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Will inverting orthographic neighbors enhance neighborhood frequency effects?

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**WILL INVERTING ORTHOGRAPHIC NEIGHBORS ENHANCE
NEIGHBORHOOD FREQUENCY EFFECTS?**

**A Thesis
Presented to
the Faculty of the Department of Psychology
San Jose State University**

**In Partial Fulfillment
of the Requirements for the Degree
Masters of Arts**

**by
Michelle L. Yamamoto
December 2002**

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ABSTRACT

WILL INVERTING ORTHOGRAPHIC NEIGHBORS ENHANCE
NEIGHBORHOOD FREQUENCY EFFECTS?

Some experiments report that neighborhood frequency effects yield faster lexical access times, while others report neighborhood size. In the current study, using lexical decision as an index of lexical access, three types of stimulus words were used. The conditions employed words with no higher-frequency neighbors, words with one higher-frequency neighbor, and words with two higher-frequency neighbors. The stimuli were equated on the mean number of neighbors, the mean word frequency, and word length across conditions.

All of the words were presented upside down since Grainger reported that neighborhood frequency effects are more pronounced if the stimulus words are degraded. According to Grainger's neighborhood frequency hypothesis, top position words will produce faster response times than second and third position words. In this experiment, third position words yielded the fastest response times.

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TABLE OF CONTENTS

SECTION	PAGE
INTRODUCTION.....	1
Neighborhood Size Effects	2
Neighborhood Frequency Effects.....	4
Neighborhood Frequency Effects With Interferences	8
METHOD.....	11
Participants.....	11
Materials.....	11
Design.....	13
Apparatus.....	13
Procedure.....	13
RESULTS	14
DISCUSSION	18
REFERENCES.....	21
APPENDICES	24
Appendix A. Human Subjects Approval.....	24
Appendix B. Human Subjects Extension	25
Appendix C. Participant Consent Form.....	26
Appendix E. Stimulus List	27

LIST OF TABLE

TABLE	PAGE
1. Characteristics of Stimulus Words	12

LIST OF FIGURES

FIGURE	PAGE
1. Mean reaction times (in ms) as a function of neighborhood position	15
2. Mean percent errors as a function of neighborhood position	17

Will Inverting Orthographic Neighbors Enhance Neighborhood Frequency Effects?

Word recognition and word processing affect lexical access by extracting information from the representation of a given word which is then processed further. There are a multitude of theories and models giving explanations about how lexical access actually occurs such as the serial search model (Becker, 1976; Forster, 1976), the interactive-activation model (McClelland & Rumelhart, 1981), activation-verification model (Becker, 1976; Papp et al., 1982), parallel distributed processing (PDP) model (Seidenberg & McClelland, 1989), direct access theory (Baron, 1973), and the dual access theory (Coltheart, 1978). There is no recognized view of lexical access (Andrews, 1989, 1997).

One factor that may influence lexical access is a word's orthographic neighborhood structure. The N metric is a measurement of a word's neighborhood size created by changing one letter of the word, while maintaining letter position (Coltheart et al., 1977). For example, the word NEXT has four neighbors: TEXT, NEAT, NEST, and NEWT (Huntsman, 1995; Huntsman & Lima, 1996). Research shows that a word's neighborhood appears to affect the recognition of that word (Andrews, 1989, 1992, 1997; Forster & Shen, 1996; Grainger, 1989, 1990; Grainger & Jacobs, 1996; Grainger, Spinelli, & Ferrand, 2000; Huntsman & Lima, 1996; Perea & Carreiras, 1998; Perea & Pollastek, 1998; Pollastek, Perea, & Binder, 1999; Sears, Hino & Lupker, 1995; Van Heuven & Grainger, 1998). The size (Andrews, 1989, 1992, 1997; Forster & Shen, 1996; Sears, Hino & Lupker, 1995) of the word's neighborhood as well as the

frequency of the target word and its relationship to its surrounding neighbors may influence lexical decision (Grainger, 1989, 1990; Grainger & Jacobs, 1996; Grainger, Spinelli, & Ferrand, 2000; Huntsman & Lima, 1996; Perea & Carreiras, 1998; Perea & Pollastek, 1998; Pollastek, Perea, & Binder, 1999; Van Heuven & Grainger, 1998). However empirical results are mixed on this issue (Huntsman & Lima, 1991).

Neighborhood Size Effects

Andrews (1989) claims that neighborhood size influences lexical access. Andrews also claims that these effects are mainly facilitory for words that occur less frequently in the English language when compared to words that occur more often. Andrews (1989) found that lower-frequency words from large neighborhoods generated faster lexical decision responses and naming latencies than lower-frequency words from small neighborhoods. Neighborhood size effects were more apparent for low rather than for high frequency words. These results suggest that neighborhood size has a facilitory effect on lexical access for lower-frequency words.

Andrews (1992) wanted to investigate whether or not neighborhood size is affected by orthographic redundancy rather than orthographic similarity. When a word is broken down into letter groups, those groups of letters may be higher in orthographic redundancy because other words may share those letters as well. Therefore, a word from a large neighborhood may be recognized faster due to the letter groups being similar to other words' letter groups. Obviously, frequency affects orthographic redundancy. Biagram

Frequency can be determined by breaking down a word into its constituent two letter groups and then determine in the mean frequency of two letter pairs occurring in the English language. For example, the letter pairs for the word SEAT are: SE EA AT. Andrews states that neighborhood size will tend to be correlated with measures of orthographic redundancy such as frequency which may in turn affect lexical access. Therefore, these factors were examined in the 1992 study.

Andrews (1992) conducted a study to investigate neighborhood effects of lexical access in terms of orthographic redundancy and lexical similarity. The first experiment manipulated neighborhood size and word frequency in word recognition. Bigram frequency was held constant. High frequency words had the fastest response times and lowest error rates. Results showed a significant interaction between neighborhood size and word frequency. Responses were faster and more accurate for low frequency words from larger neighborhoods than responses for low frequency words from smaller neighborhoods. Since these results were a reflection of the Andrews 1989 study, an assumption was made that lexical similarity and orthographic redundancy were not confounds in the lexical decisions (Andrews, 1992).

Additionally, Andrews (1997) reviewed sixteen experiments to resolve the conflicting evidence of research regarding neighborhood structure. Andrews investigated neighborhood size and frequency. Andrews further examined whether or not the effects of size or frequency was facilitatory or inhibitory. The preponderance of evidence supported facilitation with increased neighborhood size and inhibition for neighborhood frequency.

Other researchers have also reported evidence of facilitory effects of neighborhood size. Forster and Shen (1996) found facilitation (i.e. faster reaction times and fewer errors) proportional with neighborhood size. Facilitation increased in a linear manner with neighborhood size. Sears, Hino and Lupker (1995) also examined word frequency, neighborhood size, and neighborhood frequency. Results showed higher-frequency neighbors did facilitate lexical access for low frequency words in large neighborhoods. Although a facilitatory effect for neighborhood size was found, there was no interaction between neighborhood size and word frequency.

Neighborhood Frequency Effects

Grainger and his colleagues argue that it is the frequency of neighbors rather than size of the neighborhood that affects word processing. Grainger et al. (1989) conducted two experiments, one involving a lexical decision task and the other an eye movement study, to test his theory. The stimuli were French words grouped into four categories: the first group had no higher-frequency neighbors, the second group contained words with at least one orthographic neighbor, none of which was of higher frequency than the word itself, the third group consisted of words with at least one orthographic neighbor, only one of which was of higher frequency than the word itself, and the fourth group had words with more than one orthographic neighbor of higher frequency. There was no significant increase in response times between groups one and two. According to Grainger, these results implied neighborhood size did not affect lexical access. There was also significant increases in reaction times and error rates from the second group to the third

and fourth groups. Furthermore, there was not a significant increase between group three and four suggesting that increasing the number of higher frequency neighbors does not increase processing difficulty. The experiment with gaze durations produced similar results. Grainger concluded that words with at least one higher-frequency neighbor will produce slower response times. Increasing the number of neighbors may cause interferences. Grainger labeled these effects as the “neighborhood frequency effect”: words with no higher-frequency neighbors are more readily recognized than words with orthographically similar neighbors (Grainger et al., 1989).

Grainger (1990) attempted to account for the inconclusive effect of the number of higher-frequency neighbors in his follow-up study, which examined high and low frequency words. He contended it was the neighborhood frequency effects of low and high frequency words that was a confound which may have produced interference in past studies. Therefore, if neighborhood frequency was controlled for, then the effects of word frequency would diminish in the lexical decision task. Grainger attempted to demonstrate this in a study with both lexical decision and naming. He claimed that if neighborhood frequency was controlled, and stimulus word frequency was manipulated, then word frequency effects would disappear in the lexical decision task while appearing in the naming task. An interaction between neighborhood frequency and task indicated that neighborhood frequency did interfere with lexical decisions and not naming tasks. Once again, there was no significant difference in response times or error rates between words with one higher-frequency neighbor and words with more than one higher-frequency neighbor.

The neighborhood frequency effect has been supported despite the lack of inhibitory effects displayed in other experiments. Perea and Carreiras (1998) examined the first syllables of Spanish words and neighborhood frequency. It was hypothesized that words containing high frequency first syllables would have higher-frequency syllabic neighbors because the search process is frequency ordered. Reaction times were significantly lower for high frequency words. The syllable frequency effect was found to be inhibitory due to the number of higher-frequency neighbors. Perea and Pollatsek (1998) also located neighborhood frequency effects in reading. Lower frequency words with one interior letter changed and one or no higher frequency neighbors were used in a lexical decision task. Inhibitory effects for neighborhood frequency were found. A second study was conducted using the same conditions for silent reading. These results demonstrated inhibitory effects for neighborhood frequency for low frequency words.

Huntsman and Lima (1996) examined neighborhood frequency effects while controlling for neighborhood size. Word frequency and neighborhood size were held constant. Relative frequency within the neighborhood was varied. One set of words containing the highest frequency of their neighborhood words was termed “top” words. The other set of words had several higher-frequency neighbors and were termed “bottom” words. Consistent with the neighborhood frequency effect, it was predicted that “top” words would be processed more quickly than “bottom” words. The results indicated “top” words were unaffected by the words in their neighborhood. Conversely, neighbors activated words with the same frequency but were at the bottom of its neighborhood.

Other research studying orthographic neighborhoods used interference techniques to decipher how lexical access is affected. For example, Pollastek, Perea, and Binder (1999) conducted a study on neighborhood size that had conflicting results. Their first experiment involving the lexical decision task found a facilitative effect for words with large neighborhoods. In the next two experiments involving sentences and reading, opposite results were found. Inhibitory effects were found for sentences containing many neighbors. According to Pollastek, Perea, and Binder (1999), the inhibitory effects in the reading task were due to neighborhood frequency rather than neighborhood size.

Grainger and Jacobs (1996) examined neighborhood size and frequency effects for words and nonwords. The progressive demasking tasks produced a significant inhibitory effect when the target word had at least one higher-frequency neighbor. In the lexical decision task with higher-frequency words and nonwords, a significant inhibitory effect was found in the presence of one higher-frequency neighbor. Conversely, in the lexical decision task with lower-frequency words and nonwords, a significant inhibitory effect in the presence of one higher-frequency neighbor was also found. Lastly, speed instructions were given with the lexical decision task with high frequency words and nonwords. Results were inhibitory in the presence of one higher-frequency neighbor (Grainger & Jacobs, 1996).

In Grainger's latest research on pseudohomophones (Grainger, Spinelli, & Ferrand, 2000), experiments were conducted to test frequency and size in correspondence to their orthographic neighborhoods. Mixed results were

found. The first experiment containing pure lists of pseudohomophones in speeded naming showed a significant interaction between frequency and orthographic neighborhood. These effects could be seen in the immediate naming but not in the delayed naming. When mixed lists were used in the second experiment there was a significant effect of neighborhood size but no significant effect for frequency. The last experiment conducted used the phonological lexical decision task. A main effect was found for frequency, but no effect was found for neighborhood size. Furthermore, response times for the number of orthographic neighbors was not significantly different. In this study alone, there are three separate experiments to test the presence of neighborhood frequency in a word's orthographic neighborhood that generated different results. Even with these varied results, Grainger still indicates it is frequency rather than size that influences the orthographic neighborhood.

Neighborhood Frequency Effects with Interferences

The opposing effects of neighborhood frequency (Grainger, 1990; Grainger et al., 1989; Grainger & Jacobs, 1996) and neighborhood size (Andrews, 1989; Andrews, 1992; Andrews, 1997) illustrate a controversy regarding the actual effects of orthographic neighborhood structure on lexical access. The neighborhood frequency effect states it is frequency that inhibits lexical access. Conversely, the neighborhood size effect claims size facilitates lexical access. Although there is support for both of these interpretations, this experiment will investigate neighborhood frequency effects hypothesizing the effects to be inhibitory.

Neighborhood frequency is manipulated by the position of a word in its neighborhood. For example, a word can have zero, one, or more than one higher-frequency words in their neighborhood. According to Grainger (1989), the number of higher-frequency neighbors should not produce interference effects. Words with one or more higher-frequency neighbors will be recognized more slowly, than a word with no higher-frequency neighbors (Grainger et al., 1989).

Huntsman and Lima (1991) tested Grainger's theory about interference effects in an orthographic neighborhood. They hypothesized that if Grainger's claim was correct, words with no higher-frequency neighbors would be recognized the quickest, and the words with one or two higher-frequency neighbors would be recognized equally slowly. Three types of stimulus words were examined: words with no higher-frequency neighbors (top-position words), words with one higher-frequency neighbor (second-position words), and words with two higher-frequency-neighbors (third-position words). Results showed no significant differences among the response latencies for the three types of stimulus words. Therefore, the relative position in the orthographic neighborhood had no effect on the speed of processing. There was also no speed or accuracy tradeoff shown by the error rates for five letter words (Huntsman & Lima, 1991).

Another study conducted by Grainger's colleagues (Van Heuven, Dijkstra, & Grainger, 1998) examined orthographic neighborhood effects with bilingual participants. English and Dutch words were used. In the first two experiments, progressive demasking techniques were employed. Results of

both experiments found inhibitory effects. Words with many neighbors were significantly slower than words with fewer neighbors.

Stimulus degradation techniques, such as progressive demasking (Grainger, 1996; Grainger & Segui, 1991) and spatial misorientation (Huntsman, 1998; Jordan & Huntsman, 1995), have been used to produce interference. Spatial misorientation, the orthographic inversion of a word 180 degrees, will be introduced in the current effort as an interference effect. According to Jordan and Huntsman (1995), misorientation affects lexical access by increasing response latencies and error rates. The decrease in reaction times suggests a shift from parallel processing of letters to serial, letter-by-letter processing (Huntsman, 1998; Jordan & Huntsman, 1995). If this is the case, then reaction times will increase as the position of the target word moves down the list from top position to the second position to the third position. Since each inverted high-frequency neighbor must be assessed letter-by-letter, more time will be required as the number of neighbors increase. Inversion may slow reaction times as a form of degradation, which may in turn enhance the neighborhood frequency effects that were not found in the Huntsman and Lima (1991) study.

This study hypothesizes that the combination of both higher-frequency neighbors and misorientation effects will generate enough interference to identify if frequency effects are occurring in an orthographic neighborhood, a result that is consistent with neighborhood frequency effects. If this theory is correct, then the number of higher-frequency neighbors a word has and the inversion of these words should affect reaction times and error rates.

Method

Participants

Thirty-six San Jose State University undergraduates participated in this study in exchange for course credit. All participants were native or fluent English speakers, right-handed, and had normal or corrected-to-normal-vision.

Materials.

Stimulus word items consisted of 50 word triplets selected from Kucera and Francis (1967). There were three types of stimulus words: those with no higher-frequency neighbor (top-position words), those with one higher-frequency neighbor (second position words), and those with two higher-frequency neighbors (third position words).

For example, the stimulus word SONG has a frequency of 70 per million, it has seven neighbors, it is in the second position in its orthographic neighborhood, and it is four letters in length. Specifically, SONG has seven neighbors: BONG, LONG, TONG, KONG, SING, SANG, and SUNG. More specifically, SONG has one higher-frequency neighbor above it (LONG) with a frequency of 755 and six lower-frequency neighbors below it (BONG, TONG, KONG, SING, SANG, and SUNG). The overall mean frequency for this neighborhood is 115.48.

The characteristics of the word triplets are word length with a mean of 4.58 and a range of 4-5, the number of neighbors with a mean of 4.58 and a range of 3-11, and word frequency with a mean of 30.87 and a range of 2-103. Important characteristics are listed in Table 1 for the stimulus words. Thirty

Table 1

Characteristics of stimulus words

Characteristic	Type of Word		
	Top-Position	Second-Position	Third-Position
Number of higher-frequency neighbors	0	1	2
Word length	4.58	4.58	4.58
Number of neighbors (mean of N)	4.52	4.34	4.88
Word frequency (mean)	31.52	31.02	30.08

practice words, 150 stimulus words, and 150 nonwords were used (refer to Appendix A for stimulus list).

Design

Thirty-six stimulus lists were generated. Each list contained random ordered identical stimuli. The stimulus lists consisted of 30 practice words, 150 experimental words, and 150 nonwords. The experimental triplets did not overlap in the neighborhood with each other or with the nonwords. This was a within-subjects design. The experiment had one independent variable (i.e. position) with three levels (i.e. top, second, third).

Apparatus

Stimulus word strings were displayed in lowercase letters on a computer monitor of an apple laptop computer. Letters were white against a black background. Participants chose a comfortable viewing distance. The average letter string subtended a visual angle of approximately 2 degrees. The keyboard of the laptop was used for initiating trials and making lexical decision responses. The letter K of the keyboard was labeled “YES” and the letter D was labeled “NO”.

Procedure

This experiment employed the lexical decision task. Trials were self-paced. Participants identified each stimulus item as a word or as a nonword. In the beginning of each trial, a fixation asterisk (*) appeared in the center of the screen. The asterisk then disappeared. A letter string then appeared in 350 ms in the center of the screen and remained until the participant made a response. Participants used the letter “D” on the keyboard that was labeled

“NO” to indicate a nonword response or hit with the letter “K” that was labeled “YES” to indicate a word response. Participants were instructed to respond as quickly and accurately as possible. Each participant completed 30 practice trials and 300 experimental trials. Practice items did not appear elsewhere in the experiment. Each session was completed in less than 30 minutes. letter string subtended a visual angle of approximately 2 degrees. The keyboard of the laptop was used for initiating trials and making lexical decision responses. The letter K of the keyboard was labeled “YES” and the letter D was labeled “NO”.

Results

Data sets for participants and for stimulus words were computed from the response times and error rate data. In the analysis of variance for subjects, computing mean reaction times and error rates over stimulus items for each participant formed two data sets. In the analysis of variance for items, computing mean reaction times and error rates over participants for each stimulus item formed two data sets. Any participants with an overall percent error (PE) higher than 30 was eliminated. Four participants were eliminated from the study that had a PE greater than 30.

The overall mean reaction time for experimental word trials was 1622 ms. Mean response latencies are shown in Figure 1 as a function of neighborhood position. The mean response times were 1646 ms for top position words, 1644 ms for second position words, and 1575 ms for third position words. Analyses revealed participant reaction times to be significant, $F(2,70) = 6.17, p < .01$. Reaction times were not significant, $F(2,98) = .25, p > .05$

Figure 1

Mean reaction times as a function of neighborhood position

in the item analyses, however. In the multiple comparisons, a significant difference was found between top and third position words, $t(35) = 3.00$, $p < .05$. A significant difference was also found between second and third position words, $t(35) = 2.60$, $p < .05$. No significant difference was found between top and second position words, $t(35) = .13$, $p > .05$.

The overall PE was 13.56 for experimental word trials. Error rates are shown in Figure 2 as a function of neighborhood position. The mean error rates were 13.69 for top position words, 13.59 for second position words, and 13.39 for third position words. Analyses indicated that, the subject PE was not significant, $F(2,70) = .06$, $p > .05$. The PE of items was also not significant, $F(2,98) = .15$, $p > .05$. No significant differences were found in the multiple comparisons, ($t < 1$).

According to the neighborhood frequency effect, top position words (i.e., words with no higher-frequency neighbors) should have been recognized the fastest (Grainger, 1990), however, third position words (i.e., words with two higher-frequency neighbors) were recognized the fastest in this experiment. Therefore, words such as HATE (a third position word) were recognized faster than words such as MOON (a top position word) or SONG (a second position word).

An examination of the items revealed the word KILL (a third position word) to yield the fastest reaction times in the study. The mean reaction time was 829 with a PE of .06. Therefore, the triad containing the words KILL, HUNG, and GROW was eliminated from the item analysis to make sure that this fast reaction time did not skew the rest of the data. The reason for doing this

Figure 2

Mean percent errors as a function of neighborhood position

was in an attempt to see if a neighborhood frequency effect like Grainger (1989) speculates would be apparent after the removal of the word with the fastest reaction time. Analysis of variance was repeated, and the differences among means was still not significant, $F(2,96) = 9.00, p > .05$.

Discussion

The results found in this study present a couple of implications for word recognition. The first important finding of this study was word position in its orthographic neighborhood is not affected by neighborhood frequency the way Grainger (1990) theorizes. As opposed to Grainger, the current effort found third position words to be recognized the fastest. Grainger's results led to the incorrect prediction that first position words would be processed the fastest. Although the results were not significant by items, they were significant by subjects. The second important finding was that inversion of the stimulus word did not enhance neighborhood frequency effects.

In the current experiment, misorientation was used to slow response times to see if neighborhood frequency effects would be more apparent. In opposition to Grainger's assumption (Grainger, 1989), the inversion of words did not enhance neighborhood frequency effects in this experiment. As stated above, Grainger's previous research showed facilitation effects with morphological priming (Grainger & Segui, 1991). The facilitation may have occurred because masked priming techniques were used. The response times in this study were not faster for stimulus words with no higher frequency neighbors. Furthermore, more time was not needed as the number of

neighbors increased (Huntsman, 1998; Jordan & Huntsman, 1995). It is unclear why other researchers (Sears, Lupker, & Hino 1999; Van Heuven, Dijkstra, & Grainger, 1998) examining orthographic neighborhoods by using interference techniques inhibitory neighborhood frequency.

Sears, Lupker, and Hino (1999), investigated the effects of orthographic neighborhoods with perceptual identification and semantic categorization tasks. Their study employed interferences as well. High and low visibility conditions were used as an interference. The first experiment had a significantly higher percent of correct identifications for words with high frequency neighbors in large neighborhoods, but the opposite was found in small neighborhoods. The neighborhood size effect was also found to be inhibitory. In the second experiment, a significant effect was found for neighborhood frequency in the low visibility condition for words with one higher-frequency neighbor. When interferences were used, words with higher-frequency neighbors were easier to identify than words with no frequency neighbors as in the current effort. Furthermore, no facilitatory or inhibitory effects were found.

The neighborhood frequency effects found in the current effort was consistent with Huntsman and Lima (1991). Using the lexical decision task, word position was manipulated to investigate neighborhood frequency. Although not significant, second position words were found to be the fastest and they concluded that word position in a word's orthographic neighborhood had no effect on response times. Like the current study Huntsman and Lima also failed to produce neighborhood frequency effects as postulated by Grainger.

Further research done by Huntsman and Lima (1996) generated different results than their first study (Huntsman & Lima 1991). In this study, neighborhood frequency did effect lexical decisions. They found response latencies and error rates to be affected by a word's orthographic neighborhood. Words at the top of their neighborhood yielded significantly faster response times than words at the bottom of their neighborhood. Significantly less errors were made for top words. Post-hoc analyses further supported the neighborhood frequency effect and the amount of interference a word has. Words with one or more higher-frequency neighbors did have significantly faster response latencies. The two experiments may have produced different results because the Huntsman and Lima 1991 study examined top, middle, and bottom words while their 1996 study only examined top and bottom words.

The mixed findings in the current and past research regarding neighborhood frequency makes it hard to assume that these effects are consistently present. The various results of orthographic neighborhood research leave uncertainties for theories examining word processing. The results of this experiment are opposite of Grainger's theory that words with one or more higher-frequency neighbors will be recognized slower, and that the amount of interference created is not affected by how many higher-frequency neighbors a word has (Grainger et al., 1989). These present findings propose that the neighborhood frequency effect is not occurring the way Grainger suggests.

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Appendix A
Human Subject Approval

San José State
UNIVERSITY

Office of the Academic
Vice President

Associate Vice President
Graduate Studies and Research

San José State
San Jose, CA 95192-1000

Phone: (408) 924-2480

Fax: (408) 924-2477

Internet: gsr@csj.sjsu.edu
<http://www.sjsu.edu>

TO: Michelle Yamamoto
932 Owens Lake Drive
San Jose, CA 95123

FROM: Nabil Ibrahim,
AVP, Graduate Studies & Research

DATE: April 14, 2000

The Human Subjects-Institutional Review Board has approved
your request to use human subjects in the study entitled:

**"Will Inverting Orthographic Neighbors
Enhance Neighborhood Frequency Effects?"**

This approval is contingent upon the subjects participating in your research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, and with regard to any and all data that may be collected from the subjects. The Board's approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Nabil Ibrahim, Ph.D., immediately. Injury includes but is not limited to bodily harm, psychological trauma and release of potentially damaging personal information.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services the subject is receiving or will receive at the institution in which the research is being conducted.

If you have any questions, please contact me at
(408) 924-2480.

The California State University:

Chico State
Bakersfield State
Fresno State
Long Beach State
Maritime State
Merced State
San Bernardino State
San Francisco State
San Jose State
Santa Clara State
Santa Cruz State
Stanford State
Stockton State
Sutter State
Tulare State
Trinity State
Yuba State

Appendix B
Human Subject Extension

San José State
UNIVERSITY

**Office of the Academic
Vice President**
Associate Vice President
Graduate Studies and Research

One Washington Square
San José, CA 95192-0025
Voice: 408-924-2480
Fax: 408-924-2477
E-mail: gstudies@yahoo.sjsu.edu
<http://www.sjsu.edu>

To: Michelle Yamamoto
932 Owens Lake Drive
San Jose, CA 95123

From: Nabil Ibrahim
AVP, Graduate Studies & Research

Date: April 9, 2001

This letter acknowledges that the Human Subjects-Institutional Review Board has received the request for extension of the following proposed study entitled:

"Will Inverting Orthographic Neighbors Enhance Frequency Effects?"

Since there are no major changes to the protocol, the Human Subjects-Institutional Review Board has granted this project a one-year extension effective from the date of this letter.

If you have any questions, please do not hesitate to contact me at (408) 924-2480.

Appendix C
Participant Consent Form

San José State
UNIVERSITY

**Office of the Academic
Vice President**

**Associate Vice President
Graduate Studies and Research**

1000 Washington Square
San José, CA 95131-0009

Phone: 408/284-2481

Fax: 408/284-2177

E-mail: gradstudies@sjstate.edu

<http://www.sjstate.edu>

AGREEMENT TO PARTICIPATE IN RESEARCH

Michelle Yamamoto, research assistant of the Psychology Department, is conducting a study with Dr. Laree A. Huntsman of how people use their mental lexicons, or mental dictionaries. You will be asked to make decisions about strings of letters you see on a computer screen, and you will indicate your decisions by pressing response buttons.

Benefits of participating in this research include learning more about how the mind stores and processes words. The possible risk of participating in this research is minimal eye strain equivalent to what might occur from 30 minutes of work on a computer. The response data are recorded in anonymous form. No information about you will be released to anyone in any way that could identify you. The entire session will take no longer than half an hour.

Participation in this study is completely voluntary. If you want to withdraw from the experiment at any time, you may do so without penalty. The data collected from you up to that point will be destroyed.

Once the study is completed, I would be glad to give you the results. In the meantime, if you have any questions, please contact me at 927-5931 or stop by DMH 313.

If you have any complaints about the procedure, you may contact Dr. Robert Cooper, Psychology Department chair at 924-5600. If you have questions about your rights as a participant you may contact Dr. Serena Stanford, Associate Academic Vice President for Graduate Studies at 927-2480.

I have received an explanation of this study as well as a copy of this consent from and I agree to participate.

Signature

Printed Name

Date

Investigator

Date

Appendix D
Stimulus List

path
drew
hung
moon
jump
poet
ship
rock
span
soil
pick
bowl
slab
trot
tube
myth
plot
drug
damn
gray
pink
glaze
crash
steam
dwell
bulge
lunch
shift
straw
brick
nurse
scoop
cramp
drill
draft
coast
bless
brush
belly
silly
folly
boost
crawl
gloom
blind
lodge
fetch
slave
guide
slump

tour
song
grow
task
star
clay
nine
nice
fury
risk
draw
deck
scar
drum
blow
calm
foam
card
tape
camp
luck
groom
trail
ditch
barge
bride
brain
chart
purse
brand
blink
goose
grunt
trash
guilt
mount
block
prime
begin
candy
vocal
cease
scout
nerve
shelf
spark
mouse
bleak
stool
pinch

hate
beat
kill
save
harm
walk
laid
gain
fuel
wild
holy
gang
glue
sign
horn
rice
rare
disk
wave
rain
mile
stove
roast
flush
greet
drank
tough
teach
storm
saint
flood
couch
hedge
theme
sweat
mouth
brood
hunch
motel
loyal
apple
guild
swear
blond
bloom
stray
cheer
creep
blend
dread