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LEARNING NEW VOCABULARY WORDS: THE ROLE OF INHIBITION

By

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ABSTRACT

LEARNING NEW VOCABULARY WORDS: THE ROLE OF INHIBITION

By

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The possibility of an inhibitory center surround attentional mechanism aiding retrieval of newly learned vocabulary words was tested by examining priming effects in a lexical decision task. According to Dagenbach, Carr, and Barnhardt (1990) newly learned primes whose meanings are recognized but not recalled can lead to inhibition of related target words, whereas primes whose meanings are recalled facilitate related targets. The present experiments attempted to replicate these effects, and manipulated number of exposures to the new words to chart deployment of the attentional mechanism that supposedly produces them.

Results indicated that when primes were recalled facilitation occurred and when primes were unrecalled neither facilitation nor inhibition appeared in any systematic fashion. These experiments showed that facilitatory episodic priming was present in early learning and this priming depended on subjects being able to recall the newly learned meanings, but produced no evidence for center-surround inhibition in recalling them.

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INTRODUCTION

Episodic and semantic memory have long served to organize our ideas about how information is stored and retrieved from long term memory. Episodic memory is generally defined as memory for events that have occurred at a certain time and place whereas semantic memory is memory for general information about the world without the temporal-spatial context attached. Many argue over the reality of two separate stores in memory. Tulving (1972) defines the two as separate with different properties. Episodic memory stores specific events that happen to a person and semantic memory stores facts and general information about the world. Since this declaration from Tulving much research has been conducted trying to prove the existence of one memory store with episodic and semantic information being two points along a continuum (Ashcraft, 1989). Information in semantic memory was described by Ashcraft (1989) as being highly related and integrated and overlearned. This seems to suggest that if certain episodic information is overlearned and practiced it will begin to become integrated into semantic memory and will also behave like semantic information. We may then wonder how much exposure to information and practice does it take to integrate episodic memories into semantic ones. A criterion commonly used in the memory literature suggests that if words automatically prime semantically or associatively related words then the information is semantic in nature. It is a general phenomenon in the semantic priming literature that if a related word occurs before a target in a lexical decision trial, responses will be faster to the target than if it was preceded by an unrelated word (Meyer & Schaneveldt, 1971; Neely, 1991). Subjects will be faster to decide that butter is a word if it is preceded by bread rather than an unrelated word such as table. So, if automatic priming occurs in episodic memory then we could suggest that the information is integrated and part of semantic memory. From recent priming literature one may assume that priming is automatic when a 200 or 250 ms Stimulus Onset Asynchrony (SOA) separates the prime and target and facilitation still occurs from newly learned words that is approximately equal to the facilitation produced under the same conditions by old, well learned words.

Evidence of Priming from Newly Learned Information

Many researchers have attempted to find automatic priming with newly learned or episodic information. Neely (1977) told subjects that an instance from category A (body parts) would be followed by an instance from category B (buildings) in a primed lexical decision task. He wanted to see if automatic priming would occur if subjects expected these two types of stimuli to come together. Priming did occur, but only at a long SOA suggesting that strategies were coming into play and that the priming was not automatic as in semantic memory. McKoon and Ratcliff (1986) also tried to find automatic priming with newly learned information. They taught subjects new associations and then tested them to see if one member of the pair automatically primed the other member. McKoon and Ratcliff claimed that newly learned associations did in fact automatically prime each other in a lexical decision task. Durgunoglu and Neely (1987) reviewed various articles which had failed to find automatic priming in episodic associations. In their paper they attempted to systematically discover what parts of McKoon and Ratcliff's design were necessary to produce their results. They manipulated SOA, the use of nonwords in the study list and the episodic and semantic associations within the study list. They tried to replicate McKoon and Ratcliff's design and realized that they only found priming at short SOAs when subjects responded "word" when they saw a studied target and "nonword" when they encountered a nonstudied target creating a definite bias in responding. Episodic priming was found only when the episodic information was useful. The basic flaw in McKoon and Ratcliff's design lessens their claim of automatic priming in episodic memory.

It seems then that previous studies show that episodic associations are not very well learned and integrated with limited amounts of study. Dagenbach, Horst, and Carr (1990) were interested in just how much study of new information is necessary in order for it to become well integrated and automatically accessed. They were also interested in whether an association between two unrelated words or a new vocabulary word and its definition would be easier to integrate into semantic memory. In Experiment 1 subjects learned 24 unrelated word pairs by studying each of them for 30 s on the computer screen and then completing booklets where they were given one word of the pair and had to provide the other. They then did lexical decision trials with a 200 ms SOA in order to see if automatic facilitation occurred for the association. Although a small amount of facilitation did occur it was far from significant. They then did the same procedure but used new vocabulary words and their definitions as the episodic association. They thought that perhaps it would be easier to create a new association in memory rather than create one between two words that were already well established in memory and had associations of their own. In the lexical decision trials, the studied words served as the primes and the targets were either related words, unrelated, or nonwords. Surprisingly, when a studied prime was followed by a related word, a small amount of inhibition rather than facilitation occurred, although it was also not significant. The last two experiments were similar to the first two but study time was increased to a 5 week period with both vocabulary words and their definitions and unrelated word pairs. Automatic facilitation occurred in the lexical decision trials between the new vocabulary words and related words, but no facilitation existed for the previously unrelated word pairs that were studied. It seems that semantic memory can develop more easily from a new, meaningful association than from a link between two unrelated words in semantic memory, at least when the operation of semantic memory is assessed by way of a short SOA or automatic priming. Even for meaningful associations, however, development appears to be slow and effortful.

Retrieving Newly Established Codes

It is becoming quite obvious that episodic associations take a lot of over learning and practice in order to become well integrated in semantic memory. The question then becomes how do we retrieve information from episodic memory when the codes are quite new and weak? There seems to be a period of time when these codes get used but not automatically like information in semantic memory as in Neely (1977). Using this new information takes effort and attention. At this point it is important to focus on non-automatic priming, priming that occurs over a longer SOA, giving attention and other strategies time to activate the new weak code when it is in competition with stronger, related codes.

A few recent studies suggest that an attentional mechanism could be playing an important role in helping new codes beat out the competition and gain access into working memory. Dagenbach, Carr, and Wilhelmsen (1989) provided the first evidence for this attentional mechanism in their masked priming work. In masked priming the prime in the lexical decision trial is briefly presented and then a mask appears on the screen. The mask then disappears and the target appears. Most (though not all) researchers agree that masked visual primes can activate the meaning of the prime enough to have an effect on the target. The controversial issue is how long the prime must be presented before the mask in order for the prime to influence the target while still leaving the person unaware of the prime's identity. Therefore experiments of this type employ a psychophysical threshold-setting procedure to determine the prime-mask SOA that limits or prevents awareness. Then a set of primed lexical decision trials is run using prime-mask SOA's determined in the psychophysical threshold-setting procedure.

In this experiment Dagenbach et al. used different kinds of judgment tasks in the psychophysical threshold-setting procedure to determine prime-mask SOA's. They reasoned that even if the retrieval attempt of the masked prime fails, the effort of trying to obtain the prime could influence responding to the target. Dagenbach et al. (1989) believed that different threshold setting tasks require accessing different types of information about the prime and should affect the retrieval strategies and processing of the prime and subsequently the target. The subjects' first threshold task was to decide whether a blank field or a word was presented before the mask (detection task). Half of the trials that preceded the mask consisted of a word and half consisted of a blank field. Next, after the detection task, each subject performed a second threshold judgment task, representing one of three different variations of a word discrimination task. One variation (constrained detection) asked subjects whether a certain word (doctor) or a blank field was presented. Another (word-word discrimination) asked subjects which of two words was presented (for example, doctor or table). In a final variation of the threshold judgment called the semantic similarity judgment task, a prime word would be presented (doctor) and subjects would be asked which of two words was closer in meaning to the prime (nurse or table). Immediately after this second judgment task, subjects performed a set of primed lexical decision trials. The prime was presented at the detection-threshold SOA determined in the first threshold judgment task. Thus physical prime presentation conditions were approximately the same for all subjects, but subjects differed in which type of judgment they had last been trying to make just before they participated in the primed lexical decision trials. Dagenbach et al. found facilitation from the masked prime to the target when subjects had just been making detection judgments or word discrimination judgments. However inhibition occurred after subjects performed semantic similarity judgments on the prime. In this experiment retrieval of the prime's meaning always failed because of the masking. In a control experiment with SOA's long enough for retrieval of the prime to succeed, they did find facilitation from the prime to the target. Thus when attention is directed toward the meaning of the prime and the retrieval attempt is successful facilitation occurs but if the retrieval attempt fails inhibition results.

These results seem quite puzzling. Dagenbach et al. interpreted them in terms of a hypothetical attentional mechanism specialized to help in retrieving a weakly activated semantic code that might be suffering competition from other codes that are similar or related and as a result, are also partially activated. This attentional mechanism seems to work on a center surround principle in that related meanings to the prime are inhibited in order to try to allow the desired prime to rise to the surface of activation. The mask in this case serves to help make it difficult to retrieve the prime's meaning. In the non-semantic judgment subjects do not attempt to retrieve the meaning of the prime so no semantic inhibition occurs. Dagenbach et al. (1989) suggest that this center surround attentional mechanism may be working in other paradigms where attention is directed toward the desired meaning of a word and retrieval fails.

Retrieval of word meanings fails in many different situations. When learning new words the codes are relatively weak compared to older, well established codes in memory. This creates a similar situation to masked priming, but in masked priming activation is weak because of limited physical input and in the learning of new words, activation is weak because of limited learning time. Dagenbach, Carr, and Barnhardt (1990) investigated semantic priming effects from new vocabulary words that were learned by subjects to varying degrees in a lexical decision paradigm. They believed that words that were not learned as well may produce inhibition to a related target in a lexical decision trial, at least if the subject tried to retrieve the word meaning and failed. Subjects studied 45 vocabulary words and their short definitions for 15 s each and then did lexical decision trials where the studied words served as the primes and subjects were supposed to report the meaning of the prime aloud if they could remember it. In 15 of the 45 lexical decision trials the prime was unrelated to the target, in 15 it was related, and in 15 the prime was followed by a pronounceable nonword. Subjects were told that sometimes the prime would be related to the target and they should use the prime to anticipate the target. Subjects hit one key on the computer if the target was a word and another if it was not. The SOA between the prime and target was either 7 or 17 s in hopes that the longer interval would give the subject enough time to retrieve the prime's meaning. Dagenbach et al. predicted that if subjects could report the meaning of the prime, facilitation to the target would occur. A slight trend toward significant facilitation did occur. However Dagenbach et al. also predicted that if the prime's meaning could not be recalled the center surround attentional mechanism would inhibit codes that were related to the prime and inhibition would occur. No inhibition occurred in this experiment. The experimenters reasoned that perhaps nothing was learned in the first place since the study period was extremely short. If this was the case, then no code existed, not even a weak one, resulting in a lack of significant inhibition. Another reason for a lack of significant inhibition or facilitation could have been the unusually long SOA, allowing facilitation or inhibition to dissipate before the presentation of the target.

In Experiment 2 Dagenbach et al. (1990) shortened the SOA to 2 s, which was more in line with SOA's standardly used in other studies of priming, and subjects were instructed to bring the prime's definition to mind instead of recalling it aloud. After the lexical decision trials subjects took a recognition memory test and a recall test. The purpose of the recognition test was to see whether unrecalled primes were in memory at all. Presumably if the prime's definition was recalled it was probably successfully retrieved in the lexical decision trial. However if the prime was recognized on the test but not recalled, it was probably not recalled during the lexical decision task, although correct recognition performance ensures that at least a weak code exists. The prediction would be that the words that were correctly recalled would produce facilitation in the lexical decision task and words that were only recognized would produce inhibition. These weaker codes would need the center surround mechanism to push down words related to the new code in order to help the new word rise to retrievable levels of activation. On 83% of the trials the prime was at least recognized. Dagenbach et al. then broke the 83% into categories according to whether the prime had been recalled or not. Significant facilitation (64 ms) occurred when the prime and target were related and when the prime's definition had been recalled and recognized. Significant inhibition (also 64 ms coincidentally) occurred when the prime and target were related but the prime's definition could not be recalled at the time of the lexical decision--in other words, when the prime's definition was recognized on the test, but the code was not strong enough to be recalled.

In Experiment 3 Dagenbach et al. tested the idea that if the strength of the codes was increased in semantic memory, inhibition would begin to turn into facilitation, although they were not sure how much extra study would be necessary. Subjects saw each word twice (10 s each time) for a total of 20 s rather than seeing the words once for 15 s as in Experiments 1 and 2. Subjects now recognized 91% of the words rather than 83%. Primes that were recalled and recognized, indicating a successful retrieval attempt during the lexical decision trial, produced 70 ms of facilitation, replicating Experiment 2. Primes that were recognized but not recalled did not produce inhibition like in Experiment 2, but actually produced 32 ms of facilitation, though this effect was not significant. Dagenbach et al. propose that the facilitation in this case could be due to increased code strength but they also point out the fact that they could not control which primes were recalled. Perhaps some words were simply more memorable than others and the ones that were less memorable produced inhibition. The fact that the 32 ms of facilitation was not significant indicates that the data from unrecalled primes were quite noisy. This then suggests the possibility that at slightly higher levels of learning the influence of the inhibitory mechanism is beginning to decrease, resulting in a mix of trials on which its impact is seen and trials on which it was not deployed but recall still fails.

In the fourth experiment Dagenbach et al. manipulated the study sessions in order to eliminate some of the variance in the previous experiments. Subjects in the "cycled' (or "long-lag") group saw 48 new vocabulary words once for 10 s each during the first session. During the second session, 4 days later, subjects saw 48 more vocabulary words two times each. In this second session, one exposure was given to each of the words and the study list was repeated for a second cycle-hence the name "cycled". The cycled group was used with the hopes of replicating experiments 1 and 2 using a within subjects design. Subjects in the "short-lag" group also did 2 sessions but half of the 48 words in each session were seen once for 15 s and half were seen twice. One exposure and two exposures were mixed together to produce an average lag between repetitions of three items. The short-lag group was used to extend the findings of the previous experiments while manipulating the exposures within a single session and shortening the lag between repeated words. Another difference occurred in the lexical decision trials. Subjects were told to bring the prime's meaning to mind, but they were not told that the prime would sometimes be related to the target, and they were not instructed to use the prime to predict the target. Also a delayed lexical decision test was given at the end of the second session, using the words subjects had studied during the first session, 4 days earlier, as primes. In this final experiment inhibition was found when the primes were recognized but not recalled, in other words, when the codes were relatively weak. This inhibition was found in both the cycled and short-lag study groups and was present during the immediate and delayed lexical decision trials. However, the facilitation when primes were recalled disappeared. Dagenbach et al. suggest that the change in instructions may have affected the facilitation. Subjects were not told to use the prime predictively and perhaps this caused a lack of facilitation, although the authors admit that this idea is speculative.

This set of experiments is a major breakthrough for the demonstration of the existence of an inhibitory attentional mechanism for the retrieval of semantic codes. Dagenbach et al. suggest that it is difficult to incorporate new information into semantic memory because related concepts and words have greater strength than the new code. It is more likely that related codes will be activated before the new code because of their strength. How then does new information become integrated and useful in semantic memory? The existence of an inhibitory mechanism that serves to push down or squelch the activation of related codes may be the answer. When trying to retrieve a new code in memory, the mechanism inhibits stronger, related codes and helps the new code gain access into working memory. When the code becomes stronger or more well learned it will not require as much of the mechanism's help, and eventually it will not have to be used at all.

Evidence for the inhibitory mechanism appeared again in some additional research by Carr and Dagenbach (1990) using the masked prime paradigm and the threshold setting task. This research is based on their previous research in 1989, where subjects experienced inhibitory semantic priming after making semantic similarity judgments about masked primes. The goals of the 1990 experiment were to confirm the 1989 results and to suggest that a center surround mechanism is responsible for the inhibition. Experiment 1 confirmed the previous Dagenbach, Carr, and Wilhemson (1989) experiment where facilitation is seen when subjects make a presence-absence judgment on the prime in a threshold setting task prior to the lexical decision trials. Experiment 1 also included a repetition condition where the same word was presented as a prime and then as a target. These trials were mixed in with the other lexical decision trials where targets were related, unrelated, or nonwords. Half of the related trials were repetitions of the prime and half were different words that were related to the prime. This first experiment confirmed that after presence-absence threshold setting tasks, priming is facilitatory when the prime and target are related. The repetition condition also produced about the same amount of facilitation as the semantic priming condition.

Experiment 2 used the same materials as the first experiment but semantic similarity judgments were used to set the threshold. Carr and Dagenbach predicted that inhibition would occur for semantically related primes and targets in the lexical decision trials. This is what occurred in the 1989 experiments. Because the primes were masked and subjects were searching for the meaning of the prime, the inhibition mechanism should come into play to try to help access the code. This suppression of related codes would lead to inhibition of related target words. The second experiment also included a repetition condition. There are two predictions one could make about the repetition condition. If a center surround inhibition mechanism exists for weak codes, then if the same weak code serves as the target and prime, repetition priming should be facilitatory. For example, if the mechanism pushes down stronger codes that are related to the prime in order to enhance its accessibility, then if the same code is repeated again as the target, it should be responded to more quickly. The other prediction that might be made about the repetition condition would be that instead of a center surround suppression, a general reduction of the accessibility of all the codes in a given region of semantic memory occurs. If one has trouble accessing the code, then repeating the same code will be inhibitory. The experiment supports the first prediction. Using the same word as the prime and target leads to facilitation for the sought for code, whereas following the same prime with a related target leads to inhibition. This is direct evidence that a center surround attentional mechanism exists to help out codes that are weak due to masking or limited perceptual input. This idea can also be generalized to Dagenbach, Carr, and Barnhardt (1990). Instead of limited perceptual input, the primes were words that were newly learned and low in strength, and needed the help of the center surround mechanism to boost their activational level.

Evidence of the inhibition mechanism also occurred in another paradigm where subjects learned artificial categories of shapes called "fleps" and "gleps" (Carr et al., in press) College students practiced putting the unfamiliar shapes named "fleps" and "gleps" into the proper categories after they had spent some time studying the shapes in the two categories. After learning the categories well, the subjects participated in trials where one shape served as a prime and another served as a target. The two shapes were either from the same category, from the opposite category, or on neutral trials, the prime was a cross. Across several sessions of practice in which the prime-target SOA and proportion of related prime-target pairings were manipulated, these well-learned category members produced consistent evidence of facilitatory semantic priming. Targets were classified faster following same-category primes than different category primes. In the most interesting session, Session 8, subjects studied new fleps and gleps but only for a very limited amount of time, in order to ensure that they were weak in memory compared to the old items that had already been practiced. Then a situation was set up similar to Dagenbach et al. (1990) with the learning of new vocabulary words. The old and new fleps and gleps served as primes for old target shapes, a primed classification task. The SOA was 2000 ms and subjects were instructed to try to bring the category of the prime to mind. Carr et al. (in press) predicted that the newly learned fleps and gleps would produce inhibition to related shapes from the same category, especially the weaker ones, similarly to the way recognized but unrecalled words produced inhibition to related targets. In order to classify the newly learned shapes into weaker and stronger ones, they had subjects categorize the new shapes and the ones that took the longest to categorize were considered the weaker ones in memory. They assumed that the ones that were categorized quickly were already fairly well learned and probably did not need the center surround mechanism as much as the ones that were categorized slowly and were not as well learned. Facilitation was found from old primes to related targets. Facilitation was also found from the quickly categorized new primes to related targets, however inhibition occurred when the new primes were not well learned and were followed by a related target. The results of this study suggest that when retrieving a category member is difficult, the center surround mechanism steps in to help the weak items gain accessibility into working memory. This causes related targets to be responded to more slowly because they are temporarily suppressed in order to allow the weak code to rise to the surface.

Directions for Further Research

We have seen examples of an attentional center surround mechanism in masked priming, artificial category learning, and vocabulary acquisition paradigms. I focused my research on vocabulary acquisition and how the attentional mechanism aids in the process. However, instead of teaching real words I taught subjects an artificial vocabulary in which pseudowords were associated with carefully selected "meanings" consisting of already known words. Although

Dagenbach, Carr and Barnhardt (1990) found evidence of inhibition in the early stages of vocabulary learning, their paradigm has much room for error. The goal for my first experiment was two-fold. First I used pseudowords instead of real words in order to control how much contact individuals have with the things that they studied. None of the subjects have ever seen the pseudowords so they all start at the same level of familiarity with the stimuli. Another reason I used pseudowords is to control the degree of association between the definition of the pseudoword and the related target in the lexical decision trials. Dagenbach et al. (1990) wrote short definitions for the infrequent words based on their actual dictionary definitions, and then thought up another word that could be used as the related word in the lexical decision trials. The degree of the association was not controlled, which could affect the amount of priming from the prime to its related target. According to Rueckl and Olds (1993) pseudowords behave similarly to real words in a priming paradigm in which they are associated with meanings via paired associate training. This means that I can gain control over degrees of association and still study the same kinds of priming processes previously studied with real words. My second goal for the first experiment was to add another study condition to the one used by Dagenbach et al. (1990), one in which subjects saw each word five times in addition to conditions in which they saw the words only once and twice. Dagenbach, Horst and Carr (1990) demonstrated that it takes a huge amount of learning (5 weeks) to incorporate the meanings of new words into semantic memory. It would be interesting to see whether the center-surround mechanism is still activated for information that is a little stronger in memory. The studies reviewed thus far suggest that the mechanism is needed when perceptual input is low or the strength of the desired code is low. But does this mechanism also work for items that are stronger? We are not sure when items need the mechanism and when they become strong enough on their own so that they no longer need it. Perhaps the mechanism is used for higher efficiency items as well but it is used earlier or quicker for these items. Incorporating a higher level of learning into the study may supply some answers to these questions. In addition, Dagenbach, Carr, and Barnhardt (1990) speculated that a change in instructions from active to passive use of prime information might increase evidence of inhibition and decrease evidence of facilitation, based on the results of their fourth experiment. However, after a careful review of the stimulus materials used in that experiment some flaws were discovered that might have been responsible for the apparent increase in inhibition. The prime-target pairings were not properly counterbalanced as they had been in the first three experiments. The same set of 45 target words was used in the unrelated condition of all the subjects' lexical decision trials, and these target words were never used as related targets in any other condition as before.

Experiment 1

In Experiment 1 I collected lexical decision latencies for the target stimuli of Experiment 4. Perhaps a bias existed in response times to the groups of target words themselves (regardless of the prime) and this may help explain the findings of Dagenbach et al's (1990) Experiment 4.

Method

Subjects.

The subjects were 72 undergraduates recruited from the psychology pool at Michigan State University. They all received course credit for their participation.

Materials and Procedures.

The letter strings that served as related, unrelated, and nonword targets for the primed lexical decision trials in Dagenbach et al. were presented to the subjects without their primes. Dagenbach et al's. different lexical decision lists were kept together and the primes were simply removed. Subjects were instructed to press one key if the letter string was a real English word and another key it was not a real word. They were told to respond to the target as quickly and accurately as possible.

Results and Discussion

The average time it took to respond to the words that served as related targets (710 ms) was longer than the time it took to respond to unrelated targets (627 ms). The overall analysis revealed a significant effect of relatedness of the target, $F(1, 71) = 15.4$. MS_e=16010.1, $p<.05$. Targets that has appeared in the unrelated condition were recognized as words when presented in isolation 83 ms faster than the average of the targets that had appeared in the related condition. While this may not explain the interaction between prime-target relatedness and recall success or failure (in Experiment 4 there was massive inhibition for unrecalled primes and a small amount of facilitation for recalled primes), it could explain the larger amounts of inhibition and smaller amounts of facilitation in Experiment 4. This difference in base response times to the targets creates an obvious bias for Experiment 4. Because lexical decision latencies for the related targets were longer to begin with, this increased the odds of finding inhibition to related target words and decreased the chances of finding any facilitation. The materials in the present experiment were much more controlled and were fully counterbalanced to avoid this type of inherent bias in the target words.

Experiment 2

The second experiment was a replication and extension of Dagenbach, Carr, and Barnhardt's (1990) Experiment 2, substituting pseudowords for real but infrequent words, and adding a two and five time learning condition. Subjects learned 45 pseudowords as best as they could, given the amount of study time allowed. Different subjects saw the words once, twice, or five times. Next they participated in a primed lexical decision task with an SOA of 2000 ms, enough time to use the definition of the prime strategically to predict the target. Subjects were instructed to bring the definition of the prime to mind and use it to anticipate the target because sometimes it was related to the target. After the lexical decision trials subjects took two memory tests. The first was a recall test and the second was a recognition test. Presumably, if the subject could recall the definition of the pseudoword, then the word was incorporated to some extent into memory and was probably recalled during the lexical decision trials. However, if the subject could recognize the definition of the word but not recall it, the trace may be quite weak in memory and thus the word may have not been recalled during the lexical decision trials. The predictions for this study are as follows. Pseudowords whose definitions are recognized but not recalled are weak traces in memory and probably need the help of the center surround attentional mechanism in order for the new word's meaning to be activated enough to be recalled. In order for the mechanism to work, it has to push down stronger codes that are related to the desired code. If the subject is then presented with a related target, inhibition may occur in responding to that target, since related codes were pushed below resting level. Pseudowords whose definitions are recalled on the memory test (and were presumably accessed during the lexical decision trials) are stronger codes in memory and may no longer need the help of the center surround mechanism to become activated, or perhaps they use the mechanism quicker or earlier in the retrieval attempt. Regardless, we may expect facilitation from a prime to a related target when the prime's definition is recalled. The different learning conditions will give us some idea of how long the mechanism continues to be necessary in early learning. It will probably be present in the one and two exposure learning conditions but it may no longer be used when subjects see the words five times each.

Method

Subjects.

The subjects were 90 undergraduates. About 75% of them were recruited from the psychology pool at Michigan State University and received course credit for their participation. The other undergraduates responded to an advertisement in the university newspaper and were paid $4.00 for their participation. These two kind of subjects were mixed randomly through all of the conditions. All of the subjects were native English speakers.

Materials and apparatus.

The words that the subjects studied in the study phase, that ultimately served as primes in the lexical decision trials, were pronounceable nonwords obtained from several other journal articles (Sereno, 1991; Smith & Oscar Berman,

1990) along with some of my own. One word definitions were chosen for each pseudoword along with a related word that would serve as a related target in the lexical decision trials. These words and their associates were chosen from Word Association Norms by Palermo and Jenkins (1964). Palermo and Jenkins had different age groups provide free associations to various words and they published the norms for many of the common responses. The word that was most frequently associated to the initial word was used most often for the present experiment. However, sometimes associates were related to other words in the list and in that case another high associate was used instead. There were two lists of 45 pseudowords and their definitions and subjects saw one or the other (see Appendix A).

The stimuli were presented on a Macintosh SE computer using stimulus presentation and response collection routines created with Psychlab, an experiment construction package developed by Daniel Bub and Teren Gum at McGill University.

Procedures.

In the first phase of the experiment, subjects studied 45 pseudowords from either List A or List B and their definitions. The number of times subjects saw each word and definition, once, twice, or five times, was manipulated between subjects and counterbalanced across lists. The words stayed up on the computer screen for 10 s each. Subjects were told that these words were unusual and old English words that had been use many years ago and had since been dropped from the language. They were told to study these things for a later memory test. An equal number of subjects studied the pseudowords from List A and List B.

In the second phase of the experiment, the studied pseudowords were used as primes in the lexical decision trials for well known target words. Subjects first did 15 practice trials to get used to the procedure where the prime was always the word "practice". The subjects were told to read the prime silently and then respond as quickly and accurately as possible by pressing one key on the keyboard if the target was a real word, and another key if it was not.

The real lexical decision trials followed. Subjects were told that instead of the word "practice", the studied pseudowords would serve as the primes. The subjects were told to try to bring the meaning of the pseudoword to mind when they saw it and to use it to help them respond to the target, since sometimes it would be related to the target. Appropriate examples were then given.

The Stimulus Onset Asynchrony (SOA) between the prime and the target was 2000 ms. This amount of time should have given the subjects ample opportunity to bring the definition of the word to mind if they could recall it.

In the 45 lexical decision trials, the target was related to the meaning of the prime 15 times, was unrelated 15 times and was a pronounceable nonword 15 times. These nonwords were all different from the pseudowords learned as new "vocabulary" items. Unrelated prime-target pairings were created by assigning the related targets from the other list of study words to the primes from the first list (see Appendix A). Targets were moved in groups of 15 throughout the design in order to carefully control association strength between the definition of the pseudoword and its related target, along with frequency, length and number of syllables of the target words. Related targets from List A served as the unrelated targets for List B. For example, if targets 1-15 were paired with related primes in List A's lexical decision trials, the same 15 served as targets to unrelated primes in List B's lexical decision trials in order to keep prime-target pairings counterbalanced correctly. The designation of prime-target pairings to the related, unrelated, and nonword conditions was counterbalanced between subjects. Across subjects, each newly learned pseudoword occurred equally often as a related, unrelated, and nonword prime, and each target word occurred equally often as a related or unrelated target.

After the lexical decision trials subjects took two memory tests to determine the degree of learning that had taken place. The first test was a recall test. Subjects saw each pseudoword they had studied on an index card and were instructed to write down the appropriate definition. The second test was a multiple choice recognition test in which subjects saw each study word along with four response choices. One of the alternatives was the actual definition of the pseudoword, another was a definition of one of the other studied pseudowords, and the other two were definitions that had not been studied.

Results

First, the lexical decision trials were categorized according to whether the subject had at least recognized the prime's definition. Only trials on which the meaning of the prime was at least recognized were analyzed. In the condition where subjects studied the words once, 88% of the words' meanings were recognized (compared to 83% in Experiment 2, Dagenbach et al. (1990)). When subjects saw the pseudowords and definitions twice, they recognized 94% of the words' meanings (compared to 91% in Experiment 3, Dagenbach et al.), and when subjects studied each pseudoword 5 times, recognition went up to 99%. Recall percentages of the recognized words' meanings were as follows: 36% of the words' meanings were recalled in the one time study condition, 54% in the two time study condition and 81% in the five time study condition. Dagenbach et al. did not report recall percentages. For each learning condition the words that were recognized were divided into four categories according to whether the prime's meaning had been recalled and the relatedness of the prime and target: recalled and related, recalled and unrelated, unrecalled and related, and unrecalled and unrelated. Primed lexical decision data were then analyzed with the prime categories as factors. Because of the procedure of the experiment, the number of responses in each category could not be predetermined. Subjects with at least 3 data points per cell were included in the analysis. This resulted in the deletion of 12 subjects from the study one time condition and 15 from the study two times condition. When subjects studied the words 5 times each they usually recalled most of the words, leaving very few observations in the unrecalled cells of the design. If the same criterion of at least 3 data points per cell was applied here virtually all of the subjects would be thrown out. As a result I conducted another analysis where only the data from trials with recalled primes were used for each study condition. Subjects who contributed at least 3 data points to each recalled cell in the design were included in this analysis. Mean correct reaction times and error rates for positive lexical decision trials are shown in Table 1. Again, for the five time study condition, all 30 subjects are included in the recalled means. For the unrecalled cells in the five time condition, a criterion of at least 1 data point per cell was set and this includes 17 subjects. Although the means for the unrecalled cells are reported, too few observations are present to make any certain conclusions. A 2x2x2 analysis of variance was done on the 33 subjects left in the one and two time learning condition and a main effect of prime-target relatedness was found, $\underline{F}(1, 29) = 9.59$. $\underline{MS}_e = 5297.1$. $\underline{p}<.05$. The analysis also revealed a significant interaction between

Table 1

Mean RT (msec) and Percent Error for Positive Lexical Decisions as a Function of Prime Recall

Prime-target relatedness	Unrecalled Prime M obs/sub	Unrecalled Prime RT	Unrecalled Prime PE	Recalled Prime M obs/sub	Recalled Prime RT	Recalled Prime PE
Pseudowords studied one time (88% recognized; n=18)						
	64% were unrecalled			36% were recalled		
Related	6.2	704	1.8	6	690	.8
Unrelated	6.4	739	1.7	6.7	755	3.2
Net effect		+35	-.1		+65	+2.4
Pseudowords studied two times (94% recognized; n=15)						
	46% were unrecalled			54% were recalled		
Related	5.7	687	2.3	7.8	620	1.7
Unrelated	6.1	654	2.1	7.5	707	3.4
Net effect		-33	-.2		+87	+1.7
Pseudowords studied five times (99% recognized; n=30)						
	19% were unrecalled			81% were recalled		
Related	1.8	587	0	12.8	603	.5
Unrelated	2.0	603	1.6	12.5	632	3.8
Net effect		+16	+1.6		+29	+3.3

Table 1 (cont'd)

Note. M obs/sub = Mean observations per subject; RT = response time; PE = percent error. Percent recalled was calculated from the percent recognized, not all the words.

whether the subjects successfully recalled the meaning of the pseudowords and prime-target relatedness, $\underline{F}(1,29) = 5.80$. $\underline{MS_e} = 7615.8$. $\underline{p}<.05$. The interaction showed 75 ms of facilitatory priming from the related primes when the meaning was recalled, and only 4 ms of facilitation when the prime's meaning was not recalled but was recognized. The 75 ms of priming was significant when tested individually with a post hoc $\underline{t}$ test ($\underline{p}<.05$), but the 4 ms was not significant. Additional analyses were done on each study time and the means are found in Table 1. Post hoc $\underline{t}$ tests revealed that the facilitation present in each study time for the recalled primes is significant ($\underline{p}<.05$), whereas none of the effects for the unrecalled primes are significant. A main effect of list (either A or B) was also present, $\underline{F}(1, 29) = 11.0$. $\underline{MS_e} = 60495.0$. $\underline{p}<.05$. However list did not interact with any other variables although the patterns of the means did differ between the lists.

I also calculated overall priming effects for all recognized items in each study condition (without the criterion of at least 3 data points per cell per subject). In the one time study condition there was 48 ms of facilitation when primes' meanings were recalled and 24 ms of facilitation when subjects did not recall the primes' meanings. For the two time study condition when primes' meanings were recalled there was 64 ms of facilitation and 11 ms of inhibition when they were not. All recognized items were used in the five time learning condition in the original analysis.

Another analysis of variance was done to include the five study time condition, but only the data from the primes whose meaning was recalled were analyzed for each study condition. The analysis revealed a main effect of prime-target relatedness, $\underline{F}(1, 73) = 29.7$. $\underline{MS_e} = 3240.0$, $\underline{p}<.05$. The amount of study time approached significance, $\underline{F}(2, 73) = 2.7$. $\underline{MS_e} = 32239.2$, $\underline{p}=.07$. The interaction between relatedness and study time was not significant, $\underline{F}(2, 73) = 1.5$. $\underline{MS_e}=3240.0$, $\underline{p}=.23$, though the amounts of priming did vary a bit for each study time. Sixty five ms of priming was found in the one time study condition, 59 ms in the two time condition, and 29 ms in the five time. All of these were significant when tested individually with one way F-tests.

Discussion

The results do not replicate Dagenbach, Carr and Barnhardt (1990). In the one time learning condition, which compares to Experiment 2 in Dagenbach et al., when experiments are classified by amount of exposure to primes during study, facilitation was found when the prime's meaning was recalled, but no evidence of inhibition was found when the prime's meaning was not recalled. It is interesting to note that almost identical amounts of facilitation were found for the primes whose meaning was recalled--65 ms in this study compared to 64 ms in the Dagenbach et al. (1990) paper. However they found 64 ms of inhibition for the primes whose meaning was not recalled, compared to 35 ms of facilitation in the present experiment. In the two time learning condition (which compares to Experiment 3 in Dagenbach et al. when classified by amount of exposure during study) 87 ms of facilitation was found when the prime's meaning was recalled, similarly to Dagenbach et al. where 70 ms of facilitation was found. However, in Dagenbach et al. the inhibition that was found for the primes whose meaning was not recalled had disappeared and now these primes produced 32 ms of facilitation to their related targets in the lexical decision trials (though this facilitation was not significant). In the two time learning condition in the present experiment 33 ms of inhibition was found when the primes' meanings were not successfully retrieved (although this was not significant). Dagenbach et al. hypothesized that increased code strength may eliminate inhibition because in their experiment inhibition was present at the one time study condition, when the primes' meanings were not recalled, and was disappearing after two exposures to the word. This experiment does not lend support to that interpretation. In the present experiment one sees facilitation from the prime to its related target if the prime's definition is successfully retrieved. However, instead of seeing inhibition when the prime's definition is not recalled, we see nothing or a slight trend toward some inhibition although the pattern of inhibition does not follow degree of learning. Here, the 33 ms of inhibition occurs after 2 exposure to the study words. If an attentional center surround mechanism was at work one would expect inhibition for the unrecalled definitions, especially at the lowest level of learning when subjects were struggling to retrieve the meaning of the prime and failed. The small amount of facilitation found in the five time study condition was surprising because presumably these codes should be the strongest in memory and if recalled, should provide a lot of facilitation.

Perhaps "degree of learning" is not being captured by number of exposures to the study words, although a good alternative measure of learning is not readily apparent. Two alternate ways to measure learning are recognition rate and recall rate from the post-lexical decision memory tests. Recognition rates from all three study conditions in the present experiment were higher than the 83% observed in Experiment 2 of Dagenbach et al., and approaching or exceeding the 91% recognition rate Dagenbach et al. reported in Experiment 3. Using recognition rate as a criterion the present results of facilitation from recalled primes accompanied by insignificant and noisy effects from unrecalled primes look more similar to the findings of Dagenbach et al. However recall rates seem like a more intuitive index of degree of learning than recognition rate. Unfortunately, Dagenbach et al. did not report overall recall rates. Although one can calculate them for primes that were paired with unrelated and related targets, they fail to supply enough information to calculate the overall recall rate for all words that were at least recognized.

Experiment 3

Experiment 2 did not replicate Dagenbach et al. when degree of learning was indexed by amount of exposure to the primes during study, and no significant inhibition was found in any condition. Experiment 3 tried again to replicate Dagenbach et al., but two changes were made. First, in order to eliminate the list differences indicated by the main effect of list observed in Experiment 2, more lists were constructed using a modified generation procedure. Instead of only two combinations of the 90 pseudowords and their definitions, there were 10 combinations. This reduces the chance of random differential list effects like the ones found in the first experiment. Second, the recall test was presented on the computer and the latencies of the subjects' responses were measured by a voice key apparatus. In Experiment 2 it was assumed that if subjects could recall the definition of the pseudowords at all they could probably do it in less than 2000 ms. However after looking at the small amount of facilitation for the successfully recalled primes and their related targets in the five time study condition, one could hypothesize that perhaps recall was taking longer than the time allowed in the lexical decision trials, and that for some recalled primes, the attentional retrieval mechanism, if it exists, was still in operation at the time the lexical decision target appeared. If so, then priming from "recalled" primes would be a mix of trials in which recall was fast, producing facilitation and trials in which recall was slow, producing inhibition. Applying the logic of Carr et al's. (in press) "fleps" and "gleps" experiment, analyzing data from primes whose meanings were recalled as a function of recall speed gives another place in which to look for evidence of inhibition. Thus, subject's recall times in the free recall test were broken down into two categories. The first was pseudoword definitions recalled under 1800 ms--clearly less than the 2000 ms prime-target SOA during lexical decision--and the second was pseudoword definitions recalled after 1800 ms. Lexical decision times were then analyzed for these two categories for each study time based on prime-target relatedness.

Method

Subjects.

Subjects were 90 undergraduates from the same population as the first experiment. However, in this experiment all the subjects participated in the study for course credit.

Procedures.

The procedures were the same as in Experiment 2 except for the timed recall test. Subjects were instructed to look at each word on the computer screen and report the definition into the microphone if they could recall it. If they did not know the meaning of the word or had no guess, they were told to say "pass". The experimenter recorded subjects' responses on a sheet of paper Latencies were collected by a voice key connected to the mouse port.

The 10 lists were generated by each list having a "partner" list (A and B, C and D . . .). Forty five of the 90 words were randomly assigned to one of the lists and the rest to the partner list. For the lexical decision trials, each prime had a related target word. The related targets from the partner list served as the unrelated targets in the other list. This ensured that every target was seen equally often as a related and unrelated target. The unrelated and related targets in a particular list were controlled for frequency and each group of related targets in a list were controlled for association strength between the definition of the prime and the related target (see Appendix C).

Results

Subjects' recognition rates were similar to the second experiment. Recognition was 91% in the one time learning condition, 95% in the two time condition and 97% in the five time condition. Recall percentages were slightly lower than the first experiment. Subjects recalled 38% of the pseudowords' meanings in the one time condition, 46% in the two time condition and 70% in the five time condition (the 70% is based on all subjects--recall percentage for the 11 who had at least 3 data points per cell was 48%) as compared to 36%, 54%, and 81% in Experiment 2. Lexical decision times were analyzed as in Experiment 2. However, the subjects in the five time condition were included in the overall analysis this time because more subjects (11) met the 3 data points per cell criterion. This is a direct result of lower recall in this experiment. Twelve out of 30 subjects in the one time condition, 21 out of 30 in the two time condition, and 11 from the five time condition contributed data to the overall analysis. Results from these 44 subjects appear in Table 2. A 3x2x2 analysis of variance was done on these 44 subjects. The interaction between recall success and prime-target relatedness approached significance, $F(1,41) = 3.45$. $MS_e = 8898.1$. $p = .07$. This interaction reflected 45 ms of priming when the pseudowords' definitions were recalled and no effect of prime-target relatedness (mean priming = 0) when the pseudowords' definitions were not recalled. A post hoc t test found the 45 ms of priming to be significant. When the analysis was broken down by study time no significant effects were found. Post hoc t tests showed that the facilitation found for recalled definitions of the primes to related targets was not significant for any of the study times ($p>.05$). Also, none of the effects for the unrecalled definitions of the primes were significant.

I also calculated overall priming effects for all recognized items in each study condition. In the one time study condition when primes' meanings were recalled there was 72 ms of facilitation and 29 ms of facilitation

Table 2

Mean RT (msec) and Percent Error for Positive Lexical Decisions as a Function of Prime Recall

Prime-target relatedness	Unrecalled Prime M obs/sub	RT	PE	Recalled Prime M obs/sub	RT	PE
Pseudowords studied one time (91% recognized; n=12)						
	62% were unrecalled			38% were recalled		
Related	7.4	705	3.3	6.3	720	2.6
Unrelated	7.6	710	2.2	5.7	784	1.4
Net effect		+5	-1.1		+64	-1.2
Pseudowords studied two times (95% recognized; n=21)						
	54% were unrecalled			46% were recalled		
Related	6.4	729	.7	7.7	723	1.2
Unrelated	6.7	740	4.1	7.1	753	2.6
Net effect		+11	+3.4		+30	+1.4
Pseudowords studied five times (97% recognized; n=11)						
	52% were unrecalled			48% were recalled		
Related	6.7	736	3.9	7.5	710	1.2
Unrelated	6.8	709	0	7.0	766	4.9
Net effect		-27	-3.9		+56	+3.7

Table 2 (cont'd)

Weighted overall mean	0	+45

Note. M obs/sub = Mean observations per subject; RT = response time; PE = percent error. Percent recalled is taken from the percent recognized.

when they were not recalled. For the two time learning condition when primes' meanings were recalled there was 18 ms of facilitation and 32 ms of facilitation when they were unrecalled. For the five time condition when the primes' definitions were recalled there was 56 ms of facilitation and 1 ms of facilitation when they were not recalled.

In a separate analysis the lexical decision reaction times for successfully recalled definitions were further broken down by recall latency. Lexical decision times were then analyzed for each of these categories based on prime-target relatedness. The results are in Table 3. Average recall time for primes' meanings when the pseudowords were studied once was 2156 ms. When pseudowords were studied twice each average recall time was 1861 ms, and when they were studied five times each average recall time was 1716 ms. An analysis of variance was done on the related and unrelated lexical decision times based on recall times and amount of study time. Nothing reached significance in the overall analysis although if primes' meanings were recalled under 1800 ms there was 49 ms of priming which was significant when tested with a post hoc t test ($p<.05$). Analyses were also done on each individual study time. The only significant effect was found in the two time study condition where a significant interaction was found between recall time and relatedness, $F(1, 29) = 6.9$. $MS_e=20235.8$, $p<.05$. If the primes' meanings were recalled in less than 1800 ms a trend toward facilitation was found, although

Table 3

Mean RT (msec) and Percent Error for Positive Lexical Decisions broken down by Recall Latency

Prime-target relatedness	<1800 ms M obs/sub	RT	PE	>1800 ms M obs/sub	RT	PE
study one time condition						
Related	2.4	756	0	1.9	778	5.1
Unrelated	2.2	799	3.0	1.5	836	2.1
Net effect		+43	+3.0		+58	-3.0
study two times condition						
Related	4.3	735	3.0	2.6	801	0
Unrelated	4.7	794	1.4	1.7	725	3.8
Net effect		+59	-1.6		-76	+3.8
study five times condition						
Related	7.9	723	.4	2.6	747	1.3
Unrelated	7.3	767	7.2	2.5	800	6.3
Net effect		+44	+6.8		+53	+5.0
Weighted overall mean		+49				+12

Note. M obs/sub = mean observations per subject; RT = response time; PE = percent error.

it was not significant when tested with a post hoc *t* test. When primes' meanings were recalled after 1800 ms, 76 ms of inhibition was present which was significant ($p<.05$). None of the other individual effects shown in Table 3 were significant.

Discussion

Experiment 3 differed from Experiment 2 in a few ways. First the recall test was timed and subjects had to report the definitions into a microphone instead of writing them on a sheet of paper. The percentage of pseudoword definitions recalled in Experiment 3 was lower than Experiment 2 in the two and five time study conditions. Subjects may have been intimidated by speaking aloud or felt they were under more pressure to recall than in the second experiment. Perhaps we need a better way to chart the progress of new learning.

In Experiment 3, when broken down by study time, nothing was significant. The facilitation found when pseudowords' meanings were recalled was not significant which shows how noisy these data are (also there were few subjects per group). However, the basic trend remains. When primes' definitions are recalled a trend toward facilitation exists whereas when primes' definitions are not recalled there is no overall explainable pattern, producing a net effect of 0 averaged across study time conditions.

Recall latencies were than broken down into primes whose meanings were recalled before the presentation of the target and after the target. This pattern of results is also difficult to comprehend. About the same amounts of facilitation exist when the primes' meanings were recalled before 1800 ms but very different patterns occur when they were recalled after 1800 ms. One would imagine that if the subjects could not access the prime's definition before the target appears, inhibition would result. Significant inhibition did occur for primes recalled after 1800 ms in the two time study condition. It is puzzling that inhibition only occurs here whereas trends toward facilitation occur for the other study conditions.

General Discussion

Generally it seems that when primes' meanings are recalled facilitation exists and when primes' meanings are unrecalled neither facilitation nor inhibition is present in any systematic pattern. Instead of providing evidence for a center surround attentional mechanism, this set of experiments basically shows that episodic priming exists in new learning as long as the meaning of the newly learned primes can be successfully recalled--however the amount does not vary in a consistent pattern across study conditions. Although trends toward inhibition do not follow the amount of learning in an understandable way, they are present and do suggest that something may be going on. It is interesting to note that the qualitative pattern in these data when measured by recognition rates does match the pattern in Experiment 3 in Dagenbach et al. (1990) pretty well. This may be a replication or a coincidence but it suggests that "degree of learning" is something that has to be more carefully measured. Subjects in each study time vary greatly according to how well they recognize and recall the words they had just seen. A key to understanding the pattern may be linked to more accurately charting new learning and the strength of new codes.

As was previously mentioned, the present experiment was much more rigorously controlled than Dagenbach et al. (1990). Frequencies of the target words were controlled for related and unrelated targets as well as the length of the words and number of syllables. Dagenbach et al. did not control for any of these factors which may account for the differences in the results. Another factor that was controlled in the present experiment was the degree of association between the definitions of the pseudowords and the related targets. This should directly affect the amount of priming between the prime and target. Dagenbach et al. intuitively generated related targets for definitions of the study words. Perhaps this lack of control also contributed to the differences between these studies. The present study also used pseudowords instead of real, but infrequent words, although the subjects were probably equally unfamiliar with both.

The idea of a center surround retrieval mechanism for new knowledge seems very logical and even quite possible if one looks at the results of Dagenbach et al. (1990), especially interpreted in the context of the masked priming results of Dagenbach et al. (1989); Carr and Dagenbach (1990), and the category learning results of Carr et al. (in press). However, the present results do not lend much support to that interpretation. Perhaps the mechanisms that control masked priming, category learning, and vocabulary learning are very different. Although an inhibition mechanism seems to exist in both masked priming and category learning, it does not seem be working in vocabulary learning. Perhaps there are three separate mechanisms controlling each type of learning and a general "inhibition mechanism" can not be applied across all types of learning. Small amounts of inhibition do occur in some of the unrecalled cells in the present experiments, but the overall patterns of facilitation and inhibition needed to claim that a center surround mechanism exists in vocabulary acquisition are lacking.

APPENDICES

APPENDIX A

APPENDIX A

Stimulus Materials for Experiment 2

List A

Pseudowords	Definitions	Targets in lexical decision: Related	Unrelated	Nonwords
1. trolix	sweet	candy	law	affir
2. rell	lion	tiger	job	wend
3. hevil	deep	dark	hair	roven
4. swerp	take	give	low	serd
5. dister	anger	mad	carry	kellon
6. wenny	thinner	fatter	lamp	frit
7. plaret	cabbage	lettuce	stream	bottar
8. hucus	tobacco	smoke	round	trask
9. trucent	music	song	sour	greel
10. asrow	whiskey	drunk	then	vade
11. prive	bath	clean	older	lant
12. lanodyne	black	white	bad	ruckly
13. hestim	wish	want	cats	fand
14. drime	spider	web	steal	crist
15. jeek	boy	girl	dirt	gope
16. rital	sell	buy	fear	peval
17. albing	city	town	nearer	vig
18. croxy	swift	fast	house	soleg
19. marlet	citizen	American	flowers	predab
20. skires	guns	shoot	letters	zade
21. shokets	doors	windows	cry	rive

22. parbin	eagle	bird	walking	deize
23. doil	joy	happy	sleep	toinpy
24. gultan	people	crowd	hand	geets
25. olmster	clearer	foggy	pepper	seary
26. wape	carpet	rug	train	sude
27. thave	street	road	up	colast
28. bour	appear	see	games	bimp
29. pomare	king	queen	plant	benth
30. jadir	hungry	food	nail	chube
31. vupial	moon	stars	hill	fubbler
32. sagad	ocean	sea	cut	namp
33. bink	find	look	ache	rimsape
34. mivers	shoes	feet	water	katile
35. mitney	sheep	wool	talk	vorst
36. gruce	soldier	army	pretty	dort
37. danal	always	forever	mouse	leb
38. hoat	stand	sit	harder	glub
39. fandler	broader	wider	noise	favig
40. femon	butter	bread	moth	pim
41. hewer	farther	away	church	bram
42. shantling	command	order	under	riggy
43. woral	table	chair	peace	clebe
44. dute	live	die	hot	sarp
45. chope	short	tall	mind	bleam

List B

Pseudowords	Definitions	Related	Unrelated	Nonwords
		Targets in lexical decision		
1. roaken	salt	pepper	tiger	sharm
2. plew	beautiful	pretty	dark	gorl
3. santler	younger	older	candy	nell
4. donter	now	then	give	lacat
5. calark	thief	steal	fatter	mese
6. puxil	closer	nearer	mad	gresh
7. andle	river	stream	lettuce	legate
8. tramet	square	round	smoke	poudry
9. pight	trouble	bad	song	floom
10. nacuna	light	lamp	drunk	hend
11. spraw	high	low	clean	lunk
12. fergin	head	hair	want	wode
13. drocking	working	job	web	sludor
14. sance	justice	law	girl	tasil
15. teast	lift	carry	white	trake
16. yerule	cottage	house	fast	flopate
17. shain	afraid	fear	buy	murp
18. lunter	bitter	sour	town	bince
19. bummler	blossom	flowers	American	blash
20. soabits	numbers	letters	shoot	wazo
21. clasking	running	walking	windows	glur
22. summy	baby	cry	crowd	sket
23. adode	dream	sleep	bird	ponzo

24. bettals	fingers	hand	happy	tofe
25. sharms	dogs	cats	foggy	masset
26. alyss	whistle	train	feet	thag
27. corple	jump	up	rug	abran
28. glanking	playing	games	see	crug
29. elent	stem	plant	die	gleed
30. dreed	hammer	nail	queen	lerst
31. vedom	mountain	hill	look	ched
32. amony	thirsty	water	stars	bleam
33. sardel	scissors	cut	sea	tudus
34. onium	stomach	ache	wool	cheen
35. gipe	speak	talk	road	gar
36. orenic	earth	dirt	army	rild
37. awner	easier	harder	forever	rantag
38. snush	cheese	mouse	sit	dolk
39. raptic	loud	noise	wider	latting
40. lonsure	butterfly	moth	order	breeth
41. heese	priest	church	away	morod
42. jible	over	under	bread	shern
43. laper	quiet	peace	chair	pash
44. stime	stove	hot	tall	lany
45. lepon	memory	mind	food	tomp

Strength of association between the definition of the pseudoword and its related target word in the lexical decision trials

List A		List B	
#1-15	association=291	#1-15	association=256
#16-30	association=308	#16-30	association=291
#31-45	association=285	#31-45	association=250
overall=295		overall=267	

Average frequency of related target words

List A		List B	
#1-15	frequency=206	#1-15	frequency=206
#16-30	frequency=204	#16-30	frequency=208
#31-45	frequency=208	#31-45	frequency=206
overall=206		overall=207	

Length of words and number of syllables

	List A		List B	
	length	syllables	length	syllables
Pseudowords				
#1-15	5.5	1.7	5.7	1.7
#16-30	5.5	1.7	6.1	1.8
#31-45	5.6	1.9	5.3	1.9
overall	5.5	1.8	5.7	1.8

Definitions

#1-15	5.1	1.6	5.5	1.5
#16-30	5.2	1.6	5.9	1.7
#31-45	5.5	1.5	6.1	1.8
overall	5.3	1.6	5.8	1.7

Related Targets

#1-15	4.6	1.3	4.5	1.4
#16-30	4.6	1.4	4.7	1.1
#31-45	4.5	1.3	4.7	1.2
overall	4.6	1.3	4.7	1.2

Nonword Targets

#1-15	4.7	1.3	4.8	1.3
#16-30	4.7	1.4	4.7	1.3
#31-45	4.7	1.3	4.7	1.3
overall	4.7	1.3	4.7	1.3

APPENDIX B

APPENDIX B

Stimulus Materials for Experiment 3

<u>List A</u>

		Targets in lexical decision		
Pseudowords	Definitions	Related	Unrelated	Nonword
1. laper	quiet	peace	town	pash
2. swerp	take	give	sleep	serd
3. gruce	soldier	army	water	dort
4. alyss	whistle	train	hand	thag
5. hevil	deep	dark	walking	roven
6. hewer	farther	away	die	bram
7. rell	lion	tiger	forever	wend
8. puxil	closer	nearer	plant	gresh
9. heese	priest	church	hair	morod
10. mivers	shoes	feet	bread	katile
11. wenny	thinner	fatter	talk	frit
12. drime	spider	web	stream	crist
13. croxy	swift	fast	games	soleg
14. lanodyne	black	white	want	ruckly
15. woral	table	chair	mind	clebe
16. sance	justice	law	sit	tasil
17. asrow	whiskey	drunk	under	vade
18. plew	beautiful	pretty	food	gorl
19. orenic	earth	dirt	wool	rild
20. trucent	music	song	American	greel
21. drocking	working	job	lamp	sludor

22. bour	appear	see	ache	bimp
23. teast	lift	carry	bad	trake
24. calark	thief	steal	lettuce	mese
25. tramet	square	round	foggy	poudry
26. shain	afraid	fear	queen	murp
27. chope	short	tall	clean	leam
28. hucus	tobacco	smoke	noise	trask
29. parbin	eagle	bird	buy	deize
30. jeek	boy	girl	pepper	gope
31. bink	find	look	cut	rimsape
32. gultan	people	crowd	cats	geets
33. lunter	bitter	sour	order	bince
34. lonsure	butterfly	moth	shoot	beeth
35. sagad	ocean	sea	windows	namp
36. corple	jump	up	mouse	abran
37. fandler	broader	wider	letters	favig
38. vedom	mountain	hill	hot	ched
39. doil	joy	happy	road	toinpy
40. dister	anger	mad	candy	kellon
41. donter	now	then	low	lacat
42. dreed	hammer	nail	stars	lerst
43. santler	younger	older	cry	nell
44. awner	easier	harder	rug	rantag
45. bummler	blossom	flowers	house	blash

List B

Pseudowords	Definitions	Targets in lexical decision: Related	Unrelated	Nonwords
1. olmster	clearer	foggy	train	seary
2. thave	street	road	look	colast
3. danal	always	forever	drunk	leb
4. glanking	playing	games	flowers	crug
5. trolix	sweet	candy	tall	affir
6. andle	river	stream	harder	legate
7. onium	stomach	ache	steal	cheen
8. albing	city	town	then	vig
9. fergin	head	hair	up	wode
10. stime	stove	hot	fast	lany
11. gipe	speak	talk	nail	gar
12. jible	over	under	mad	shern
13. rital	sell	buy	web	peval
14. sardel	scissors	cut	job	tudus
15. pomare	king	queen	see	benth
16. marlet	citizen	American	wider	predab
17. hestim	wish	want	army	fand
18. pight	trouble	bad	away	floom
19. lepon	memory	mind	church	tomp
20. jadir	hungry	food	peace	chube
21. soabits	numbers	letters	dark	wazo
22. vupial	moon	stars	happy	fubbler
23. clasking	running	walking	crowd	glur
24. dute	live	die	moth	sarp

25. wape	carpet	rug	smoke	sude
26. shokets	doors	windows	white	rive
27. amony	thirsty	water	sour	bleam
28. skires	guns	shoot	girl	zade
29. sharms	dogs	cats	nearer	masset
30. adode	dream	sleep	feet	ponzo
31. nacuna	light	lamp	dirt	hend
32. plaret	cabbage	lettuce	bird	bottar
33. summy	baby	cry	sea	sket
34. snush	cheese	mouse	pretty	dolk
35. mitney	sheep	wool	law	vorstq
36. elent	stem	plant	order	gleed
37. shantling	command	order	round	riggy
38. raptic	loud	noise	give	latting
39. yerule	cottage	house	tiger	flopate
40. bettals	fingers	hand	fear	tofe
41. hoat	stand	sit	hill	glub
42. prive	bath	clean	carry	lant
43. roaken	salt	pepper	song	starm
44. spraw	high	low	fatter	lunk
45. femon	butter	bread	chair	pim

List C

Pseudowords	Definitions	Targets in lexical decision: Related	Unrelated	Nonwords
1. marlet	citizen	American	stars	predab
2. lunter	bitter	sour	pretty	bince
3. gruce	soldier	army	nearer	dort
4. glanking	playing	games	pepper	crug
5. trolix	sweet	candy	sea	affir
6. drocking	working	job	older	sludor
7. vedom	mountain	hill	cut	ched
8. fandler	broader	wider	order	favig
9. swerp	take	give	cats	serd
10. wape	carpet	rug	shoot	sude
11. donter	now	then	windows	lacat
12. dreed	hammer	nail	letters	lerst
13. rital	sell	buy	hot	peval
14. woral	table	chair	cry	clebe
15. awner	easier	harder	round	rantag
16. nacuna	light	lamp	happy	hend
17. gipe	speak	talk	church	gar
18. hestim	wish	want	crowd	fand
19. thave	street	road	sit	colast
20. mitney	sheep	wool	dark	vorst
21. trucent	music	song	food	greel
22. raptic	loud	noise	girl	latting
23. dute	live	die	moth	sarp
24. yerule	cottage	house	white	flopate

25. prive	bath	clean	peace	lant
26. jible	over	under	feet	shern
27. amony	thirsty	water	foggy	bleam
28. spraw	high	low	dirt	lunk
29. bummler	blossom	flowers	bad	blash
30. rell	lion	tiger	sleep	wend
31. sance	justice	law	train	tasil
32. plaret	cabbage	lettuce	stream	bottar
33. lepon	memory	mind	drunk	tomp
34. snush	cheese	mouse	hand	dolk
35. onium	stomach	ache	look	cheen
36. hewer	farther	away	steal	bram
37. albing	city	town	tall	vig
38. bour	appear	see	walking	bimp
39. shain	afraid	fear	up	murp
40. wenny	thinner	fatter	forever	frit
41. drime	spider	web	mad	crist
42. croxy	swift	fast	carry	soleg
43. hucus	tobacco	smoke	bread	trask
44. parbin	eagle	bird	plant	deize
45. pomare	king	queen	hair	benth

List D

Pseudowords	Definitions	Targets in lexical decision: Related	Unrelated	Nonwords
1. laper	quiet	peace	hill	pash
2. gultan	people	crowd	rug	geets
3. summy	baby	cry	fatter	sket
4. orenic	earth	dirt	chair	rild
5. soabits	numbers	letters	house	wazo
6. corple	jump	up	queen	abran
7. puxil	closer	nearer	clean	gresh
8. teast	lift	carry	noise	trake
9. stime	stove	hot	tiger	lany
10. pight	trouble	bad	candy	floom
11. mivers	shoes	feet	want	katile
12. chope	short	tall	bird	leam
13. adode	dream	sleep	mouse	ponzo
14. femon	butter	bread	American	pim
15. jeek	boy	girl	buy	gope
16. olmster	clearer	foggy	army	seary
17. danal	always	forever	town	leb
18. alyss	whistle	train	low	thag
19. lonsure	butterfly	moth	sour	beeth
20. sagad	ocean	sea	wool	namp
21. fergin	head	hair	give	wode
22. heese	priest	church	lettuce	morod
23. shantling	command	order	smoke	riggy
24. bettals	fingers	hand	road	tofe

25. shokets	doors	windows	fear	rive
26. andle	river	stream	law	legate
27. hoat	stand	sit	see	glub
28. roaken	salt	pepper	song	starm
29. santler	younger	older	harder	nell
30. sharms	dogs	cats	die	masset
31. bink	find	look	talk	rimsape
32. asrow	whiskey	drunk	wider	vade
33. plew	beautiful	pretty	away	gorl
34. calark	thief	steal	lamp	mese
35. hevil	deep	dark	job	roven
36. skires	guns	shoot	water	zade
37. elent	stem	plant	games	gleed
38. vupial	moon	stars	ache	fubbler
39. clasking	running	walking	then	glur
40. doil	joy	happy	nail	toinpy
41. tramet	square	round	under	poudry
42. dister	anger	mad	fast	kellon
43. jadir	hungry	food	web	chube
44. lanodyne	black	white	flowers	ruckly
45. sardel	scissors	cut	mind	tudus

List E

Pseudowords	Definitions	Related	Unrelated	Nonwords
		Targets in lexical decision		
1. nacuna	light	lamp	water	hend
2. soabits	numbers	letters	drunk	wazo
3. orenic	earth	dirt	harder	rild
4. summy	baby	cry	look	sket
5. onium	stomach	ache	forever	cheen
6. drocking	working	job	flowers	sludor
7. bour	appear	see	walking	bimp
8. albing	city	town	then	vig
9. puxil	closer	nearer	nail	gresh
10. calark	thief	steal	bread	mese
11. tramet	square	round	hair	poudry
12. dister	anger	mad	talk	kellon
13. woral	table	chair	army	clebe
14. rital	sell	buy	crowd	peval
15. pomare	king	queen	church	benth
16. sance	justice	law	want	tasil
17. lonsure	butterfly	moth	dark	beeth
18. lepon	memory	mind	away	tomp
19. lunter	bitter	sour	sit	bince
20. elent	stem	plant	smoke	gleed
21. andle	river	stream	under	legate
22. vupial	moon	stars	American	fubbler
23. dute	live	die	wool	sarp
24. yerule	cottage	house	feet	flopate

25. shokets	doors	windows	foggy	rive
26. jadir	hungry	tall	lettuce	leam
27. adode	dream	sleep	pretty	ponzo
28. jible	over	under	flowers	shern
29. lanodyne	black	white	noise	ruckly
30. roaken	salt	pepper	sea	starm
31. laper	quiet	peace	older	pash
32. snush	cheese	mouse	cut	dolk
33. alyss	whistle	train	fear	thag
34. pight	trouble	bad	order	floom
35. corple	jump	up	cats	abran
36. glanking	playing	games	shoot	crug
37. rell	lion	tiger	hot	wend
38. fandler	broader	wider	give	favig
39. doil	joy	happy	carry	toinpy
40. bettals	fingers	hand	road	tofe
41. prive	bath	clean	candy	lant
42. drime	spider	web	song	crist
43. croxy	swift	fast	hill	soleg
44. spraw	high	low	rug	lunk
45. jeek	boy	girl	fatter	gope

List F

		Targets in lexical decision		
Pseudowords	Definitions	Related	Unrelated	Nonwords
1. bink	find	look	clean	rimsape
2. plaret	cabbage	lettuce	die	bottar
3. gruce	soldier	army	windows	dort
4. thave	street	road	mind	colast
5. trucent	music	song	town	greel
6. skires	guns	shoot	moth	zade
7. clasking	running	walking	web	glur
8. vedom	mountain	hill	games	ched
9. shain	afraid	fear	peace	murp
10. gipe	speak	talk	stream	gar
11. mivers	shoes	feet	bad	katile
12. hoat	stand	sit	wider	glub
13. amony	thirsty	water	girl	bleam
14. santler	younger	older	tiger	nell
15. sharms	dogs	cats	fast	masset
16. hewer	farther	away	ache	bram
17. asrow	whiskey	drunk	mouse	vade
18. gultan	people	crowd	hand	geets
19. danal	always	forever	cry	leb
20. sagad	ocean	sea	pepper	namp
21. mitney	sheep	wool	low	vorst
22. raptic	loud	noise	buy	latting
23. heese	priest	church	round	morod
24. stime	stove	hot	letters	lany

25. shantling	command	order	steal	riggy
26. donter	now	then	stars	lacat
27. olmster	clearer	foggy	chair	seary
28. parbin	eagle	bird	house	deize
29. femon	butter	bread	up	pim
30. sardel	scissors	cut	happy	tudus
31. awner	easier	harder	train	rantag
32. swerp	take	give	food	serd
33. hestim	wish	want	see	fand
34. plew	beautiful	pretty	nearer	gorl
35. hevil	deep	dark	job	roven
36. trolix	sweet	candy	law	affir
37. marlet	citizen	American	sleep	predab
38. fergin	head	hair	dirt	wode
39. teast	lift	carry	white	trake
40. wape	carpet	rug	tall	sude
41. wenny	thinner	fatter	queen	frit
42. jible	over	under	plant	shern
43. dreed	hammer	nail	sour	lerst
44. hucus	tobacco	smoke	lamp	trask
45. bummler	blossom	flowers	mad	blash

List G

Pseudowords	Definitions	Related	Unrelated	Nonwords
		Targets in lexical decision		
1. sance	justice	law	water	tasil
2. hestim	wish	want	hand	fand
3. soabits	numbers	letters	tall	wazo
4. plew	beautiful	pretty	walking	gorl
5. trolix	sweet	candy	up	affir
6. hewer	farther	away	web	bram
7. elent	stem	plant	talk	gleed
8. fergin	head	hair	white	wode
9. shantling	command	order	under	riggy
10. tramet	square	round	then	poudry
11. hoat	stand	sit	peace	glub
12. awner	easier	harder	girl	rantag
13. jadir	hungry	food	job	chube
14. rital	sell	buy	smoke	peval
15. femon	butter	bread	army	pim
16. bink	find	look	stream	rimsape
17. gultan	people	crowd	see	geets
18. danal	always	forever	fast	leb
19. alyss	whistle	train	moth	thag
20. sagad	ocean	sea	sour	namp
21. glanking	playing	games	drunk	crug
22. stime	stove	hot	American	lany
23. heese	priest	church	dark	morod
24. yerule	cottage	house	happy	flopate

25. dister	anger	mad	lamp	kellon
26. shokets	doors	windows	die	rive
27. albing	city	town	wool	vig
28. adode	dream	sleep	ache	ponzo
29. woral	table	chair	dirt	clebe
30. sharms	dogs	cats	bad	masset
31. olmster	clearer	foggy	queen	seary
32. plaret	cabbage	lettuce	clean	bottar
33. lepon	memory	mind	nearer	tomp
34. swerp	take	give	noise	serd
35. trucent	music	song	tiger	greel
36. dreed	hammer	nail	bird	lerst
37. vupial	moon	stars	cut	fubbler
38. teast	lift	carry	fear	trake
39. fandler	broader	wider	shoot	favig
40. calark	thief	steal	mouse	mese
41. wape	carpet	rug	low	sude
42. mivers	shoes	feet	cry	katile
43. roaken	salt	pepper	road	starm
44. santler	younger	older	hill	nell
45. bummler	blossom	flowers	fatter	blash

List H

Pseudowords	Definitions	Targets in lexical decision: Related	Unrelated	Nonwords
1. laper	quiet	peace	mad	pash
2. thave	street	road	forever	colast
3. lunter	bitter	sour	harder	bince
4. summy	baby	cry	nail	sket
5. mitney	sheep	wool	away	vorst
6. andle	river	stream	town	legate
7. dute	live	die	hair	sarp
8. gipe	speak	talk	wider	gar
9. vedom	mountain	hill	bread	ched
10. lonsure	butterfly	moth	plant	beeth
11. bettals	fingers	hand	want	tofe
12. jible	over	under	flowers	shern
13. hucus	tobacco	smoke	mind	trask
14. sardel	scissors	cut	sit	tudus
15. jeek	boy	girl	sleep	gope
16. marlet	citizen	American	food	predab
17. gruce	soldier	army	foggy	dort
18. hevil	deep	dark	feet	roven
19. shain	afraid	fear	look	murp
20. drocking	working	job	church	sludor
21. orenic	earth	dirt	steal	rild
22. onium	stomach	ache	train	cheen
23. rell	lion	tiger	games	wend
24. raptic	loud	noise	lettuce	latting

25. puxil	closer	nearer	crowd	gresh
26. donter	now	then	pretty	lacat
27. chope	short	tall	buy	leam
28. amony	thirsty	water	pepper	bleam
29. spraw	high	low	song	lunk
30. parbin	eagle	bird	stars	deize
31. nacuna	light	lamp	candy	hend
32. asrow	whiskey	drunk	round	vade
33. corple	jump	up	older	abran
34. snush	cheese	mouse	law	dolk
35. pight	trouble	bad	carry	floom
36. skires	guns	shoot	rug	zade
37. bour	appear	see	chair	bimp
38. clasking	running	walking	sea	glur
39. doil	joy	happy	hot	toinpy
40. wenny	thinner	fatter	letters	frit
41. prive	bath	clean	house	lant
42. drime	spider	web	give	crist
43. croxy	swift	fast	order	soleg
44. lanodyne	black	white	windows	ruckly
45. pomare	king	queen	cats	benth

List I

Pseudowords	Definitions	Targets in lexical decison Related	Unrelated	Nonwords
1. marlet	citizen	American	sleep	predab
2. asrow	whiskey	drunk	town	vade
3. thave	street	road	flowers	colast
4. summy	baby	cry	train	sket
5. hevil	deep	dark	harder	roven
6. mitney	sheep	wool	steal	vorst
7. bour	appear	see	fast	bimp
8. clasking	running	walking	mad	glur
9. stime	stove	hot	then	lany
10. pomare	king	queen	web	benth
11. jible	over	under	plant	shern
12. mivers	shoes	feet	army	katile
13. chope	short	tall	want	leam
14. hucus	tobacco	smoke	hair	trask
15. femon	butter	bread	peace	pim
16. bink	find	look	church	rimsape
17. plaret	cabbage	lettuce	sour	bottar
18. danal	always	forever	job	leb
19. dute	live	die	wider	sarp
20. trolix	sweet	candy	moth	affir
21. andle	river	stream	happy	legate
22. vupial	moon	stars	nail	fubbler
23. vedom	mountain	hill	away	ched
24. shantling	command	order	white	riggy

25. bettals	fingers	hand	foggy	tofe
26. hoat	stand	sit	ache	glub
27. prive	bath	clean	nearer	lant
28. jadir	hungry	food	noise	chube
29. santler	younger	older	buy	nell
30. sardel	scissors	cut	pepper	tudus
31. nacuna	light	lamp	law	hend
32. gultan	people	crowd	windows	geets
33. plew	beautiful	pretty	mouse	gorl
34. lepon	memory	mind	fear	tomp
35. sagad	ocean	sea	shoot	namp
36. corple	jump	up	letters	abran
37. rell	lion	tiger	low	wend
38. glanking	playing	games	bad	crug
39. gipe	speak	talk	give	gar
40. yerule	cottage	house	carry	flopate
41. amony	thirsty	water	round	bleam
42. parbin	eagle	bird	chair	deize
43. jeek	boy	girl	dirt	gope
44. sharms	dogs	cats	song	masset
45. wape	carpet	rug	fatter	sude

List J

Pseudowords	Definitions	Targets in lexical decision: Related	Unrelated	Nonwords
1. gruce	soldier	army	cut	dort
2. swerp	take	give	cats	serd
3. lunter	bitter	sour	order	bince
4. teast	lift	carry	hot	trake
5. trucent	music	song	smoke	greel
6. drocking	working	job	queen	sludor
7. onium	stomach	ache	under	cheen
8. fandler	broader	wider	mind	favig
9. shain	afraid	fear	lamp	murp
10. raptic	loud	noise	feet	latting
11. doil	joy	happy	wool	toinpy
12. wenny	thinner	fatter	cry	frit
13. croxy	swift	fast	pretty	soleg
14. adode	dream	sleep	road	ponzo
15. bummler	blossom	flowers	tiger	blash
16. olmster	clearer	foggy	food	seary
17. pight	trouble	bad	older	floom
18. alyss	whistle	train	American	thag
19. lonsure	butterfly	moth	see	beeth
20. hewer	farther	away	candy	bram
21. elent	stem	plant	hill	gleed
22. orenic	earth	dirt	girl	rild
23. calark	thief	steal	bird	mese
24. puxil	closer	nearer	clean	gresh

25. drime	spider	web	stars	crist
26. donter	now	then	lettuce	lacat
27. roaken	salt	pepper	house	starm
28. dreed	hammer	nail	rug	lerst
29. spraw	high	low	water	lunk
30. lanodyne	black	white	drunk	ruckly
31. laper	quiet	peace	hand	pash
32. hestim	wish	want	look	fand
33. sance	justice	law	sea	tasil
34. snush	cheese	mouse	tall	dolk
35. skires	guns	shoot	walking	zade
36. soabits	numbers	letters	up	wazo
37. albing	city	town	talk	vig
38. fergin	head	hair	games	wode
39. heese	priest	church	dark	morod
40. tramet	square	round	stream	poudry
41. dister	anger	mad	crowd	kellon
42. shokets	doors	windows	sit	rive
43. woral	table	chair	die	clebe
44. awner	easier	harder	bread	rantag
45. rital	sell	buy	forever	peval

APPENDIX C

APPENDIX C

Additional Information for Experiments 2 and 3 (Pseudowords and the associative strength between their definitions and related targets in the lexical decision trials and the frequency of the targets.)

Pseudowords	Definitions	Targets	Association	Frequency
1. adode	dream	sleep	480	97
2. albing	city	town	232	281
3. alyss	whistle	train	106	86
4. amony	thirsty	water	432	486
5. andle	river	stream	154	61
6. asrow	whiskey	drunk	110	26
7. awner	easier	harder	419	14
8. bettals	fingers	hand	341	717
9. bink	find	look	83	910
10. bour	appear	see	218	1513
11. bummler	blossom	flowers	630	54
12. calark	thief	steal	264	39
13. chope	short	tall	411	55
14. clasking	running	walking	218	54
15. corple	jump	up	159	712
16. croxy	swift	fast	450	45
17. danal	always	forever	135	39
18. dister	anger	mad	352	38
19. doil	joy	happy	260	97

20. dreed	hammer	nail	450	20
21. donter	now	then	375	1348
22. drime	spider	web	378	6
23. drocking	working	job	200	302
24. dute	live	die	232	183
25. elent	stem	plant	200	182
26. fandler	broader	wider	232	17
27. femon	butter	bread	575	41
28. fergin	head	hair	208	160
29. gipe	speak	talk	252	275
30. glanking	playing	games	100	52
31. gruce	soldier	army	149	152
32. gultan	people	crowd	141	63
33. heese	priest	church	225	451
34. hestim	wish	want	120	631
35. hevil	deep	dark	170	160
36. hewer	farther	away	190	458
37. hoat	stand	sit	383	314
38. hucus	tobacco	smoke	475	33
39. jadir	hungry	food	413	198
40. jeek	boy	girl	700	374
41. jible	over	under	378	685
42. lanodyne	black	white	580	334
43. lepon	memory	mind	117	350
44. lonsure	butterfly	moth	125	4
45. lunter	bitter	sour	150	2
46. laper	quiet	peace	53	198

47. marlet	citizen	America	71	128
48. mitney	sheep	wool	187	10
49. mivers	shoes	feet	358	283
50. nacuna	light	lamp	82	24
51. olmster	clearer	foggy	58	5
52. onium	stomach	ache	159	11
53. orenic	earth	dirt	143	43
54. parbin	eagle	bird	576	83
55. pight	trouble	bad	107	134
56. plaret	cabbage	lettuce	140	3
57. plew	beautiful	pretty	150	41
58. pomare	king	queen	651	51
59. puxil	closer	nearer	247	8
60. prive	bath	clean	380	58
61. raptic	loud	noise	231	43
62. rell	lion	tiger	206	9
63. rital	sell	buy	560	162
64. roaken	salt	pepper	408	13
65. sagad	ocean	sea	155	124
66. sance	justice	law	45	387
67. santler	younger	older	525	93
68. sardel	scissors	cut	675	245
69. shain	afraid	fear	280	280
70. shantling	command	order	255	416
71. sharms	dogs	cats	680	17
72. shokets	doors	windows	358	53
73. skires	guns	shoot	200	117

73.	skires	guns	shoot	200	117
74.	swerp	take	give	116	1264
75.	snush	cheese	mouse	106	20
76.	soabits	numbers	letters	190	113
77.	spraw	high	low	518	147
78.	stime	stove	hot	226	130
79.	summy	baby	cry	120	64
80.	teast	lift	carry	245	304
81.	thave	street	road	118	262
82.	tramet	square	round	315	32
83.	trolix	sweet	candy	159	18
84.	trucent	music	song	164	129
85.	vedom	mountain	hill	213	119
86.	vupial	moon	stars	230	26
87.	wape	carpet	rug	310	17
88.	wenny	thinner	fatter	321	3
89.	woral	table	chair	700	89
90.	yerule	cottage	house	265	662

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