Lexicalizing Letter Strings:
The Effects of Repetition, Phonology, Grammatical Category and Context on the Lexicalization of Nonwords

Heather Mateyak
Lexicalizing Letter Strings:  
The Effects of Repetition, Phonology, Grammatical Category and Context  
on the Lexicalization of Nonwords

This study investigated the effects of repetition, grammatical category, and context on the lexicalization of nonwords. Toward this end, nonword targets were presented in sentential contexts over the course of two learning sessions. The effects of initial lexicalization of the target nonwords were measured using response latencies from a lexical decision task. The expectation was that signs of initial lexicalization would be evident when comparing response latencies from the post-learning session lexical decision task to the latencies from the pre-learning session lexical decision task. A longer post-learning session latency would suggest that the nonword had been lexicalized to some degree. However, the analyses indicate that repetition priming had an overwhelming effect on all the experimental variables. Marginal effects of grammatical category and context were also found. These last two results are suggestive, but firm conclusions would require further experimentation. The discussion focuses on modifications of the current investigation.

““To ride on a camel,  
you sit on a wamel.  
A wamel, you know,  
is a sort of a saddle  
held on by a button  
that’s known as a faddle,””  
DR. SEUSS

As fluent speakers of a natural language, we could never say in truth that we are ‘at a loss for words’. Every human language has words (or signs) to describe almost any object, action, or idea imaginable. Words are glorified for their sounds in songs, their meanings are teased in poems, and they are used to map out the lives of numerous fictional characters. They are utilized effortlessly in our everyday conversations, and yet they are poured over, raised up as mysteries unsolved, by the philosopher and the social scientist alike. Yet for all their seeming steadfastness of meaning, one might once stop to wonder mid-sentence about how in fact we come to know that the words we use are in fact words. We might suddenly ponder why certain sequences of sounds have been chosen to mean certain things, and we might rightly be puzzled when considering the process that was undertaken by our minds to recognize, process, and store these sound units and meanings. Dr. Seuss employed an interesting tactic in his many rhyming stories; many of the ‘words’ in his stories were not in fact words of English, yet we understood perfectly well what they meant. If we were particularly inclined that way, we might have even accepted these letter strings to be actual words when we were children. As adults, we can readily accept new words into our vocabulary if the words are of a technical sort. We are more likely to use *e-mail* or *telnet*
in a normal conversation, but quite a bit less likely to use *wamel*.

The current investigation begins with the question, “What is a word?” This question is in fact very complex and can be decomposed into many different queries. First, what information is stored in a lexical entry? For example, a lexical entry might consist of orthographic, phonological, and semantic information that is stored only as a pattern of activation in a lexical network (Seidenberg and McClelland, 1989). On the other hand, it may simply be a list of features that includes morphological and syntactic information, in addition to the features described above (Clark, 1990; Forster, 1976). The next question addresses how new lexical entries are established. When a person sees a letter string they have never seen before, to what extent do they use the string’s phonological, syntactic, and semantic information to begin to recognize and process the string as a word? Furthermore, what kinds of letter organizations can become lexical entries? For example, does a letter string have to be pronounceable in order for us to consider it to be a word? In a forthcoming book, Jackendoff (1996) devotes an entire chapter in the consideration of the composition of the lexicon. Jackendoff concludes that the lexicon of English speakers is rich with various kinds of information, from regular single word-meaning correspondences, to multi-word constituents, such as idioms, to even acronyms or other regulated abbreviations.

The last question I will consider is whether or not there are degrees of being a word. Many psycholinguists (e.g., Forster, 1976, 1989; Levelt, 1989, 1992; Pinker and Prince, 1988) would have us believe that there exists a clear-cut distinction between words and nonwords. Most would say that words are explicitly stored in some part of memory, and that there can be no real linguistic processing for nonwords aside from perhaps a phonological process used for their pronunciation. However, there are some in the field who might argue that our distinction between words and nonwords is in some ways more flexible than had been previously conceived (e.g., Seidenberg and McClelland, 1989; Rumelhart and McClelland, 1986). If our brain is in fact rigid in this respect, as many people would claim, then how can we understand nonwords such as *wamel*, as well as begin to accept into our lexicon new-age terms such as *e-mail* or *telnet*?
What constitutes a lexical entry?

The answer to the question of what constitutes a lexical entry seems fairly clear. On the abstract level, the theories of the composition of a lexical entry are almost equivalent. As Jackendoff (1995) states, “Pretty much everyone agrees that a lexical item is regarded as a triple of phonological, syntactic, and semantic features” (p.20). Other proposals allow for the inclusion of morphological structure (Clark, 1990), as well as orthographic features (Forster, 1976). The details of what is included in the lexical entry depends a lot upon the particular theory of lexical processing that one adopts. The information for a given lexical entry is viewed as being contained as a list of the different features described above (Clark, 1990; Forster, 1976). However, there are others that claim that the disparate kinds of information residing in a lexical entry is connected within the lexical entry, rather than simply being stored as a list (Jackendoff, 1995; Dell, 1986; Seidenberg & McClelland, 1989).

Working from a Neominimalist perspective, Jackendoff (1995) proposes a radically different conception of a lexical entry. Within Jackendoff’s Neominimalist perspective, the architecture of the language faculty is divided into three separate generative systems, one each for phonological, syntactic, and semantic processing. Each generative system specifies formation rules within its specific domain (see Jackendoff, 1995 for justification for the separation of the generative systems). The interface or correspondence between these systems is the lexicon. Hence, Jackendoff perceives the lexical entry as a correspondence rule. The lexical entry contains the phonological, syntactic, and semantic information, as well as a description of the correspondences between these structures. Jackendoff allows for correspondence rules between the phonological structure and the syntactic structure (PS-SS correspondence rules), in addition to a correspondence between the syntactic structure and the semantic structure (SS-CS correspondence rules). Thus, Jackendoff considers the lexicon, consisting of the PS-SS and SS-CS correspondence rules, to be the central, driving force of language that dictates the relationship between the three different linguistic structures (see Chomsky, 1993, for an alternative perspective).
Lexical Representation and Processing

Although there is general agreement as to the features that constitute a lexical entry, the organization of these features in the lexicon is much debated. Many theories suggest that the lexicon is merely a laundry list of symbolic lexical entries, organized according to frequency (Forster, 1976) and possibly semantic content (Meyer and Schvaneveldt, 1971; Collins and Quillian, 1969, 1970, 1972). On the other hand, there is a whole class of connectionist models that assume that the lexicon is a network of associated features. These models vary on the level of distributiveness of representation in the system; some models retain word representations and impose some minimal ordering on the processing of features (e.g., Dell, 1986), while others claim that lexical entries are identified by activated patterns of features within the lexical network (Rumelhart and McClelland, 1986; Seidenberg and McClelland, 1989). The differences between lexical representation theories become more apparent once processing is taken into consideration.

There are several different varieties of symbolic lexical representations that are utilized by processing models. One example of a symbolic approach is Forster’s Lexical Search Theory (1976, 1989). In this approach, the lexicon is viewed as a collection of symbolic lexical entries that contain a unique set of access codes for each type of input (semantic, syntactic, phonological, orthographic). The lexicon can be accessed through any of the four different codes. For example, if a word is perceived visually, a serial search is performed on the lexicon using the orthographic access code until a match is found. The serial search is performed according to frequency, thus this model can account for frequency effects, as well as semantic priming effects and repetition priming.

Levelt (1989; Levelt et al., 1991) offers another symbolic approach to lexical representation and processing. Levelt et al. (1991) claim that the lexicon is accessed during production in “two successive, non-overlapping stages” (p.122). The first stage is lemma access, which is a mapping from the meaning or concept to be lexicalized and the lemma. The lemma itself specifies the grammatical encoding for a given lexical entry that assists in the creation of syntactic frames. The second stage is form access, during which the lemma is translated into its phonological representation. The lemma and form for a given lexical entry are connected; however, during production, processing can proceed only in one direction. Once a lemma is chosen, then only the phonological form that corresponds to that lemma is ‘activated’; there is no partial activation of
phonological codes for lexical entries whose lemmas are related to the chosen lemma. This model offers a strictly serial, symbolic model of production.

The connectionist models of Dell (1986) and Seidenberg and McClelland (1989) provide a stark contrast to the symbolic models described above. However, these two models also differ in many important ways.

Dell (1986) provides an in-depth description of a spreading-activation model of retrieval of lexical items during sentence production. In this model, the lexicon is represented as a lexical network that interconnects four levels of linguistic encoding for lexical entries: semantic, syntactic, morphological, and phonological. Processing during lexical access proceeds simultaneously at the four levels, however, the output at a higher level of processing constrains the result of the processing at the next level. Thus, there is somewhat of a serial ordering imposed on the system, however the results of processing at lower levels can filter back up the network and affect processing at higher levels. In response to a criticism leveled by Levelt et al. (1991), Dell (1991) has emphasized that it is highly unlikely that the output of a level further down in the system, for example, phonological output, will affect processing at a level that is far removed, e.g., semantic processing. A set of categorically specified generative rules feeds into the representational nodes at each level within the system to provide a frame with categorized slots for that level. The lexical network and the categorical rules at each level are related through insertion rules, which indicate what nodes can be legally inserted into the slots within the frames that were determined by the categorical rules at that level. The concept of distinct linguistic levels, each with its own set of generative rules, is key to the theory of production within this model.

In the parallel distributed processing model of Seidenberg and McClelland (1989), words are not explicitly represented within the processing network. Words are only 'represented' by patterns of activation among orthographic, phonological, and semantic units. These units are connected within and between levels, and activation is passed back and forth between the levels of units. Seidenberg and McClelland use a computer simulation of their neural network model to reproduce some important lexical decision data, as well as to claim that there may be a single cognitive mechanism that is used to pronounce words with regular spellings, irregularly-spelled words, and nonwords. To compute whether or not letter strings are words, Seidenberg and McClelland suggest that there is an error score (e.g., an orthographic error score) that computes the
activation of nodes throughout the network to judge whether a ‘YES’ or ‘NO’ response is warranted. As a result of the distributed representations of words, Seidenberg and McClelland infer that the main difference between what is a word and what is a nonword is the level of activation contributing to the recognition of a given letter string. If the three different types of linguistic representations (semantic, phonological, and orthographic) have high levels of activation for a given letter string, meaning a pattern within the network is clearly identifiable, we can then say that the given letter string is perceived as a word within the network. In a sense, Seidenberg and McClelland’s model allows for the possibility of there being varying degrees of being a word, since a word is simply a sum of activation from the various linguistic levels that affect the make-up of a lexical entry.

**How do we establish lexical entries?**

In the current investigation, I am not going to address directly the issue of whether the mind stores words symbolically or non-symbolically. However, I plan to use these models to assist in an investigation of how we establish lexical entries, and in addition, whether or not there are varying degrees of being a word. We have already seen that the symbolic models of Forster (1979, 1986) and Levelt et al. (1991) establish a clear distinction between words and nonwords, whereas the PDP approach of Seidenberg and McClelland (1989) in fact suggests that the boundary between words and nonwords is not nearly so rigid (Dell’s (1986) spreading-activation model lies somewhere in between these two camps). A simple description of what it means to learn a word might be learning its pronunciation, its meaning, and how it fits into a sentence (Jackendoff, personal communication). Coining a simple description of exactly how this process is accomplished, however, is not a trivial task. In this experiment, I will consider each of the aforementioned attributes of words in terms of its contribution to the ability of a given letter string to become established as a word in a person’s lexicon.

*A Lexicalization Investigation*

The main focus of the current investigation is to explore the factors that may be involved in the initial lexicalization of letter strings. The accuracy and latencies measured from a lexical decision task were utilized to measure whether experience with nonword strings in a sentential
context is sufficient to instantiate these strings as lexical entries. The instantiation process from nonword status to word status can be affected by the following factors: (1) the number of times the string is perceived in context, (2) the phonemic structure of the string, (3) the grammatical category of the string, and (4) the context in which the string is presented. The experiment is designed to examine these various aspects of the lexicalization process. In the next section, I will describe why each of these factors might have an effect on the outcome of the lexicalization of a particular letter string, and what we might expect would be the optimal values for each of the features listed above to induce initial signs of instantiation for a given letter string.

Repetition: Sheer Repetition vs. Sentential Context

The effect that repeated presentation might have on the lexical instantiation process is important. This effect is possibly similar to frequency effects; high frequency words are processed differently than items with low frequency. It is reasonable to wonder whether merely seeing the string outside of a sentential context multiple times would be enough for the latency of the response during the lexical decision to be greater, indicating that the string is showing signs of instantiation in the participant's lexicon. In a parallel distributed processing approach such as the lexical decision and naming network of Seidenberg and McClelland (1989), one might predict that providing high levels of activation for particular orthographic patterns might be enough to allow a string to begin to show signs of being recognized as a word. However, it has been shown that there is a repetition priming effect for nonwords (Ratcliff et al., 1985), which indicates that mere repetition of a nonword letter string would inhibit its instantiation as a lexical entry. In addition, Kinoshita et al. (1985) have shown that there is a priming effect for lexical decision that is performed on nonwords that appear at the end of a sentence. Kinoshita et al. (1985) state that “nonword targets have been found to produce faster decision latencies when they are preceded by a sentence context compared with a neutral context...because nonwords, by definition, are not part of the lexicon and have no reason to be affected by context” (p. 346). Thus, repeated presentation alone should not lead to lexical instantiation.

In the current investigation, the nonword target items are integrated into a sentence. This process was repeated over two sessions. I would predict that merely seeing the letter strings several times would not be enough to allow for measurable instantiation of the letter strings, given
the evidence from Ratcliff et al. (1985). However, contrary to the nonword priming evidence (Ratcliff et al., 1985; Kinoshita et al., 1985), I would anticipate that the latencies for lexical decision will be greater for letter strings that appear in a sentential context. I am suggesting that integration of these strings within a sentential context leads to instantiation. Thus, instead of priming, I should find evidence for interference when comparing the accuracy and latencies of the target items between session one and session two. Non-target items should show a repetition priming effect.

**Phonological Type: Pronounceable vs. Non-Pronounceable Nonwords**

Another factor that might affect the lexical instantiation of a letter string is whether or not a given letter string is a legal phonotactic pattern for English. In the current investigation, half of the nonword target items obeyed the phonotactic patterns of English (e.g., *trave*), while the other half can be classified as illegal strings for English (e.g., *wvsul*). Empirically, it has been shown that lexical decision latencies are greater and accuracy is diminished for pronounceable nonwords as compared to non-pronounceable nonwords (Rubenstein, Lewis, and Rubenstein, 1971). This evidence suggests that participants are treating legal and illegal strings differently. Thus, when participants are forced to perform lexical decision on nonword strings that have appeared in context, will the legal strings and illegal strings be processed differently? In terms of the phonemic structure of the letter string affecting its instantiation, I would predict that participants would exhibit a greater tendency to begin to accept pronounceable nonwords as lexical entries as compared to their tendency to initialize lexicalization of non-pronounceable nonwords. This would be reflected as inhibition when comparing the latencies of the pronounceable nonword target items between session one and session two. The non-pronounceable target items should exhibit a repetition priming effect.

**Grammatical Category: Noun vs. Verb**

Another factor that may influence the instantiation process is the grammatical category of the target item. Both nouns and verbs are open-class items; one of the features of open-class items is that new items are easily created by speakers of the given language, whereas new closed-class items are rarely created by speakers. Thus, all non-word targets in the experimental conditions
were presented in either noun frames or verb frames. This factor is assigned between groups; half of the participants in the experimental condition saw the target nonword in noun frames, and the other half of the participants saw the target items in verb frames. Whether or not this factor will have an effect is an open question.

If we consider linguistic theories of the lexicon that allow for extensive syntactic information to be specified in a given lexical entry (for example, Lexicalized TAG, Joshi, 1975, Schabes, Abeillé, and Joshi, 1988; Minimalist Program, Chomsky, 1993; Neominimalist Program, Jackendoff, 1996), then we might suggest that a verb, in a sense, requires more syntactic information for it to establish its syntactic specifications in the lexical entry. The basic syntactic structure specified for nouns is not very extensive and specifies comparatively few features (person, number, etc.). On the other hand, verbs must specify the number and types (theta-roles) of their objects, which one might take to mean that verbs lay out the basic syntactic framework for the entire sentence (see especially Lexical TAG, IRCS Report, 1995).

The above evidence leads us to two alternative positions concerning the outcome of this manipulation. On one hand, the fact that nouns require less syntactic information in their lexical entry might mean that in terms of syntax, nonwords that appear as nouns in a sentential context might be easier to lexicalize. There would be less information to encode for nonwords that appear as nouns, and it is possible that there may not be enough experience with the nonword in its verbal context to glean the necessary subcategorization information. In contrast, if the subcategorization information for the verb does begin to register significantly, there would then be more syntactic information overall instantiated for verbs as compared to the syntactic information for nouns. This increase in overall syntactic activation might lead to a higher probability of participants' exhibiting signs of lexicalization of the nonwords when they appear as verbs in the sentential contexts.

**Semantic Context: Context-Rich vs. Context-Poor**

The final factor manipulated in this experiment is a contrast in the semantic strength of the sentential context. The nonword targets were presented in either a 'context-rich' condition or a 'context-poor' condition. To qualify as a context-rich condition, the sentence in which the letter string appears must sufficiently restrict the semantic field such that there is a small set of possible meanings for the given letter string. In the context-poor condition, there are many various possible
meanings available for the nonword string. In a sense, the context-rich sentences allow the
nonwords to be classified into a narrow category of a semantic network. The context-poor
sentences only supply enough semantic information to place the nonwords that appear within them
into a very broad category, which suggests that the semantic activation for these strings is much
less focused than the activation for nonwords that appear in context-rich sentences. If this
characterization is correct, then nonwords that appear in context-rich contexts should be more
likely to exhibit early signs of lexicalization since participants are more likely to have associated a
specific meaning with these strings. Thus there should be greater latencies and less accuracy in
lexical decision for nonword targets that were presented in rich contexts as compared to those that
were presented in poor contexts.

In the past, it has been demonstrated that the contextual information provided by a letter
string can influence the speed of lexical decision (Coltheart, 1978; James, 1975), however these
approaches assume that the retrieval of semantic information for the purposes of lexical decision is
under the participants' control. This means that participants can selectively utilize semantic
information to perform lexical decision, and their choice to do so depends upon the proportion of
occasions during the task on which adopting such a strategy is useful. For the purposes of the
current investigation, this might mean that since the pronounceable target items look and sound like
English words, participants cannot rely on familiarity in terms of orthographic and/or phonological
information to perform the lexical decision on these items. The lexical decisions will be based on a
combination of orthographic, phonological, syntactic, and semantic factors. Thus, although
semantic information usually does not play a role in lexical decision tasks, the differing contexts of
the target items will be reflected in terms of slower reaction times and a greater number of mistakes
for target items that appear in rich contexts, as compared to those that appear in poor contexts.

To summarize, this study examines how the manipulation of phonological, syntactic, and
semantic variables, as well as manipulation of the type of repetition, affect the creation of new
lexical items. The predictions are that there will be greater latencies and less accuracy for lexical
decision for pronounceable nonwords that appear in context-rich sentential contexts during the
learning sessions of the experiment. At this point, I am uncertain as to the effects of grammatical
category on the ability to lexicalize letter strings. In the following section, I will explain the
procedure and stimuli used in the current investigation in greater detail.
Method

Participants.

23 undergraduates enrolled in an introductory psychology course at Swarthmore College participated in the experiment for credit. 20 participants were native speakers of English, and 3 were non-native English speakers.

Procedure.

The experiment consisted of two sessions separated by a span of 24-72 hours. In the first session, participants were asked to perform a baseline lexical decision on the entire list of 128 items. After they completed this task, participants in the experimental conditions were instructed about a learning session, where the target items were presented within a sentential context. The second portion of the experiment began with a repeat of the same learning session performed during the first session, followed by a second lexical decision task, that also required a judgment of the 128 items. The participants were split into groups of 8 (control group), 8 (noun group), and 7 (verb group). The control group did not participate in the learning sessions; they merely performed the baseline lexical decision task during the first session, and then returned to repeat the lexical decision task in the second session. The noun group participated in all aspects of the experiment; however, they saw the target items only in sentences where the items were used as nouns. The verb group saw the target items in sentences where the items were used as verbs.

For the two lexical decision portions of the experiment, the 128 items appeared in a randomized order. The items were displayed on an IBM monitor in a white-on-black format. All items appeared in lower case. The participants were informed to respond as quickly and accurately as possible for this portion of the experiment. The participants were supplied with a small box with two push-buttons, the one on the left labeled 'YES', the one of the right labeled 'NO'. The participants were told to respond ‘YES’ with the left thumb if the string was a word, ‘NO’ with the right thumb if the string was not a word. A plus appeared in the center of the screen at the start of the trial, and the participant caused the next string to appear by pressing the space bar when he/she was ready for the next word. There was a break after 64 of the strings were presented. Along the way, the participant could take a rest merely by pausing before pressing the space bar when the plus appeared in the middle of the screen. The lexical decision portion of the experiment lasted
approximately 10 minutes.

For the learning session portions of the experiment, the sentences were printed on 3 x 5 in. index cards in a New York font, size 24. The cards were shuffled before each learning session for each participant to ensure a randomization of order. Each sentence was presented for the participant's viewing for ten seconds, after which time the participant was asked to rate the sentence on its comprehensibility. The participants were provided with delineated sheets and a pencil with which to record the comprehensibility. Comprehensibility was rated on a scale of 1-7, with the following gradient: 1- highly incomprehensible, 2- mildly incomprehensible, 3- slightly incomprehensible, 4- neutral, 5- slightly comprehensible, 6- mildly comprehensible, and 7- highly comprehensible. The participants were informed that speed of response was not a critical factor in this portion of the experiment. Both groups of participants that took part in the learning session saw only 48 sentences, half of which were context-rich sentences, the other half context-poor. One group saw sentences that contained the items as nouns, the other saw sentences that utilized the items in a verb position. Each learning session lasted approximately 15 minutes.

Stimuli.

Letter Strings. In total, there were 48 target letter strings used in this experiment. The letter strings were divided equally among pronounceable nonwords, non-pronounceable nonwords, and actual English words. To classify as pronounceable nonwords, the 16 items had to have a pronunciation that is consistent with the phonotactic constraints on words in the English language, however, the items had to be sufficiently different from any existing English word so as not to be confused with that word (for example, pseudohomophones such as *wheet* were excluded). The 16 non-pronounceable strings were constructed by putting together consonant and vowel sequences that do not follow the phonotactic constraints of English. The 16 words exhibit a wide range of frequencies; in addition, each word can be used as either a noun and a verb in a normal discourse. The three different types of strings were matched for first letter and length, so if *bont* is the pronounceable nonword, then *bgnl* and *bend* are the corresponding non-pronounceable nonword and the actual word, respectively. For each item on the target list, there was a corresponding item that was matched to it on length and first letter. Thus, using the example mentioned above, *belm* is matched to *bont*, *bdrr* is matched to *bgnl*, and *boss* is matched to *bend*.

These 96 strings, along with 32 other real words of varying lengths and frequencies,
appeared in the lexical decision tasks that were performed in both sessions of the experiment. The other 32 words were added in order to obtain a 1:1 ratio of 'YES' and 'NO' responses during lexical decision. The letter strings ranged in length from 4-7 letters, with an average string-length of 5.19. See Appendix 1 for a listing of the 128 strings presented in this experiment.

Sentences. The 48 target items described above each appeared in two sentences, for an overall total of 96 sentences. In one sentence, the item was used as a verb, in the other, it was used as a noun. The sentences were also divided between context-rich sentences and context-poor sentences; if the item appeared as a verb in a context-rich sentence, then it consequently appeared as a noun in a context-poor sentence. A sentence qualified as context-rich if the meaning of the sentence was such that it greatly narrowed the range of possible meanings for the target item. Context-poor sentences, on the other hand, allowed for a wide range of possible meanings for the target items. All the target items appeared in the sentences without inflectional morphology. All of the items, when being used as nouns, appeared either as the object of a verb, or the object of a preposition, in order to approximately match the position of the item when it appeared as a verb in the other sentences.

The sentences ranged in word length from 7 - 32 words, with an average length of 10.46 words for context-poor sentences and 19.23 words for context-rich sentences. Measures were taken to ensure that no nonword target item appeared in a sentence that suggested the meaning of a valid word that might be similar in orthography or phonology to the nonword target. All of the sentences were constructed by the experimenter. Refer to Appendix 2 for a list of the sentences that were utilized throughout the learning sessions of this experiment.

Results

Mean reaction times were computed for the correct responses for all item types and every experimental condition. An analysis of variance was performed for the mean reaction times. Words and nonwords were analyzed separately. Outliers were determined on an individual participant basis to be any reaction time that was 2.5 standard deviations above or below the mean. The independent variables were session (1 and 2), group (control, noun, or verb), item type (word, pronounceable nonword, and non-pronounceable nonword), and target type (target or
matched). The last two variables were within subject manipulations. The results of the analysis appear in Table 1. The degree of facilitation/inhibition was also computed. These results appear in Table 2. The discussion of the different independent variables is based upon the data for the nonword trials only.

Table 1. Mean reaction times for lexical decision (in ms).

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th></th>
<th>Noun</th>
<th></th>
<th>Verb</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target</td>
<td>Matched</td>
<td>Target</td>
<td>Matched</td>
<td>Target</td>
<td>Matched</td>
</tr>
<tr>
<td>S1</td>
<td>S1 S2</td>
<td>S1 S2</td>
<td>S1 S2</td>
<td>S1 S2</td>
<td>S1 S2</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>545 536</td>
<td>542 538</td>
<td>595 595</td>
<td>618 629</td>
<td>545 541</td>
<td>547 548</td>
</tr>
<tr>
<td>PW</td>
<td>770 672</td>
<td>696 669</td>
<td>828 758</td>
<td>796 726</td>
<td>774 700</td>
<td>713 644</td>
</tr>
<tr>
<td>NW</td>
<td>564 535</td>
<td>560 542</td>
<td>672 610</td>
<td>624 596</td>
<td>577 558</td>
<td>582 535</td>
</tr>
</tbody>
</table>

Note. S1 = session 1, S2 = session 2, W = word, PW = pronounceable nonword, NW = non-pronounceable nonword.

Table 2. Interference effect (S2 - S1) between session 1 and session 2 (in ms).

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th></th>
<th>Noun</th>
<th></th>
<th>Verb</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target</td>
<td>Matched</td>
<td>Target</td>
<td>Matched</td>
<td>Target</td>
<td>Matched</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S1 S2</td>
<td>S1 S2</td>
<td>S1 S2</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>-9</td>
<td>-4</td>
<td>0</td>
<td>+11</td>
<td>-4</td>
<td>+1</td>
</tr>
<tr>
<td>PW</td>
<td>-98</td>
<td>-27</td>
<td>-70</td>
<td>-70</td>
<td>-74</td>
<td>-69</td>
</tr>
<tr>
<td>NW</td>
<td>-29</td>
<td>-18</td>
<td>-62</td>
<td>-14</td>
<td>-19</td>
<td>-47</td>
</tr>
</tbody>
</table>

Note. W = word, PW = pronounceable nonword, NW = non-pronounceable nonword. + = facilitation, - = inhibition.

In terms of repetition, I predicted that there would be an interaction between target type and session. The prediction was that the decision latencies would be greater for nonwords that appeared in sentences (target) than for nonwords that did not appear in sentences (matched). There was no interaction between target type and session \[F(1,39) = 1.16, p = .29\], however, there was a marginal session effect \[F(1,39) = 2.35, p = .13\]. The response times were faster in the second session across nonword items (see Tables 1 and 2). This most likely reflects a repetition priming effect. There was also a significant effect of target type \[F(1,39) = 15.09, p < .001\]. All target
nonword items were slower than matched items across sessions and groups (see Table 1). This result was unexpected.

The second factor that was investigated was item type (PW and NW). The prediction was that target items of type PW would exhibit inhibition from session 1 to session 2, and NW would exhibit facilitation (i.e., there would be an interaction between session and item type). A significant effect of item type $[\pi(1,39) = 87.89, p < .001]$ was found across sessions. Response times for NW were faster than those for PW. This is a standard result. There was no interaction between session and item type $[\pi(1,39) = 1.15, p = .29]$. The difference in reaction times between session 1 and session 2 showed that there was a greater effect of facilitation for PW as compared to NW, although both exhibited facilitation (see Table 2).

The next factor considered was group, or grammatical category. There was no specific prediction made for this variable. A marginal group effect was found $[\pi(1,39) = 2.02, p = .14]$. The noun group exhibited slower reaction times than both of the other groups (the verb group and the control group). This provides some minimal evidence that nonwords that appear in noun frames are being processed differently than nonwords that appear in a verb frame.

The final factor that was considered was the richness of the context in which the nonword target items appeared during the learning sessions. The mean reaction times with respect to context appear in Table 3, and the values for the degree of facilitation/inhibition appear in Table 4.

Table 3. Mean reaction times with respect to the independent variable, context (in ms).

<table>
<thead>
<tr>
<th></th>
<th>Noun</th>
<th></th>
<th>Poor</th>
<th></th>
<th>Verb</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rich</td>
<td>S1</td>
<td>Poor</td>
<td>S1</td>
<td>Rich</td>
<td>S1</td>
</tr>
<tr>
<td></td>
<td>S2</td>
<td></td>
<td>S2</td>
<td></td>
<td>S2</td>
<td></td>
</tr>
<tr>
<td>PW</td>
<td>855</td>
<td>726</td>
<td>801</td>
<td>791</td>
<td>752</td>
<td>710</td>
</tr>
<tr>
<td>NW</td>
<td>654</td>
<td>627</td>
<td>690</td>
<td>594</td>
<td>585</td>
<td>574</td>
</tr>
</tbody>
</table>

Note. S1 = session 1, S2 = session 2, PW = pronounceable nonword, NW = non-pronounceable nonword.
Table 4. Interference effect (S2 - S1) between session 1 and session two (in ms).

<table>
<thead>
<tr>
<th></th>
<th>Noun</th>
<th>Verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rich</td>
<td>Poor</td>
</tr>
<tr>
<td>PW</td>
<td>-129</td>
<td>-10</td>
</tr>
<tr>
<td>NW</td>
<td>-27</td>
<td>-96</td>
</tr>
</tbody>
</table>

*Note.* PW = pronounceable nonword, NW = non-pronounceable nonword. + = facilitation, - = inhibition.

The results showed that context affects the degree of priming differently in different conditions. There were marginal interactions between session, item, and context across groups \(E(1,24) = 2.99, p = .10\), and between session, group, item, and context \(E(1,24) = 3.25, p = .08\). The first interaction shows that there was a greater facilitation for PW that appeared in rich contexts, as compared to those in poor contexts (PW in rich context = -85ms, PW in poor context = -36ms). The second interaction shows that there was greater facilitation for PW that appeared in noun frames in rich contexts than for PW that appeared in verb frames in rich contexts. The opposite pattern is the case for NW; NW that appear in noun frames in poor contexts have a higher degree of facilitation than NW in noun frames in rich contexts (see Tables 3 and 4). The context difference in the verb group was not significant.

**Discussion**

Evidence of repetition priming dominated the results of the current investigation. Participants exhibited facilitation from session one to session two for every letter string of every type, across grammatical category and context. The effects of repetition priming almost completely masked the effects of any of the distinctions that I attempted to investigate: phonology, grammatical category, and semantic content of the letter string. However, some marginally significant results were attained for context and grammatical category. Although I obtained the classic result that non-pronounceable nonword strings exhibit faster lexical decision times than pronounceable nonword strings, I also found that pronounceable nonwords showed a greater facilitation effect between sessions than non-pronounceable nonwords. In addition, I found a marginally significant effect of grammatical category; nonwords that appeared in noun frames
exhibited slower lexical decision times than those that appeared in verb frames. In terms of context, the results indicated that pronounceable nonwords that appear in rich contexts exhibit a greater facilitation effect for lexical decision than those that appear in poor contexts. Finally, for pronounceable nonwords that appeared in rich contexts, those that were in noun frames exhibited greater facilitation than those that were in verb frames.

The results seem to suggest that my original predictions were flawed. I had predicted that pronounceable nonwords would exhibit a greater tendency to initialize the lexicalization process than non-pronounceable nonwords by exhibiting inhibition in the lexical decision task from session one to session two. Additionally, I had predicted that target nonwords that appeared in rich contexts would be more likely to exhibit inhibition than target nonwords that appeared in poor contexts. However, the reverse of these predictions was found; pronounceable nonwords exhibited greater facilitation from session one to session two than non-pronounceable nonwords, and nonword targets that appeared in rich sentential contexts displayed more facilitation from session one to session two than nonword targets that appeared in poor contexts. In what follows, I will discuss the relevance of possible oversights in the experimental design to the overwhelming repetition priming effect that was found. I suggest that errors in the experimental design might be the cause of the repetition priming effect that was demonstrated in the current investigation. Thus, the original predictions might not necessarily be wrong. I will then discuss each of the original predictions in turn in light of the results of the current investigation.

**Questioning the Experimental Design**

I have surmised that the practice effect evidenced by the results of this experiment derived from errors in the experimental design. The main error that I committed was an underestimation of the strength of repetition priming. To allow for a strict control on the measures of interference from session one to session two for the target items, these items appeared in both the baseline and experimental lexical decision task. What I did not take into account is the fact that I was going to then attempt to persuade participants, through the learning sessions, to change their minds about the word/nonword categorization of the letter string. Thus, after responding ‘NO’ to the target nonwords during the baseline lexical decision task, participants saw these nonwords in sentences. The prediction was that seeing the target nonwords in sentences would facilitate their becoming
instantiated as lexical items. However, having just tagged the letter strings as nonwords in the baseline lexical decision task, it is unlikely that the participants would have changed their minds about the word/nonword categorization of the letter string as a result of seeing the nonwords in sentential contexts. In terms of the experimental results, this effect appeared as facilitation in the lexical decision task from session one to session two. Another side to this issue is that because the two parts of each session were completely identical (just in reverse order), participants quickly become aware that it was the same task. In any experimental condition were the same task is repeated, one should expect to see repetition priming dominating the results.

Another possible error in experimental design is the fact that the same set of sentences was used for both learning sessions. At the very least, seeing the target words in the same sentences during the second learning session served to further emphasize their dissimilarity to real words and increase the repetition priming effect. It is also possible that upon recognizing that the first few sentences in the second learning session are the same as they had seen in the first learning session, the participant may not even process the sentences as they would process novel sentences presented to them in normal conditions. The participant might simply read the first few words, recognize the sentence, and assign it a comprehensibility value similar to what they remember having given the sentence in the first session.

A Reconsideration of the Predictions

As a result of the oversights in design discussed above, the effect of repetition priming does not allow for a close examination of the lexicalization process. However, the results do suggest that manipulations of the various factors did affect the repetition priming pattern. The factors that were expected to facilitate the lexicalization of a nonword string only served to strongly mark those target items in those conditions as nonwords. If participants had not seen the target nonwords in the baseline lexical decision task and had not already decided they were nonwords, then it is quite possible that the factors might work as predicted and serve to assist in the lexicalization of the nonwords. Thus, I still strongly believe that these factors contribute to the lexicalization process in the manner I had predicted at the beginning of this study. I will now review each of these factors in light of the findings of the current investigation.
**Repetition:**

The first prediction dealt with the effects of priming on lexicalization. I predicted that nonword targets that appeared in sentences would exhibit inhibition, and the matched items (that did not appear in sentences) would show facilitation. The results indicated facilitation for all nonword items, including both target and matched items. Again, the main reason for this pattern of results is the repetition priming effect generated by the experimental design. The design was not conducive to inducing the initial stages of lexicalization for the target items, and hence, I did not find inhibition for these target items in the second lexical decision task. In fact, the design led participants to store the nonwords in memory specifically as nonwords. Every factor that would normally be used to establish a letter string as a word and make it memorable as such, in combination with the repetition of the target items, further emphasized the fact that the letter strings were nonwords. Then, the fact that the string was a nonword was particularly memorable, although this fact was stored in another part of memory, separate from the lexicon.

**Phonology:**

The second prediction was that participants would be more likely to initialize the lexicalization of pronounceable nonword targets than the lexicalization of non-pronounceable nonword targets. This would appear in the results of the investigation as an inhibition effect for the pronounceable nonwords for the lexical decision task from session one to session two, while non-pronounceable nonwords would either produce no interference effect, or perhaps facilitation. The results showed that pronounceable nonwords exhibited a greater facilitation effect than non-pronounceable nonwords, the exact opposite of the effect that I predicted. The primary explanation for the disparity in facilitation effects for pronounceable and non-pronounceable target items is simply that the non-pronounceable target items were almost at the limit of how fast participants can respond ‘NO’ in a lexical decision task. This means that there was less room to improve on reaction time in the case of the non-pronounceable nonwords. This effect is even more apparent in the case of the response times to the actual words in this experiment; little or no repetition priming effect was apparent in the results for words since the baseline reaction times were close to the upper bound on how quickly the lexical decision can be made. Another possible explanation for why pronounceable nonwords exhibited a greater facilitation effect is that given the fact that they
are pronounceable, it makes the letter strings easier to remember than the non-pronounceable nonwords. The participants remember the pronounceable nonwords in association with the fact that they are nonwords. Making the lexical decision, then, is simply a matter of reproducing the association that the given letter string is not a word. The association that the letter string was a nonword was most likely stored in episodic memory as a result of the baseline lexical decision task; the association was reinforced during the learning sessions.

**Grammatical Category:**

The effect that grammatical category might have had on the lexicalization of the target strings was an open question. The results suggest that nonword items that were presented as nouns appeared to be processed differently than verbs in that the targets in the noun group exhibited slower reaction times than those in both the verb group and the control group. There are two possible interpretations of this result. First, one might say that the targets that appeared in noun frames were more resistant to the effects of repetition priming. This could be taken as evidence that nonwords that appear in noun frames are more likely to become lexicalized than nonwords that appear in verb frames. On the other hand, going along with our practice effect explanation, it is possible that the verb frame was a more salient condition for lexicalization, and hence, the nonwords that appeared as verbs were more marked as nonwords than those that appeared in noun frames. One might postulate that given the right experimental conditions, the increased grammatical activation provided by the verb frame condition might result in signs of lexicalization for the nonword target items.

**Context:**

The final prediction I made was that nonword target items that appear in rich contexts would exhibit greater inhibition than those that appear in poor contexts. The results indicated that there was greater facilitation for pronounceable nonword targets in rich contexts compared to those that appeared in poor contexts. This result has two related interpretations. The first interpretation is that the narrow meaning for the nonword provided by the rich sentential context is in a sense too constricting. It is possible that participants are less likely to accept a nonword as a word if its meaning is well-defined, since participants have either high activation for an actual word with the
same or a similar meaning, or if there is not a word associated with that meaning, find it highly unlikely that there would be any word at all with that meaning. The second possibility follows the general picture of the repetition priming effect that I have been developing. The richer the surrounding context, the more a letter string that had been previously identified as a nonword will stick out as a nonword. The rich context emphasizes a particular meaning, and strongly suggests that the spot where the nonword is located should contain a content word of English. Since the target letter string has been identified as a nonword, and is established as such in memory, the rich context only serves to further distance the letter string from what would be its lexicalized counterpart.

**Future Work**

The main focus of future work should be on solving the problem of the repetition priming effect so that the factors that may affect the process of lexicalization can be investigated more thoroughly. There are several ways to accomplish this. Changes to the current design range from a simple removal of the target items from the baseline task, to a complete revamping of the conditions and intentions of the learning sessions. In this last section, I will discuss the various changes that could be made, and how these changes might shed light on both the predictions of the current investigation, as well as the theoretical issues of lexicalization that were discussed in the introduction of this paper.

The simplest design change would require the removal of the target items from the lexical decision task. Lexical decision on the matched items would provide enough of a baseline measure to which to compare the lexical decision times for the target items in the lexical decision task during session two. Thus, removing the items would eliminate the bias on the target items that causes them to become increasingly marked as nonwords throughout the remainder of the experiment.

Another way of attempting to remove the repetition priming effect from the current experimental design would be to alter the nature of the final task that is used to measure the signs of lexical instantiation of the target items. One way to measure whether or not a word is beginning to become established as a lexical entry is to test whether or not it has a meaning at least loosely associated with the orthographic representation. To gain a measure of the amount of semantic information associated with a given letter string, a semantic priming task can be used. The
The semantic priming task is composed of two parts. First, a letter string (the prime) appears on the screen for a short period of time. After the prime disappears, the target word appears and the participant is required to either name the target or perform a lexical decision for the target. Meyer and Schvaneveldt (1971) have shown that response times for targets are faster when the prime is semantically related to the target item.

In the case of the current investigation, consider the meaning of the nonword target *bont* in the following sentence:

(1) The chef added three teaspoons of *bont* to the exotic chicken dish.

During the semantic priming task, one might predict that participants would be faster to respond to the target *spice* when it is primed by *bont* (which can be understood to mean some sort of spice, given the context of the sentence), than if it were primed by some string, word or nonword, that is completely unrelated to it. In addition, the response time to the nonword *bont* could be measured when it is preceded by the semantically related *spice*, and when it is preceded by an unrelated item such as *dog*. It is possible that different effects might result when *bont* appears as the target and when it is used as the prime. Evidence of semantic priming for the targets in a semantic priming task would indicate that the nonword letter strings being used as either primes or targets are exhibiting signs of becoming lexicalized.

The semantic priming task is also interesting in light of the assertions of Coltheart (1978), where he suggests that the use of semantic context during lexical decision is not automatic, that it depends upon the number of times during the task that the use of such information is helpful. In judging the pronounceable nonwords during the lexical decision task, the unfamiliarity of the orthographic representation may be enough to classify the strings as nonwords, although the processing of pseudowords is a case that Coltheart (1978) cites as a condition where the use of semantic information proves to be beneficial. However, in the case of the non-pronounceable nonwords, the semantic information given to the target items through the sentential contexts probably does not play a role at all in the standard lexical decision. The lexical decision task alone does not measure, then, the semantic associations of the illegal strings, if they do in fact exist. Utilizing the lexical decision task as part of a semantic priming task may be a better measure of the associations of meanings with orthographic representations that might have been established during the learning sessions. It is likely that the fact that pseudowords are pronounceable makes them
more memorable than illegal strings (they can be rehearsed in the phonological loop of working memory), and hence makes it easier to remember the meanings that were associated with the pseudowords during the learning sessions.

To enhance the worth of the investigation, I could also make changes to the learning portions of the experiment. As mentioned earlier, part of the priming effect might have arisen from the fact that the learning sessions were completely identical; the sentences were exactly the same for both sessions. An easy modification would be to change the sentences for the second learning session such that the context suggests the same meaning as the sentences that were used in the first session. Because the sentences are new, participants would have to read and process the entire sentence, including the nonword target, a second time, emphasizing the intended meaning in a slightly different fashion. Thus, the meaning for the nonword target might be even more salient after having seen it in two different sentences.

The second possibility for changing the learning sessions is a bit more drastic. Instead of having the targets appear in sentences, the targets would appear in substantial, natural discourses, where it is possible that the nonword item might blend in more within the greater context of a discourse. Generally, when one comes across unfamiliar lexical items, it is in the course of reading longer passages rather than individual sentences outside of a greater context. Thus, having the target strings appear in a discourse seems to be a more natural circumstance for the learning of new words than seeing them in individual sentences. Not only is the discourse setting a more natural circumstance for learning new words, but in addition, the global context of the discourse might provide more activation for the meaning of the nonword, more than the context of the sentence could provide. There is evidence that global context that is related to a target word that appears at the end of the passage speeds lexical access for that word, as compared to lexical access when the word is at the end of a single sentence (Hess, Foss, and Carroll, 1995). Thus, it is possible that there would be a greater chance that the nonword targets would begin lexicalization when they appear in a larger discourse, as opposed to when they appear in single sentences only.

An additional aspect of this change from single sentence to discourse context could include presenting the experimental discourses to participants outside of the laboratory session. The experimenter could relay to the participants that the reading of the discourses is part of a different experiment, and the participants could be made to answer questions appropriate to the discourses to
ensure that they have read and processed the discourses. Each participant would read maybe 8 passages. Each passage would be approximately two paragraphs long, and would contain at most three target strings. The questions would be comprehension questions similar to those that might appear on a standardized test, while the topics of the discourses would range from anything to specific events to discourses describing a particular cooking method or kind of animal. Conducting the learning session (there would be only one, most likely) in this manner would separate the nonword/word judgment from the reading comprehension task. In this manner, participants are not primed to be judging the nature of the questionable letter strings within the discourses.

**Dr. Seuss and Lexicalization**

The proposal to present nonwords within the level of discourse is reminiscent of my original observations about the Dr. Seuss passage presented at the top of this paper. The manner in which nonwords are presented and processed within the text of many Dr. Seuss stories leads to several interesting questions about theoretical issues of lexicalization. Consider what would happen if the participants in this experiment had been presented with Dr. Seuss excerpts instead of the sentential contexts. Would the reaction times for the nonword target items within the Dr. Seuss excerpts be any different than the reaction times for the nonword target items presented in the sentential contexts used in this experiment? Nonwords in Dr. Seuss stories often vary in terms of pronounceability (some strings are more pronounceable than others), nonwords appear in both noun and verb frames, and the semantic context ranges from explicit definitions (‘rich’ contexts), to contexts that only implicitly suggest a broad meaning for the nonword (‘poor’ contexts). It appears that the experimental condition is very similar to the Dr. Seuss stories.

Clearly, we can comprehend the nonwords within Dr. Seuss stories with relative ease. Are these nonwords in the process of establishing lexical entries? I can describe what the string *warnel* means, its part of speech as it is used in the passage, and I can pronounce it, and at the same time, I will also report that *warnel* is not a word. Where is *warnel* stored in memory? The main question is whether or not *warnel* has a lexical entry. Is there a mechanism that prevents nonwords such as *warnel* from forming a lexical entry, even after it has been provided with all of the supporting linguistic information? It is reasonable to question whether or not there is an
inherent difference between a nonword such as wamel, and an extremely low frequency word such as junket, which most English speakers would not recognize as a word. I question the existence of a rigid distinction between words and nonwords. Along these lines, it is also interesting to ponder whether or not the degree of lexicalization of a letter string should be measured on the basis of comprehension only. How does the likelihood of the string to be used in productive speech reflect the degree to which a letter string is lexicalized?

At the most basic level, I have been questioning the nature of the linguistic environment that can encourage the lexicalization of letter strings. It is possible that in addition to the phonological, syntactic, and semantic features discussed in this paper, there is a pragmatic side to this issue. There seems to be something crucial to the lexicalization potential of a given nonword that has to do with the likelihood that a new word might appear in the surrounding context. For example, anyone familiar with Dr. Seuss recognizes that he utilizes nonwords continually in many of his stories. It might not seem usual to read wamel in the context of Did I Ever Tell You How Lucky You Are?, but it would seem strange if wamel appeared in the context of a popular adult fiction novel (unless the novel dealt with fantastical objects or inventions of some sort). Can the pragmatic context determine the flexibility of the lexicon? Is it the lexicon that is demonstrating flexibility, or is it some other aspect of cognition? What cognitive or linguistic mechanism might one propose that would allow the pragmatic situation to have such an effect? This issue remains to be explored.

Summary

The purpose of this experiment was to explore how various linguistic factors, such as phonology, grammatical category, and semantics, influence the speed of lexicalization of novel letter strings. At the outset, I described various theories of lexical representation and processing that might be useful as background to support such an investigation. Through the use of the linguistic factors as independent variables, I attempted to produce empirical evidence to support my predictions that pronounceable nonwords presented in rich contexts during two learning sessions would exhibit signs of implicit learning, measured by means of a lexical decision task. The results indicated an overwhelming effect of repetition priming across experimental conditions. There were, however, some marginally significant effects of grammatical category and context, even
though interpreting these results in a way that reflects upon my original predictions is not possible with the current data. Therefore, there seems to be something valuable in the contrasts investigated in this paper. I also discussed various ways of altering the current experiment to probe the issue of lexicalization in perhaps a more telling manner. With these modifications, I might arrive at data that would better allow me to return to the lexical theories presented in the introduction of this paper and analyze the results in light of these theories.

Studying the process of lexicalization has proven to be a complicated endeavor, although I feel that investigating this process more extensively could prove to be very fruitful. Throughout the course of this study, I have discussed the specific factors that may have an impact on the speed of lexicalization of letter strings. The current investigation has provided some evidence that the phonology, grammatical category, and semantics of a letter string can have some effects on the way in which the string is processed. Discovering a more precise relationship between these factors and the lexicalization process may possibly lead to insights about the information, and the connectivity of the information, that is stored in a lexical entry. It might also provide further insight into the nature of lexical processing in terms of the order in which the different types of information are accessed and utilized during the processing of a given lexical item. An additional aspect of this kind of investigation is the implications it has for the nature of the boundary between what is a word and what is a nonword. Slower response times and less accuracy in the lexical decision task for nonword targets that have appeared in a sentential context may indicate that these letter strings have begun the process of lexicalization. This suggests that the lexical status of the nonword target items lies somewhere between the strict classifications of word and nonword. At the heart of this study is the desire to provide some initial answers to the seemingly insurmountable question of what it means for a letter string to be stored in memory as a word.
References


Appendix 1

<table>
<thead>
<tr>
<th>PSEUDOWORDS</th>
<th>WORDS</th>
<th>ILLEGAL STRINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Matched</td>
<td>Target</td>
</tr>
<tr>
<td>bont</td>
<td>belm</td>
<td>bend</td>
</tr>
<tr>
<td>clore</td>
<td>crent</td>
<td>chart</td>
</tr>
<tr>
<td>dask</td>
<td>dush</td>
<td>dial</td>
</tr>
<tr>
<td>frestral</td>
<td>fentran</td>
<td>fashion</td>
</tr>
<tr>
<td>goller</td>
<td>gamper</td>
<td>glower</td>
</tr>
<tr>
<td>handle</td>
<td>herent</td>
<td>hammer</td>
</tr>
<tr>
<td>jope</td>
<td>jide</td>
<td>jail</td>
</tr>
<tr>
<td>keef</td>
<td>kith</td>
<td>kick</td>
</tr>
<tr>
<td>ludge</td>
<td>lenge</td>
<td>latch</td>
</tr>
<tr>
<td>mirst</td>
<td>manch</td>
<td>mount</td>
</tr>
<tr>
<td>neak</td>
<td>nowl</td>
<td>name</td>
</tr>
<tr>
<td>poove</td>
<td>preel</td>
<td>pound</td>
</tr>
<tr>
<td>ronk</td>
<td>rund</td>
<td>rain</td>
</tr>
<tr>
<td>spowl</td>
<td>sturch</td>
<td>scope</td>
</tr>
<tr>
<td>trave</td>
<td>trome</td>
<td>taste</td>
</tr>
<tr>
<td>whirt</td>
<td>wurve</td>
<td>waste</td>
</tr>
</tbody>
</table>

Appendix 2

**PSEUDOWORDS**

**NOUN TARGET, CONTEXT-RICH SENTENCES**

1. The chef added three teaspoons of BONT to the exotic chicken dish.
2. The secretary threw a DASK into the drawer, along with the other office supplies.
3. The department store manager decided to put the GOLLER on sale, since the public’s demand for that kitchen appliance was low.
4. The candlemaker used a JOPE to delicately carve the exquisite wax creation.
5. The little boy knocked a POOVE off the crystal store counter filled with figurines, clocks, and vases.
6. The society woman’s new earrings crafted from MIRST caused a stir at the last charity ball.
7. The bartender poured some WHIRT into the woman’s vodka drink to add some fruity flavor.
8. The governor signed a bill that outlaws the use of the SPOWL, along with several other automatic weapons.

**NOUN TARGET, CONTEXT-POOR SENTENCES**

9. The man put some CLORE in the shed.
10. The well-dressed man added a FRESTRAL to the display.
11. The young woman put the HUNDLE on the windowsill.
12. The waitress brought another KEFF to the table in the corner.
13. The man tossed a LUDGE into his truck.
14. The mother slapped some NEAK on the table top.
15. The technician stuck the RONK in the designated hole.
16. The dissatisfied woman returned the TRAVE to the corner store yesterday.
VERB TARGET, CONTEXT-RICH SENTENCES
17. The farmer will CLORE the soil in preparation for the spring planting of wheat.
18. The designer has to FRESTAL the scarf so that its color complements the color of the model's hair.
19. If one owns an African Violet, one must be sure to HUNDLE it three days a week before it is watered.
20. The waitress suggested that the dieting woman should ask the cook to KEEF the chicken, rather than fry it in oil.
21. The lumberjack plans to LUDGE the chopped timber in the back of his truck in neat rows of four.
22. The mother had to NEAK some mustard onto the sandwiches so that her finicky children would eat them.
23. The electrical engineer will RONK the connections between the wires so that they won't spark anymore.
24. The dissatisfied woman wanted to loudly TRA VE the man at the store for selling her a faulty product.

VERB TARGET, CONTEXT-POOR SENTENCES
25. The woman will BONT the pot before dinner time arrives.
26. The man had to DASK the papers before leaving the office.
27. The salesperson will GOLLER the sale item on Saturday.
28. The man has to JOPE the object after dipping it in the hot water.
29. The store was forced to POOVE the items last Thursday.
30. The woman hoped to MIRST at the party that was scheduled for next Friday evening.
31. The man had to WHIRT the drink so that it would not taste so bad.
32. The governor signed a bill that allowed people to SPOWL at any time of the day.

WORDS
NOUN TARGET, CONTEXT-RICH SENTENCES
33. The preoccupied driver was shocked to discover the sharp BEND in the road, even though there had been warning signs miles before the curve.
34. If you only want to lower the volume, turn the first DIAL to the left and leave the other knobs as they are.
35. The carpenter used a hammer to POUND the nail into the wood.
36. The murderer was put in JAIL for six years with no chance of contact with the outside world.
37. The prairie woman pushed the LATCH across the door since the wind was gusting and blowing it open constantly.
38. When I told you to give me a POUND of chicken, I meant exactly sixteen ounces, no more, no less.
39. With the use of a well-designed SCOPE, we were able to see clearly across the river to the other river bank.
40. The proud chef allowed his anxious clientele a small TASTE of the luxurious dinner that he was preparing for them by suggesting that they sample a small bowl of his delicious stew.

NOUN TARGET, CONTEXT-POOR SENTENCES
41. The professor showed the class the unemployment CHART from 1990.
42. The wealthy old woman purchased the latest FASHION.
43. The woman turned away from the GLOWER her husband was giving her.
44. The boy gave the ball a KICK that caused the ball to fall over the edge of the cliff.
45. The young man peered at the MOUNT from his lakeside window.
46. The gaunt woman would not tell me her NAME.
47. The bored woman stared out the car window at the RAIN.
48. The men were discussing how to dispose of WASTE.

VERB TARGET, CONTEXT-RICH SENTENCES
49. The statistician is going to CHART the results of the company's second quarter investments using a line graph.
50. As I watched the craftsman FASHION the ornament from a block of wood, I wondered how he could control his hands to make such delicate movements.
51. The bitter woman could only GLOWER at her opponent sitting nonchalantly on the porch, who was, by his towering victories, the original cause of the woman’s anger.
52. The mischievous child had tried to KICK the teacher in the shin, but the teacher quickly moved his leg out of the way of the child’s oncoming foot.
53. The cowboy attempted to MOUNT the horse, but as soon as he tried to get on top of it, it reared back on its hind legs.
54. When asked to NAME her new dog, the small child matter-of-factly said they should call the dog “My-dog”.
55. Despite the fact that much of our area is flooded, the weatherman predicts that it will continue to RAIN into early next week.
56. Her parents never allowed her to WASTE anything because they were too poor to throw anything away that had not been completely worn through.

VERB TARGET, CONTEXT-POOR SENTENCES
57. The student must BEND the tube at the appropriate time.
58. The frightened man forgot to DIAL the correct number.
59. The woman will HAMMER the metal before she polishes it.
60. The townspeople wanted to JAIL the man for his wrongdoings.
61. The old woman tried to LATCH the door.
62. The man told the woman she had to POUND to get into the house.
63. The captain decided that we should SCOPE out the area.
64. My mother suggested that I should TASTE the dishes on the table.

ILLEGAL STRINGS
NOUN TARGET, CONTEXT-RICH SENTENCES
65. When the doctor gave me BGNL for my bronchitis, I was hesitant to use it since strong antibiotics irritate my stomach.
66. Among the plants at the arboretum’s plant sale were young elm, DBGI, and oak trees.
67. The produce stand along route 3 specializes in the sale of strawberries, cantaloupe, GWTIIB, and apples.
68. Sometimes when we go fishing in Canada, we catch JMPQ, but usually we catch bass.
69. Last time I went to the dentist, she told me that LDWIP was beginning to build up on my teeth.
70. When I played my first game of PXOLQ, I had trouble hitting the ball with the thin stick.
71. On the surface of many of this harvest’s apples, there is a small RBWY, which mars the appearance of the apples and has made them very difficult to sell.
72. The emergency paramedic put a THNZG on the woman’s leg wound to stop it from bleeding.

NOUN TARGET, CONTEXT-POOR SENTENCES
73. The little girl ate CTZOL earlier, and now she doesn’t feel very well.
74. The children trampled through the FNUXRLL on their way to school.
75. The man bought HLBODW at the store yesterday.
76. The woman took some KVFO to her friend.
77. The farm sells MFILW, among other things.
78. The woman wore a NGTP to the lecture.
79. The wind blew the SEQZW against the wall.
80. The old woman dropped the WVUSL onto the floor.

VERB TARGET, CONTEXT-RICH SENTENCES
81. When I suggested that we boil the potatoes, my friend said that it would be more interesting to CTZOL them with onions and green pepper.
82. To prepare children to go out into the cold, you should FNUXRLL their hands and feet with warm mittens and socks.

83. The salesperson will very carefully HLBODW the woman’s computer in styrofoam before he ships it to her home.

84. The mother’s friendly neighbor offered to KVFO some brownies for her child’s school bake sale.

85. The dairy farmer will MFILW he milk to insure freshness for a longer shelf life.

86. The woman had to NGTP her hair so that her coworkers at the lecture would not recognize her.

87. The gusty wind caused the leaves to SEQZW around in circles in the air.

88. The old woman will only take about a week to WVSUL the yarn into a beautiful, warm blanket.

VERB TARGET, CONTEXT-POOR SENTENCES

89. The doctor decided to BGNL the patient with a cold.

90. The woman decided to DBGI the plant on a regular basis.

91. The woman had to GWTIIB the fruit before Saturday.

92. The old man will JMPQ some fish tomorrow.

93. The man in the white coat told me I should LDWIP my mouth at least once a day.

94. I tried to PXOLQ the ball, but I didn’t do it very well.

95. The tired woman forgot to RBWY the apples.

96. The man attempted to THNZG the cut.