

WORD ASSOCIATIONS AND PHONOLOGICALLY
LEGAL AND ILLEGAL SOUND SEQUENCES

by

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Introduction

Phonology refers to the sound system of a language. This sound system consists of rule-governed processes which determine the pronunciation of English. A portion of what a person acquires in learning a language is a mastery of these processes. After one has mastered these processes, if a new word is encountered one automatically, and usually unconsciously, knows some aspects of the word's pronunciation. How we learn the rules of English pronunciation is not definitely known. We do know that we do not memorize individual pronunciations, nor do we learn them directly from a study of English spelling (Read, 1971). When a child first encounters the printed word and begins writing he/she must already have some basic knowledge of English phonology.

In the present paper the literature on phonological rules is reviewed, focusing on the preference for phonologically legal versus illegal sound sequences. Present theorists assert that when choosing between two nonsense words, one of which follows the sound sequences of English while the other violates these sequences, the person will choose or prefer the legal word on the basis of its phonological legality. An alternative associative explanation is suggested, and four experiments which support this explanation are presented.

There are two tasks which the child must master in his/her acquisition of the sound system of a language. The first thing the child must be able to do is to categorize the environmental sounds into speech and nonspeech sounds. This task also involves the ability to categorize speech sounds in terms of grammatically meaningful

components in a language, which may be accomplished during the babbling stage of the infant. Evidence for the ability to distinguish speech and non-speech sounds comes from a study by Lewis, Kagan, Zavala, and Grossberg (1964). They found that children as young as 5 to 6 months old responded differently to a tone, music, and male, female, and mother's voices.

Nakazima (1962) found evidence that children distinguish some phonemic elements during the babbling stage. In the early stages of babbling, both Japanese and American children exhibit a similar repertoire of sounds. By the time the child is nine months old, the sounds which were being used by the child tend to be the speech sounds of his/her language.

The second task which the child must accomplish involves the acquisition of the phonological rules of the language. These are the rules which tell us the phonological sequences that can occur in a language. There is some evidence that the words which children produce as approximations to words in the language follow the set of phonological rules of the language. For example, a child will substitute "tuck" or "twuck" for truck, but he/she will not substitute "tluck". There are some exceptions, such as substituting "w" for "r" and "l". For example, the child may say "gwass" instead of grass. But, for the most part, children do not produce sound sequences which are not consistent with the phonological rules of their native language.

Another thing the child must have learned before he/she successfully encounters the written word is that certain sounds are to be thought of as the same, even though they may be pronounced differently.

For example, the third segments (n) of ten and tenth are functionally the same even though the articulation (how they are produced by the articulatory apparatus) of the two is different.

The general purpose of the present study was to assess one technique which has been used to investigate children's knowledge of phonology. The first section of the introduction will look at two current theories of word processing and how phonology relates to them. The second section deals with a formula which is a description of the phoneme combinations which are possible in English. Research with adults which supports predictions made using this formula will be presented in the third section. In the last section of the introduction, the literature concerning children and their knowledge of phonology will be reviewed.

Phonology and the Internal Lexicon. The issue of phonology is important because of its role in current theories of word processing. According to some current theories, certain tasks require the use of phonological knowledge. Rubenstein and his associates (1971), for instance, suggested that a visual stimulus is recorded into a phonemic form which is compared to a representation in the internal lexicon in order to recognize a word. In other words, when visual stimuli are presented, the subject assigns a phonological representation to the stimuli.

Rubenstein, Lewis and Rubenstein (1971) investigated phonemic recoding in relation to the internal lexicon, which is thought of as that part of long-term memory which holds the knowledge we have about words. There are four stages in the Rubenstein et al. model of

recognition. The first stage is quantization, in which the visual stimulus is broken into segments and these segments are assigned phonemes. The second stage is marking, which involves marking those lexical entries in long-term memory which are in agreement with the output from the quantization stage. The third stage is a comparison of the quantization output with the marked entries. The fourth and final stage is selection of the entry which meets the accuracy criterion that has been adopted by the person making the search.

In order to recognize a word, one must search the internal lexicon. The authors suggest that a visual stimulus is quantized into letters but is also quantized into phonemes at the same time. Rubenstein et al. devised an experiment to examine response latencies to English and nonsense words when asked if the word was English. Three types of nonsense words were used. In the first set of nonsense words, the words were orthographically and phonologically legal, so that they could actually be words in English. The second set of nonsense words contained words in which the final consonant clusters were illegal but pronounceable. The third set contained nonsense words whose final consonant clusters were both illegal and unpronounceable. It was found that response latency was longer for the legal than the illegal types of nonsense words, and that the illegal pronounceable words had a longer response latency than the illegal unpronounceable words. Within the framework of Rubenstein's theory, these findings suggest that phonological illegality is detected without an exhaustive search of the internal lexicon. Thus, according to Rubenstein, phonemic recoding occurs in the quantization stage.

In an additional study Rubenstein et al. obtained data which indicated that for real English words subjects compare the phonemic form of the stimulus and its representation in phonemic form of the stimulus and its representation in the internal lexicon to recognize a word, even when the word is presented visually.

Rubenstein's research has implications for how we can identify the boundaries of words in spoken speech. In spoken speech the sounds are almost continuous, so we usually are not able to use the pauses between words to determine word boundaries (Rubenstein, Lewis & Rubenstein, 1971). We therefore need some other method to determine the boundaries. There is some evidence that we can determine boundaries between words using our knowledge of illegal phoneme strings. There are limitations in every language on particular phonemes or sequences of phonemes which can occur in the initial or end positions of a word. It has been suggested that these sequences are used by an individual to detect the boundaries between words (Rubenstein, Lewis & Rubenstein, 1971).

Rubenstein and Gilbert (1966) have substantiated the above claim by showing that native speakers of English realized that particular consonant sequences which are not permitted either initially or finally, indicated a word boundary. Subjects heard two-syllable sequences, taken from tape-recorded sentences, in which the first syllable was the end of one word and the second syllable was the beginning of the next word. Even though the subject did not hear a sequence which he/she could recognize as a word on the basis of its presence in the internal lexicon, he/she was able to determine where

the word boundaries occurred with a high degree of accuracy. Presumably, the subject was able to do this because, as part of his/her linguistic competence, he/she knew that certain consonant combinations do not occur and that this knowledge can be used to determine word boundaries.

The research of Rubenstein suggests that the visual stimuli encountered in reading or word-recognition tasks are translated into an acoustic or phonological code. Additional evidence for this interpretation is found in the Vocalic Center Group (VCG) model proposed by Smith and Spoehr (1974). When a word is presented, first the features of each letter position are extracted, and then these are matched to particular letter categories. This categorized information is held in a sensory store which keeps the visual information for a short period of time so that a parsing process can segment the letter string into higher-order units (VCGs). A translation process then assigns an acoustical code to each unit. When the translation process is finished, perceptual processing is assumed to be completed.

The important aspects of the model are the VCGs and the parsing process by which they are created. A VCG is a letter sequence with one vocalic element (a single vowel or diphthong), and anywhere from zero to three consonants preceding or following the vocalic element. The VCG is the smallest pronunciational unit and so is a reasonable unit for a translation process.

There are four rules involved in the parsing process. The first indicates that positions of vowels should be marked. According to the second rule, the initial consonant(s) are used with the initial

vowel, while the final consonant(s) are used with the final vowel. In Rule 3, intermediate consonant(s) are parsed in particular ways which will not be specified here. The fourth rule is a reparsing rule so that if the previous rules yield an inappropriate result the intermediate consonants can be reparsed.

Using a tachistoscopic recognition-accuracy task in which the letter string is briefly exposed using a tachistoscope and the dependent variable is an accuracy score, Spoehr and Smith (1974) have confirmed the prediction that a letter string which forms a single VCG should be better perceived than one which does not. So, a nonword like "blst" which does not contain a vowel. "Blost" can be translated as a single unit while "blst" must be translated letter-by-letter. Another prediction which has been substantiated is that words with only one VCG will be better perceived than words with two VCGs.

To explain results with nonwords in which unpronounceable nonwords were less perceptible than words or pronounceable nonwords, an additional aspect of the model must be considered. This aspect concerns the ease with which the translation process can be applied to different kinds of letter strings. It is proposed that the more the letter string conforms to the phonological rules of English, the faster the translation process will be. Spoehr and Smith (1974) found evidence which supports this proposal. With a tachistoscopic recognition task, recognition of three types of visual stimuli was compared. The three types of stimuli were consonant strings, unpronounceable nonwords that contained a vowel but violated some phonological rules, and pronounceable nonwords. Both types of nonwords contained a single VCG. If one based

predictions only on the number of translation units, the prediction would be that both types of nonwords would be perceived better than consonant strings, and would be equal to each other. If one adds the additional assumptions concerning conformity to phonological rules, one might expect that the pronounceable nonwords would be perceived better than the unpronounceable nonwords. This prediction was confirmed.

The evidence which has been presented is consistent with the use of phonological rules in visual word recognition. Evidence supporting the use of phonological rules in visual word-recognition tasks has been found in two types of tasks--the latency to respond task which Rubenstein et al. (1971) used and the recognition-accuracy task of Spoehr and Smith (1974). The next section deals with formula which has been used to generate all English monosyllabic words.

The Whorfian Formula. Linguists have attempted to specify the precise form of the phonological rules of English. Whorf (1956) has developed a structural formula which generates all English monosyllabic words, as well as words which are not meaningful, but which would be permissible in English. The formula is a description of the phoneme combinations which are possible in the English monosyllabic word. There are fifteen terms in the formula, all of which tell us which phonemes may follow each other. For example, the first term indicates that a word may begin with a vowel. A complete description of the formula can be found in Appendix B. Whorf's formula also excludes specific consonant clusters and labels them as non-English. For example, there are no provisions for syllables beginning with /zr/, /sr/, or /vd/ because these syllables do not occur in English. An

example of a permissible word would be "toves", while "zrern" would violate the sequence constraints of the consonants in the formula. Out of 14,424 possible combinations of three consonants or less that could occur as initial consonant clusters in English morphemes, less than 100 are possible in English (Brown, 1965). This system of rules concerning possible consonant combinations forms a part of the system of phonological rules which are characteristic of languages.

Whorf has ruled out the possibility that these impermissible consonant combinations are impossible to pronounce. For example, when one is asked whether "bench", "blench", and "bnench" are English words, one is very certain that "bench" is a word and the "bnench" is not a word, but one is not so certain about the status of "blench". When a person is asked why "bnench" is not an English word, he/she usually says that they cannot pronounce "bn" and so it could not be used in a real word. If this were the case then the "bn" combination could not occur in other languages we know it is pronounceable. We can also see that it is pronounceable by observing that people who speak English pronounce it when they say "hobnob". So, we cannot say that "bnench" is not an English word because we cannot pronounce it. The real reason we know that "bnench" is not an English word is that we know that the sequence of sounds "bn" cannot occur at the beginning of a word or syllable in English. Our knowledge of this implies that we tacitly know the rules of English phonology that determine the permissible consonant combinations in English. In this case, the rule which we tacitly know is this: the initial segment of a word containing a stop can not be immediately followed by another stop segment. The same type of reasoning occurs

with the word "blench". We are unsure as to whether "blench" is a word or not since "bl" is a permissible consonant combination and so is a potential English word. In actuality, "Blench" is an English word, but one which most people would not have encountered before (Foss & Hakes, 1978).

Whorf predicts that when a person attempts to coin a new monosyllabic word it will fit his formula. For example, a person might invent the word "thrub" since it is possible by the formula, but Whorf asserts that this same person would not invent the word "srub". Therefore, he argues that there is a behavioral disposition which is created by familiarity with the possible combinations of phonemes. He also assumes that there is a perceptual disposition to hear possible morphemes and words, that is, we are "prepared" to hear these sounds.

Whorf's system represents one attempt to specify the phonological rules of English. There have been other systems proposed by linguists. An example of a more recent attempt to specify the phonological rules of English is given by Chomsky and Halle (1968).

Evidence from Adult Studies Consistent with Whorf's Formula

Several studies have examined the extent to which the rules concerning possible consonant combinations govern the behaviors of speakers of English. Evidence for Whorf's prediction that invented monosyllabic words will conform to his formula is found in a study by Brown (1958). Brown asked 30 adult, native speakers of English to invent English monosyllables, and found that all but two of the monosyllables fit Whorf's formula. Brown and Hildum (1956) presented three sets of 10 words under white noise conditions to adult, native speakers of English.

Each person received each of the three sets of words for a total of 30 words. The first set of words consisted of real English words. The second list was composed of words in which the initial consonant cluster was permissible in English, but which were not actual English words. The third set of words consisted of words in which the initial consonant cluster violated the formula, and so could not possibly be English words. It was found that the subjects reproduced the possible monosyllables more accurately than the impossible ones. In addition to using subjects who had never had any linguistic training, Brown and Hildum also used subjects who had extensive training in linguistics. These subjects were used to assure that the speaker was not producing the improbable sound combinations less clearly or forcefully. These people were trained linguists and so should notice if the person was pronouncing the improbable sound combinations in a different manner than the probable ones. They also should be bringing less expectancies derived from English phonology than the first group. It was found that for English words they had the same score as the untrained subjects. On the other two groups of words they performed significantly better than the untrained subjects. They conclude that auditory acuity was approximately equal and that untrained subjects use their knowledge of the sequential probabilities (how probable a particular consonant combination is) in making an identification. When the expectancy was appropriate to the material presented, the identifications were correct. When the expectancies were misleading, the identifications were incorrect. Most errors were changes of one phoneme and of one feature within a phoneme, so they were not serious errors. The trained subjects made

fewer errors, supposedly because they had less of an expectancy. These results are what would be expected if Whorf's formula is correct. The untrained persons have difficulty with the impossible monosyllables since they have not had any exposure to consonant clusters which violate the formula. The trained linguists on the other hand, had been exposed to consonant clusters which violate the formula and so did not perform differently on the three types of words.

A final study involves both adults and children. Anisfeld, Barlow and Frail (1968) looked at four age groups--6,7,8, and 19-year-olds. The subjects were asked to choose from a pair of nonsense words the word which was the preferred plural for a corresponding singular word. The age of the subjects made a difference in the endings they chose. The 7, 8, and 19 year-olds all preferred the sounds /f,v,ch/. The six year-olds showed no significant preference for any features. These results indicate that children six years of age have not yet mastered the phonological rules completely. The results do support Whorf's contention that we have a behavioral disposition to use specific phoneme combinations.

Evidence from Research Exclusively with Children. Menyuk (1968) looked at children's ability to reproduce impermissible versus permissible words. The permissible words were nonsense words in which the consonant clusters were permissible in English. The impermissible words were words chosen from other languages in which the consonant clusters were not permissible in English. A third set of words were used which were actual English words beginning with the same initial consonant sequences as the permissible nonsense words. Each set of

words had five members. The children were presented with five colored circles, all the same color, and were asked to learn the names of the circles. Each circle was given the name of one member of a set. The child was told the name of each of the circles. The experimenter then repeated each of the names and asked the child to point to the circle with that name. The children were also asked to repeat the name of a circle immediately after it was spoken by the experimenter. The third task the children were asked to do was to repeat the list of English words. The set was said to be learned when 10 sequential responses were correct. The set was considered to be reproduced when all five members of the set were repeated correctly.

Menyuk found that the sequences were perceived with equal accuracy whether they were permissible or impermissible. That is, there were no significant differences due to the permissibility of the stimuli in the percentage of children who learned the task or the percentage of correct responses at any age level. The older children did have more correct responses than the younger children. The children perceived and stored permissible and impermissible sequences with equal accuracy, so the phonological rules of the child's native language did not appear to interfere with this process. In recall, the permissible words were remembered better than the impermissible words. The children's ability to reproduce these words was dependent on their previous production experience with the consonant combinations, that is, they had previously used the consonant combinations found in the permissible words. This suggests that the existence of consonant cluster rules in the phonological system increases the speed with which the permissible sequences

could be coded and stored.

Another interesting result found by Menyuk was that at the nursery-school level the percentage of children learning the permissible versus the impermissible words was equal. In kindergarten, a greater percentage of the children learned the impermissible words than the permissible words. First- and second-grade children, on the other hand, learned the permissible words more often than the impermissible. One reason for this may be the fact that kindergarten children were just being introduced to reading and may have been paying more attention to the sound sequences and the oddity of the stimuli than the younger and older children. This may mean that it would be beneficial to introduce the auditory-vocal aspects of another language at this time, before the reversal occurs and makes it more difficult for the child to learn a second language.

The study which will be presented last is the study which prompted the present study. Messer (1967) conducted a study to determine whether very young children can discriminate between monosyllabic words which are possible according to Whorf's formula and those which are not. If the child was able to discriminate, Messer would have evidence that the child has abstracted and internalized the implicit syntax of phonemes. Whorf asserts that by the age of six the formula is ingrained and automatic. Messer also wanted to see what effect legality or illegality had on children's pronunciations of the words. He predicted that the impermissible words would be mispronounced more often than the permissible words. Twenty children, ranging in age from 3 years to 4 years old were used as subjects. The stimuli were 25 pairs of monosyl-

labic words. Each pair was composed of one word which was generated by the Whorfian formula, and so was a possible English word, and a second word which violated the formula and so was either very infrequent or impossible in English. For 15 of the 25 pairs, the illegal word was one degree removed from English so that only the initial consonant cluster was impermissible. These will be referred to as L1-I1 pairs. In the other 10 pairs, the illegal word had two violations - both the initial and final consonant clusters were violations of English. These 10 pairs will be referred to as L2-I2 pairs.

The word pairs were presented and it only and the children were asked to choose which word of the pair sounded more like a real word. They were also asked to repeat each word as it was presented. Messer found that there was a significant tendency for the subjects to choose the legal words, that is, those words which are permissible according to Whorf's formula. They also showed a moderate tendency to discriminate words two degrees removed from English more easily than words one degree removed. This effect was found for all but four of the 25 pairs in the stimulus list. Messer also reported that the children mispronounced the illegal words more often than the legal ones, which is consistent with results found with adults.

Messer had claimed that choosing legal words over illegal words reflects tacit knowledge of English phonology. However, there is another possibility. The judgments could be the result of word associations made during the judgment. In this case, word associations refer to phonological associations. It is hypothesized in the present study that whichever stimulus more readily elicits a realword associate

is the stimulus that is chosen by the subject as more word-like. This is not to say that the subject does not have implicit knowledge of phonological rules, but rather that these rules may not be utilized in this task.

In order to examine the role of word associations in this task, it was proposed that word association norms for the 50 stimuli which Messer used be obtained. The procedure and results are found in Appendix A. Four experiments were then conducted to test various hypotheses concerning the stimuli and their association values.

Experiment 1 was an attempt to replicate the Messer study with adults and also to assess whether subjects' preferences were related to the word association values of the stimuli. Experiments 2 and 3 were designed to assess the influence of word association values with specifically constructed stimulus pairings. In Experiment 4, an attempt was made to measure subjects' preferences for phonologically legal sequences when word association values between legal and illegal stimuli were equated.

Experiment 1

The purpose of Experiment 1 was twofold. The first objective was to attempt a replication of Messer's 1967 study using adults as subjects instead of children, and to examine the possibility that word associations play a role in this task. Brown and Berko (1960) found that in free word association tests, childrens responses tended to be syntagmatic. That is, the response term was of a different grammatical class than the stimulus term. Frequently the response term was a word that could follow the stimulus in a sentence. For example, if the stimulus word was "green", the child might respond "grass." It was also found that there was not a lot of agreement in responses among children. On the other hand, adults' responses tended to be paradigmatic, with the stimulus and the response belonging to the same grammatical class. For example, if the stimulus is "green" the adult might respond "red." With adults, Brown and Berko found a high commonality of responses. The shift from syntagmatic to paradigmatic responding occurs around 5 to 9 years of age. Because there do appear to be differences in association response of young children and adults, adults were used in the present study.

The second part of this experiment examined whether it was important that in most of the original pairs used by Messer the two words differed in only a few sounds. This may have an affect on the person's choice. It is possible that when pairs are used in which the items differ in only a few sounds, the subjects attention may become focused on these sounds and, as a result, the detection of illegal sound combinations may be facilitated.

Method

Subjects

The subjects were 24 college students who were enrolled in various undergraduate psychology classes and received credit for their voluntary participation. All subjects were native born speakers of English and reported no hearing difficulties which would interfere with the perception of sounds at the level of a normal speaking voice. Each subject was tested individually in a single session which lasted approximately 15 minutes.

Design

The three main variables of interest in this experiment were an associative index of each pair (the associative value of the legal member minus the associative value of the illegal member), the type of pair (whether the members of the pair were similar or dissimilar in sound), and the degree of legality (whether the illegal member of the pair involved one or two phonological violations). These variables were used as predictors in a regression equation in which the dependent variable was preference for the legal member of the pair.

The main hypothesis of interest was that the associative value of the stimulus pairs would be significantly related to the subjects' preference for a particular member of the pair. In order to assess the associative value of the stimulus words, associative norms were obtained using all of the stimuli from the original Messer study. The details of the norm procedure are given in Appendix A. These associative values were then used to compute a difference index for each of the pairs used in the present study. The difference index involved subtracting the

associative value of the illegal member of each pair from the associative value of the legal member. The difference in associative values was of interest because it was assumed that if subjects used word associations in making a choice, the greater the difference in associative values, the more likely the subject would be to choose the word with the higher associative value.

A second hypothesis of interest is related to the similarity (overlap) in sounds between the legal and illegal words within the pairs. Therefore, half of the subjects received the original similar sounding pairs used by Messer and the other half received newly generated pairs in which members within each pair differed in most, if not all, sounds. It was hypothesized that similar sounding pairs would result in stronger preference scores by focusing the subjects' attention in the phonological violations. The number of phonological violations was also of interest. For both the similar and dissimilar sounding pairs, there were 15 pairs in which the illegal members contained only one phonological violation and 10 pairs in which the illegal member had two violations. On the basis of Messer's results, it was expected that pairs associated with two phonological violations would result in higher preference scores for the legal member than would pairs in which the illegal member had one phonological violation.

Materials

The stimuli were the same as those used by Messer (1967) and consisted of 25 pairs of monosyllabic words. In the first set of stimuli, the actual pairs from Messer's original study were used. Each pair was composed of one word which was generated by the Whorfian formula and so

was a possible English word, and a second word which violated the formula and so was either very infrequent or impossible in English. An example of a permissible (legal) word would be "dwil" while an example of an impermissible (illegal) word would be "nwil." For 15 of the 25 pairs, the illegal word was one degree removed from English so that only the initial consonant cluster was illegal, as in "mrul." These will be referred to as L1-I1 pairs, where L1 is simply the legal member which is paired with an illegal word with one violation. In the other 10 pairs, the illegal word had two violations -- both the initial and final consonant clusters are violations of English, such as in "gnilb." These 10 pairs were the L2-I2 pairs, where L2 is the legal word which is paired with an illegal word with two violations. The list of the stimulus pairs and their corresponding association values are given in Appendix C. The mean of the difference index is .66 ($SD=.89$).

The second set of stimuli in Experiment 1 contained pairs which had been newly generated. The words were paired differently than in the original Messer study. In this order, the difference in association values was kept as constant as possible. For example, for the original Messer pair of "gluwf" and "cluwf" (with a difference in association values of $-.43$), the pair "gluwf" and "fweyz" (with a difference in association values of $-.46$) was created. Whether the legal member was paired with an illegal member with one or two violations was kept constant (i.e., an L1 was always paired with an I1, and an L2 was always paired with an I2). The stimulus list is found in Appendix D. The mean of the difference index was .61 ($SD=1.0$).

Procedure

Each subject was told that he/she would be hearing a pair of nonsense words which would be played on a tape recorder. They were asked to choose the nonsense word which (a) better described some object, (b) sounded more like something they had heard before in English, or (c) sounded better in their opinion. Subjects were instructed to indicate their choices on an answer sheet which did not contain the actual words. The answer sheet consisted of two columns labeled "first word" and "second word" with the corresponding number of the pair along the side of the paper. Subjects were instructed to put a check mark in the appropriate space.

Each of the 25 pairs, plus three practice pairs, were repeated three times successively to better ensure that subjects heard the stimulus words. There was a five-second interval between the third repetition and the beginning of the next pair. This gave the subject the opportunity to record his/her choice. Each subject was told that each pair would be repeated three times and that he/she would then have a short time to make his/her choice before the next pair was presented.

One difference between the present procedure and that used by Messer was that in the Messer study the subjects repeated each stimulus word as it was given and their responses were recorded on tape. This was done so that the experimenters could later check which word the child actually chose. The use of an answer sheet in the present study alleviated this problem.

The order of presentation of the 25 pairs was randomized in two different orderings for each type of pair. Thus, one-fourth of the

subjects received similar sounding pairs in one random order and one-fourth received them in a different order. Similarly, one-fourth of the subjects received dissimilar sounding pairs in one random order and one-fourth received them in a different order. Approximately one-half of the pairs had the legal member presented first and the other half of the pairs had the illegal member presented first. Three practice pairs were constructed from nonwords taken from another source (Rubenstein & Rubenstein, 1971).

Results

In order to assess the degree of preference for the legal members of the pairs, each subject was assigned a preference score, the percentage of pairs for which the subject indicated a preference for the phonologically legal member. The preference scores in the present study replicated Messer's finding of a significant tendency for the subjects to choose the legal member of a pair. Across all subjects, the mean preference score was .70 (SD=.14), which was significantly greater than .50, the value that would be expected on the basis of random responding, $t(22)=6.90, p<.001$. For those subjects who received the original pairings used by Messer, the mean preference score was .74 (SD=.15) which was also significantly greater than the value of .50, $t(11)=5.54, p<.001$. For those subjects that received the newly generated pairings, the value was .66 (SD=.13), $t(11)=4.37, p<.001$.

A two-way mixed-design analysis of variance was conducted on the preference scores in order to assess the effect of degree of legality. The within-subjects variable was the degree of legality. Each subject was assigned two preference scores, one for those pairs in which the illegal member had one phonological violation and another score for those pairs involving two phonological violations. The between-subjects variable was the type of pairing (Messer's original pairings versus the newly generated pairings). A summary table for the analysis is given in Table 1. The mean preference scores for Messer's original pairings were .75 (SD=.16) for those pairs involving one violation and .73 (SD=.19) for those pairs involving two violations. The means for the newly generated pairings were .64 (SD=.11) and .69 (SD=.19) for one and two

violations, respectively. Neither of the main effects was significant, nor was the interaction. A planned comparisons test was conducted between the two means for the original pairings used by Messer and there was no significant effect of number of violations (critical difference=.13). A similar comparison between the two means for the newly generated pairings was not significant. Thus, the present data fail to replicate Messer's finding that there is a stronger preference for the legal member when the illegal member has two phonological violations as opposed to one. In addition, there was no indication that the preference scores were significantly higher for Messer's original, similar sounding pairings than for the newly generated, dissimilar sounding pairings.

A stepwise regression analysis was performed to assess which variables were the best predictors of the preference scores. The three predictor variables in the analysis were type of pair (Messer pairings versus the newly generated pairings), the associative difference score, and the degree of legality (one versus two phonological violations for the illegal member). The analysis indicated that the associative difference score was the best predictor, with an $\underline{R}^2$ of .15 which was significant, $\underline{F}(1,44)=8.41$, $p<.001$. The $\underline{R}^2$ for order was .19 with an $\underline{R}^2$ change of .04, which was not a significant change, $\underline{F}(1,44)=2.21$, $p>.05$. For legality, the $\underline{R}^2$ was .22 with an $\underline{R}^2$ change of .03, which was not significant, $\underline{F}(1,44)=1.64$, $p>.05$.

An analysis of variance for the same three variables that were in the stepwise regression was conducted in order to assess the effect of each variable as well as the interactions. A regression procedure was

Table 1

(Experiment 1)

Comparison of type of pair (Messer's original pairs or newly generated pairs) and number of violations in the illegal member

Source	df	SS	<u>F</u>	MS	<u>p</u>
Type of pair	1	.064	1.53	.064	.229
Number of violations	1	.002	.11	.002	.739
Type of pair	1	.019	1.41	.019	.248
Number of violations					

used for the analysis and the summary table is given in Table 2. The only effect to reach significance was the main effect for the associative difference score, $F(1,48)=8.65$, $p<.001$. The correlation coefficients between the factors in the regression equation are shown in Table 3.

Table 2

(Experiment 1)

Analysis of variance for the variables in the regression analysis

Source	df	Beta	<u>F</u>
Difference	1	.47757	8.649*
Order	1	-.08357	.281
Legality	1	-.16529	1.019
Legality x Difference	1	.02735	.033
Difference x Order	1	.01084	.004
Legality x Order	1	.07680	.217
Legality x Order x Difference	1	-.24469	2.043

* $p < .001$

(Regression ANOVA)

Table 3

(Experiment 1)

Correlation coefficients between factors
in the regression equation

	Legality	Difference	Pair-type	Legal prf
Legality				.04
Difference	.47*			.39
Pair-type	.03	.09		-.16

* $p < .05$

Discussion

The data indicate that the difference in association values is a significant factor in predicting the preferences subjects have in choosing between phonologically legal and illegal sound sequences. This finding is consistent with the hypothesis that what may actually be occurring is that subjects are forming associations to the sound sequences and are making choices according to the ease with which associations are formed. These data do not rule out the possibility that subjects are using tacit phonological knowledge as well as implicit associations to make their judgments. The data indicate that word associations play a role in the task and it is possible that both associative factors and tacit phonological knowledge are the basis for subjects' preferences.

There was no indication that stronger preference effects occur with similar sounding as opposed to dissimilar sounding pairings. Thus, there is no evidence for the hypothesis that similar sounding pairs focus the subjects' attention upon the phonological violations within illegal members. The observation of significant preference effects for the newly generated pairings is of methodological importance. The issues to be examined in the experiments which follow require that the sound sequences be paired in combinations that are different from those used by Messer. The data in Experiment 1 suggest that when such new pairings are made, the resulting dissimilarity in sounds will not attenuate the basic effect observed by Messer.

The results failed to replicate Messer's finding that there was a tendency to choose the legal word more often when it was paired with a word with two violations than when a legal word was paired with a word

with one violation. One possible explanation for the inability to replicate Messer's results is the difference in ages between the subjects. The children in Messer's study may have been at an age at which they were paying particular attention to sounds of words. Therefore, these children may have had their attention focused more closely on sound and so became aware of the fact that there were two violations. Adults, on the other hand, may have noticed the first violation and either ignored or were not really aware of the second violation.

Experiment 2

In Experiment 1 it was noted that the possibility that the subject was basing his/her judgments on phonological knowledge was not ruled out. It is possible that both phonological knowledge and word associations play a role. Experiment 2 is an attempt to see if word associations could play a role in this task, not whether they did play a role in Experiment 1. Experiment 2 was designed to attempt to eliminate the possibility that subjects could base their judgments on phonological knowledge. This was accomplished by pairing legal words with other legal words and illegal words with illegal words. Each of the words in the pair had a different association value. Pairing the words in this manner eliminated the possibility that subjects could use phonological knowledge to make their decisions. The same subjects from Experiment 1 were used in Experiment 2 to save time and resources. There were no specific patterns of response found; i.e. no one chose all the second words, or alternated choices.

Method

Subjects

The subjects were the 24 psychology students who participated in Experiment 1. The stimuli from Experiment 2 were presented immediately after the stimuli of Experiment 1. The presentation of these pairings required about 8 minutes.

Design

The main purpose of this experiment was to construct pairs in which both members had the same phonological status (both legal or both illegal) and yet differed in association value. Messer's theory concerning the way in which subjects make judgments would predict no difference in preference for either member of the pair, so that the probability should be .50 for choosing either member. If word associations are influential in this task then it would be expected that the probability of choosing the member with the higher associative value should be greater than .50. Therefore, it was predicted that the subjects would choose the word with the higher associative value.

A second point of interest involved an analysis of variance using a regression procedure. The first variable of interest was an associative index of each pair, called the difference index, in which the associative value of the member with the lower associative value is subtracted from the associative value of the member with the higher associative value (high value minus low value). The second variable of interest was the legality of the pair, that is, whether both members of the pair were legal or both members were illegal. These two variables were analyzed in an analysis of variance based upon a regression procedure.

The dependent variable was the preference for the member with the high associative value. Whether the member with the high associative value was presented at the first or second member of the pair was determined on a random basis. Two different orders of the stimuli were used with half of the subjects receiving the first order and the other half receiving the second order.

Materials

The pairs were constructed using the stimuli from Messer's study and the corresponding association values found in Appendix A. In this experiment, legal words which were originally paired with illegal words with one violation (L1 words) were paired with other legal words which were originally paired with illegal words with one violation. This means that an L1 (legal one) word was paired with another L1 word. For the rest of the pairs, L2 words were paired with other L2 words, I1 with other I1 words, and I2 words were paired with other I2 words. A total of 15 pairs was created.

Six of the pairs were composed of legal words which had previously been paired with illegal words with one violation. Two of the pairs were composed of L2 words, four pairs were composed of illegal words with one violation, and three pairs were composed of illegal words with two violations. For each pair, one member had a relatively high associative value while the other member had a relatively low associative value. The stimulus list is given in Appendix E. The mean of the difference index is .99 ($SD=.09$).

Procedure

The 15 stimuli were presented immediately after the subject received

the 25 pairs in Experiment 1. There was no break and the same method of presentation was used as in Experiment 1.

Results

Results for Experiment 2

A preference score was determined for each subject by obtaining the percentage of pairs for which the subject chose the member of the pair with the high associative value. When the preferences for the member with the high associative value was combined so that both legal and illegal pairs were taken into account, the mean preference for the member with the high associative value was .57 ($SD=.10$), which is significantly greater than .50, $t(23)=3.33$, $p < .005$. Because this value was fairly low, separate t-tests were done on the two types of pairs (legal or illegal).

The mean preference for the member with the high associative value when both members of the pair were legal was .62 ($SD=.20$), which was significantly greater than .50, $t(23)=2.88$, $p < .01$. The mean preference for the member with the high associative value when both members of the pair were illegal was .51 ($SD=.22$). This was not significantly different from .50, $t(23) = .23$, $p > .01$. A regression analysis indicated that the only predictor which was significant was legality (whether the members of the pair were both legal or both illegal), $F(1,13)=6.31$, $p < .05$.

Reanalysis of Experiment 1

The data presented above suggest that the use of word associations is restricted to legal sequences. This implies that the absolute value of the associative values for legal members, but not illegal, should have been related to preferences in Experiment 1. For this reason the data of Experiment 1 were reanalyzed using the two additional predictors of

the association value of the legal member and the association value of the illegal member. The results of the analysis of variance using a regression equation indicate that the associative difference score was still the best predictor and was significant, $F(1,48)=9.47$, $p < .001$. The association value of the legal member of the pair (assoclegal) was significant at the .05 level, $F(2,47)=4.25$, $p < .05$. The rest of the predictors did not reach significance. The results of the analysis of variance can be seen in Table 4. These results offer a second piece of evidence that subjects might use word associations to influence their choice only for legal sequences.

Table 4
(Reanalysis of Experiment 1)

Source	df	Beta	<u>F</u>
Difference	1	.496	9.472*
Assoclegal	1	- .467	4.230*
Associllegal	1	.378	0.972
Legality	1	-1.97	1.807
Order	1	- .023	.003

* $p < .001$

Discussion

The hypothesis that word associations play a role in this task when phonological status is held constant was supported by the significance of the overall preference for the member with the high associative value. What was not expected was the finding that the preference for the member with the high associative value was significantly greater than .50 for the pairs composed of legal nonsense words, but not for the pairs composed of illegal nonsense words. It may be that there are certain conditions under which the person follows the associative norms. This result can be explained in terms of an hypothesized internal lexicon. When the person is trying to make a judgment between the two words, when the word is legal he/she may find similar consonant sequences in the internal lexicon which correspond to those in real words. On the other hand, for illegal words the person might not encounter any familiar sequences. Therefore, it may be that associations are more readily available for legal words than for illegal words.

Rubenstein, Lewis and Rubenstein (1971) found evidence which supports this proposal. They found that it took longer for a person to say that a legal nonword was not an English word than it did for them to say that an illegal nonword was not an English word, suggesting that phonological illegality is detected without an exhaustive search of the internal lexicon.

Another possible explanation may be that associative connotations for the legal words may be more pleasant than those for the illegal words (Osgood, Tannenbaum & Suci, 1957). The person may feel that neither of the illegal words is very pleasant, so it does not matter to

them which word is chosen.

Experiment 3

The original purpose of Experiment 3 was to assess whether the associative values of stimulus pairings could influence subjects' responding to such a degree that subjects would express a preference for the illegal rather than the legal member of the pair. The stimulus pairings in Experiment 3 were constructed so that one term would be phonologically legal and have a low associative value and the other term would be phonologically illegal and have a high associative value. If subjects were to base their preferences solely upon the associative characteristics of the stimuli, one would expect them to choose the illegal member of each pair. However, on the basis of Experiments 1 and 2 one would not expect this to be the case. In those experiments, it was observed that the associative value of illegal stimulus members failed to predict subjects' preferences. To the extent that subjects do not make use of associations for illegal stimuli one would expect the high normed values for illegal members in Experiment 3 to be of little consequence. In addition, to the extent that subjects have a tendency to prefer phonologically legal rather than illegal stimuli, one would expect that the legal members of the pairings would be chosen despite their low associative ratings.

Method

Subjects

Subjects were 24 Introductory Psychology students who received credit for their participation. All subjects were native speakers of English and reported no hearing difficulties. Each subject was seen individually in a single session which was approximately 15 minutes long. None of the subjects had participated in Experiments 1 and 2.

Design

There were two types of pairings, experimental and control. The 12 experimental pairs consisted of one legal stimulus word of relatively low associative value and one illegal stimulus word of relatively high associative value. The main analysis was concerned with which of the two stimulus members would be preferred. On the basis of the data from Experiments 1 and 2, it was predicted that the high associative values of the illegal members would not lead to a strong preference for these members. Rather, it was assumed that the use of implicit phonological knowledge, hypothesized by Messer, would lead to a tendency for the subjects to choose the low associative value legal members significantly more often than the chance or random value of .50.

In addition to the experimental pairs, there were 10 control pairs taken from Messer's study. These control pairs were used in order to assess whether the sample of subjects was comparable in their preferences to those subjects in the previous experiments. A significant preference for the legal member was expected.

Two random orders of the pairings were presented, with control and experimental pairs randomly arranged within those orders. For half of

the pairs, the legal member was presented first, while for the other half the illegal member was presented first. The same practice pairs were used as those in Experiment 1.

Materials

The stimuli were pairs created using the association values found in the norm procedure (Appendix A). Each of the pairs involved a legal word and an illegal word. Experimental pairs were chosen so that the illegal member of the pair had a higher association value than the legal member of the pair. Twelve experimental pairs were created with 10 pairs consisting of one high associative value illegal word with one violation and a low associative value legal word which had originally been paired with an illegal word with one violation. Two of the pairs consisted of an illegal word with two violations and a legal word which had originally been paired with an illegal word with two violations. The mean of the difference index was .50 ($SD=.22$).

The control pairs were composed of legal words which had a higher associative value than the illegal words they were paired with. These pairs were taken from Messer's original pairs. Ten control pairs were used. The mean of the difference index was .49 ($SD=.35$). A list of the experimental and control pairs can be found in Appendix G. Three practice pairs generated from another source (Rubenstein, Lewis & Rubenstein, 1971) were also given, so that the total number of pairs presented was 28.

Procedure

The same procedure was used as that in Experiments 1 and 2.

Results and Discussion

For the experimental pairs the mean preference for the legal member of the pair was .47 ($SD=.20$), which was not significantly different from .50, $t(23)=.76$, $p > .05$. One might argue that the differences in associative ratings were not great enough to yield a significant difference. However, the differences in ratings for the control pairs were comparable and a significant preference for the high associative value legal member was observed for those pairs. The mean preference score was .70 ($SD=.15$), $t(23)=6.456$, $p < .001$.

One possible explanation for the lack of significant preferences for either member within the experimental pairings is that the subjects may have attempted to make decisions based upon the legality of the word and upon its associative value. These two factors may have opposed each other and yielded a finding of no difference. The second possibility is that neither associative values nor legality influenced subjects' judgments. With respect to associative values, subjects may have failed to form or may have disregarded the associative values of the illegal stimulus members. Since the legal stimulus members were of low associative value there may have been little basis, in terms of associations, for selecting one member of the pair or the other.

In addition, since there is no direct evidence from either Experiment 1 or 2 that subjects actually use implicit phonological knowledge as a basis for their judgments, it may be the case that phonological violations may not have influenced subjects' responding. Thus, if neither phonological violations nor association values influenced subjects' responding one would not expect a preference score significantly

different from .50. The reasonableness of the latter explanation could be evaluated if one could obtain direct evidence as to whether phonological violations actually do form a basis for subjects' responding. Experiment 4 was designed to test this possibility.

Experiment 4

The purpose of this experiment was to equate associative values of the pairs in an attempt to encourage the subjects to use some decision strategy based on something other than word associations. In the case of these pairs the subject cannot rely on word association value as a criterion. This should force the subject to use the legality and illegality of the words as a criterion. In other words, it would appear that these pairings should measure more directly subjects' tendency to use phonology as their basis for judgment.

Method

Subjects

The subjects were 24 students from various undergraduate psychology courses who received credit for their voluntary participation. Each subject was seen individually in a session which lasted 10 minutes. None of the subjects had participated in Experiments 1, 2, or 3.

Design

There were two types of pairs, experimental and control. The 15 experimental pairs consisted of an illegal and a legal member equated in associative value. It was predicted that if subjects use implicit phonology as a basis for making their judgments, the preference for the legal member should exceed a value of .50.

In addition to the experimental pairs, there were 10 control pairs taken from Messer. These pairs were used in order to assess whether the sample of subjects in the experiment was comparable in their preferences to those subjects in the previous experiments. A significant preference for the legal member was expected.

Two random orders of the pairings were presented, with control and experimental pairs randomly arranged within these orders. For approximately half of the pairs, the legal member was presented first, while for the other half the illegal member was presented first. The same practice pairs were used as those in Experiments 1 and 3.

Materials

Each of the pairs had a legal word and an illegal word. The experimental pairs were generated using the association values found in the norm procedure (Appendix A). The legal and illegal member of each pair

was equated as closely as possible on association value so that the difference in association values was as close to zero as possible. There were 15 experimental pairs, four of which contained an illegal word with two violations, and 11 which contained an illegal word with one violation. The mean difference index was .003 (SD=.07).

There were also 10 control pairs used. These pairs were taken from Messer's stimuli and were generated so that the legal member had a greater associative value than the illegal member. The mean difference index was 1.38 (SD=.57). Both the experimental and control pairings are given in Appendix H.

Procedure

The procedure was the same as Experiments 1 and 3.

Results and Discussion

For the experimental pairs the mean preference for the legal member of the pair was .66 (SD=.14), which is significantly greater than .50, $t(23)=5.64$, $p < .001$. Thus, when associative factors are equated, subjects' responding indicates a significant preference for legal members. This finding suggests that subjects are sensitive to the phonological violations of the illegal stimuli. For the control pairs the preference for the legal member was .77 (SD=.15), which was also significantly greater than .50, $t(23)=8.86$, $p < .001$.

General Discussion

The results of the first experiment partially replicated Messer's (1967) results, indicating that both children and adults prefer the phonologically legal member in a pair of nonsense words. In Experiment 2, when both members of the pair were either legal or illegal, it was found that subjects used association values in making a judgment only when both members of the pair were legal. Because of these results, the results of Experiment 1 were reanalyzed. When the results of Experiment 1 were reanalyzed, it was discovered that the association value of the legal member of the pair was a significant predictor, while the association value of the illegal member did not account for a significant amount of the variance.

The results of Experiment 3 appear to be consistent with the results of the first two experiments. When the legal member of a pair had a low associative value and the illegal member had a high associative value, there was no preference for either member of the pair. One explanation given for this in the discussion of Experiment 3 was the possibility that the subjects either did not form associations for the illegal members of the pair or, if they did form associations, they ignored them. This explanation would be consistent with the results found in Experiments 1 and 2, in which associations were important for the legal members only.

In Experiment 4, in which the legal and illegal members had approximately the same association values, the legal members of the pair were preferred over the illegal members. Since the association values of both members were approximately the same, it was thought that the subjects

would have to make their choice based on phonology. But, it appears that the subjects may either be ignoring the association value of the illegal member or failing to form associations to it in the first place.

As was mentioned in Experiment 2, these results could be explained by referring to the hypothesized internal lexicon. A person's phonological knowledge consists of a set of features and the rules which govern the way in which these features can be combined to form phonetic segments and the permissible sequences of these segments. For a phonological sequence that makes up a word the person knows, there is associated with it a representation of the word's meaning. The internal lexicon is thought to contain the above information for each and every word that a person knows. Rubenstein, Lewis, and Rubenstein (1971) found evidence which suggests that for an illegal word, when asked if it is an English word, the person does not need to search the entire lexicon. The person discovers in the quantization stage that the consonants are not permissible and so there is no need to search any further. For this reason, when a person is asked to choose between a legal and illegal word, he/she may not be able to form associations for the illegal word because there are no consonant combinations found in the internal lexicon which match it. For the legal words, although there are no actual representations of them in the internal lexicon, there are similar consonant combinations found. These similar consonant combinations may make it easier for the person to make associations to the legal word. So, the associative explanation offered for Messer's results could also be playing a role in a task such as Rubenstein's.

The Spoehr and Smith (1974) results do not lend themselves quite as easily to an associative explanation. One difficulty lies in the stimuli used. Spoehr and Smith used unpronounceable nonwords, which adds an additional variable not presented in the Rubenstein et al (1971) or Messer (1967) studies. Also, in Spoehr and Smith's study, the person is not required to say whether the word is an English word.

There are some possible problems with the stimuli used. Messer does not mention in his study how the stimuli were chosen, therefore it is uncertain whether a representative sample was reported. To a linguist it would not matter if there was a representative sample, as long as there were violations. Psychologists, on the other hand, would feel that lack of a representative sample adds to the uncertainty about the effects found. The consonant combinations found in the legal stimuli may have favored consonant combinations with which the American English speaking person may be very familiar. So, it may be that the combinations used were ones to which children would be exposed every day. This could be investigated by determining the frequency of occurrence in the English language of each particular legal consonant combination. This can be done by using a procedure similar to that used to find word frequency counts. Even with the illegal stimuli there may have been consonant combinations to which the subjects may have been exposed because of the words we have incorporated into English from foreign languages. This could have affected the results. In those cases in which the illegal word was chosen over the legal word, it may have been that subjects have been exposed to the illegal consonant combination more often than the legal combination.

Another problem with Messer's study is the possibility that his estimate of the age at which these phonological rules are mastered may not be accurate. Anisfeld, Barlow and Frail (1968) found that six-year olds had not mastered the set of phonological rules. The results of the present study indicate that in certain cases adults use word associations in making a decision. Messer's results for children could, in part, reflect associative processes. To examine this possibility, children should be tested with materials similar to those in Experiment 4. The results of such an experiment would be of importance because, according to Rubenstein's theory, children rely on these phonological rules in word recognition. If this is the case, then there would be implications about when a child is ready to read.

It may be beneficial to use a task such as Menyuk's (1968) to examine the issue of phonology and word associations further. The results from using a task such as Menyuk's would add information to what is already known. One could examine whether word association value make a difference with legal nonwords in learning and reproducing them. One could also examine these issues using a task like Rubenstein et al. (1971). It might be found that legal nonwords with a high associative value might be responded to more quickly than those with a low associative value.

A methodological suggestion which would be made if this experiment were to be done again, in addition to those which have already been mentioned, would be to use people from the same area of the country to obtain the word association norms and then to have people with this same dialect participate in the experiment. This is of concern because of

comments that were made by some of the subjects after the norm procedures were completed. Subjects from the south seemed to feel that certain nonwords sounded like words, while people from the north did not mention this. Perhaps demographic information should be obtained from subjects in the future.

In conclusion, it was found that for Messer's original set of stimuli and for the newly generated pairing of these stimuli, subjects preferred the legal member of the pair. Association values were found to be important only for the legal members of the pair. An explanation for these results came from the findings of Rubenstein, Lewis and Rubenstein (1971). They suggest that the processing of illegal nonwords stops at the quantization stage when the person is asked if the word is an English word. It may be the case that when asked to choose between a legal nonword and an illegal nonword, a person may be able to more easily form associations for the legal word. This ease in forming associations may occur because they are able to find similar sounding words in the internal lexicon. When an illegal word is given a high associative value, it may be because the person is only using part of the nonword (in the case of illegal words with one violation) in making an association. Or, the person may be changing one phoneme to make the nonword more acceptable, and so is using his perceptual and behavioral predisposition to hear and create possible morphemes and words.

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Appendix A

Table A

(Appendix A)

Mean Association Values for Legal and Illegal Stimuli

Stimulus	Legality	Association Value	Stimulus	Legality	Association Value
śrib	L	4.17	tlīb	I	3.13
škib	I	4.40	dret'	L	5.37
klek'	L	5.20	sret'	I	4.73
dlek'	I	3.23	gwig	L	4.03
plər	L	4.06	fwig	I	4.03
zlər	I	4.70	twan	L	4.20
θrup	L	4.56	bwan	I	4.80
pšup'	I	4.00	gluwf	L	3.70
nardž	L	3.97	čluwf	I	4.13
žardž	I	5.43	šrərn	L	3.96
frul	L	4.96	špeln	*I	3.03
mrul	I	4.40	trisk'	L	4.33
tej	L	3.46	tlīdk'	*I	2.70
žej	I	4.00	flamp'	L	4.07
sprejt'	L	4.26	fwavp'	*I	2.36
spwejt'	I	3.63	šrənt'	L	4.73
dwil	L	5.90	škumv	*I	3.57
nwil	I	5.50	snerb	L	3.73
skejz	L	5.50	gnīlb	*I	2.16
fwejz	I	4.16	spraně'	L	4.50
spīb	L	3.40	spwafě'	*I	2.73

Table A (continued)

Stimulus	Legality	Association Value	Stimulus	Legality	Association Value
blərf	L	4.53	brult'	L	4.30
bjusf	*I	3.43	džrulv	*I	5.13
klest'	L	4.47	næsk'	L	5.07
dlesf	*I	2.50	žæzb	*I	5.10

Note: Stimuli marked with an asterisk are stimuli in which there are two violations (both initial and final consonant sequences are illegal).

Appendix B

Appendix B

Whorf's formula consists of fifteen separate terms. Since the formula is somewhat complicated it will not be presented in detail. The fifteen terms are briefly described. The first term tells us that it is possible for the vowel to not be preceded by anything. This means a word may begin with a vowel. The second term indicates that a word can begin with any single English consonant except the consonant which is the sound we usually write as "ng" as in "hang." In the third term we find that a word can begin with various consonants (such as g, k, d, f or b) followed by r, or with g, k, f or b followed by l. According to the fourth term, the word can begin with several consonants (such as h, g, t or d) followed by w. The fifth term indicates that a word may begin with the consonants h, k, g, f, v, p, b or m followed by y only when the vowel of the word is u. In the sixth term we find that certain pairs (kw, tr, pl) may begin a word, either alone or preceded by s. The seventh term, which completes the parts of the word that can precede its vowel, indicates that a word may begin with s followed by one of the following consonants (k, t, l, n, f, p, m, w).

The eighth term of the formula is the least complicated term. This term means that all English words contain a vowel, and that any one of the English vowels could occur in the monosyllabic word. Terms nine through fifteen show what comes after the vowel. The ninth term indicates that a vowel can end the word if the vowel is "a" as in "pa" or "ma", or if the vowel is the "aw" sound as in "paw" or "thaw". Term ten means that r, w, or y may be interpolated here except when the

interpolation would result in joining w and y with each other. In term eleven we find that the word can end in any single English consonant except h. The twelfth term means that l can be followed by b, m, f; m, s can be followed by p; s by k; l, n by g; and s can be followed by t, d, s. Term thirteen, which has the 'ch' sound as in 'child' and the 'j' sound as in 'joy', deals with the possibility of having such words as 'health, width, eighth.' In term fourteen, various consonants such as k, ks, n, t, d, l, n, f, p may be followed by the "th" sound, while m may be followed by pf. This term allows us to say things such as 'humph' or 'oomph'. In term fifteen the t, s, and st forms are added after voiceless sounds while d, z and zd are added after voiced sounds.

Appendix C

Appendix C

The stimuli consisted of 50 monosyllabic nonwords taken from Messer's 1967 study. All the nonwords in his study were used. Two random orders of the stimuli were created using a random numbers table for the first order. Three practice words were given. The second order counterbalanced the first. Each subject was seen individually and heard one of the two orders. Each word was presented auditorally on a tape recorder and was repeated three times. There was a ten second interval between presentations of words. The subjects were told that this experiment was concerned with the degree to which nonsense words remind people of actual English words. Subjects were instructed to make ratings on a 7-point scale, where "one" is a low associative rating and "seven" is a high associative rating. The numbers in between "one" and "seven" were for nonsense words of intermediate ease or difficulty in their ability to make a person think of a real word. The subjects were also told that if the nonsense word made them think of a real English word they were to write that word down on the blank provided. This was done to assure that people were actually trying to see if the nonsense word reminded them of a real English word. Fifteen subjects from the Introductory Psychology pool were used in each order. The ratings obtained for each individual nonword was averaged across subjects. A correlation was done between Order 1 and Order 2 ratings and was found to be .60. A correlational analysis was also done within each order for each individual nonword. The scores of every other subject were taken and averaged for each nonword (within each order). The correlations found here were .70 for

Order 1 and .77 for Order 2. All three of these correlations are significant at the .05 level. The mean association value for the legal words was 4.42, (SD = .6341). The mean association value for the illegal words was 3.88, (SD = .9791). The results of the association norms can be found in Table A. The mean number of words generated for the legal nonsense words was 18.9, (SD=6). The mean number of words generated for the illegal nonsense words was 17.5, (SD=6). These two means are not significantly different from each other, $t(58) = .60$, $p > .001$.

An analysis was also done to see if there were differences in the number of words given for each association value. For example, if a person chose a rating of 1 for a particular nonsense word, it was noted whether that person wrote down a real English word. The results of this analysis can be seen in Table B. As the associative rating increased, the percentage of people who wrote down a real English word also increased. There were no significant differences between legal and illegal nonwords.

Table B

(Appendix C)

Percentage of Nonsense Words Which Were Given a Real Word

(For Each Associative Value)

<u>Associative Value</u>	Percent Given Real Word	
	<u>Legal</u>	<u>Illegal</u>
1	7	9
2	47	56
3	64	78
4	91	90
5	97	98
6	97	98
7	98	100

Appendix D

Table C

(Experiment 1)

Mean Association Values, Difference Values
and Preference Values for Messer's Original Pairs.

Stimulus Pairs		Associations for	Associations for	Legal-Illegal	Preference for
Legal	Illegal	Legal	Illegal	Difference	Legal
šrib	škib	4.17	4.40	- .23	.66
klek'	dlek'	5.20	3.23	1.97	.75
plər	zlər	4.06	4.70	- .64	.83
θrup	pšup'	4.56	4.00	.56	.50
nardž	žardž	3.97	5.43	-1.46	.75
frul	mrul	4.96	4.40	.56	.66
tej	žej	3.46	4.00	- .54	1.00
sprejt'	spwejt'	4.27	3.63	.64	.92
dwil	nwil	5.90	5.50	.40	.66
skejz	fwejz	5.50	4.16	1.34	.83
spib	tlīb	3.40	3.13	.27	.92
dret'	sret'	5.37	4.73	.64	.83
gwig	fwig	4.03	4.03	.00	.50
twan	bwan	4.20	4.80	- .60	.83
gluwf	čluwf	3.70	4.13	- .43	.66
*šrær̃n	špeln	3.96	3.03	.93	.42
*trisk'	tlidk'	4.33	2.70	1.63	.83
*flamp'	fwavp'	4.07	2.36	1.71	.92
*šrær̃nt	škumv	4.73	3.57	1.16	.75

Table C (continued)

Stimulus Pairs		Associations for	Associations for	Legal-Illegal	Preference for
Legal	Illegal	Legal	Illegal	Difference	Legal
*snerb	gnilb	3.73	2.16	1.57	.75
*spraně'	spwafě'	4.50	2.73	1.77	.83
*blərɸ	bjusɸ	4.53	3.43	1.10	.83
*klest'	dlesɸ	4.47	2.50	1.97	.92
*brult'	džrulv	4.30	5.13	- .83	.50
*næsk'	žæzb	5.07	5.10	- .03	.59

Note: Pairs marked with an asterisk are pairs in which the illegal member has two violations (both initial and final consonant combinations are illegal).

Appendix E

Table D

(Experiment 1)

Mean Association Values, Difference Values,
and Preference Values for Newly Generated Pairs.

Stimulus Pairs		Associations for	Associations for	Legal-Illegal	Preference for
Legal	Illegal	Legal	Illegal	Difference	Legal
*blærf	škumv	4.53	3.57	.96	.66
*šrærn	dlesf	3.96	2.50	1.46	.34
gluwf	fwejz	3.70	4.16	- .46	.17
plær	sret'	4.06	4.73	- .67	.66
klek'	tlib	5.20	3.13	2.07	.92
dwil	žardž	5.90	5.43	.47	.75
sprejt'	škib	4.27	4.40	- .13	.50
gwig	zlær	4.03	4.70	- .67	.59
θrup	žej	4.56	4.00	.56	.66
frul	bwan	4.96	4.80	.16	.59
*spraně'	tlidk'	4.50	2.70	1.80	.83
*flamp	gnilb	4.07	2.16	1.91	.66
*šrænt'	bjusf	4.73	3.43	1.30	.42
*klest'	špein	4.47	3.03	1.44	.75
dret'	dlek'	5.37	3.23	2.14	.75
*trisk'	spwafě'	4.33	2.73	1.60	.92
*næsk'	džrulv	5.07	5.13	- .06	.59
skejz	čluwf	5.50	4.13	1.37	.92
*brult'	žæzb	4.30	5.10	- .80	.92

Table D (continued)

Stimulus Pairs		Associations for	Associations for	Legal-Illegal	Preference for
Legal	Illegal	Legal	Illegal	Difference	Legal
*snerb	fwavp'	3.73	2.36	1.37	.83
tej	pšup'	3.46	4.00	- .54	.83
spib	nwil	3.40	5.50	-2.10	.42
šrib	mrul	4.17	4.40	- .23	.42
twan	spwejt'	4.20	3.63	.57	.83
nardž	fwig	3.97	4.03	-0.06	.66

Note: Pairs marked with an asterisk are pairs in which the illegal member has two violations (both initial and final consonant combinations are illegal).

Appendix F

Table E

(Experiment 2)

Mean Association Values, Difference Values,
and Preference Values for High and Low Associative Value Stimuli.

Stimulus Pairs		Legality	High Associative Rating	Low Associative Rating	High-Low Difference	Preference for High
High	Low					
dwil	frul	L	5.90	4.96	.94	.67
skejz	θrup'	L	5.50	4.56	.94	.84
dret'	sprejt'	L	5.37	4.27	1.10	.79
klek'	twan	L	5.20	4.20	1.00	.67
šrib	spib	L	4.17	3.40	.77	.55
næsk	flamp	L	5.07	4.07	1.00	.63
šrənt	snərb	L	4.73	3.73	1.00	.38
nwil	mrul	L	5.50	4.40	1.10	.63
žardž	škib	I	5.43	4.40	1.03	.46
zlər	spwejt'	I	4.70	3.63	1.07	.58
fwejz	dlek'	I	4.16	3.23	.93	.63
čluwf	tlib	I	4.13	3.13	1.00	.55
*špeln	gnilb	I	3.03	2.16	.87	.46
*bjusf	fwavp'	I	3.43	2.36	1.07	.50
*škumv	dlesf	I	3.57	2.50	1.07	.21

Note: Pairs with an asterisk are pairs in which the illegal
members have two violations.

Appendix G

Table F

(Experiment 3)

Mean Association Values, Difference Values,
and Preference Values for Legal and Illegal Stimuli.

Stimulus Pair		Legal Assoc.	Illegal Assoc.	Difference	Type of	Preference for
Legal	Illegal	Rating	Rating	(Legal-Illegal)	Pair	Legal
spib	fwig	3.40	4.03	- .63	Experimental	.54
tej	čluwf	3.46	4.13	- .67	" "	.46
gluwf	fwejz	3.70	4.16	- .46	" "	.58
nardz	skib	3.97	4.40	- .43	" "	.63
gwig	mrul	4.03	4.40	- .37	" "	.42
plər	zlər	4.06	4.70	- .64	" "	.50
šrib	sret'	4.17	4.73	- .46	" "	.21
twan	ḃwan	4.20	4.80	- .60	" "	.75
sprejt'	žardž	4.27	5.43	-1.16	" "	.42
ərup'	nwil	4.56	5.50	- .94	" "	.33
*snerb	zæzb	3.73	5.10	-1.37	" "	.75
*srørn	džrulv	3.96	5.13	-1.17	" "	.29
trisk'	bjusf	4.33	3.43	.90	Control	.66
spraně'	gnilb	4.50	2.16	2.34	" "	.42
klek'	tlib	5.20	3.13	2.07	" "	.86
šrənt	spwafě'	4.73	2.73	2.00	" "	.66
dwil	dlek'	5.90	3.23	2.67	" "	.86
klest	fwavp	4.47	2.36	2.11	" "	.79
blərɤ	tlidk'	4.53	2.70	1.83	" "	.54

Table F (continued)

Stimulus Pair		Legal Assoc.	Illegal Assoc.	Difference	Type of	Preference for
Legal	Illegal	Rating	Rating	(Legal-Illegal)	Pair	Legal
flamp	Ÿkumv	4.07	3.57	.50	Control	.75
frul	Ÿspeln	4.96	3.30	1.93	" "	.71
skejz	Ÿzej	5.50	4.00	1.50	" "	.63

Appendix H

Table G

(Experiment 4)

Mean Association Values, Difference Values,
and Preference Values for Legal and Illegal Stimuli.

Stimulus Pair		Association for	Association for	Legal- Illegal	Type of	Preference for
Legal	Illegal	Legal	Illegal	Difference	Pair	Legal
*spib	bjusf	3.40	3.43	- .03	Experimental	.71
*tej	škumv	3.46	3.57	- .11	" "	.75
snorb	spwejt'	3.73	3.63	.10	" "	.46
šrørn	pšup	3.96	4.00	- .04	" "	.71
nardž	žej	3.97	4.00	- .03	" "	.67
gwig	fwig	4.03	4.03	.00	" "	.54
šrib	fwejz	4.17	4.16	.01	" "	.84
trisk'	škib	4.33	4.40	- .07	" "	.92
klest'	mrul	4.47	4.40	.07	" "	.92
šrənt'	sret'	4.73	4.73	.00	" "	.84
frul	bwan	4.96	4.86	.16	" "	.88
*næsk'	žæzb	5.07	5.10	- .03	" "	.38
*klek'	džrulv	5.20	5.13	.07	" "	.67
dret'	žardž'	5.37	5.43	- .06	" "	.34
skejz	nwil	5.50	5.50	.00	" "	.71
dwil	zlər	5.90	4.70	1.20	Control	.96
blərř	fwavp'	4.53	2.36	2.17	" "	.58
*brult'	dlesf	4.30	2.50	2.20	" "	.84
flamp'	dlek'	4.07	3.23	.84	" "	.67

Table G (continued)

Stimulus Pair		Association for	Association for	Legal- Illegal	Type of	Preference for
Legal	Illegal	Legal	Illegal	Difference	Pair	Legal
*twan	spwafě'	4.20	2.73	1.47	Control	.75
*gluwf	gnilb	3.70	2.16	1.54	" "	.63
*spraně'	tlidk	4.50	2.70	1.80	" "	.54
plər	tlīb	4.06	3.13	.93	" "	.88
θrup	čluwf	4.56	4.13	.43	" "	.88
*sprejt'	špel'n	4.27	3.03	1.24	" "	.75

Note: Pairs marked with an asterisk are pairs in which the illegal member has two violations (both initial and final consonant combinations are illegal).

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WORD ASSOCIATIONS AND PHONOLOGICALLY
LEGAL AND ILLEGAL SOUND SEQUENCES

by

Karen A. Heimsoth

(Abstract)

This study investigated a method used to determine whether children were using implicit phonology in making a choice between phonologically legal and illegal nonwords. An additional aspect was also investigated, this being the role of association value in making a choice. In Experiment 1, which used the original pairings found in Messer (1967), it was found that adults preferred the legal nonwords over the illegal nonwords. These are the same results which were found by Messer using children as subjects. An additional analysis was done, and it was found that subjects used association values in making a judgment only when the stimuli were phonologically legal.

In Experiment 2, when both members of the pair were either legal or illegal and one had a high associative value and one had a low associative value, it was found that subjects used association values in making a judgment only when both members of the pair were legal. In Experiment 3 the legal member of the pair had a low associative value while the illegal member had a high associative value. It was found that there was not a preference for either member of the pair.

In Experiment 4, the legal and illegal members of each pair had approximately the same associative value, and the legal member of the pair was preferred over the illegal member. The results of these four experiments were related to the internal lexicon and hypotheses made about it by Rubenstein, Lewis and Rubenstein (1971).