Word Attributes Predict the Speed of Translation from English to French (Do They Do So by Facilitating First Language Processing?)

by

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Abstract

It has been found that some attributes of a word predict how easy it will be to translate that word into a second language (Murray, 1986). It is not clear whether these attributes are specific to translation itself or reflect the ease of access to the lexicon in the first language. The present study was designed to provide a replication of Murray's results as well as to determine whether the word attributes that predict translation do so by facilitating processing in the first language, or by facilitating the production of a word in the second language. In a two phase study, twenty-six bilinguals identified English words from English non-words in a lexical decision task to provide a measure of first language processing. In the second phase they translated English words into French to replicate Murray (1986). The data were analyzed in two parts. First, following Murray, an item analysis which averaged response time over subjects was conducted for translation and lexical decision. A multivariate regression analysis of the scores revealed that word frequency was the best predictor of both translation ease and lexical access; and that number of synonyms, age of acquisition, and goodness correlated highly with both processes; memorability, similarity, and emotionality appear to be unique predictors of translation. Second, a within subject comparison of translation time with lexical decision times for words seen earlier in the experiment revealed that lexical decision reaction time had a small but

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highly reliable correlation with translation time. There was no pronounced effect of the lexical decision task on the speed of translation.

Word Attributes Predict the Speed of Translation From English to French (Do They Do So by Facilitating First Language Processing?)

Translation is a task that requires a response to a word given in a first language with a response in another language that has the same or a related meaning. For example if the English word "chair" is to be translated into French, a correct response would be "chaise". This French equivalent is only one of many possible reactions that the English word "chair" can arouse (Murray, 1986, p. 353-354). Certain word characteristics such as the frequency of the word in the language or the similarity of the translation equivalents, can make the translation process easier (Murray, 1986). The identified characteristics may facilitate translation either by describing the access to the lexicon in the first language, or by describing the retrieval of a related word in the second language. The purpose of the present investigation was to replicate Murray (1986) and to determine whether the facilitating word characteristics identified by Murray facilitate access to the lexicon in the first language or facilitate retrieval of a related word in the second language.

Translation

It has been claimed that translations can be derived from semantic memory, from episodic memory, or from procedural memory (Murray, 1986). Procedural memory is essentially "know-how knowledge" and is mainly involved in motor skills (e.g., tying shoelaces, typing, skiing). Episodic memory is memory for specific, personally experienced past events. In episodic memory, various items are related to other events in life and it is frequently possible to remember when an item or event occurred. Semantic memory refers to a structured and stable representation of knowledge. Items of information or word meanings are recalled but not information specific to when the word was actually learned. Murray (1986) suggests that foreign vocabulary is an example of information in semantic memory. It is suggested that generally we only recall the meaning of the words in direct association with the first language equivalent and typically we do not explicitly remember the context in which second language words were learned.

Murray (1986) investigated the hypothesis that factors that are known to be specific to semantic memory are more important for translation than are factors specific to episodic memory. This hypothesis was evaluated in an item analysis involving a multiple regression and a factor analysis of the average time it took to translate an item. These analyses used measures from 15 category variables and 10 independent measures for each item. It was found that some of the category variables were correlated with semantic memory, while others were correlated with episodic memory. Only a few of the variables were required to predict the ease of translation. Translation task was influenced by characteristics of words such as: the frequency of words in the language, the similarity of translation equivalents, the associative difficulty, the age of acquisition, the meaning uncertainty, the familiarity of the words, and the number of meaning and imagery. Because these above factors are known to affect retrieval from semantic memory, it suggests that translation is primarily a task involving semantic memory. Word characteristics like emotionality and concreteness, known to affect episodic memory, were less important in determining the efficiency of translation. A factor analysis found that the factor that weighed most heavily on the measures of translation ease also weighed heavily on word frequency and similarity, whereas the factor that loaded most heavily on episodic recall also loaded most heavily on memorability and emotionality. Murray (1986) interpreted the results as an evidence for a dichotomy between episodic and semantic memory, with translation being a task involving mainly semantic memory. Finally, Murray also found that the more errors associated with finding the translation for a word, the longer the mean reaction time to translate. This implies that translation accuracy as well as translation speed is a semantic memory task.

The results of Murray (1986) suggest that translation is an example of information in semantic memory. Word attributes which facilitate retrieval from semantic memory also influence the ease of translation, while word aspects which are associated with episodic memory retrieval do not affect ease of translation.

<u>Lexical decision task</u>

It is possible that word characteristics may influence the ease of translation by facilitating access to the lexicon in the first language rather than the generation of a word in the second language. The lexicon is hypothesized to be the place in the language processing system where diverse information codes come together (Foss, 1988). A lexical item is associated with information about its phonetic, spelling, a specification of its syntactic category, and other information as well. The lexicon is the place where the diverse codes can communicate.

Psychologists have been interested in the process involved in word recognition for a long time. In studying variables that affect the speed of lexical access, researchers have relied heavily upon the lexical decision task (Balota & Chumbley, 1984). A lexical decision task involves the retrieval of information about a word or a lexical item. Information about the lexical item may decrease the reaction time to decide if a stimulus item is a word or a non-word. Most lexical decision investigations involved the examination of a within-subject manipulation of category variables on speed of lexical access (see Balota & Chumbley, 1984; Bleasdale, 1987; Brown & Watson, 1987; Day, 1977; Gernsbacher, 1984; James, 1975; Kroll & Merves, 1986; Richardson, 1975,1976; Scarborough, Cortese, & Scarborough, 1977; Schwanenflugel, Kipp Harnishfeger, & Stowe, 1988; Schwanenflugel & Shoben, 1983). The present study differs from those studies in that it used item based correlation between the category values and the lexical decision results.

There is an influence on lexical decision of several word characteristics that have been found to influence translation. The frequency of the word is one of the most stable characteristics of decision time in lexical decision experiments (Frederiksen & Kroll, 1976; Scarborough et al, 1977). Indeed, Balota and Chumbley (1984) suggested that the demand characteristics of the decision process in the lexical decision task may result in an exaggerated role of word frequency. They found that changing the task that is used to access the lexicon resulted in dramatically different effects.

Connine, Mullennix, Shernoff, and Yelen (1990) found a reaction time advantage in lexical decision for both high-familiarity and high-frequency words. Brown and Watson (1987) however, found that rated age at which a word was learned is a better predictor of word naming latency than are word frequency and other variables. Gernsbacher (1984) manipulated lexical familiarity as assessed by experimental familiarity, bigram frequency, semantic concreteness, and number of meanings. She concluded that only experimental familiarity reliably affected recognition latencies. In fact, it has been shown that professionals (Gardner, Rothkopf, Lapan, & Lafferty, 1987) respond to words pertinent to their profession more rapidly than when responding to words not normally used within their profession. Fardner et al (1987) concluded that the frequency of occurrence of familiar words is of major importance in the rapidity of lexical decision concerning such words.

Word characteristics such as concreteness and imagery, which were found by Murray (1986) to be less influential on the ease of translation have also been investigated in lexical decision.

Concreteness of words produced inconsistent results. James (1975) found a ceiling effect; lexical decision reaction times for concrete words were faster than for abstract words, only when the words were of relatively low frequency. Day (1977) found effects of mixed versus blocked lists. Lexical decision reaction times were shorter for concrete words when the words were presented in the left visual field (i.e., to the right hemisphere). Kroll and Merves (1986) found that lexical decision reaction times for concrete words were shorter when blocks of abstract words followed blocks of concrete words. When blocks of concrete words followed blocks of abstract words there was no difference in response time. Schwanenflugel and Shoben (1983) found that lexical decision times were longer for abstract than for concrete words in the absence of context. With a sentence context, however, the reaction times for the concrete and the abstract words were equivalent. Context availability (Schwanenflugel et al, 1988) was found to be a better predictor of lexical decision time than imagery and concreteness, familiarity, or age-of-acquisition ratings. Bleasdale (1987) proposed that the lexical process may be functionally distinct for concrete and abstract words. However, Richardson (1975, 1976) found no evidence for any reaction time differences in lexical decision tasks for concreteness and imagery.

The literature indicates that word frequency, familiarity, and age of acquisition influence lexical decision tasks, and that concreteness and imagery influence lexical decision under certain conditions. These variables may influence translation time by influencing the initial first language process prior to the generation of a response in the second language.

Priming effect

Priming effect refers to the facilitative effect of performing a task after performing the same or a similar task (Tulving, 1983). It is possible that a situation involving a lexical decision task followed by a translation task on the same word facilitates the translation by priming the word. To evaluate the hypothesis that translation speed is affected by factors influencing lexical access in a first language, the factors are directly manipulated. If words presented in a lexical decision task in a first step, and translated in a second reliably results in shorter reaction time, the repetition of the word in the two steps would suggest a priming effect. However, if there appears to be a decrease in lexical decision reaction time in a same language situation, most studies suggest no advantage when the stimuli are repeated in different languages (Kirsner, Brown, Abrol, Chadha, & Sharma, 1980; Kirsner, Smith, Lockhart, King, & Jain, 1984; Scarborough, Gerard, & Cortese, 1984). Between language priming has been found under specific conditions, for example when the words in the two languages are morphologically similar (Cristofanini, Kirsner, & Milech, 1986), or when the study presentation precedes the test by extremely short time lapses (Glanzer & Duarte, 1971; Kirsner et al, 1984; Schwanenflugel & Rey, 1986), or when the subjects are instructed to translate the words during the study presentation (Kirsner et al, 1984). Similar results were found when a word-fragment completion task was used to assess facilitation. Durgunoglu & Roediger (1987) studied the effects of language change on priming tasks and found that if the study language matched the test language, the fragment completion rates were significantly improved compared to non-studied words. If the study language was different from the task language however, the fragment completion rates were not significantly better than the rates for non-studied words. Thus, priming effects for both lexical decision and fragment completion tasks have been found to occur only if the study and the test are done in the same language.

<u>Within-subject assessment of lexical access on translation</u>

There is the possibility that the task of identifying a word in lexical decision may provide some prediction about the performance on translation. Items slowly responded to in one task may be responded to slowly in the other, or items which result in fast responding in one task may be responded to quickly in the other, or items which are rapidly responded to in one task are not responded to quickly in the other task.

<u>Experiment</u>

The present experiment had four purposes. First, it was designed as a partial replication of Murray's (1986) results. To that end, twenty-six English-French bilinguals were given English words to translate, and their reaction time to translate these words were measured. A second purpose of the present study was to determine which variables would predict both translation and lexical decision, and which would be unique to translation or lexical decision. For that purpose, all twenty-six bilinguals identified the words in a lexical decision task, and their reaction time to identify the words from non-words were measured. The stimulus presentation for the translation and the lexical decision tasks was the same, with only the instructions for responding being different. Third, the present study was designed to investigate whether lexical decision reaction time was predictive of translation time for the same word. To this end, an item correlation between lexical decision reaction time and translation reaction time was performed for primed and non-primed words. Finally, in addition to an item analysis, the extent to which processing for individual subjects within the first language may be used to predict translation time was also examined. To this end subjects were timed on both a lexical decision task and a translation task. The reaction time to decide if a word stimulus is a word or a non-word was correlated with the reaction time to translate.

Method

Subjects

Twenty-six students participated in the experiment. For 22 students English was their first language and French their second. Four students had French as their first language and English as their second. The students were enrolled in a Modern French Usage and Translation course given by the French department at Lakehead University.

Material

The 144 words and corresponding norms on 21 dimensions (15 categories and 6 dependent variables) were taken from the 145 words used by Murray (1986). The following is a description of the 15 category variables and the 6 dependent variables:

Category variables:

Rated memorability (MEM). Sixty students rated each word on a 7-point scale, on how memorable they thought a word was (Murray, 1986): M = 3.83, S.D. = 0.63, min = 2.6, max = 5.47.

Rated intensity (INT). Fifty-nine students rated each word on a 7-point scale, on how intense they thought certain words would be. "Intense" meant "striking, interesting, and arousing" (Murray, 1986): M = 3.22, S.D. = 0.99, min = 1.45, max = 5.83.

Rated emotionality (EMOT). Each word was rated on a 7-point scale for how strongly emotional the meaning is. The kind of emotion was not relevant, only the intensity of emotion mattered (Brown & Ure, 1969): M = 3.57, S.D. = 1.35, min = 1.55, max = 6.45.

Similarity of English and French equivalents (SIM). Thirty-two students rated each word on a 7-point scale, on how similar they thought it was to the French equivalent (Murray, 1986): M = 4.25, S.D. = 1.71, min = 1.7, max = 6.97.

Rated goodness (GOOD). Each word's meaning was rated on a 7-point scale, on whether the meaning is good or bad, and how intensely good or bad it is (Brown & Ure, 1969): M = 4.47, S.D. =

1.26, _min_ = 1.2, _max_ = 6.66.

Rated pleasantness (PLEA). Each word's meaning was rated on a 7-point scale on whether the meaning is pleasant or unpleasant, and how intensely pleasant or unpleasant it is (Brown & Ure, 1969): _M_ = 4.41, _S.D._ = 1.32, _min_ = 1.26, _max_ = 6.74.

Associative difficulty (ASDIF). Volunteers had to decide on a 7-point scale how quickly and easily they could find a rich flow of associations to the words (Brown & Ure, 1969): _M_ = 3.61, _S.D._ = 0.74, _min_ = 1.97, _max_ = 5.15.

Age-of-acquisition (AACQ). Thirty-six student volunteers were asked to state when they believed they had learned a word according to the following scale: 1 (age 0-2 years), 2 (age 3-4 years), 3 (age 5-6 years), 4 (age 7-8 years), 5 (age 9-10 years), 6 (age 11-12 years), and 7 (age 13 years and older) (Gilhooly & Logie, 1980): _M_ = 3.3, _S.D._ = 1.06, _min_ = 1.44, _max_ = 6.31.

Familiarity (FAM). Thirty-six student volunteers rated the words on a 7-point scale as to the number of times they have experienced them, with: 1 "never seen, heard, or used" and 7 "seen, heard, or used every day" (Gilhooly & Logie, 1980): _M_ = 5.38, _S.D._ = .075, _min_ = 3.14, _max_ = 6.83.

Concreteness (CONC). Words referring to objects, materials, or persons received a high concreteness rating on a 7-point scale. Words referring to abstract concepts that could not be experienced by the senses received a low concreteness rating. Thirty-six students rated the words (Gilhooly & Logie, 1980): _M_ = 5.03, _S.D._ = 1.46, _min_ = 2.23, _max_ = 6.8.

Word frequency (WRDFQ). Each word's frequency was taken from Kucera and Francis (1967). Because of the wide range involved, Murray (1986) transformed the raw values into natural logarithms to make the range more compatible with the measures on the other variables: M = 3.54, S.D. = 1.5, min = 0, max = 6.3.

Imagery (IMAG). Words arousing an image most readily were rated 7. Words arousing images with great difficulty or not at all were rated 1. Thirty-seven student volunteers rated the words (Gilhooly & Logie, 1980): M = 5.27, S.D. = 1, min = 2.3, max = 6.59.

Meaning uncertainty (MU). In a first step, 17 student volunteers were asked to indicate on a 3-point scale whether they judged the word to have one, two, or three or more meanings. Words which were rated by three or more participants as ambiguous were given to 40 student volunteers who wrote down the first meaning of the word that occurred to them. The relative frequencies of each meaning was then calculated. A score of 0 implies there was no ambiguity about the meaning of the word. The higher the score, the less certain the subject is about the intended meaning of the word (Gilhooly & Logie 1980): M = 0.23, S.D. = 0.41, min = 0, max = 1.72.

Number of meanings (NMEAN). The number of meanings of a word were taken from dictionaries which demarcate separate meanings of words and give lists of synonyms under each (Murray, 1986): M = 5.25, S.D. = 4.58, min = 1, max = 26.

Number of synonyms (SYN). The number of synonyms for each word was derived by counting the number of synonyms found in a synonym dictionary (Murray, 1986): M = 83.84, S.D. = 78,11, min = 4, max = 590.

Dependent variables:

Long-term recognition (RECOG). The proportion of 53 students correctly recognizing each word in a recognition task (Murray, 1986): M = 0.59, S.D. = 0.32, min = .07, max = 0.94.

Long-term recall (RECAL). Fifty-four students wrote down as many words as they could recall, in any order after presentation of the word list (Murray, 1986): M = 0.18, S.D. = 0.13, min = 0. max = 0.82.

Reaction time to give English equivalents to French words (RTE). The reaction times of 11 students translating the words from English into French were measured (Murray, 1986): M = 1.32, S.D. = 0.56, min = 0.7, max = 4.24.

Number of students not knowing the English equivalent of a French word (ENGER). For each word, the number of students (out of 11) not knowing the exact word, or making an error, was determined (Murray, 1986): M = 1.62, S.D. = 2.94, min = 0, max = 11.

Reaction time to give French equivalents to English words (RTF). The reaction times of 10 students translating the words from French into English were measured (Murray, 1986): M = 1.742, S.D. = 1.188, min = .82, max = 7.81.

Number of students not knowing the French equivalent of an English word (FRER). For each word, the number of students (out of 10) not knowing the exact word, or making an error, was determined (Murray, 1986): $\underline{M}$ = 1.62, $\underline{S.D.}$ = 2.267, $\underline{min}$ = 0, $\underline{max}$ = 9.

The values for word frequency, rated emotionality, rated goodness, rated pleasantness, associative difficulty, rated imagery value, age of acquisition, rated familiarity, concreteness, number of meanings, and uncertainty were checked against the original sources, and 25 entry errors were found. Comparisons of the corrected data with the original revealed only minor changes in the inter-correlations between the categories of variables and those described by Murray (1986). It was not possible to double check the entries for data collected by Murray.

The last word from Murray's (1986) list of 145 words was dropped to obtain an even number of words so that 2 balanced sub-lists could be created for the lexical decision task. The 144 words were sub-divided into two approximately balanced sub-lists, A, B, by assigning words from odd numbered rows of the master list to sub-list A and words from even numbered rows to sub-list B. To serve as distracters in the lexical decision task a set of non-words was generated on the basis of words from the word list by rearranging and substituting several letters in each word. The non-words were constructed to be as pronounceable, and to look as much like English words as possible without giving the illusion that it was a misspelling of an actual English word. For example, "accordance" became "abbordence" and "description" became "descroptium" (see appendix for complete list of words and non-words). At the beginning of each list the same six items were presented as practice items. The participants were not told that these six items were practice items.

<u>Design</u>

The average time it took bilingual students to generate a French translation from an English word was gathered for 144 words and averaged over 26 subjects. For lexical awareness, the average time it took bilingual students to identify an English word from non-words was gathered for 72 words and averaged over 13 subjects. Potential priming effect of the lexical decision on translation was evaluated by comparing within-subject the translation reaction times for words presented in the lexical decision task to words not presented in the lexical decision task. A within-subject correlation between lexical decision reaction time and translation reaction time was performed on 72 items per subject to evaluate the predictability of translation from the performance on lexical decision.

<u>Analysis</u>

The results of the experiment will be reported in the order of the theoretical implication by reporting the replication of Murray's (1986) study first, and then the lexical decision to assess the generalization of the theory.

The translation data collected in the experiment were initially analyzed following Murray (1986). First, a correlation among all variables was performed. It was expected that the characteristics identified by Murray would also correlate with the present translation times. Second, multiple regressions were performed to identify the best predictors of translation. Third, a factor analysis was performed to determine the weight of the variables.

Similar analyses were conducted on the lexical decision reaction time, and factors predictive of translation were compared to factors predictive of lexical decision. It was attempted to determine if the same factors are predictive of both ease of lexical access and of translation.

Because participants performed a lexical decision task on half the words that they were to translate, subjects translated words they had recently encountered. To determine the extent of a repetition priming effect, the time it took to translate these words was compared to words that had not been exposed.

Finally, correlations between lexical decision time and translation time were performed for each subject to determine if a participant's lexical decision time would be used to predict that participant's translation time.

<u>Procedure</u>

All stimulus materials were presented on a CRT monitor under computer control and all responses were recorded to the nearest millisecond by the computer. Participants were tested individually in a session lasting less than an hour. At the beginning of the session, the experimenter told the participants that they would be asked to perform two tasks; a lexical decision task and a translation task.

The words were presented one at a time on the computer screen. Each word was presented in the centre of the screen and the letters were 1 centimetre in height. The subject sat at a distance comfortable for them, 40 to 50 cm from the screen. When the participants were ready to begin the session, the experimenter pressed the "enter" key to initiate the first trial. Within 30 msec of the release of the key, the word was presented. A 100 msec auditory cue (a beep) preceded the presentation of each word. The timing started when the word appeared on the screen and stopped when a key on the keyboard was pressed. The stimuli were presented until the participants made a response.

Lexical decision

First the lexical decision task was explained to the participants. They were told: "A string of letters representing either an English word or a nonsense word will appear on the screen. You will have to identify the string of letters as being an actual English word or a nonsense word as quickly and accurately as you can. Two specially marked keys at the bottom of the keyboard are used, one to record "Yes, it is an English word", and one to record "No, it is a nonsense word"." Two hands were used for making the responses. The left index was used to hit the "No" key and the right index was used to hit the "Yes" key. Once the procedure was clear to the participants, the experimenter introduced them to the experimental apparatus and demonstrated its use. When the participants indicated that they were ready to begin the lexical decision task started.

Translation

After the lexical decision task, the translation task was explained to the participants. They were told: "An English word will appear on the screen. You translate it as quickly and as accurately as you can. Press the "enter" key as soon as you think of a French translation equivalent and say that word aloud. Some words will be easy and some will be difficult. There may be English words for which you never learned a French equivalent; if this happens, say so. You may not be able to translate all the words, but try to translate as many words as you can, as quickly and as accurately as possible." The translation required the same apparatus as the lexical decision. When the participants were ready, the session began. With the informed consent of the participants, their answers were tape recorded to help the experimenters correct the translation. When the session was over, the experimenter answered any further questions the participants may have had.

Murray (1986) used voice-keyed reaction times. There are some potential problems associated with using voice-keyed reaction times. Not all subjects may pronounce the word loud enough to stop the timing. Extraneous noises may accidentally trigger the voice-key. Incidental noises made by the subjects not related to speaking may also trigger the voice-key. The present study asked the subjects to press a key as soon as they thought of a translation. It has been shown that manual naming reaction times (pressing a key) correlated with voice-keyed reaction times and imagery reaction times (Paivio, Clark, Digdon, & Bons, 1989).

Results

Because the first purpose of the present study was to replicate Murray's (1986) study, the first set of analyses follow those described by Murray. A Pearson item correlation among all the variables, two multiple regressions with translation reaction time and translation error as independent variables, and a factor analysis were performed on the translation measures.

For the lexical decision measures, the same set of analyses was performed, substituting lexical reaction time for translation reaction time. A Pearson item correlation, two multiple regression with lexical decision reaction time and lexical decision error as independent variables, and a factor analysis on all the variables were done to determine the weight of the factor predicting translation measures and lexical decision measures.

Three items were dropped from the analyses of the present data set because less than 6 students translated these words correctly. With only 2 or 3 subjects producing a reaction time for a given item, a selection effect may be produced because only the fastest students may translate the item and result in short reaction time for these words. Following Murray (1986), logarithmic transformations were performed on: IMAG, MU, NMEAN, SYN, RECOG, RECAL, RTE, RTF, FRER, and ENGER to adjust for skewed distribution. To remain consistent with the analyses reported by Murray, the translation measures of this study were also transformed. For symmetry, the same transformation was applied to the lexical decision measures. Using the non-transformed response measures had no effect on the result patterns. TRT _skewness_ = 0.521, TER, _skewness_ = 0.948, LRT, _skewness_ = 2.257, and LER, _skewness_ = 3.746, were found to be skewed when checked for normality. For this sample size, a skewness of .413 departs significantly from the normal distribution. After this transformation, lexical reaction time, translation accuracy, and lexical accuracy scores were still skewed, but less than before the transformation. All analyses were performed on the transformed data.

Translation, correlations

This analysis included the 15 category variables, Murray's (1986) translation, recognition, and recall measures, and the translation and lexical decision measures of the present study. By using the standard method of assessing the significance of an individual correlation ($p < .05$) among the 300 correlations, it would be expected that in a set of 300 correlations 15 correlations may occur by chance alone. The Bonferroni procedure ensures that the likelihood of accepting any correlation in the set of 300 correlations by chance is .05. The Bonferroni correction was applied to the data, and any correlation over .29 is significant at .05, and any correlation over .32 is significant at .01.

Pearson correlations among the 25 variables revealed several minor differences between Murray's (1986) study and the present

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Insert Table 1 about here

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one. These differences did not occur only in correlations where reaction time to give French translation of English word and number of students not knowing the French equivalent of English word were substituted, but also for correlations among the category variables for which the values provided by Murray were used. However, all differences are very small (maximum .1) Most of the differences occurred in correlations with pleasantness, meaning uncertainty, and recall.

Insert Table 2 about here

The similarity of an English word with its French equivalent word was significantly correlated with reaction time to translate, $r = -.37$, $p < .01$, as was also found by Murray (1986). However, similarity did not significantly correlate with translation error, $r = -.07$, $p > .05$. In fact, translation error did not correlate significantly with any of the variables.

Translation reaction time, $M = 1.706$ seconds, S.D. = 0.652, min = 0.682 seconds, max = 3.319 seconds, correlated significantly, $r = .72$, $p < .01$, with Murray's (1986) reaction time to give French translation of English word, $M = 1.742$ seconds, S.D. = 1.188, min = .82 seconds, max = 7.810 seconds. A t-test between the two means was not significant (t (140) = .45, _p_ = .652). When the present data for 26 subjects were split in half, the two subsets of translation reaction time of 13 subjects correlated significantly, $r = 0.75$, $p < .001$, which is comparable to the correlation between Murray's translation reaction time and the present translation reaction time. These results suggest that both studies are dealing with a similar population. But translation error of English to French, $M = 4.96$ errors, $S.D. = 4.784$, _min_ = 0 error, _max_ = 20 errors, did not correlate significantly with Murray's, $M = 1.57$ errors, $S.D. = 2.26$, _min_ = 0 error, _max_ = 9 errors, $r = -.08$, $p > .05$. A t-test between the present mean translation error, $M = 1.191$ errors, $S.D. = .184$, and Murray's mean translation error, $M = 1.60$ errors, $S.D. = .228$, was not significant, $t\ (140) = -1.3$, $p = .196$, suggesting that both studies are dealing with a similar degree of accuracy in translation. When the present translation error data were split in half, the two sub-tests of 13 subjects, correlated significantly, $r = .84$, $p < .001$, indicating a consistency in the present subject sample. In addition, translation error did not correlate significantly with translation reaction time, $r = -.04$, $p > .05$, as observed by Murray. This finding is counter intuitive as it would be expected from a simple process model of reaction time and error that the longer the mean reaction time for translating a word, the greater the likelihood of an error for the word. It is possible that the participants in the present study never learned English to French translations for some of the words and that the factors involved in the likelihood of acquiring this knowledge are not those involved in predicting the ease of translation, once the knowledge is acquired.

Translation, multiple regression

Following Murray's (1986) procedure, stepwise multiple regressions were performed on reaction time to translate and the error of the translation. As used by Murray, the criteria for entering into the regression equation was a *p* of .05. As can be seen in Table 3, the most important sources of variance in

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Insert Table 3 about here

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translation reaction time was contributed by word frequency, $t = -5.845$, $p < .0001$, memorability, $t = -5.011$, $p < .0001$, similarity, $t = -4.924$, $p < .0001$, goodness, $t = -4.423$, $p < .0001$, age of acquisition, $t = 2.966$, $p = .0036$, emotionality, $t = 2.841$, $p = .0052$, and number of synonyms, $t = 2.096$, $p = .0379$. In comparing Murray's regression equation to the regression equation for the present data, some variables entered in the regression equations are similar, and some are different. Word frequency and similarity were entered in both the present multiple regression equation and in Murray's. Associative difficulty, which was entered in Murray's regression equation, was not significant in the present analysis. Associative difficulty may not may have gained entry into the regression equation because of its intercorrelation with category variables already entered into the regression equation. Associative difficulty was redundant with memorability, goodness, age of acquisition, emotionality, and number of synonyms, which have been included in the present regression equation but not in Murray's. Associative difficulty correlated significantly with word frequency, $r = -.33$, $p < .01$, memorability, $r = -.34$, $p < .01$, goodness, $r = -.47$, $p < .01$, age of acquisition, $r = .66$, $p < .01$, and emotionality, $r = .-32$, $p < .01$.

The present results are consistent with Murray's (1986), but include additional factors, perhaps because the present study used a larger sample. Because the translation measures for a larger sample of participants (26 for the present study vs. 10 for Murray), would lead to a decrease in random error, then variables which had not been entered into Murray's would be entered into the present multiple regressions.

<u>Translation, factor analysis</u>

Following Murray (1986), a factor analysis was performed on the data provided by Murray, and the two lexical decision and the two translation measures from the present experiment. A principal component analysis (default values for all criteria, principal component analysis, Kaiser normalization, varimax rotation), rather than a principal axis factoring, was used because it provided a better match for Murray's results. The principal axis factoring resulted in a quantitative rating change, but had a qualitative pattern similar to the principal component analysis.

Because the present analysis employed the same variables as Murray (1986), in addition to the present translation and lexical decision measures, it was expected that a same set of factors will appear.

The weights for the factors were similar for the present factor analysis as in Murray (1986). The weights have a similar pattern, but with the exception of the addition of factor 6. The following is a detailed description of the factors.

Insert Table 4 about here

Factor 1 has loadings of 0.80 on Murray's (1986) reaction time to translate from English into French, 0.78 on the present reaction time to give French translation of English word, 0.76 on Murray's number of students not knowing the French equivalent of English word, and 0.76 on Murray's number of students not knowing the English equivalent of French word. This factor has heavy loadings on word frequency (0.64), similarity (-0.55), and familiarity (-0.54). In contrast to Murray's results, this factor has a small loading (0.14) on translation error.

Factor 2 has loadings of 0.92 on imagery, 0.83 on concreteness, -0.82 on age of acquisition, and -0.67 on associative difficulty. High scores in age of acquisition is indicative that an item is rated as having been acquired later in life and higher score in associative difficulty is indicative that it is harder to find associations for that item. Although, factor 2 seems to load heavily on variables associated with good memory, this factor is not predictive of translation reaction time (−0.15) or translation error (−0.07).

Factor 3 has loadings of 0.92 on emotionality, 0.89 on intensity, and 0.85 on memorability. These variables constitute a cluster similar to the one reported by Murray. The next highest loading (0.39) was on concreteness. This factor is not related to the translation measures.

Factor 4 has high loadings on number of meanings (0.87), number of synonyms (0.84), and meaning uncertainty (0.62). Factor 4 has a negligible loading on translation error (−0.25).

Factor 5 has loadings of 0.90 on pleasantness and of 0.89 on goodness, with the next highest weighting on associative difficulty (−0.47).

Factor 6 was not present in Murray's (1986) analyses and has a loading of −0.75 on translation error. The next highest weighting is on recognition (0.50) and frequency is next with (−0.46). This factor is unique to the present study and does not have any equivalent in Murray (1986). This factor is a useful predictor of the present translation error and of recognition. It may be that subjects made errors in translation because they were not familiar with the English word. If they were not familiar with the English word, then they would have difficulty in recognizing an item. However, because factor 6 has a negligible weighting on lexical decision (0.22) and on recall (0.02), then factor 6 cannot be treated as a simple result of familiarity.

The main factors that both Murray (1986) and the present study found, were also found in an analysis by Rubin and Friendly

(1986) that included many word variables but not translation.

<u>Lexical decision, multiple regression</u>

The second purpose of this study was to identify variables predictive of both translation reaction time and lexical decision reaction time, and variables unique to either translation or lexical decision.

A stepwise multiple regression was performed on the data in order to identify the variables which contributed most to lexical decision. As can be seen in Table 3, the SPSS regression programme revealed that the best predictors of lexical decision were age of acquisition, $t = 4.765$, $p < .0001$, and word frequency, $t = -4.058$, $p = .0001$.

While word frequency, memorability, similarity, goodness, age of acquisition, emotionality, and number of synonyms are predictive of ease of translation; only age of acquisition and word frequency were predictive of lexical decision. Lexical decision was not significantly correlated with number of synonyms, $r = -.20$, $p > .05$, memorability, $r = 0.10$, $p > .05$, similarity, $r = .08$, $p > .05$, emotionality, $r = .05$, $p > .05$, and rated goodness, $r = -.17$, $p > .05$. Furthermore, while familiarity was predictive of lexical decision and was not entered in the regression equation for translation, familiarity correlated significantly with the independent variable translation reaction time, $r = -.46$, $p < .01$. Familiarity was also intercorrelated with several category variables entered in the regression equation for translation reaction time, word frequency, $r = .65$, *p* < .01, age of acquisition, *r* = −.63, *p* < .01, and number of synonyms, *r* = .30, *p* < .05.

Significant correlations between lexical decision reaction time and translation reaction time, *r* =.32, *p* < .01 indicate that translation may not be independent of factors predicting lexical decision task. Interestingly, when the regression equation was calculated on translation reaction time and then on lexical reaction time, with translation reaction time, translation error, lexical reaction time, and lexical error included among the regression variables, it appeared that lexical decision error and lexical decision reaction time were significantly predictive of translation reaction time, *R Square* = .6380, *B* = −1.492, *Beta* = −.177, *t* = −2.766, *p* = .0065 and *R Square* = .6380, *B* = .304, *Beta* = .127, *t* = 2.000, *p* = .0476, respectively. However, neither translation reaction time nor translation error were entered in the regression equation for lexical reaction time. These results suggest that the significant correlations of translation with lexical decision reflects a causal model of lexical access. An easy way of summarizing these results is to assume that access in English is required and hence is predictive of translation, but translation is not required for lexical access, and therefore, is not predictive of lexical access.

Lexical decision, factor analysis

A factor analysis was performed on the data, including the translation measures from both the present study and Murray (1986), and the lexical decision measures.

As can be seen in Table 4, factor 1 weighted heavily on all translation measures with the exception of translation error from the present study and the category variables word frequency, similarity, and familiarity. Factor 1 also had a large weighting on lexical decision measures, 0.36 on lexical decision reaction time and −0.46 on lexical decision error. In summary, these results reveal that factor 1 is a useful predictor of translation and lexical decision, suggesting that a common factor underlies these processes. Factor 1 may be a semantic memory variable influencing both translation and lexical access ease.

Factor 2 had high weighting on imagery, age of acquisition, concreteness, associative difficulty, similarity, and familiarity. Factor 2 has also a weighting of −0.34 on lexical decision reaction time and of −0.20 on lexical error. Factor 2 was not predictive of translation measures.

Factor 3 has little influence on translation or lexical decision measures.

Factor 4 has a weighting of −0.32 on lexical decision reaction time and −0.20 on lexical decision error. Factor 4 also has a small weighting on translation error (−0.25).

Factor 5 and 6 have little influence on translation and lexical decision measures.

The results indicate that translation ease is predominantly predicted by factor 1. However, multiple factors (factor 1, factor 2, and factor 4) seem to be equally predictive of ease of lexical access. These results would suggest that variance in translation is based upon a few factors, while variance in lexical access is based upon multiple factors.

Priming effect

The participants in the present study performed a lexical decision task on half the words that they had to translate. As a test of the priming effect, paired t-tests were performed within-subjects on the reaction time and error to translate for prime-words and non-primed words. There was no priming effect for reaction time to translate, t (25) = 0.54, p = .59. Reaction time for primed words, M = 1.800 seconds, S.D. = 0.707, min = 0.369 seconds, max = 3. 484 seconds, compared to reaction time for non-primed words, M = 1.769 seconds, S.D. = 0.717, min = 0.342 seconds, max = 4.084 seconds. There was also no priming effect for errors of translation, t (25) = −0.47, p = .646. The accuracy of translation for primed words, M = 57 correct translations, S.D. = 7.272, min = 44 correct translations, max = 72 correct translations, compared to the accuracy of translation for non-primed words, M = 57.423, S.D. = 6.760, min = 38 correct translations, max = 69 correct translations.

Within-subject correlations

A within-subject item correlation between lexical decision reaction time and translation reaction time based on 72 reaction times per subject revealed a significant but small correlation, r = .121, p = .0003. The mean number of words out of 72 correctly identified in the lexical decision task and correctly translated was 56.27. It should be noted that the item correlation between lexical decision and translation was greater than the within-subject correlation. A within-subject item analysis predicts about 1% of the variance in translation reaction times, while a between-subject item analysis predicts up to 32% (word frequency) of the variance in translation and up to 18% (age of acquisition) of the variance in lexical access.

Discussion

Translation

Murray's (1986) main results were replicated in the present study. Variables such as printed word frequency and similarity between the English word and its French equivalent which influence retrieval from semantic memory also strongly influence ease of translation. Imagery and concreteness, which are variables that influence retrieval from episodic memory, have little influence on translation ease.

The present multiple regression analyses and factor analysis support Murray's (1986) hypothesis. Translation ease was best predicted by the factor which also weighted heavily on word frequency, similarity, familiarity, and lexical decision.

In contrast with Murray's (1986) results, the present translation error was best predicted by a factor which was a good predictor of recognition, and which weighted heavily on word frequency.

The present results may be interpreted in two different ways. First, following Murray (1986), factor organization may be taken as evidence for a strong dichotomy between semantic and episodic memory. Factor 1 may represent semantic memory and the other factors representative of episodic memory. If this is the case, translation would primarily involve semantic memory, but lexical decision would involve semantic and episodic memory.

The second interpretation is to suggest that lexical decision is a task sensitive to many different aspects of semantic memory, and that factor organization does not represent the dichotomy suggested by Murray (1986). Factor 1 weighed heavily on translation may specify the semantic memory required for translation. Factors 2 and 4 however, may also be semantic in nature, while Factor 3 may represent an episodic factor. Factor 3 weighs on the measure of recall and weighs heavily on emotionality, memorability, intensity which are category variables that influence episodic memory. Factor 3 does not weigh on either translation measures or lexical decision measures, but weighs on recall and may be the "purest" measure of episodic memory. The present results suggest a distinction between semantic and episodic memory; however, the difference may not be clear cut.

The present translation error did not correlate with either translation reaction time, nor any other translation measures, nor any of the category variables. The lack of correlation between translation error and any other measure may be explained by assuming that the subject population of the present study had not learned the French translation for some English words, and the factors affecting whether a translation had been learned were not related to factors that predict ease of translation once it had been learned. The factor weighing heavily on translation error also weighed heavily on recognition and word frequency. The meaning of infrequent words may be less easily brought to mind in the first language, and the French equivalent of such words may be less likely to be learned since the bilingual does not encounter that word often, and so results in a decrease in the probability of learning the translation equivalent of that word.

Influence of category variables on translation

As in Murray (1986), the relation between translation reaction time and the log of printed word frequency does not appear to be simple linear relation. As can be seen in the scatter plot in figure 1, the mean translation reaction time

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Insert Figure 1 about here

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decreases with increased word frequency, it appears that high frequency words are associated with short reaction time and with little variability, but medium and lower frequency words are associated with a broader ranger of reaction times. It is therefore reasonable to suggest, as Murray, that for words with medium and lower frequency other factors come into play in determining word translation speed.

As in Murray (1986), the scatter plot of familiarity with translation reaction time, as seen in figure 2, also

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Insert Figure 2 about here

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indicates that highly familiar words are associated with lower translation reaction times, and that medium familiarity is associated with a broader range of translation times.

The scatter plots of the other category variables (not shown), memorability, similarity, goodness, age of acquisition, and number of synonyms, that predict translation reaction time reveal a relation with translation reaction time similar to word frequency and familiarity. High ratings are associated with short reaction times, medium and low ratings are associated with a wider range of reaction times.

As Murray (1986) mentions, translation is not mediated uniquely by word frequency. A short reaction time for a low frequency word may be mediated by a great similarity between that word and its translation equivalent. In the present study several category variables were revealed as predicting translation ease. Number of synonyms, age of acquisition, and goodness correlated highly with both translation and lexical access. Memorability, similarity, and emotionality were identified as category variables predictive of only translation. Thus low frequency can be compensated by one or a combination of attributes. A low frequency word can be easily translated because it is very similar to its translation equivalent, its meaning has a high goodness rating, and has been acquired at an early age.

Lexical decision

Gernsbacher (1984) has shown that familiarity was a key variable in determining lexical decision reaction time. In the present analysis, familiarity had the highest correlation with lexical decision, and was entered first in the multiple regression equation. However, as word frequency and age of acquisition were entered, familiarity was removed from the equation suggesting that word frequency and age of acquisition are more complete predictors of lexical decision. This was consistent with other studies (Brown & Watson, 1987, Connine et al, 1990, Frederiksen & Kroll, 1976; Scarborough et al, 1977).

Lexical decision is best predicted by 4 factors. One factor weighed heavily on word frequency and was also a good predictor of translation. The second factor weighed heavily on concreteness and was a good predictor of recall. The third factor weighed heavily on number of meanings, number of synonyms, and meaning uncertainty, and was also a good predictor of recall. The fourth factor weighed heavily on word frequency and was a good predictor of both recognition and translation error. As mentioned above, the weighing of these different factors on lexical decision suggest that the factor organization does not represent a dichotomy between semantic memory, represented by factor 1, and episodic memory, represented by the other factors. Rather, translation and lexical decision may be processes involving different aspects of semantic memory functioning. Lexical decision is not invariant and context free, but will show variability depending on the overall task difficulty. This makes it difficult to treat lexical decision as an exact measure of visual recognition in translation.

The scatter plot of the mean lexical decision time and word

Insert Figure 3 about here

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frequency does reveal a pattern similar to the kind presented in Murray (1986). The triangular shaped scattergram however is not as obvious. High frequency words are associated with shorter lexical decision reaction time, and lower frequency words are associated with a broader range of reaction times.

The scatter plot of age of acquisition with lexical decision reveals a similar pattern. Words learned at an early age are

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Insert Figure 4 about here

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identified rapidly in a lexical decision task, while for words acquired later in life are associated with a wider range of reaction times.

Familiarity, which was shown to be a key factor in lexical decision reaction times correlated highly with lexical decision times (Gernsbacher, 1984)(in the present study the correlation was .65 [$p < .001$]). However, a scattergram showing log lexical decision reaction time as a function of familiarity did not show a pattern similar to the one presented in Murray (1986). Rather, as can be seen in figure 5, the present relation was more linear.

Insert Figure 5 about here

The scatter plots for familiarity with natural-log word frequency, and familiarity with age of acquisition (not shown) have linear patterns. Familiar words tend to be high frequency words, learned at an early age, and unfamiliar words tend to be low frequency words learned at a later age.

Again, as in translation ease, it would be a mistake to suggest that lexical decision is mediated by one word attribute, such as familiarity. Other variables can determine if a word will be accessed rapidly or slowly. A word low on one attribute can be high on another, and thus lexical decision reaction times reflect the combination of these influences. The present scattergrams appear to be roughly triangular.

The factor analysis suggest that more factors are predictive of lexical access. The category variables predictive of lexical access may represent different aspect of the automatic access to semantic memory. Word frequency predicts both translation ease and ease of lexical access. Number of synonyms, age of acquisition, and goodness are category variables which correlate highly with both tasks. Word frequency, number of synonyms, age of acquisition, and goodness facilitate translation by facilitating access to the lexicon. The category variables, memorability, similarity, and emotionality do not facilitate access to the lexicon, but predict ease of translation. Thus, memorability, similarity, and emotionality facilitate translation by facilitating the access to a translation equivalent, rather than facilitating lexical access in the first language.

Priming effect

As found by Kirsner et al (1980), Kirsner et al (1984), and Scarborough et al (1984), there was no evidence of the priming of translations after the lexical decision task on the word list.

Within-subject

Lexical decision reaction time for items is predictive of translation reaction time. However, within-subject predictability is very small. About 1% of the variance in translation reaction time can be predicted from lexical decision reaction time. Between-subject item analysis proved to be a much better predictor of lexical decision and ease of translation, than a within-subject item analysis. When individual differences are not taken into consideration, item analysis can account for about 30% of the variance in translation reaction time. The difference between the two correlations suggests that there is no causal relation between lexical access and variations in translation reaction time, but there is a third set of factors that influence these measures.

Conclusion

The present study investigated word attributes that predict translation. The results are consistent with those reported by Murray (1986). A larger population sample was used in the present study, however producing some notable differences. Accuracy of translation was not predictive of translation ease. Also, factors entered in the regression equation of the present study were not significant in Murray's study.

Murray (1986) found word frequency and similarity to be good predictors of translation. In addition to these factors, the present study also identified memorability, goodness, age of acquisition, emotionality, and number of synonyms, as also predictive of translation. Associative difficulty was not included because it was redundant to word frequency, memorability, goodness, age of acquisition, and emotionality.

The present study investigated if the word attributes that predict ease of translation also predict ease of lexical access. Although word frequency was found to be the best predictor of both tasks, memorability, similarity, and emotionality appear to be the only predictors for ease of translation.

Factors identified by Murray (1986) as reflecting semantic memory are better treated as reflecting semantic memory specific to translation. Factors identified by Murray as reflecting episodic memory are better treated as having a semantic function not related to translation.

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Appendix 1

List of words for which ratings and non-words were available in this study. The values shown include corrected versions of the errors found in Murray's printout.

WRDFQ, MEM, INT, EMOT, RECOG, RECAL, RTF, SIM, RTE, RTECR,
GOOD,PLEA,ASDIF,IMAG,AACQ,FAM,CONC,MU,NMEAN,SYN,FRER,ENGER
TRT, LRT, TAC, LAC
missing values RECOG (-3.00) RECALL (-3.00) FRER (-3.00) ENGER (-3.00)
TRT (-3) LRT (-3), LRT (-3) LAC (-3)

```
ACCORDANCE    20 2.87 2.48 2.90 .491 .278 2.583 5.85 1.90 1.60
ABBORDENCE  4.55 4.48 4.71 2.43 5.44 4.31 2.60  .00  2  12 3  1
            1745 952 13 12

AGENCY        56 3.05 2.38 1.87 .547 .037 1.389 4.12 1.19 1.27
ATENLY      4.21 4.03 4.69 3.72 5.53 4.20 4.37  .00  4  38 0  0
            1716 626 21 13

ANGEL         18 4.60 3.67 4.77 .575 .204 1.148 4.90  .98 1.45
GANOL       6.03 5.76 3.84 5.78 2.42 4.62 4.06  .00  2  17 0  2
            1407 708 25 13

ARMY         132 4.27 3.84 3.48 .292 .167 1.203 5.94 1.22 1.27
YARM        3.79 3.32 3.82 5.70 3.17 5.38 5.60  .00  2  53 1  0
```

(appendix continues)

682 656 6 13

AUTUMN 22 3.82 3.53 4.90 .558 .093 .93 5.91 1.21 1.09

BITUMN 5.62 6.15 2.66 6.28 2.78 5.33 4.31 .00 1 6 0 0

1380 651 26 13

BATH 26 3.57 2.30 3.42 .717 .148 1.771 4.16 1.29 1.40

BUCH 5.65 6.18 2.97 6.30 1.72 6.18 6.40 .54 9 130 1 1

1828 621 19 13

BEAUTY 71 4.47 4.53 5.91 .575 .204 .978 6.29 1.20 1.09

BRAITY 6.06 6.49 3.33 5.05 3.44 5.44 3.31 .00 3 37 0 0

1703 691 26 13

BED 127 4.37 2.78 5.39 .632 .389 .984 2.61 1.02 1.10

DEB 6.00 6.26 2.10 6.59 1.69 6.83 6.31 .17 14 179 3 1

882 540 18 13

BEGGAR 2 3.77 3.40 4.33 .717 .019 1.403 2.34 2.25 1.86

BOGGER 2.76 3.09 3.82 5.81 3.64 3.75 5.63 .00 3 52 6 4

2872 829 19 10

BIRD 31 3.50 2.27 3.65 .434 .296 1.019 2.87 .85 1.00

BORT 5.26 5.32 2.56 6.00 2.06 6.09 6.53 .29 5 36 0 0

1146 525 26 13

(appendix continues)

BITE 10 3.83 3.90 3.97 .632 .130 2.232 1.94 1.44 1.25
BOTU 2.86 2.74 3.92 5.59 2.14 5.93 5.31 .00 5 81 1 3
3156 728 25 13

BOOK 193 3.70 2.88 3.52 .406 .259 .852 2.94 .78 1.00
BIOK 5.69 5.80 2.54 6.05 2.14 6.77 6.57 .17 8 51 0 1
959 482 21 13

BOWL 23 2.93 1.56 1.61 .632 .074 1.336 5.15 1.73 1.56
BOUL 4.11 3.83 4.23 5.73 2.56 5.65 6.31 .77 10 92 3 2
2191 550 21 13

BOX 70 3.57 2.02 1.90 .660 .204 1.189 5.03 1.16 1.09
BOT 4.44 4.21 3.77 5.81 1.92 6.10 6.31 .47 5 99 0 0
1687 509 24 13

BRANCH 33 2.82 2.03 1.79 .434 .130 1.573 6.00 1.05 1.27
BRATCH 4.63 5.06 3.33 5.54 3.03 5.29 6.14 .66 6 58 1 0
2433 606 25 13

BROTHER 73 4.68 3.55 4.64 .519 -3.0 1.022 3.22 .85 1.09
DROTIER 5.89 5.57 3.08 6.03 2.19 5.90 5.94 .00 2 31 1 0
832 615 14 13

BUTTER 27 3.44 1.95 1.91 .434 .130 1.002 4.00 .94 1.00

(appendix continues)

BOTTER 5.37 4.86 2.72 6.43 2.06 6.55 6.71 .00 7 113 0 0
1144 586 26 13

CAREER 67 3.88 4.62 3.42 .774 .185 .979 5.26 1.58 1.14
CAROUR 5.57 5.26 4.13 4.24 5.14 5.89 3.77 .00 3 56 0 4
1407 688 26 13

CHEESE 9 3.87 2.28 1.58 .679 .241 1.526 3.13 1.15 1.00
CHEELE 4.60 5.09 3.41 6.32 2.11 6.33 6.66 .00 1 4 0 0
934 534 24 13

CHURCH 348 4.18 3.41 4.24 .632 .389 .913 2.67 1.12 1.09
CHURPH 5.51 4.94 2.97 6.27 2.78 5.67 6.31 .00 8 76 0 0
1068 565 18 13

CLAY 100 2.60 2.0 1.58 .604 .148 1.57 2.06 -3.00 -3.00
CLOY 3.34 3.89 4.31 5.81 3.58 4.55 6.40 .00 3 34 7 11
2419 563 18 13

COLUMN 71 2.93 1.90 1.87 .745 .111 1.531 4.61 1.54 1.40
COLOUN 4.18 4.32 4.62 4.97 4.36 5.19 5.43 1.51 4 45 1 6
2288 693 24 13

CONSCIENCE 40 4.32 4.41 4.64 .802 .259 1.212 6.67 1.06 1.18

(appendix continues)

CONTRIENCE 5.17 3.54 4.59 3.92 5.03 5.36 2.43 .00 3 24 1 0
1183 758 15 13

CORRIDOR 17 2.97 2.40 1.67 .632 .241 1.983 2.56 1.34 1.13
CONIDORE 3.86 3.71 4.00 5.59 3.53 5.79 5.97 .00 3 53 4 3
2198 1270 16 13

COURAGE 32 4.38 4.91 5.39 .575 .056 .93 6.81 .81 1.09
COUPERGE 6.34 5.80 4.64 4.46 4.19 5.11 2.68 .00 2 82 0 0
1064 744 26 13

DAMAGE 33 4.08 4.10 4.03 .604 .037 1.367 4.63 1.89 1.91
DOMAGE 2.38 2.09 3.87 4.49 3.58 5.58 4.14 .00 5 92 4 0
2651 737 15 12

DANGER 70 5.50 5.50 5.00 .632 .111 .949 6.91 .79 1.09
DONKER 2.26 2.34 4.15 5.24 3.00 5.56 2.97 .00 2 23 0 0
1523 549 3 13

DEFINITION 38 3.50 2.50 2.00 .717 .333 1.051 6.82 .97 1.27
FEDENITION 4.41 3.88 4.84 2.30 5.67 5.19 2.51 .00 3 24 0 0
1219 711 22 13

DEPUTY 17 3.48 2.52 2.21 .491 .037 1.651 5.97 2.95 2.29
REPUDE 4.43 4.14 4.74 4.41 4.33 4.62 4.69 .00 2 44 1 4

(appendix continues)

2471 651 17 13

DESCRIPTION 54 3.35 2.74 3.39 .660 .241 .925 6.97 .97 1.18

DESCROPTIUM 4.38 4.74 4.26 3.41 4.69 5.38 3.41 .00 2 66 0 0

1531 806 26 13

DIMENSION 15 3.66 3.26 1.63 .802 .074 1.168 6.85 1.18 1.82

DERINSIUM 4.35 4.06 4.87 3.61 5.28 4.83 2.65 .00 2 33 1 0

1321 673 20 13

DOG 75 4.62 2.47 3.91 .377 .111 .962 3.12 .90 1.09

MOG 5.06 5.31 2.87 6.57 1.69 6.15 6.68 .00 7 50 1 0

849 616 25 13

DOOR 312 3.42 1.66 2.28 .066 .259 1.108 3.34 1.02 1.00

DOOP 4.53 4.29 3.46 5.84 2.14 6.66 6.51 .00 2 51 0 0

1439 511 10 13

DRESS 67 3.68 2.16 3.97 .745 .315 1.879 3.97 1.21 1.20

BROSS 5.47 5.76 2.87 6.08 2.22 6.17 6.34 .61 14 172 0 1

1526 505 22 13

DRINK 82 4.12 2.90 4.00 .434 .148 1.079 2.70 .98 1.00

DRICK 4.71 5.20 2.31 5.97 2.11 6.72 6.17 .72 9 188 1 0

1855 754 24 13

(appendix continues)

DUMP	4	3.32	2.48	2.00	.802	.019	2.548	2.73	3.06	4.00	2.41	2.12	3.95	5.38	3.33	4.99	5.57	1.04	4	35	5	9	2526	588	24	13						
DUME																																
EARTH	150	3.84	3.53	3.45	.519	.130	.991	3.61	1.10	1.09	5.03	4.91	2.90	5.84	3.17	5.74	6.26	.98	4	33	5	0	1428	553	26	13						
EARCH																																
EXCUSE	27	3.59	2.86	3.87	.547	.093	1.4	6.88	1.98	1.36	3.44	2.94	4.38	3.14	3.56	5.67	2.91	1.23	8	144	2	0	1943	669	20	12						
EXCUME																																
FAIRY	4	4.10	2.86	3.39	.830	.352	2.872	2.94	1.76	2.13	4.89	4.97	3.16	5.70	2.42	4.33	4.14	.92	1	19	1	3	1763	633	14	13						
MAIRY																																
FAMILY	331	4.97	4.21	5.84	.547	.426	.912	6.06	.79	1.09	6.09	5.97	2.61	6.00	2.80	6.11	5.49	.00	3	63	0	0	949	679	25	13						
AOLE																																
FIGHT	98	4.62	4.78	5.48	.519	.222	2.142	4.03	1.62	1.36	2.65	2.41	3.13	5.49	2.61	5.61	4.69	.00	8	21	1	0	1454	584	18	13						
FRITH																																

(appendix continues)

FRAME 74 2.62 2.00 1.61 -3.0 .037 1.696 1.76 1.39 2.00
FROME 3.94 4.17 4.72 5.14 3.94 4.94 5.91 .83 7 107 1 0
2377 508 13 13

FROG 1 4.17 2.10 2.19 .830 .370 1.686 2.12 1.13 1.09
FROT 3.62 3.18 4.31 6.14 2.58 4.60 6.80 .00 3 76 0 6
1210 552 26 13

FUTURE 227 4.55 5.02 5.03 .660 .222 1.016 2.38 1.73 1.22
FUTOUR 5.31 5.11 3.97 4.19 4.14 6.12 3.06 .00 3 41 0 0
1175 933 25 13

GARMENT 6 2.87 2.21 3.26 .858 .093 2.203 3.03 1.19 1.45
LADENTE 4.82 4.91 3.08 5.32 4.53 3.94 6.00 .00 4 73 1 2
2572 666 16 12

GIRL 220 5.08 2.97 5.39 .632 .574 1.112 3.53 1.03 1.09
GALO 5.53 5.94 2.18 6.30 1.83 6.72 6.66 .00 3 48 0 0
925 580 16 13

GREEN 116 3.38 1.95 2.88 .236 .296 .949 3.16 .89 1.18
GROON 4.40 5.09 2.92 6.24 2.25 5.89 4.66 .38 6 66 0 0
1012 628 24 13

GRIEF 10 4.32 4.80 6.23 .887 .111 3.273 2.72 3.36 2.00

(appendix continues)

GROUG 2.32 1.47 3.79 5.05 4.50 4.76 3.09 .00 5 98 4 0
2856 632 25 13

HABIT 23 3.62 3.03 3.10 .660 .037 4.457 5.84 1.56 1.20
LABIT 3.65 3.65 3.64 4.24 3.50 5.83 3.60 .54 5 120 1 1
1846 532 26 13

HAMMER 9 3.51 2.60 2.06 .689 .167 1.416 2.34 1.19 1.00
HAPNER 3.46 3.03 3.92 6.19 2.78 4.85 6.63 .00 5 74 3 2
2800 666 20 13

HATE 42 5.47 5.83 6.35 .745 .537 1.628 3.00 1.16 1.67
NATE 1.21 1.35 4.28 4.86 2.78 5.48 2.66 .00 3 54 1 5
1917 574 21 13

HAY 19 3.12 1.95 3.10 .774 .111 2.04 1.70 2.14 2.34
TAY 5.35 5.71 3.18 6.03 2.97 4.86 6.60 .00 2 13 4 8
2174 572 23 13

HEAD 424 3.98 2.17 2.91 .462 .093 1.123 2.91 .90 1.00
HOAD 5.03 4.89 3.00 6.13 1.81 6.52 6.17 .91 26 388 0 0
1018 657 26 13

HEALTH 105 3.92 4.00 3.84 .632 .093 1.576 2.52 1.20 1.27
STEALT 6.26 6.27 3.15 4.59 4.00 5.89 3.83 .00 3 43 0 0

(appendix continues)

1449 589 20 13

HEART 173 4.77 4.38 6.00 .434 .111 1.258 2.63 1.00 1.09
SEART 6.09 5.62 2.79 6.24 2.81 5.93 6.37 .77 23 178 0 0
1119 550 21 13

HIDE 22 3.12 3.03 3.61 .547 .056 1.306 3.03 1.02 1.00
HOTE 3.47 3.21 3.46 4.65 2.56 5.17 4.77 .88 9 98 0 1
1354 619 18 12

HISTORY 286 3.68 3.02 3.67 .406 .185 .918 6.18 1.09 1.45
MISPORY 4.54 4.40 3.62 4.38 3.69 5.51 3.20 .00 4 87 0 0
1037 540 25 13

HOME 547 4.47 3.72 5.39 .575 .278 1.652 3.27 .97 1.00
BOME 6.40 6.34 2.10 6.19 2.33 6.44 5.54 .00 22 590 1 0
1431 521 26 13

HOSPITAL 110 4.50 4.07 4.58 .264 .463 .86 6.48 .70 1.00
TROSITAL 4.71 3.21 3.00 6.00 3.19 5.31 6.29 .00 1 30 0 0
993 592 18 13

HUMOUR 1 4.40 4.22 5.03 .915 .000 1.859 6.34 1.49 2.18
FUMOUR 5.88 6.15 2.79 4.65 4.17 5.49 3.29 .55 5 141 1 0
1714 638 25 13

(appendix continues)

HUNGER 17 4.60 4.17 3.88 .717 .130 1.141 2.97 .90 1.55
GUNTER 2.14 2.71 3.10 5.70 2.75 5.94 4.06 .00 4 51 1 0
1607 554 18 13

INCOME 109 3.78 3.60 2.48 .377 .130 1.906 4.25 2.31 2.55
KINSOM 5.34 5.40 4.10 4.81 5.06 5.21 4.40 .00 3 46 3 0
2195 587 25 13

INDUSTRY 171 3.29 2.74 2.58 .717 .130 1.084 6.34 1.03 1.27
SINDUCTRY 5.77 4.31 3.56 4.46 4.92 5.58 4.57 .63 4 66 2 0
1144 623 26 13

IODINE 18 3.34 2.95 2.52 .887 .315 1.98 4.55 2.47 3.25
IOKINE 4.32 3.29 4.64 5.14 5.58 3.96 6.06 .00 1 28 9 7
1938 815 9 10

ISLAND 167 3.55 3.60 3.03 .660 .204 1.326 4.59 .91 1.18
ISTANG 5.23 5.86 2.38 6.49 2.89 5.07 6.29 .00 1 15 0 0
1210 567 25 13

JERK 2 4.68 3.83 3.10 .915 .815 4.717 1.88 1.22 1.10
JERG 3.32 3.15 4.46 4.89 4.00 4.11 4.26 .17 6 84 4 1
2631 566 23 13

JOY 40 4.20 4.86 6.45 .745 .296 1.002 5.53 .93 1.18

(appendix continues)

JEY	6.66 6.74 2.45 5.43 3.42 5.15 2.86 .00 4 76 0 0
	1068 459 18 13
JUMP	24 3.74 3.12 3.19 .519 .148 1.229 2.23 1.07 1.00
TUMP	4.44 4.29 3.10 5.16 2.22 5.54 4.63 .00 17 247 0 0
	1556 559 26 13
JUSTICE	114 4.19 5.16 4.45 .915 .333 1.133 6.79 .98 1.18
PUNTICE	6.31 5.43 4.21 4.22 5.00 4.77 2.60 .00 6 112 0 0
	1079 586 25 13
KINDNESS	5 4.28 4.09 5.71 .660 .111 1.672 3.79 1.93 2.45
SANDNESS	6.62 6.53 3.13 4.46 3.28 5.54 2.71 .00 3 111 1 0
	2867 665 23 13
LAMP	18 3.43 1.55 2.97 .717 .185 1.288 6.25 .83 1.18
WAMP	5.15 4.79 3.68 5.84 2.83 5.72 6.43 .00 8 138 2 0
	2199 583 22 13
LAWYER	43 4.45 3.40 2.55 .491 .420 4.003 3.73 1.55 1.27
LIMYER	4.43 3.69 4.10 5.49 4.81 4.82 5.97 .00 4 72 1 0
	1964 583 22 13
LEVITY	1 2.61 3.39 3.26 .802 .148 4.93 2.31 1.48 1.16
LAVITY	4.24 4.56 4.87 3.27 6.31 3.14 2.91 .00 3 46 9 6

(appendix continues)

2255 836 26 10

LIE 59 3.95 4.38 5.17 .689 .185 1.549 2.44 1.17 1.38
LIM 2.06 2.82 3.95 3.95 2.50 5.62 3.00 .61 13 203 2 0
1891 636 14 13

LION 17 4.30 3.71 3.68 .321 .222 .909 6.79 .79 1.27
LEON 3.76 4.41 3.72 6.41 2.44 4.80 6.74 .00 4 82 0 0
945 641 20 13

LOVE 232 5.88 5.78 6.79 .802 .556 .937 3.15 .98 1.00
NOVE 6.86 6.60 2.66 5.86 3.03 6.32 3.20 .00 13 233 0 1
604 611 3 13

MOMENT 246 2.90 2.72 2.33 .547 .000 .979 6.94 1.25 1.27
MONENT 4.09 4.34 4.33 3.22 3.50 5.88 3.20 .34 3 44 1 0
1123 556 16 13

MOTHER 216 5.37 4.02 6.32 .519 .500 .841 4.00 .77 1.00
TOTHEM 6.56 6.35 1.97 6.54 1.44 6.38 6.60 .00 4 61 0 0
820 554 14 13

MOTOR 56 3.02 2.28 2.09 .434 .056 1.194 5.70 .97 1.30
KOMOR 5.11 4.74 3.72 5.27 3.44 5.45 5.94 .34 6 132 2 1
1495 581 24 13

(appendix continues)

MOUNTAIN 33 4.18 4.07 4.23 .321 .167 .964 5.42 1.02 1.09

DOUMTAIR 5.50 6.00 3.23 6.38 2.83 5.50 6.62 .00 2 31 0 0

1444 718 24 13

MUSIC 216 4.87 4.29 5.73 .406 .167 .965 6.03 .82 1.00

KUMIS 6.09 6.51 2.64 5.86 2.72 6.00 5.26 .00 5 132 0 0

910 567 25 13

NATION 139 3.53 3.52 4.29 .491 .185 1.013 6.94 1.10 1.10

FATION 4.47 4.56 4.33 4.38 4.25 4.97 4.17 .00 2 39 0 1

1161 655 20 13

NATURE 191 3.83 3.95 4.67 .604 .204 .82 6.78 1.12 1.09

SATUNE 5.57 5.71 2.87 5.27 3.42 5.70 4.23 .67 7 93 0 0

926 516 24 13

NEEDLE 15 3.77 3.09 2.35 .575 .056 1.422 2.03 1.32 1.00

NEEPLE 4.06 3.18 3.62 6.00 2.64 5.09 6.43 .57 5 75 5 3

1975 666 8 13

NORMAL 136 3.42 2.53 3.00 .887 .037 .838 6.42 .72 1.18

GORMAT 4.94 4.89 4.03 3.05 3.75 6.05 2.23 .00 3 66 0 0

955 555 16 13

NOTICE 59 2.88 2.69 2.23 .349 .056 1.969 3.38 1.32 1.71

(appendix continues)

NOLICE 4.50 4.35 3.44 4.73 3.69 6.34 4.97 .99 9 155 2 4
833 686 2 13

OCEAN 34 4.29 4.14 4.26 .462 .296 .91 6.61 .99 1.00
OCEION 4.91 5.26 3.21 6.30 3.17 5.00 6.43 .00 2 35 0 0
1074 546 23 13

PAINTING 59 3.39 3.36 4.36 .406 .111 2.574 4.29 1.20 1.10
PARITION 5.46 5.69 3.38 6.08 2.58 5.27 6.51 .17 3 91 1 1
2027 639 21 13

PAPER 157 3.38 1.69 1.73 .123 .167 .91 5.97 1.24 1.00
PORPE 4.80 4.51 3.15 5.89 2.29 6.80 6.46 .55 8 123 0 0
956 510 18 13

PASSAGE 49 3.12 2.47 2.12 .575 .056 1.133 6.85 1.27 1.45
PANNAGE 4.09 4.23 4.49 5.31 3.56 5.25 5.86 1.49 12 246 0 0
1400 603 26 13

PENCIL 34 3.95 1.64 1.77 .123 .185 1.956 4.00 1.41 1.18
PEMIL 4.65 4.26 2.95 6.19 2.25 6.32 6.69 .00 3 40 0 0
1432 483 20 13

PERCH 1 2.98 2.45 1.97 .943 .259 1.84 5.45 1.75 1.09
DIRCH 4.32 3.94 3.92 4.68 4.14 3.96 6.06 .99 2 40 7 0

(appendix continues)

2321 771 26 11

PITY 14 3.65 3.38 5.52 .887 .093 2.15 6.15 1.73 2.00
PIKY 4.49 3.66 3.72 4.11 3.53 5.44 2.57 .00 3 70 3 2
1515 801 23 12

POETRY 88 3.92 2.98 4.77 .604 .111 1.614 4.48 1.26 1.30
PIETRY 5.59 5.52 3.00 4.89 3.86 4.87 4.46 .00 1 8 0 1
2187 637 6 13

POND 25 3.12 2.55 1.97 .689 .241 2.465 1.94 1.43 1.00
PUND 4.62 4.91 3.26 6.05 2.39 5.06 6.60 .00 1 12 6 9
2714 573 25 13

PRAIRIE 21 3.67 2.95 3.00 .575 .204 1.801 6.64 1.15 1.64
SPRAIRE 4.79 5.65 3.44 5.32 4.33 3.83 5.97 .00 1 24 0 0
1313 721 17 13

PUNCH 5 3.75 4.28 4.06 .745 .130 2.14 2.18 2.14 1.43
DAUNT 2.66 2.57 4.26 5.57 3.06 4.81 5.69 1.28 5 117 5 4
2696 563 13 13

PUPPY 2 4.53 3.43 4.29 .632 .296 2.267 3.18 1.38 1.36
PUGGY 5.47 6.06 2.62 6.41 2.03 5.22 6.60 .00 5 107 0 0
2132 607 25 13

(appendix continues)

PURPOSE 149 3.08 3.14 3.45 .491 .056 1.767 4.27 1.22 1.36
RISPOSE 4.91 4.79 5.05 2.86 4.28 5.72 2.71 .00 8 195 3 0
3177 563 17 13

RATTLE 5 3.28 2.69 2.85 .434 .148 5.73 1.97 -3.00 -3.00
ROMMEL 3.37 3.18 4.36 5.16 2.61 4.62 5.54 1.72 7 75 9 11
2551 647 25 12

REMOVAL 41 2.75 2.33 2.93 .632 .019 6.918 1.82 1.45 2.60
RAMEVIL 3.41 3.21 4.33 3.97 4.06 4.98 3.46 .00 11 211 6 1
2956 690 17 13

RING 47 4.10 3.34 4.33 .151 .167 1.392 2.34 1.30 1.22
RONG 5.11 4.97 2.95 6.28 2.08 6.05 6.26 1.39 9 270 1 2
2236 626 26 13

ROTATION 11 3.50 2.79 2.32 .689 .056 3.146 6.88 1.16 1.7
ROGAGION 4.18 3.79 4.31 4.45 4.94 4.70 3.69 .00 18 221 3 0
1886 789 15 13

RUG 13 2.80 1.45 1.79 .632 .130 1.297 4.09 1.73 3.13
RUK 4.77 4.97 3.38 6.24 2.33 5.33 6.40 .00 1 21 1 3
2074 682 26 13

(appendix continues)

SALAD	9	3.32	2.19	2.32	.547	.167	.916	6.52	.83	1.09				
CALAD	5.38	5.68	2.56	6.35	3.42	5.31	6.40	.00	2	55	0	0		
	1101	514	26	13										
SALT	46	3.48	2.03	1.97	.264	.315	1.037	4.55	.86	1.00				
CALT	4.77	4.34	4.05	6.14	2.33	6.47	6.49	.00	6	58	0	0		
	1185	594	14	13										
SAP	1	3.38	2.58	2.15	.802	.389	2.655	2.47	-3.00	-3.00				
KAD	4.09	4.09	4.67	4.57	4.64	3.77	5.66	.71	3	45	6	11		
	2336	835	19	12										
SCHOOL	492	4.88	3.34	3.58	.321	.315	1.048	3.29	.89	1.09				
CHOURE	5.09	4.69	2.72	6.25	2.28	5.90	6.26	.00	5	119	0	0		
	829	562	23	13										
SEQUEL	1	3.48	3.12	2.36	.208	.130	1.933	4.03	1.57	1.73				
CEGULE	4.14	4.09	5.05	3.59	5.56	4.01	3.43	.00	1	22	6	0		
	2602	840	26	12										
SHADOW	36	3.68	3.38	3.81	.519	.093	3.364	2.44	1.38	1.00				
PHADOS	3.65	3.47	3.18	5.89	3.11	5.48	4.69	.00	14	166	0	1		
	2595	598	17	12										
SHIP	83	3.44	2.50	3.42	.434	.074	1.599	2.85	1.88	1.00				

(appendix continues)

JISH 4.94 5.38 3.03 6.35 2.49 5.46 6.63 .17 4 65 0 10

1218 566 11 13

SICKNESS 6 3.92 4.12 4.00 .802 .204 1.268 4.00 1.05 1.09

TUKINESS 1.83 1.66 3.69 4.89 3.56 5.03 4.34 .00 2 47 0 0

1919 564 21 13

SIN 53 4.95 4.69 5.67 .802 .500 1.683 2.03 -3.00 -3.00

LIM 1.60 2.00 3.33 4.57 4.00 4.94 2.69 .00 4 102 2 -3

2002 580 16 13

SMASH 4 4.52 4.57 5.00 .858 .111 3.002 2.21 3.38 4.67

SNAST 2.26 2.44 3.74 5.24 2.78 5.36 4.09 .92 7 100 5 8

2702 657 26 12

SNEER 1 4.18 4.49 4.70 .547 .241 2.867 1.81 4.24 3.33

SUREN 1.54 1.34 4.79 5.00 4.67 3.98 3.74 .00 3 46 7 8

2145 775 18 12

SOLDIER 39 4.05 3.57 3.91 .915 .204 1.031 5.09 .85 1.09

SOKIDER 4.34 4.06 3.51 6.19 2.75 5.07 6.14 .00 5 58 1 0

1506 625 25 13

SQUARE 143 3.57 1.86 1.97 .236 .074 1.575 2.55 1.82 1.00

(appendix continues)

SKARET 3.85 3.74 3.92 6.16 2.50 5.91 5.43 .71 21 329 0 3
1943 588 23 13

STATUE 17 3.37 2.38 2.27 .717 .056 1.211 6.82 1.13 1.64
SALLUE 4.11 4.09 4.38 5.68 4.06 4.44 6.34 .00 1 28 0 0
1330 688 21 12

STEEPLE 9 3.28 2.97 2.61 .519 .204 7.81 2.34 1.50 1.00
STOOPLE 4.77 4.69 3.92 5.97 3.61 3.96 6.21 .00 1 9 8 10
2228 685 16 13

STOOL 8 2.98 1.79 1.74 .604 .204 4.933 1.91 1.38 1.00
STOUK 4.35 4.06 3.62 5.92 2.03 5.69 6.49 .17 5 46 7 10

2866 805 26 13

STOVE 15 3.17 1.84 1.55 .179 .074 1.768 2.19 2.02 1.80
STIVE 4.46 4.74 3.72 5.92 2.97 4.59 6.37 .17 1 16 1 6
2065 608 18 13

SUCCESS 93 4.30 5.03 4.82 .887 .167 1.253 6.24 1.15 1.18
SUMNESS 6.03 6.40 3.79 4.49 4.11 5.68 2.88 .00 1 41 0 0
1192 550 23 13

SWIM 15 4.12 3.17 2.48 .687 .148 1.139 2.55 1.27 1.09

(appendix continues)

SWEG 5.23 5.54 3.46 5.92 2.56 5.42 4.91 .00 3 19 0 0
1038 579 25 13

TEMPER 12 4.25 5.00 6.45 .321 .130 3.503 3.09 1.65 2.00
TENDOR 2.69 2.57 3.44 4.95 3.33 5.75 3.54 .00 7 124 3 0
3319 561 25 13

THEORY 129 3.40 2.95 1.91 .632 .204 .912 6.24 .83 1.36
THOURY 4.74 4.03 5.15 3.08 5.57 5.41 2.66 .00 2 26 0 0
1224 564 20 13

THERMOMETER 10 4.22 2.60 2.71 .915 .185 2.199 6.27 .99 1.09
HERMOTTETER 4.50 3.74 4.08 5.78 3.89 4.70 6.54 .00 2 5 1 0
1826 1170 17 13

THIEF 8 4.68 4.19 3.48 .887 .000 2.098 2.72 1.26 1.11
FIRTH 1.60 1.60 4.38 5.13 3.22 5.11 5.32 .00 8 103 2 2
2429 748 24 13

THREAT 42 4.53 4.91 4.64 .632 .074 3.265 4.13 1.23 1.22
SHREUT 1.86 1.80 4.95 4.41 3.94 5.15 3.43 .00 3 33 2 2
2922 600 25 13

TOBACCO 19 3.98 2.47 2.67 .745 .148 1.093 5.25 1.14 1.36
DOBAKKO 3.89 3.86 3.36 6.13 3.66 5.27 6.57 .00 15 147 0 0

(appendix continues)

1578 593 25 13

TORTURE 3 5.00 5.41 5.48 .717 .204 1.144 6.73 1.00 1.40
PORTUME 1.20 1.26 4.18 5.86 4.08 4.48 4.49 .00 7 124 0 1
1711 771 18 12

TROUBLE 134 4.15 4.59 5.23 .151 .111 1.442 6.61 .96 1.27
TRAMBLE 2.00 2.03 3.90 4.11 3.22 5.98 3.17 .66 12 217 1 0
2047 652 26 13

TRUNK 8 2.98 2.00 1.97 .547 .056 5.952 4.59 -3.00 -3.00
TRYPT 4.18 4.38 3.67 5.35 3.28 4.85 6.29 1.47 4 38 5 11
2879 690 23 13

TRY 140 3.25 3.41 4.19 .406 .074 1.086 2.66 1.01 1.00
JYR 5.29 4.94 4.36 3.54 2.29 6.51 2.49 .38 4 73 0 0
1200 527 18 13

UNCLE 57 3.80 2.79 3.73 .349 .185 .899 6.03 .93 1.00
MUKLE 5.51 5.43 3.53 5.51 1.92 5.57 6.06 .00 1 5 4 1
981 546 25 13

UPSET 14 3.85 4.20 5.27 .519 .056 1.902 2.81 1.68 1.60
PUSET 2.57 2.37 3.87 4.06 3.29 5.37 2.74 1.01 7 181 4 6
2820 577 26 13

(appendix continues)

WANDON 4.79 4.69 3.13 5.89 2.31 6.52 6.34 .00 1 20 0 0
1197 600 24 13

WINE 72 4.82 3.40 4.30 .830 .185 1.048 4.88 .82 1.00
VONE 5.49 5.60 2.31 6.19 4.03 5.45 6.54 .00 3 101 0 0
954 573 15 13

WOMAN 224 5.28 3.67 5.35 .604 .426 1.079 3.48 .96 1.36
VONAN 5.76 5.67 2.49 6.27 2.58 6.44 6.23 .00 4 60 1 0
1073 582 25 13

YOUTH 82 3.93 4.09 4.30 .745 .389 1.99 3.29 1.24 1.27
5.89 6.03 2.72 5.31 4.31 5.30 4.69 .29 3 73 1 0

VILLAGE 72 3.15 2.32 2.94 .802 .130 .838 6.88 .88 1.09
WOLLAGE 5.23 5.89 3.05 5.89 3.17 5.29 6.11 .00 1 16 0 0
960 602 25 13

VIRTUE 30 4.22 4.52 5.13 .321 .204 1.128 4.97 1.70 2.38
SIRDUN 6.21 5.47 3.87 3.40 5.11 4.64 2.43 .00 4 87 0 3
1704 756 21 13

VISION 56 3.42 4.00 3.73 .462 .093 1.207 6.67 1.36 1.64
LISTON 5.40 5.20 4.03 4.30 4.11 5.35 3.60 .54 4 47 0 0
1310 700 24 13

WALK 100 3.55 2.41 3.52 .774 .148 1.177 3.76 1.04 1.09
MAPE 5.24 5.85 2.56 5.05 2.06 6.66 4.74 .00 6 96 0 0
1052 516 14 13

WAR 464 4.88 5.24 5.64 .547 .019 1.187 3.03 .94 1.00
WYR 1.60 1.66 4.37 5.76 3.14 5.77 4.86 .00 6 110 0 0
1358 631 26 13

WATER 442 3.95 2.97 2.61 .406 .315 1.031 3.18 .95 1.00
WASPE 5.14 5.40 2.49 6.51 1.53 6.70 6.63 .00 4 62 0 0
949 540 21 13

WINDOW 119 3.27 2.16 1.82 .660 .204 1.105 3.18 1.07 1.00

(appendix continues)

Table 1. Pearson correlation coefficients among the 25 variables studied in the experiment

	MEM	INT	EMOT	SIM	GOOD	PLEA	ASDIF	AACQ	FAM	CONC	WDFRQ	lIMAG	lMU	lMEAN
MEM														
INT	.70**													
EMOT	.73**	.81**												
SIM	-.02	.07	.02											
GOOD	-.01	-.18	.03	.26										
PLEA	-.02	-.21	.04	.21	.94**									
ASDIF	-.34**	.03	-.32**	.13	-.47**	-.54**								
AACQ	-.21	.21	-.10	.34**	-.11	-.21	.66**							
FAM	.24	-.07	.15	-.03	.29*	.30*	-.54**	-.63**						
CON	-.09	-.52**	-.37**	-.24	.16	.21	-.46**	-.57**	.17					
WRDFQ	.16	.04	.17	-.17	.35**	.33**	-.33**	-.25	.65**	.04				
lIMAG	.25	-.16	.01	-.30*	.13	.20	-.65**	-.70**	.25	.82**	.07			
lMU	-.28	-.23	-.17	-.11	-.09	-.07	.01	-.19	.10	.09	-.06	.01		
lMEAN	.10	.02	.15	-.22	-.15	-.16	-.12	-.25	.36**	.01	.18	.06	.41**	
lSYN	.13	.12	.22	-.11	-.12	-.14	-.10	-.14	.30*	-.10	.15	-.01	.33**	.84**
lRECOG	.04	.18	.10	.01	-.08	-.07	.14	.28	-.32**	-.21	-.31*	-.16	-.10	-.07
lRECAL	.33**	.08	.16	-.05	.24	.21	-.29*	-.15	.10	.19	.11	.24	-.23	-.16
lRTE	-.21	.03	-.07	-.31*	-.36**	-.37**	.35**	.28	-.40**	-.19	-.48**	-.17	.18	-.06
lRTF	-.22	-.05	-.14	-.41**	-.38**	-.37**	.31*	.21	-.46**	-.08	-.53**	-.11	.14	.06
lTRT	-.31*	-.03	-.14	-.37**	-.50**	-.48**	.43**	.25	-.46**	-.14	-.57**	-.19	.18	.10
lFRER	-.23	-.05	-.12	-.31*	-.39**	-.41**	.34**	.19	-.38**	-.06	-.46**	-.15	.22	.03
lTER	-.04	-.07	-.04	-.07	-.07	-.11	.06	.05	-.10	.04	.08	-.04	-.09	-.13
lENGER	-.28	-.15	-.17	-.43**	-.30*	-.28	.27	.03	-.40**	.10	-.43**	.05	.21	-.07
lLRT	-.10	.07	-.05	.07	-.17	-.21	.41**	.43**	-.44**	-.18	-.39**	-.28	-.12	-.20
lLER	-.20	.01	-.03	-.08	-.22	-.24	.27	.34**	-.49**	-.08	-.43**	-.18	-.01	-.11

	lSYN	lRECOG	lRECAL	lRTE	lRTF	lTRT	lFRER	lTER	lENGER	lLRT	lLER
lSYN											
lRECOG	-.09										
lRECAL	-.17	-.06									
lRTE	-.05	.12	-.27								
lRTF	.01	.17	-.15	.57**							
lTRT	.10	.15	-.30*	.63**	.72**						
lFRER	-.02	.18	-.20	.54**	.62**	.66**					
lTER	-.11	-.07	.01	.08	.03	-.04	.08				
lENGER	-.10	.14	-.10	.53**	.53**	.53**	.49**	.10			
lLRT	-.20	.20	-.07	.27	.26	.33	.23	.06	.23		
lLER	-.05	.17	-.07	.36	.25	.33	.28	.10	.28	.40**	

The prefix l means that the natural logarithms of the raw values were entered into the calculation.
The Bonferroni correction ensures that the likelihood of accepting any correlation in the set of 300 correlations is at $p < .05$ (*), $p < .01$ (**).

Table 2. Correlation between Murray's (1986) translation reaction time to translate from English into French (lRTF) and translation accuracy (lFRER) with the translation reaction time (lTRT) and error (TER) of the present study

	lRTF	lFRER
lTRT	.72**	.66**
lTER	.03	.08

The prefix l means that the natural logarithms of the raw values were entered into the calculation.

** $p < .01$, Bonferroni correction.

Table 3. Results of stepwise multiple correlations carried out on the translation and lexical decision measures. Murray's (1986) multiple regression dependent variables, lRECOG, lRECAL, lRTE, and lENGER, are not included in the analyses.

Dependent variable	R square	Variables	B	Beta	T	Sig T
lTRT	.6110					
		WRDFQ	-.093	-.363	-5.854	p < .0001
		MEM	-.249	-.411	-5.011	p < .0001
		SIM	-.069	-.306	-4.923	p < .0001
		GOOD	-.083	-.270	-4.423	p < .0001
		AACQ	.068	-.187	2.966	p = .0036
		EMOT	.066	.233	2.841	p = .0052
		lSYN	.052	.121	2.096	p = .0379
lLRT	.2736					
		AACQ	.054	.357	4.765	P < .0001
		WRDFQ	-.033	-.304	-4.058	p = .0001
lTER no variables entered						
lLER	.2641					
		FAM	-.022	-.362	-3.765	p = .0002
		WRDFQ	-.006	-.198	-2.059	p = .0414

Table 4. Factor matrix for the factor analysis of Murray's 21 variables and the translation and lexical decision measures.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
MEM	-.23525	.24541	.85249	-.04622	-.10116	.03979
INT	-.02649	-.24007	.89032	-.01514	-.14154	.07882
EMOT	-.05299	-.02485	.92494	.11570	.12834	-.00106
SIM	-.55170	-.48221	-.09286	-.18267	.09728	.22018
GOOD	-.33433	.06687	-.06647	-.10534	.89618	.01895
PLEA	-.31589	.14988	-.07372	-.09119	.90312	.04860
ASDIF	.26337	-.67247	-.24512	-.11352	-.46692	.03310
AACQ	.17739	-.81649	-.02055	-.27288	-.06796	.16313
FAM	-.53867	.34337	.09467	.44805	.18068	-.29068
CONC	-.03253	.82515	-.39136	-.10324	.03255	.01898
WRDFQ	-.63824	.04230	.09526	.22061	.21621	-.45806
lIMAG	-.04854	.92207	.01184	-.04475	.03827	.05970
lMU	.21123	.04665	-.30783	.61913	.06059	.01649
lMEAN	-.02537	.10006	.10264	.86835	-.12197	.04812
lSYN	-.05005	-.00981	.17719	.83630	-.09354	.05716
lRECOG	.25582	-.18910	.18653	-.13550	.06881	.50123
lRECAL	-.16682	.35811	.26898	-.36279	.13224	.01774
lRTE	.77060	-.19238	-.01302	.03815	-.08159	-.08757
lRTF	.80487	-.04811	-.05276	.06732	-.12837	.04051
lFRER	.75498	-.09968	-.07566	.07495	-.15507	-.01191
lENGER	.75958	.11048	-.14766	-.04120	-.06827	-.06077
lTRT	.78112	-.14833	-.10323	.17063	-.26148	.10110
lLRT	.36485	-.33835	-.00236	-.32360	-.10539	.21868
lTER	.14227	-.06967	.00249	-.25087	-.04043	-.74755
lLER	.46033	-.20399	-.03244	-.20285	-.07753	.17690

Figure Captions

Figure 1. Mean time to translate each word into French as a function of ln printed word frequency. The scattergram is based on 141 words.

Figure 2. Mean time to translate each word into French as a function of rated familiarity of the word. The scattergram is based on 141 words.

Figure 3. Mean tim to identify each word from non-words as a function of ln printed word frequency. The scattergram is based on 141 words.

Figure 4. Mean time to identify each word from non-words as a function of the rated age of acquisition of the word. The scattergram is based on 141 words.

Figure 5. Mean time to identify each word from non-words as a function of the rated familiarity of the word. The scattergram is based on 141 words.

Figure 3

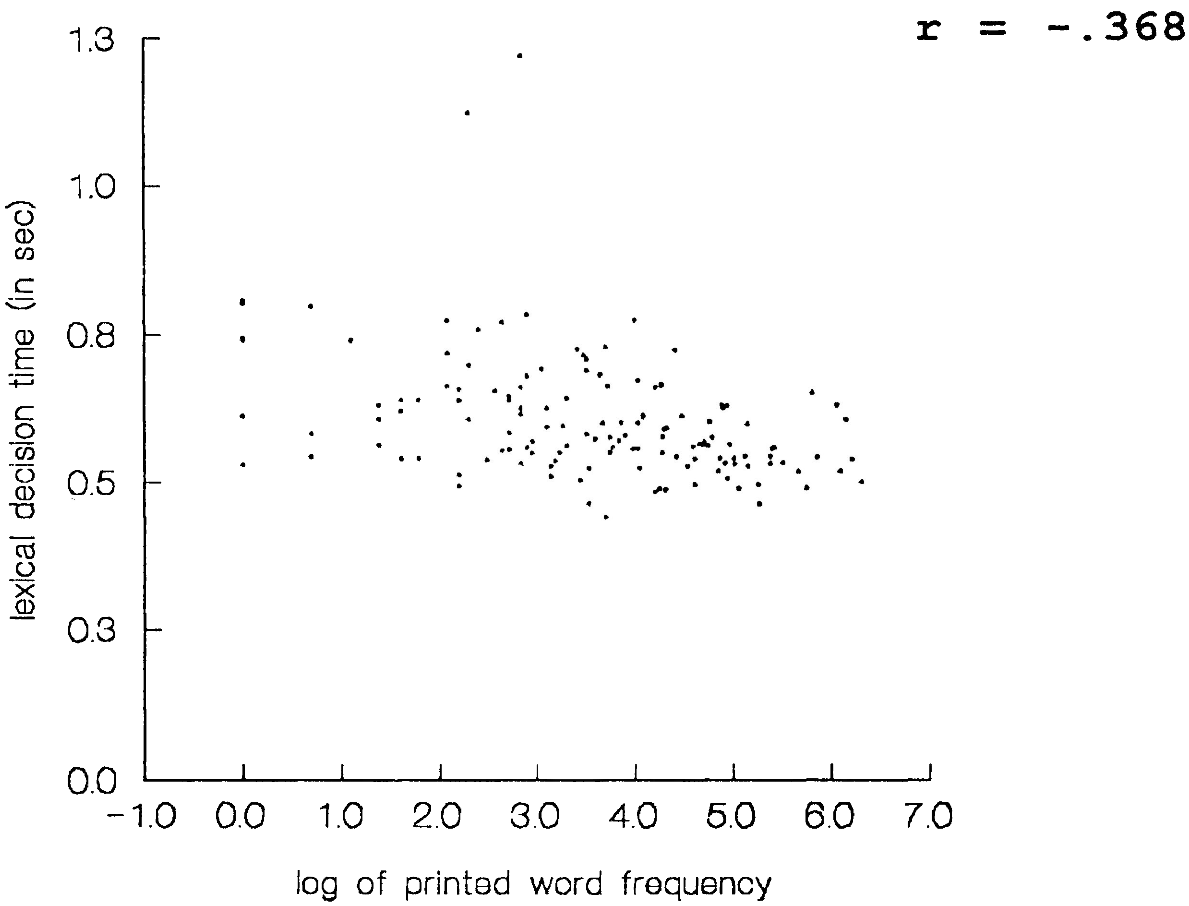

r = -.368
lexical decision time (in sec)
1.3
1.0
0.8
0.5
0.3
0.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
log of printed word frequency

Figure 4

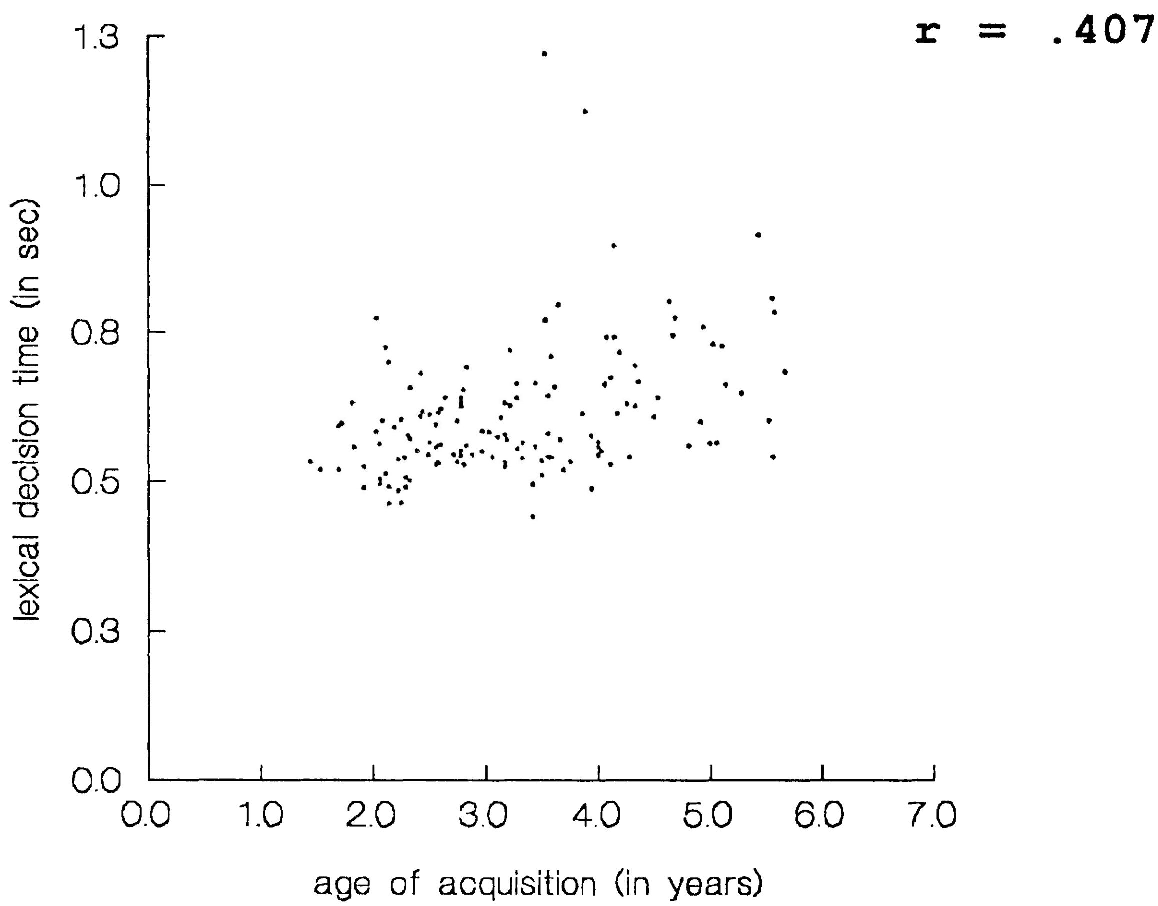

r = .407
1.3
1.0
0.8
0.5
0.3
0.0
lexical decision time (in sec)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
age of acquisition (in years)

Figure 1

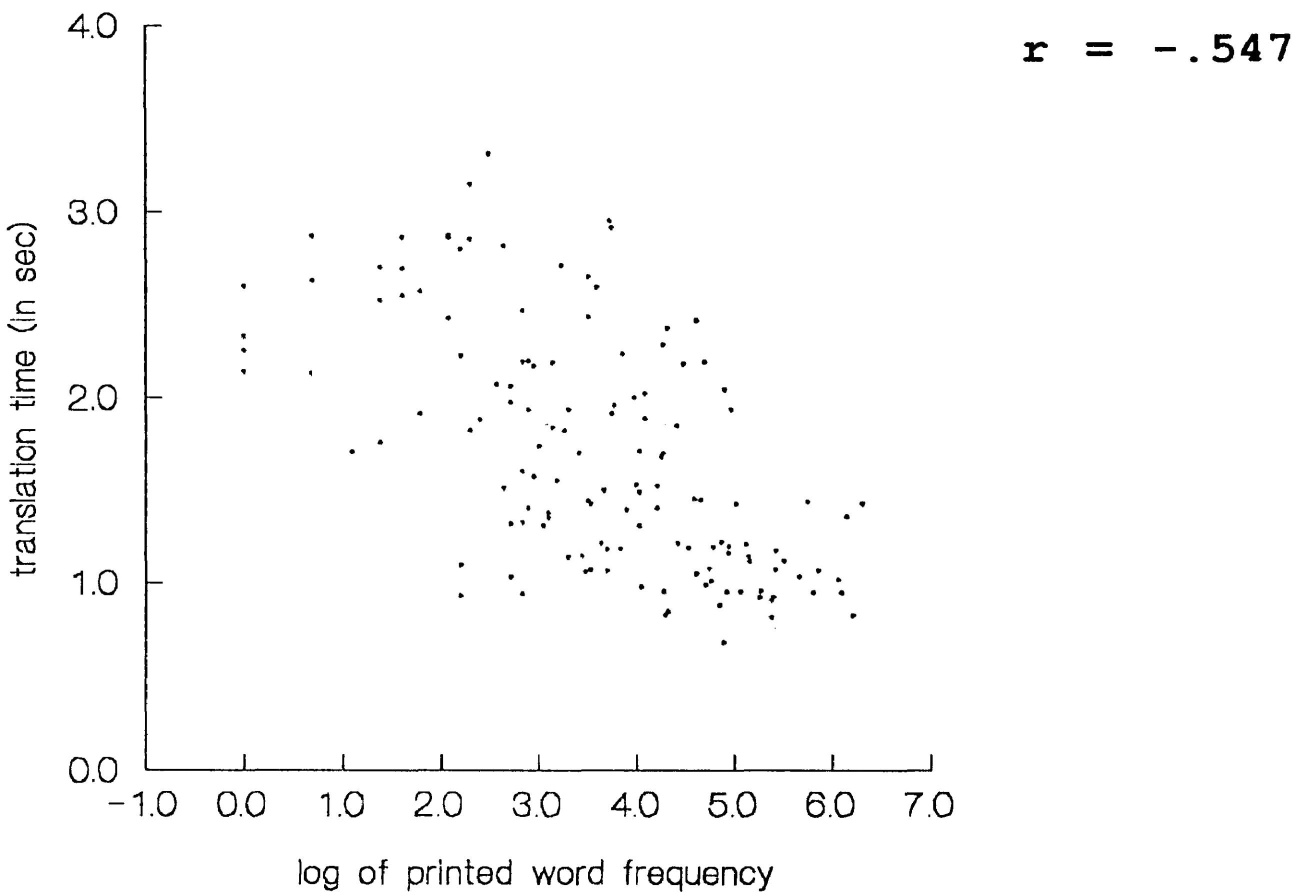

r = -.547
translation time (in sec)
4.0
3.0
2.0
1.0
0.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
log of printed word frequency

Figure 2

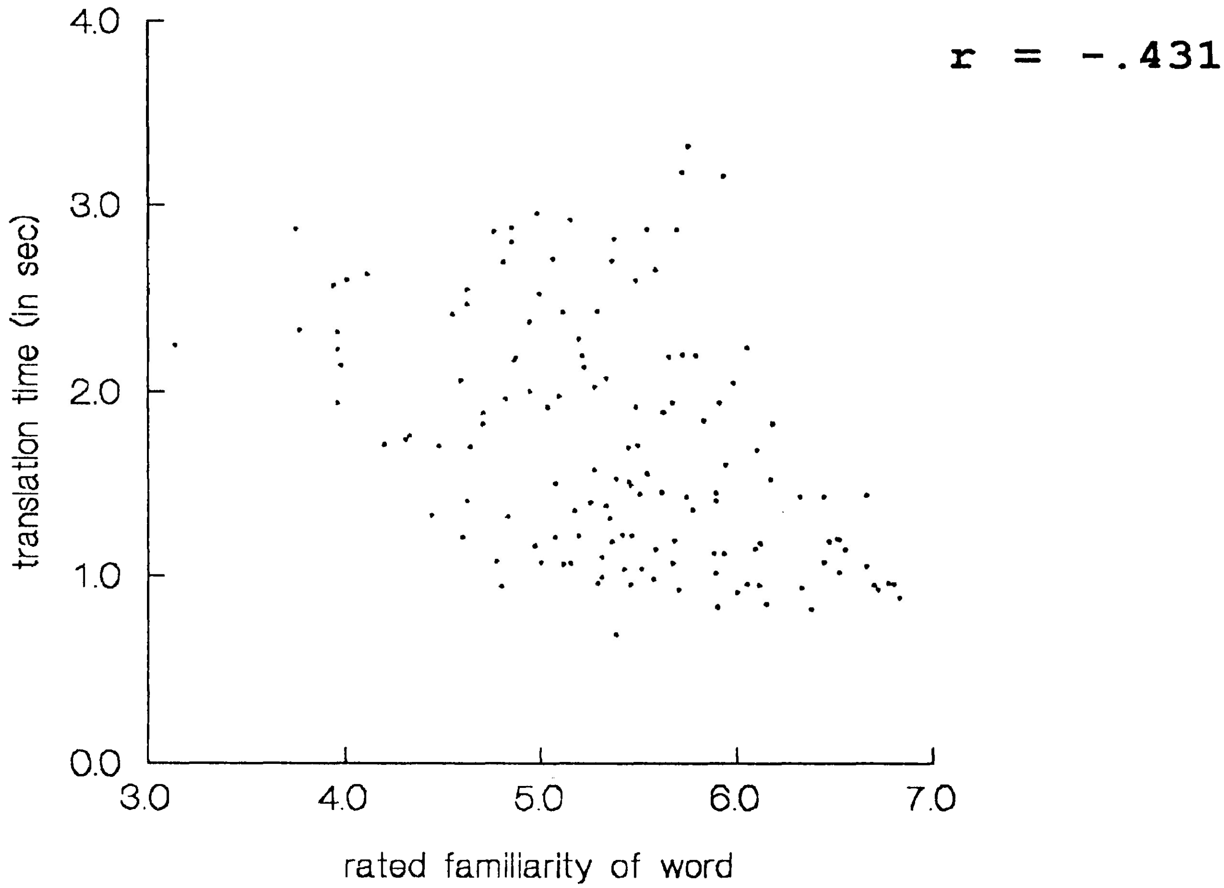
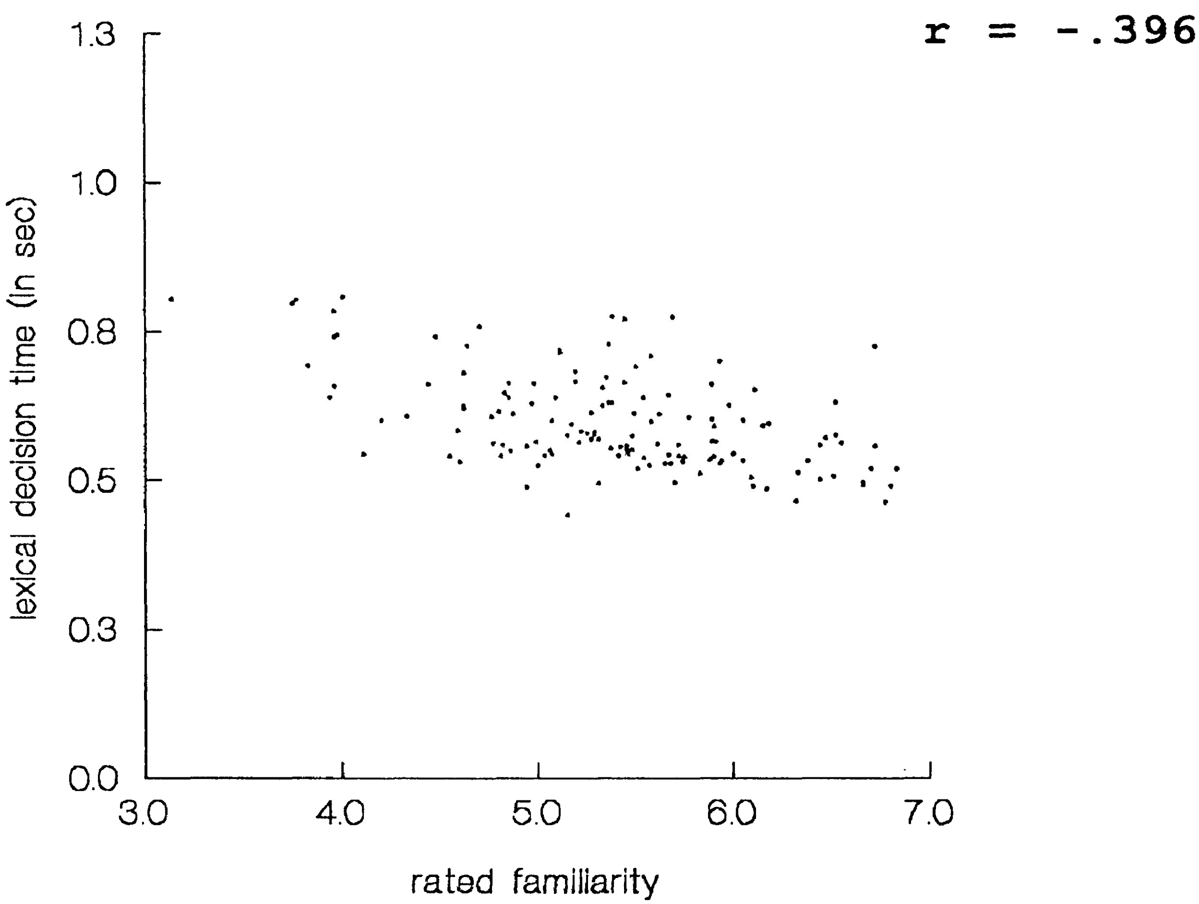

r = -.431
4.0
3.0
2.0
1.0
0.0
translation time (in sec)
3.0
4.0
5.0
6.0
7.0
rated familiarity of word

Figure 5


r = -.396
1.3
1.0
0.8
0.5
0.3
0.0
3.0
4.0
5.0
6.0
7.0
lexical decision time (in sec)
rated familiarity