.94
31	zir	Ac	1.52	zir	Ac	1.49	zir	Ac	2.25	zir	Ac	1.53

High Group

Stimulus: zir (noun)

			Test 1						Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
1	mep	Ac	1.35	mep	Ac	1.21	mep	Ac	1.39	mep	Ac	1.37
2	mep	Ac	2.74	mep	Ac	1.28	mep	Ac	1.52	mep	Ac	1.26
3	ged	Ap	1.51	jat	Nnp	1.36	mep	Ac	1.13	mep	Ac	1.10
5	jat	Nnp	1.58	hib	Nnp	1.66	hib	Nnp	0.99	jat	Nnp	1.30
8	mep	Ac	1.08	mep	Ac	1.11	mep	Ac	1.15	mep	Ac	1.07
11	mep	Ac	1.20	mep	Ac	1.49	mep	Ac	2.26	mep	Ac	1.30
13	mep	Ac	1.23	mep	Ac	1.08	mep	Ac	1.07	mep	Ac	0.92
16	mep	Ac	1.45	mep	Ac	1.30	mep	Ac	1.35	mep	Ac	1.25
18	mep	Ac	1.80	mep	Ac	1.28	mep	Ac	0.99	mep	Ac	0.93
21	mep	Ac	1.27	mep	Ac	0.90	mep	Ac	0.99	faw	Np	0.85
22	mep	Ac	0.99	jat	Nnp	2.04	faw	Np	1.23	mep	Ac	1.97
24	faw	Np	1.32	faw	Np	1.15	mep	Ac	1.85	mep	Ac	1.07
26	mep	Ac	1.48	faw	Np	1.75	mep	Ac	1.04	mep	Ac	1.03
27	mep	Ac	1.22	mep	Ac	1.51	mep	Ac	1.20	mep	Ac	1.16
29	mep	Ac	0.85	mep	Ac	1.20	mep	Ac	1.07	mep	Ac	0.95
32	ged	Ap	1.94	ged	Ap	1.67	mep	Ac	1.65	mep	Ac	1.46

Low Group

Stimulus: zir (adj.)

		Test 1						Test 2				
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
4	ged	Nc	1.66	ged	Nc	3.51	ged	Nc	1.80	ged	Nc	1.93
6	ged	Nc	2.33	ged	Nc	2.27	ged	Nc	1.51	faw	Nc	1.60
7	mep	A	1.44	mep	A	1.35	faw	Nc	1.93	mep	A	1.52
9	faw	Nc	1.32	faw	Nc	1.33	faw	Nc	1.31	faw	Nc	1.23
10	faw	Nc	1.21	faw	Nc	1.04	faw	Nc	1.24	faw	Nc	1.28
12	faw	Nc	1.55	faw	Nc	1.23	faw	Nc	1.39	ged	Nc	2.52
14	faw	Nc	1.88	faw	Nc	2.00	ged	Nc	1.87	ged	Nc	1.84
15	faw	Nc	1.81	faw	Nc	1.89	faw	Nc	1.85	faw	Nc	1.61
17	mep	A	1.30	mep	A	1.15	ged	Nc	1.43	ged	Nc	2.79
19	faw	Nc	1.31	faw	Nc	1.34	mep	A	1.13	faw	Nc	1.07
20	ged	Nc	1.20	ged	Nc	1.35	faw	Nc	1.56	faw	Nc	1.68
23	faw	Nc	1.45	faw	Nc	1.70	faw	Nc	1.41	faw	Nc	1.40
25	faw	Nc	1.41	faw	Nc	1.29	faw	Nc	1.02	faw	Nc	0.97
28	faw	Nc	1.14	jat	Np	0.89	faw	Nc	1.40	faw	Nc	0.89
30	ged	Nc	0.92	hib	Np	1.94	ged	Nc	1.57	faw	Nc	1.64
31	ged	Nc	1.50	ged	Nc	1.55	ged	Nc	1.34	ged	Nc	1.37

High Group

Stimulus: jat (noun)

	Test 1						Test 2					
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
1	ged	Ac	1.21	ged	Ac	1.49	ged	Ac	1.17	ged	Ac	1.30
2	ged	Ac	1.65	ged	Ac	1.50	ged	Ac	1.50	ged	Ac	1.28
3	zir	Nnp	1.56	ged	Ac	1.00	ged	Ac	1.01	ged	Ac	1.18
5	hib	Np	0.91	hib	Np	1.31	zir	Nnp	0.98	zir	Nnp	1.08
8	ged	Ac	0.95	ged	Ac	1.11	ged	Ac	1.14	ged	Ac	1.08
11	ged	Ac	1.30	ged	Ac	1.34	ged	Ac	1.46	ged	Ac	1.06
13	ged	Ac	1.64	mep	Ap	1.57	"geb"	Other	1.54	ged	Ac	1.40
16	ged	Ac	1.25	ged	Ac	1.39	ged	Ac	1.55	ged	Ac	1.00
18	ged	Ac	1.32	ged	Ac	1.74	ged	Ac	1.00	ged	Ac	1.06
21	faw	Ac	1.61	mep	Ac	1.69	faw	Nnp	0.96	mep	Ap	1.20
22	ged	Ac	2.29	ged	Ac	1.26	ged	Ac	1.25	ged	Ac	1.07
24	ged	Ac	1.09	ged	Ac	1.08	ged	Ac	1.27	ged	Ac	1.24
26	ged	Ac	1.10	ged	Ac	1.29	ged	Ac	0.98	ged	Ac	0.97
27	ged	Ac	1.07	mep	Ap	1.51	ged	Ac	1.24	ged	Ac	0.94
29	ged	Ac	0.97	ged	Ac	0.99	ged	Ac	0.99	ged	Ac	0.93
32	ged	Ac	1.66	ged	Ac	1.87	ged	Ac	1.44	ged	Ac	1.40

Stimulus: jat (noun)

Low Group

			Test 1						Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
4	mep	Ac	1.51	mep	Ac	1.78	mep	Ac	2.39	mep	Ac	1.67
6	mep	Ac	2.04	mep	Ac	1.42	mep	Ac	1.29	mep	Ac	1.27
7	mep	Ac	1.65	mep	Ac	1.49	mep	Ac	1.33	mep	Ac	1.73
9	mep	Ac	1.23	"zot"	Other	2.27	mep	Ac	1.57	mep	Ac	1.28
10	mep	Ac	0.91	"meb"	Other	0.97	"meb"	Other	0.94	mep	Ac	1.30
12	ged	Nnp	1.72	mep	Ac	1.93	mep	Ac	1.27	zir	Ap	2.06
14	hib	Np	7.48	mep	Ac	1.68	mep	Ac	1.22	mep	Ac	1.06
15	ged	Nnp	2.31	zir	Ap	1.50	zir	Ap	2.04	zir	Ap	1.40
17	zir	Ap	1.68	mep	Ac	1.45	mep	Ac	1.51	mep	Ac	1.46
19	zir	Ap	1.18	mep	Ac	1.52	mep	Ac	1.22	mep	Ac	1.29
20	mep	Ac	1.04	mep	Ac	0.99	mep	Ac	1.35	mep	Ac	1.18
23	mep	Ac	1.52	mep	Ac	1.23	mep	Ac	1.99	zir	Ap	1.64
25	mep	Ac	1.66	mep	Ac	1.41	mep	Ac	1.37	mep	Ac	1.43
28	mep	Ac	0.88	mep	Ac	1.32	mep	Ac	1.04	mep	Ac	1.05
30	hib	Np	2.18	mep	Ac	1.48	mep	Ac	1.62	mep	Ac	1.25
31	mep	Ac	1.30	mep	Ac	1.67	mep	Ac	1.40	mep	Ac	1.36

High Group

Stimulus: hib (noun)

			Test 1						Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
1	ged	Ac	0.99	ged	Ac	1.26	ged	Ac	0.98	ged	Ac	1.04
2	ged	Ac	1.52	ged	Ac	1.27	ged	Ac	1.37	ged	Ac	1.26
3	ged	Ac	1.33	ged	Ac	0.96	ged	Ac	1.07	ged	Ac	0.97
5	zir	Nnp	1.43	zir	Nnp	1.19	jat	Np	0.94	jat	Np	1.31
8	ged	Ac	1.10	ged	Ac	1.04	ged	Ac	1.00	ged	Ac	1.05
11	ged	Ac	1.63	ged	Ac	1.33	ged	Ac	1.24	ged	Ac	1.41
13	zir	Nnp	1.95	hed	Ac	1.04	ged	Ac	1.27	ged	Ac	0.94
16	ged	Ac	1.80	ged	Ac	1.39	ged	Ac	1.04	ged	Ac	1.06
18	ged	Ac	1.98	ged	Ac	1.30	ged	Ac	1.23	ged	Ac	0.99
21	ged	Ac	1.47	ged	Ac	1.49	"ziv"	Other	0.85	zir	Nnp	1.33
22	ged	Ac	1.40	ged	Ac	1.28	ged	Ac	1.25	ged	Ac	1.32
24	faw	Nnp	1.67	ged	Ac	1.05	ged	Ac	1.21	ged	Ac	1.24
26	ged	Ac	1.83	ged	Ac	0.98	ged	Ac	1.04	ged	Ac	0.97
27	ged	Ac	1.09	ged	Ac	1.29	ged	Ac	1.09	ged	Ac	1.15
29	ged	Ac	1.49	ged	Ac	1.26	ged	Ac	0.99	ged	Ac	0.94
33	"zeb"	Other	1.51	ged	Ac	1.46	ged	Ac	1.47	ged	Ac	1.65

Low Group

Stimulus: hib (noun)

			Test 1						Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
4	mep	Ac	2.06	mep	Ac	2.35	mep	Ac	1.83	mep	Ac	2.08
6	mep	Ac	1.42	mep	Ac	1.41	mep	Ac	1.47	mep	Ac	1.38
7	zir	Ap	1.49	mep	Ac	1.59	mep	Ac	1.81	zir	Ap	1.54
9	mep	Ac	1.31	mep	Ac	1.06	mep	Ac	1.08	mep	Ac	1.02
10	mep	Ac	0.95	"meb"	Other	0.97	mep	Ac	0.98	"meb"	Other	0.95
12	ged	Nnp	3.02	ged	Nnp	1.77	mep	Ac	1.25	mep	Ac	1.31
14	zir	Ap	1.88	mep	Ac	1.36	mep	Ac	0.93	mep	Ac	0.86
15	ged	Nnp	1.21	mep	Ac	1.48	mep	Ac	1.52	mep	Ac	1.24
17	mep	Ac	1.29	mep	Ac	1.64	mep	Ac	0.97	mep	Ac	1.92
19	mep	Ac	1.41	mep	Ac	1.30	zir	Ap	1.53	mep	Ac	1.29
20	mep	Ac	1.76	mep	Ac	1.27	mep	Ac	1.06	mep	Ac	0.93
23	ged	Nnp	1.33	ged	Nnp	1.78	jat	Np	2.01	faw	Nnp	2.93
25	ged	Nnp	2.04	mep	Ac	1.98	mep	Ac	1.32	mep	Ac	0.93
28	mep	Ac	1.13	mep	Ac	1.17	mep	Ac	0.85	mep	Ac	0.87
30	mep	Ac	1.22	mep	Ac	1.60	mep	Ac	1.68	mep	Ac	1.05
31	mep	Ac	1.41	mep	Ac	1.98	mep	Ac	1.37	mep	Ac	1.38

High Group

Stimulus: faw (noun)

			Test 1						Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
1	mep	Ac	2.35	mep	Ac	1.98	mep	Ac	1.67	mep	Ac	1.55
2	mep	Ac	1.62	mep	Ac	1.25	mep	Ac	1.40	mep	Ac	1.23
3	mep	Ac	1.16	mep	Ac	1.15	mep	Ac	1.56	mep	Ac	1.35
5	jat	Nnp	1.37	zir	Np	1.54	hib	Nnp	0.94	jat	Nnp	0.97
8	mep	Ac	1.13	mep	Ac	1.14	mep	Ac	1.00	mep	Ac	1.51
11	mep	Ac	1.23	mep	Ac	1.35	mep	Ac	1.13	mep	Ac	1.27
13	mep	Ac	1.21	mep	Ac	0.92	mep	Ac	1.00	mep	Ac	0.96
16	mep	Ac	1.52	mep	Ac	1.40	mep	Ac	1.38	mep	Ac	1.23
18	hib	Nnp	2.65	ged	Ap	1.72	mep	Ac	1.01	mep	Ac	1.85
21	"jib"	Other	1.92	ged	Ap	1.51	ged	Ap	1.45	zir	Np	0.93
22	ged	Ap	1.56	ged	Ap	1.34	mep	Ac	1.29	mep	Ac	1.26
24	mep	Ac	2.29	mep	Ac	1.35	mep	Ac	1.64	mep	Ac	1.30
26	ged	Ap	1.88	"heb"	Other	1.46	mep	Ac	1.24	mep	Ac	0.98
27	mep	Ac	1.48	mep	Ac	1.82	mep	Ac	0.99	mep	Ac	0.98
29	mep	Ac	1.08	mep	Ac	0.93	mep	Ac	1.05	mep	Ac	1.01
32	mep	Ac	2.06	mep	Ac	2.29	mep	Ac	1.83	mep	Ac	1.36

Low Group

Stimulus: faw (noun)

			Test 1						Test 2			
S	R_1	Class	Lat.	R_2	Class	Lat.	R_3	Class	Lat.	R_4	Class	Lat.
4	zir	Ac	1.32	zir	Ac	1.78	zir	Ac	1.58	zir	Ac	1.34
6	zir	Ac	1.32	zir	Ac	1.26	zir	Ac	2.20	zir	Ac	1.28
7	zir	Ac	1.60	zir	Ac	1.49	zir	Ac	1.27	zir	Ac	1.46
9	zir	Ac	0.72	zir	Ac	1.93	zir	Ac	1.26	zir	Ac	0.99
10	zir	Ac	1.41	hib	Nnp	0.98	zir	Ac	0.96	zir	Ac	1.09
12	zir	Ac	1.24	zir	Ac	1.25	zir	Ac	0.96	zir	Ac	1.03
14	zir	Ac	1.62	zir	Ac	1.25	zir	Ac	1.22	zir	Ac	1.00
15	jat	Nnp	1.88	zir	Ac	1.27	zir	Ac	1.28	zir	Ac	1.34
17	hib	Nnp	2.31	mep	Ap	1.86	zir	Ac	1.22	zir	Ac	0.93
19	zir	Ac	1.42	zir	Ac	1.33	zir	Ac	1.28	zir	Ac	1.35
20	zir	Ac	2.08	zir	Ac	1.15	zir	Ac	0.95	zir	Ac	0.93
23	zir	Ac	1.26	zir	Ac	2.03	zir	Ac	1.40	zir	Ac	1.86
25	zir	Ac	1.53	zir	Ac	1.32	zir	Ac	1.06	zir	Ac	1.69
28	zir	Ac	0.84	zir	Ac	1.30	zir	Ac	0.87	zir	Ac	0.85
30	zir	Ac	1.28	zir	Ac	1.66	zir	Ac	0.95	zir	Ac	0.92
31	zir	Ac	1.32	zir	Ac	2.30	zir	Ac	1.73	zir	Ac	1.40

APPENDIX E

FISHER'S EXACT TESTS OF NUMBER OF Ss GIVING A-A ASSOCIATIONS IN THE HIGH AND LOW GROUPS

1

	High	Low	
A-A	2	5	7
Other	14	11	25
	16	16	32

p = .3942

2

	High	Low	
A-A	1	4	5
Other	15	12	27
	16	16	32

p = .3326

3

	High	Low	
A-A	4	1	5
Other	12	15	27
	16	16	32

p = .3326

4

	High	Low	
A-A	5	5	10
Other	11	11	32
	16	16	32

APPENDIX F

THE χ^2 TESTS OF FREQUENCY OF A-A ASSOCIATIONS FOR HIGH AND LOW GROUPS ON EACH OF THE FOUR PRESENTATIONS

Presentation 1

A-A Rs		High	Low	
	Yes	2	6	8
	No	30	25	55
		32	21	63

$\chi^2_1 = 2.55$

Presentation 2

A-A Rs		High	Low	
	Yes	2	4	6
	No	30	27	57
		32	31	63

$\chi^2_1 = 0.22$

Presentation 3

A-A Rs		High	Low	
	Yes	6	2	8
	No	26	30	56
		32	32	65

$\chi^2_1 = 1.28$

Presentation 4

A-A Rs		High	Low	
	Yes	6	5	11
	No	26	27	53
		32	32	64

$\chi^2_1 = 0$

APPENDIX G

RAW DATA: ERRORS PER TRIAL FOR "NOUN ONLY" TRAINING

Number of Errors per Trial for Noun Only Training

S	Trials 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	4	4	4	3	2	3	3	1	0	2	1	1	1	1	0	2
2	3	2	3	2	4	3	2	2	2	2	4	1	3	3	2	1
3	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
5	2	2	2	1	1	1	1	1	0	0	0	1	0	0	0	0
8	2	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0
11	2	2	1	1	1	1	0	2	0	1	0	0	0	0	0	0
13	2	2	2	1	1	0	0	0	1	1	0	0	0	0	0	1
16	2	2	2	0	1	1	0	0	1	0	0	0	0	0	0	0
18	2	2	1	3	1	0	1	0	1	0	0	0	0	0	0	0
21	3	3	2	3	3	2	1	2	2	3	0	0	1	1	0	0
22	3	1	2	2	2	2	1	0	1	1	0	0	0	0	0	0
24	1	0	0	0	1	3	1	1	1	1	2	0	1	1	0	0
26	2	2	1	1	3	1	1	1	1	0	0	0	0	0	0	0
27	2	1	0	0	1	0	0	0	1	1	0	0	0	0	0	0
29	3	4	3	1	2	2	1	1	0	3	0	0	0	1	1	0
32	4	4	2	4	2	3	2	3	3	1	3	0	2	3	3	5
4	3	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	2	2	2	2	3	2	1	0	1	1	1	0	1	2	0	0
9	3	3	2	1	1	2	0	2	1	0	1	0	1	0	1	1
10	3	4	3	2	1	1	0	1	0	0	0	0	0	1	0	0
12	4	2	3	1	0	1	2	0	2	1	0	0	0	0	0	1
14	4	3	4	3	3	2	3	2	0	1	0	1	0	0	0	0
15	2	2	1	2	1	1	1	1	0	2	0	0	0	0	0	0
17	2	2	1	1	1	2	1	1	2	0	0	0	0	0	0	0
19	3	2	1	0	1	2	0	1	1	0	0	1	0	0	0	0
20	2	2	1	1	1	2	0	0	0	0	1	0	0	1	0	0
23	4	2	2	2	3	1	1	2	1	0	1	0	1	0	0	0
25	3	3	2	2	3	2	2	1	2	2	1	1	1	2	1	1
28	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	1	2	2	2	1	1	1	2	0	1	1	0	0	0	0	0
31	3	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0

APPENDIX H

RAW DATA: ERROR PER TRIAL FOR ARTIFICIAL LANGUAGE TRAINING TO CRITERIA 1 AND 2

ARTIFICIAL LANGUAGE TRAINING

Number of Errors Per Trial

	Trials to Criterion 2																					Trials to Criterion 2							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	1	2	3	4	5	6	7	
1	4	4	2	1	3	2	0	1	1	2	0	0	1									2							2
2	2	2	4	2	3	2	1	2	1													0	1						1
3	3	2	3	2	2	1	0	1														1							1
5	1	1	2	0	0	1																0	1	1	1				3
8	3	3	3	3	2	3	2	2	1	3	2	2	1	2	2	0	0	2				0							0
11	2	0	1	0	1																	2							2
13	2	2	1	1	2	0	1	1	1													1							1
16	3	2	2																			0							0
18	3	3	1	1																		3							3
21	4	3	2	2	3	2	2	1	2													3	2						5
22	2	2	1	0	2	1	0	0	1	1												2	0	0	0	0	1		3
24	3	2	3	2	2																	2	1						3
26	2	2	2																			1	0	1					2
27	0	0	1																			0							0
29	4	0	1	0	1	0	1															0							0
32	4	3	3	3	2	3	3	3	3	1	1	0	1	1	2	1	1	1	3	2	2	0							0

(Artificial Language Training, Cont.)

Number of Errors Per Trial

												Trials to Criterion 1										Trials to Criterion 2							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	1	2	3	4	5	6	7	
4	2	3	1	2	4	2	1	1	0	1	2											3	2	0	1				6
6	3	0	1	0	1																	2	2						4
7	1	3	4	3	4	3	2	2	2	2	2	2	2	1	2	2	2	2	0	2		4	2						6
9	2	2	3	1	1	1	2	0	2													3							3
10	3	4	3	1	1	0	1															2	1	1	1	0	1		6
12	1	1	2	0	1	2	3	1	2	1	1	1	1	1	1							2	1						3
14	1	2	1	2																		1	2	1					4
15	4	4	3	3	2	2	2	1	1													1							1
17	2	3	0	1	2																	2	1	1	0	0	0	1	5
19	4	3	4	1	3	3	2	3	2	1	1											1	1	0	1	1	1		5
20	3	3	1	1																		2							2
23	4	1	3	1	2																	2	0	2					4
25	3	3	4	3	3	3	1	3	1	1	1	2	1									2	0	1					3
28	4	2	0	1	2	2	0	0	1	1												0							0
30	3	0	1	0	1	1	1															1							1
31	2	2																				3							3

APPENDIX I

RAW DATA: ENGLISH WORD ASSOCIATION TESTS

ENGLISH WORD ASSOCIATIONS AND LATENCIES IN SECONDS

	MAN				LONG				ROUGH			
S	R_1	R_2	$Lat._1$	$Lat._2$	R_1	R_2	$Lat._1$	$Lat._2$	R_1	R_2	$Lat._1$	$Lat._2$
1	Woman		0.96	1.06	Short		0.99	0.92	Smooth		1.57	1.01
2	Woman		0.92	1.28	Short		1.31	1.28	Hard	Tough	1.86	1.89
3	Woman		1.03	1.04	Short		1.07	1.16	Easy	Tough	1.79	1.10
4	Woman		1.49	1.39	Short		1.57	1.49	Smooth		1.39	1.81
5	Boy		1.04	0.94	Short		0.95	1.15	Easy		1.01	1.06
6	Girl	Woman	1.62	1.42	Short		1.41	1.36	Hard		1.48	
7	Woman		1.06	1.08	Short		1.06	1.01	Soft		1.42	1.41
8	Woman		1.10	1.03	Short		1.19	1.05	Tough		1.17	1.13
9	Woman		0.24	1.01	Short		1.91	1.43	Tough	Hard	0.86	1.77
10	Woman		0.98	1.20	Short		0.91	1.01	Smooth		0.99	1.14
11	Woman		1.20	1.21	Short		1.03	1.80	Smooth		1.36	1.20
12	Woman		2.08	1.38	Short	Fast	2.26	2.12	Soft		0.84	1.73
13	Woman		1.36	0.95	Short		1.31	1.29	Smooth		1.54	1.07
14	Woman		1.89	0.99	Short		1.18	0.99	Smooth		0.93	1.22
15	Woman		2.28	1.08	Short		1.23	1.16	Tough		1.59	1.24
16	Woman		1.27	1.23	Short		1.71	1.20	Tough	Smooth	1.55	1.20
17	Male	Woman	2.76	1.92	Short		7.91	1.67	Bumpy	Smooth	1.27	1.54
18	Woman		1.22	1.07	Short		1.33	1.04	Bumpy		2.22	1.72
19	Woman		1.00	0.99	Short		1.32	0.92	Smooth		1.29	1.07
20	Woman		1.04	1.20	Short		1.00	0.98	Smooth		1.41	0.91
21	Woman		1.05	0.95	Short		1.01	1.38	Hard		1.28	1.23
22	Woman		0.99	1.07	Short		0.98	1.00	Smooth		1.51	1.25
23	Woman		1.74	1.35	Short		1.55	1.22	Smooth		1.47	1.76
24	Lady		1.31	1.27	Narrow	Short	1.28	2.52	Tough	Smooth	1.79	1.39
25	Woman		0.94	0.92	Goat	Short	2.14	1.30	Smooth		1.06	0.99
26	Woman		1.63	1.29	Short		1.83	0.98	Rock	Smooth	3.23	1.04
27	Woman		1.37	1.06	Short		0.99	1.05	Smooth		1.63	0.98
28	Woman			1.18	Short			0.92	Smooth			0.94
29	Woman		1.41	0.81	Slow	Short	1.43	1.44	Easy		1.93	1.34
30	Woman		1.33	0.83	Short		1.02	0.88	Easy		1.76	1.48
31	Girl	Woman	1.59	1.25	Short		1.41	1.26	Smooth		1.37	1.32
32	Woman		1.26	1.34	Short		1.27	1.27	Smooth		1.31	1.49

ENGLISH WORD ASSOCIATIONS AND

LATENCIES IN SECONDS

SICKNESS

S	R_1	R_2	Lat.$_1$	Lat.$_2$
1	Ill		1.30	1.25
2	Health		1.71	1.32
3	Health	Ill	1.54	1.39
4	Well	Hepatitis	1.88	1.66
5	Health		1.33	1.36
6	Illness		2.08	2.24
7	Health		1.79	1.28
8	Well		1.53	1.78
9	Illness		6.00	1.73
10	Health		1.51	0.95
11	Illness	Measles	1.59	2.03
12	Death			2.85
13	Well		1.61	1.58
14	Well		0.92	1.82
15	Health		1.58	1.24
16	Health		1.55	1.42
17	Health		1.87	1.77
18	Ill		1.60	2.28
19	Health	Sweetness	2.04	1.29
20	Well		2.00	1.24
21	Ill		1.29	0.94
22	Well		4.68	1.86
23	Health		1.87	1.51
24	Health		1.85	1.37
25	Ill		1.98	1.01
26	Health		1.65	0.95
27	Ill		1.54	1.25
28	Health			1.05
29	Help	Health	1.65	1.71
30	Illness		1.27	0.92
31	Illness	Healthiness	2.02	2.46
32	Illness		1.84	1.42

(English Word Associations and
Latencies in Seconds, Cont.)

EAGLE

S	R_1	R_2	$Lat._1$	$Lat._2$
1	Bird		1.25	1.23
2	Clock	Hawk	1.38	1.42
3	Fly	Flying	1.45	1.11
4	Bird	Bald	1.82	1.50
5	Bird		1.09	1.05
6	Hawk		1.81	1.46
7	Hawk		1.68	1.46
8	Bird		1.43	1.30
9	Hawk		1.78	1.36
10	Bird		1.26	1.22
11	American	Bird	2.06	2.25
12	Bird		0.87	1.49
13	Bird		1.34	1.06
14	Hawk		0.91	1.24
15	Bird		1.77	1.45
16	Bird		1.68	1.22
17	Bird		2.98	1.48
18	Bird		1.54	1.77
19	Golden	Bald	1.31	1.38
20	Bird		1.89	1.23
21	Bird		1.09	0.91
22	Bird		1.42	1.41
23	Bird		1.78	1.75
24	Bird		1.34	1.67
25	Tall	White	1.54	1.28
26	Bald		2.00	0.95
27	Bird		1.30	1.04
28	Bird			0.98
29	American		2.10	1.52
30	Bird		1.35	1.03
31	Bird		1.62	1.70
32	Bird		1.44	1.20

(English Word Associations and
Latencies in Seconds, Cont.)

BOY

S	R_1	R_2	$Lat._1$	$Lat._2$
1	Girl		0.97	0.95
2	Girl		0.75	1.27
3	Girl		0.98	0.91
4	Girl		1.26	1.75
5	Girl	Child	1.00	1.25
6	Girl		1.39	1.06
7	Girl		1.20	1.00
8	Girl		1.12	1.41
9	Girl		1.46	1.26
10	Girl		0.91	0.92
11	Girl		1.25	1.25
12	Girl		1.62	1.45
13	Girl		1.15	0.88
14	Girl		1.42	0.80
15	Girl		1.44	1.23
16	Girl		1.23	1.11
17	Dog	Play	2.47	2.33
18	Girl		1.38	1.32
19	Girl		1.34	0.99
20	Girl		0.97	1.25
21	Girl		1.15	0.99
22	Girl		1.20	1.25
23	Girl		1.28	1.59
24	Girl		1.34	1.23
25	Girl		1.05	0.95
26	Girl		1.41	0.96
27	Girl		0.95	0.92
28	Girl			0.79
29	Girl		1.14	0.82
30	Girl		0.94	0.88
31	Girl		1.46	1.41
32	Girl		1.22	1.08

ENGLISH WORD ASSOCIATIONS AND LATENCIES IN SECONDS

	DARK				SLOW				LAMP			
S	R_1	R_2	$Lat._1$	$Lat._2$	R_1	R_2	$Lat._1$	$Lat._2$	R_1	R_2	$Lat._1$	$Lat._2$
1	Light		0.99	0.91	Fast		1.16	0.97	Shade		1.10	1.01
2	Light		1.67	1.48	Fast		1.24	1.28	Light		1.34	1.39
3	Light		1.09	0.93	Fast		1.02	0.95	Light		1.03	1.13
4	Light		1.66	1.01	Fast		1.94	1.53	Shade		1.84	1.34
5	Light		1.07	1.32	Fast		0.99	0.94	Dark		1.41	0.96
6	Light		1.37	1.30	Fast		1.37	1.20	Light		1.77	1.29
7	Light		1.56	1.27	Fast		1.46	1.21	Shade		1.97	1.63
8	Light		1.11	1.06	Fast		1.12	1.07	Post	Light	2.46	1.17
9	Black	Light	1.69	1.73	Fast		1.64	1.23	Bulb	Light	2.49	1.42
10	Light		1.11	1.02	Fast		0.93	0.92	Light		1.33	1.00
11	Light		1.35	1.07	Fast		1.27	1.07	Table		2.53	1.28
12	Light		1.74	1.31	Fast		1.83	1.32	Light		1.63	1.37
13	Light		1.16	0.95	Run	Fast	1.09	1.21	Book		3.04	4.15
14	Light		1.56	1.02	Fast		1.15	1.02	Shade		1.52	1.15
15	Light		1.53	1.29	Fast		1.50	1.06	Light		2.02	1.31
16	Light		1.31	1.04	Fast		1.72	1.40	Light		1.41	1.38
17	Light		1.42	1.69	Fast	Walk	0.95	2.12	Light	House	1.82	2.14
18	Light		1.49	0.93	Fast		1.43	0.98	Light		1.71	0.94
19	Light		1.49	0.97	Fast		1.52	1.15	Shade		1.47	1.02
20	Light		1.97	0.98	Fast		1.03	1.25	Post	Light	2.23	1.34
21	Night		1.29	1.08	Fast		1.43	0.99	Light		1.42	1.53
22	Light		1.45	0.97	Fast		1.04	0.94	Fost		1.78	1.02
23	Light		1.44	1.66	Fast		1.78	1.60	Carpet	Shade	4.57	1.74
24	Light		1.32	1.09	Fast		1.22	1.07	Light		1.09	1.03
25	Black		1.23	1.43	Fast		1.09	1.21	Shade		1.26	0.97
26	Light		1.47	0.99	Fast		1.66	0.96	Light		1.82	1.08
27	Light		1.10	0.95	Fast		1.16	1.03	Light		1.69	1.07
28	Light			0.89	Fast			1.17	Shade			1.05
29	Light		1.36	0.94	Fast		0.99	0.89	Dark	Light	1.34	1.08
30	Light		0.99	0.91	Fast		1.65	0.95	Shade		2.63	0.90
31	Light		1.57	1.08	Fast		1.56	1.27	Light		1.98	1.69
32	Light		1.65	1.40	Fast		1.35	1.26	Light		1.75	1.29

ENGLISH WORD ASSOCIATIONS AND LATENCIES IN SECONDS

	BLACK				SOUR				SALT			
S	R_1	R_2	Lat.$_1$	Lat.$_2$	R_1	R_2	Lat.$_1$	Lat.$_2$	R_1	R_2	Lat.$_1$	Lat.$_2$
1	Light		1.04	1.26	Cream		1.37	1.01	Pepper		1.17	1.28
2	White	Dark	1.25	1.45	Sweet		1.85	1.51	Sugar		1.67	1.56
3	White		1.03	1.02	Sweet		1.02	1.03	Bitter		1.17	1.67
4	White	Dark	1.35	1.63	Sweet		1.53	1.91	Sugar	Iodine	5.81	1.24
5	Light	White	1.06	1.05	Easy	Fast	1.12	1.27	Pepper		1.12	1.01
6	Light		1.53	1.47	Sweet		1.39	1.08	Sugar		1.64	1.60
7	White		1.36	1.20	Sweet		2.32	1.24	Pepper		1.20	1.06
8	White		1.04	1.17	Sweet		1.08	1.19	Sugar		1.11	1.41
9	Board	White	7.56	1.62	Milk		1.85	2.82	Pepper	White	1.57	2.85
10	White		1.20	1.33	Sweet		1.15	0.96	Sugar		1.66	1.38
11	White		1.03	1.03	Cream	Acid	1.80	1.55	Pepper		1.42	1.32
12	White		1.70	1.28	Sweet		1.78	1.34	Pepper		2.81	1.97
13	Light		1.27	1.39	Sweet		1.47	1.11	Pepper		1.06	0.99
14	White		1.36	0.99	Sweet		1.48	1.08	Sugar		1.95	1.07
15	White		1.43	1.21	Sweet		1.41	1.07	Sugar	Pepper	1.30	1.46
16	Dark	White	1.51	1.02	Sweet		1.42	1.08	Pepper		1.22	1.05
17	White		0.99	0.95	Sweet		1.20	1.29	Pepper		7.94	1.71
18	White		1.89	0.95	Bitter		2.49	1.95	Sugar		1.65	1.04
19	White		1.09	1.33	Sweet		1.06	0.99	Sweet		1.47	1.42
20	White		1.42	1.02	Sweet		5.09	1.24	Sour		1.17	1.31
21	Night		1.13	1.03	Sweet		1.38	0.93	Pepper		2.27	2.25
22	White		0.95	1.23	Sweet		1.03	1.32	Sugar		1.04	1.20
23	White		1.38	1.32	Sweet		1.71	1.53	Pepper		1.64	1.59
24	White		1.45	1.04	Sweet		1.10	1.00	Sugar		1.27	1.50
25	Cat	White	1.06	0.98	Lemon	Sweet	1.80	1.01	Purple	White	1.65	0.95
26	Cat	Dark	1.61	1.28	Milk		1.75	0.94	Lick	Pepper	2.27	1.76
27	White		1.23	1.09	Sweet		2.02	1.25	Pepper		1.39	1.07
28	Light			1.01	Sweet			1.13	Pepper			0.99
29	White		0.97	0.93	Sweet		1.29	0.98	Sun	Pepper	4.87	1.68
30	White		1.24	0.95	Bitter	Sweet	2.98	1.57	Pepper		1.28	0.95
31	Light	White	1.52	1.44	Sweet		1.55	1.30	Pepper		2.36	1.94
32	White		1.74	1.08	Bitter	Sweet	1.38	1.20	Pepper		1.49	1.35

APPENDIX J

SUMMARY OF ENGLISH WORD ASSOCIATION TEST DATA

ENGLISH WORD ASSOCIATION TESTS

Summary of Raw Data

Stimulus	Dark			Slow			Lamp		
	Response	f	Med. Lat.	Response	f	Med. Lat.	Response	f	Med. Lat.
Test 1	Light	29	1.43	Fast	31	1.31	Light	15	1.69
	Black	2	1.46	Run	1	1.09	Shade	8	1.52
	Night	1	1.29				Post	3	2.16
							Dark	2	1.38
							Bulb	1	2.49
							Book	1	3.04
							Carpet	1	4.57
							Table	1	2.53
	Response	f	Med. Lat.	Response	f	Med. Lat.	Response	f	Med. Lat.
Test 2	Light	30	1.03	Fast	31	1.07	Light	18	1.29
	Black	1	1.43	Walk	1	2.12	Shade	9	1.05
	Night	1	1.08				Post	1	1.02
							Dark	1	0.96
							Book	1	4.15
							Table	1	1.28
							House	1	2.14

ENGLISH WORD ASSOCIATION TESTS

Summary of Raw Data

Stimulus	Black: Response	f	Med. Lat.	Sour: Response	f	Med. Lat.	Salt: Response	f	Med. Lat.
Test 1	White	21	1.25	Sweet	23	1.42	Pepper	16	1.42
	Light	6	1.27	Bitter	3	2.49	Sugar	10	1.64
	Cat	2	1.34	Cream	2	1.58	Bitter	1	1.17
	Dark	1	1.51	Milk	2	1.80	Sweet	1	1.47
	Board	1	7.56	Lemon	1	1.80	Sour	1	1.17
	Night	1	1.13	Easy	1	1.72	Lick	1	2.27
							Sun	1	4.87
							Purple	1	1.65
	Response	**f**	**Med. Lat.**	**Response**	**f**	**Med. Lat.**	**Response**	**f**	**Med. Lat.**
Test 2	White	24	1.06	Sweet	26	1.16	Pepper	18	1.34
	Light	4	1.32	Milk	2	1.88	Sugar	8	1.40
	Dark	3	1.45	Cream	1	1.01	White	2	1.90
	Night	1	1.03	Bitter	1	1.95	Bitter	1	1.67
				Acid	1	1.55	Sweet	1	1.42
				Fast	1	1.27	Sour	1	1.31
							Iodine	1	1.24

ENGLISH WORD ASSOCIATION TESTS

Summary of Raw Data

Stimulus	Man: Response	f	Med. Lat.	Long: Response	f	Med. Lat.	Rough: Response	f	Med. Lat.
Test 1	Woman	27	1.23	Short	29	1.25	Smooth	15	1.38
	Girl	2	1.60	Narrow	1	1.28	Tough	5	1.55
	Lady	1	1.31	Slow	1	1.43	Easy	4	1.78
	Boy	1	1.04	Goat	1	2.14	Hard	3	1.48
	Male	1	2.76				Soft	2	1.13
							Bumpy	2	1.74
							Rock	1	3.23
Test 2	Woman	30	1.08	Short	31	1.16	Smooth	19	1.20
	Lady	1	1.27	Fast	1	2.12	Tough	4	1.18
	Boy	1	0.94				Easy	3	1.34
							Hard	3	1.50
							Soft	2	1.57
							Bumpy	1	1.72

ENGLISH WORD ASSOCIATION TESTS

Summary of Raw Data

Stimulus	Sickness Response	f	Med. Lat.	Eagle Response	f	Med. Lat.	Boy Response	f	Med. Lat.
Test 1	Health	13	1.68	Bird	21	1.42	Birl	31	1.21
	Illness	6	1.93	Hawk	4	1.73	Dog	1	2.47
	Well	6	1.74	American	2	2.08			
	Ill	6	1.54	Bald	1	2.00			
	Help	1	1.65	Golden	1	1.31			
	Death	1		Fly	1	1.45			
				Clock	1	1.38			
				Tall	1	1.54			
Test 2	Health	12	1.34	Bird	21	1.23	Girl	30	1.07
	Ill	6	1.25	Hawk	5	1.42	Child	1	1.25
	Well	5	1.78	Bald	3	1.50	Play	1	2.33
	Illness	4	1.58	American	1	1.52			
	Healthiness	1	2.46	Flying	1	1.11			
	Death	1	2.85	White	1	1.28			
	Sweetness	1	1.29						
	Measles	1	2.03						
	Hepatitis	1	1.66						

APPENDIX K

MEDIAN LATENCIES IN ENGLISH AND ARTIFICIAL LANGUAGE WORD ASSOCIATION TESTS

Median Latencies in English and Artificial Language Word Association Tests

S	English 1	English 2	Art. Lang. 1	Art. Lang. 2	English 1 and Art. 2	English 2 and Art. 3
1	1.13	1.01	1.32	1.38	2.51	2.39
2	1.36	1.40	1.50	1.29	2.65	2.69
3	1.05	1.07	1.19	1.12	2.17	2.19
4	1.62	1.52	1.72	1.82	3.44	3.34
5	1.07	1.06	1.43	0.98	2.05	2.04
6	1.50	1.36	1.99	1.49	2.99	2.85
7	1.44	1.22	1.49	1.54	2.98	2.76
8	1.12	1.17	1.11	1.06	2.18	2.23
9	1.74	1.52	1.32	1.27	2.01	2.79
10	1.13	1.02	0.97	0.96	2.11	2.00
11	1.36	1.26	1.34	1.36	2.72	2.62
12	1.74	1.42	1.74	1.30	3.04	2.72
13	1.32	1.09	1.42	1.19	2.51	2.28
14	1.39	1.04	1.76	1.15	2.54	2.19
15	1.52	1.24	1.52	1.40	2.92	2.64
16	1.46	1.20	1.44	1.32	2.78	2.52
17	1.84	1.70	1.66	1.48	3.32	3.18
18	1.57	1.06	1.73	1.08	2.65	2.14
19	1.33	1.04	1.36	1.26	2.59	2.30
20	1.42	1.24	1.28	1.12	2.54	2.36
21	1.28	1.01	1.50	0.98	2.26	1.99
22	1.12	1.22	1.42	1.26	2.38	2.48
23	1.68	1.59	1.56	2.00	3.68	3.59
24	1.32	1.25	1.18	1.25	2.57	2.50
25	1.24	1.00	1.60	1.24	2.48	2.24
26	1.70	0.98	1.38	1.00	2.70	1.98
27	1.34	1.06	1.32	1.16	2.50	2.22
28	1.40	1.00	1.14	0.94		1.94
29	1.38	1.03	0.98	0.96	2.34	1.99
30	1.30	0.94	1.54	1.24	2.54	2.18
31	1.56	1.36	1.52	1.40	2.96	2.76
32	1.41	1.28	1.75	1.62	3.03	3.90