Lexical Decision Task Lab

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1 Introduction

The Lexical Decision Task is a useful paradigm for investigating the cognitive process of recognizing words. In this paradigm, participants are presented with a stimulus, and asked to respond whether the stimulus (audio/phonetic or visual/orthographic or both) corresponds to a valid word. Response accuracy and/or delay can be measured. Many experiments in this paradigm have yielded novel and important results (see Swinney 1979, Weber&Cutler 2004) and many abstract models have been proposed to mathematically explain the results (Forster 1989, Marslen-Wilson 1989, McClellan&Elman 1986, Morton 1969). In experiment 1, we attempt to replicate the findings offered by the Lexical Decision Task in regard to the effect of Lexical Frequency on word recall time, and Phonotactic or Orthographic Legality on nonword rejection time. In experiment 2, we attempt to replicate findings regarding the semantic priming effect. The results of the experiments will be compared against the predictions of the various models.

2 Lexical Frequency Experiment

2.1 Introduction

If we hypothesize that the lexical access system is optimized to account for varying frequencies of words, we would predict more common words to be recognized faster than less common words. Neurologically, we are also aware that neurons that fire are reinforced to fire more commonly, and it seems reasonable to predict that this mechanism will also reinforce quicker word recognition for more common words. This expectation is reflected in proposed models of lexical access: for example, in the FOBS model (Forster 1989), more frequently accessed bins are searched first. In the logogen (Morton 1969) and TRACE (McClelland&Elman 1986) models, lexical entries that are frequently accessed will have a lower activation threshold over time, which was also included in later revisions of the COHORT model (Marslen-Wilson 1989). Alternatively, we could hypothesize that no such optimization exists, in which case we would predict to see that word frequency has no effect on lexical access times.

Because all nonwords are in principle equally infrequent, it makes little sense to hypothesize an effect of their frequency. However, since words are built of phonemes or graphemes, it can make sense to expect that their parts could affect rejection times. Specifically, if we hypothesize that the lexical access system can identify and reject phonotactically or orthographically illicit sequences as soon as it encounters them (a form of bottom-up input that might be used in a TRACE model of lexical access), or if, as proposed by the COHORT model, all words are compared against the input and as soon as a word is no longer consistent with the input, it is no longer considered, we should predict that illegal non-words to be rejected by this capability sooner than legal nonwords can be rejected by an exhaustive search which has to experience the entire input.

2.2 Methods

2.2.1 Participants

There were 26 participants in this study, all recruited from a Linguistics course at the University of Utah. The participants were of mixed gender and language background and of various ages. The participants were offered course credit for their participation.

2.2.2 Stimuli

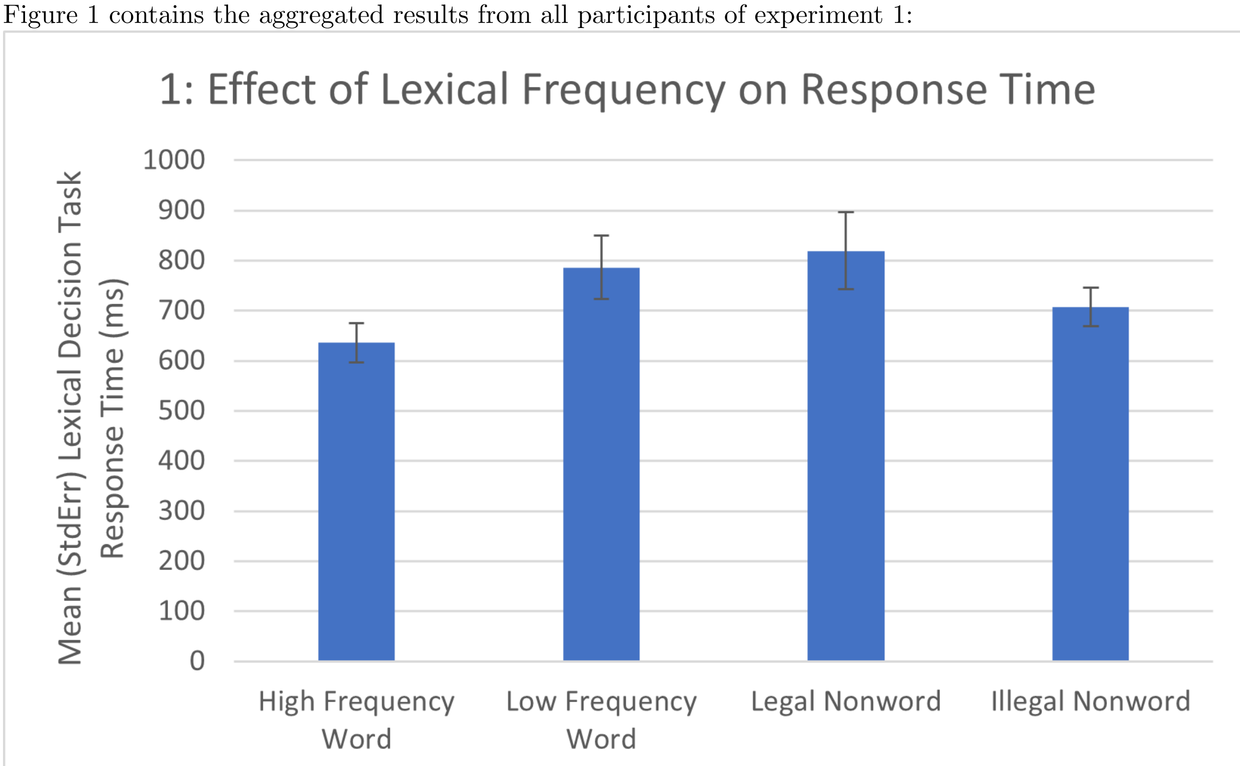
There are 40 words for each condition: High Frequency Words, Low Frequency Words, Legal Nonwords, and Illegal Nonwords.
All word stimuli were taken from MCWord: An Orthographic Wordform Database, and were controlled for word length (mean length 5.825 and 5.925 characters for high and low frequency words respectively), frequency ($\geq$ 400/million and 0/million occurences for high and low frequency words respectively), and recognizability (even the low-frequency words were found to be recognizable to participants).
Nonword stimuli were taken or adapted from the ARC Nonword Database, and were also controlled for length (mean length 5.65 and 5.98 characters for legal and illegal nonwords respectively). Illegal nonwords were adapted from other legal nonwords by metathesizing letters.

2.2.3 Procedures

The experiments were hosted online using PsychoPy and Pavlovia, and participants participants were instructed use their own computers in a quiet place free of distractions. After 500ms of a fixation cross, participants were presented with one stimulus at a time for up to one second and were instructed to press one button to indicate that the stimulus was a word or another to indicate that the stimulus was not a word. Accuracy was recorded, and incorrect responses were not included for analysis (696 trials, about 17% of trials). Response times were also recorded, and are reported below. Because there were 160 stimuli used in this experiment, the experiment took less than 5 minutes.

2.3 Results

Figure 1 contains the aggregated results from all participants of experiment 1:



Notably, the reaction time for high-frequency words is significantly lower than that for low-frequency words, and the reaction time for illegal nonwords is also generally lower than that for legal nonwords, though not quite a statistically significant effect.
Additionally, reaction times appear to be generally slightly longer for nonwords than for words, although this is also not statistically significant.

2.4 Discussion

Because reaction times are significantly lower for High Frequency Words than for Low Frequency Words, the prediction made by our hypothesis is supported by our findings. The non-significant finding that response times are lower for Illegal Nonwords than for Legal Nonwords is also in support of our hypothesis, although ideally this should be substantiated by a statistically significant result. On the whole, however, our measurements support the predictions made by the logogen, FOBS, TRACE, and COHORT models. The FOBS model is of particular interest for this experiment, as it was designed in response to the observation that more frequent lexical entries are recognized as words more quickly; it also is compatible with the hypothesis that legal nonwords should take longer to be rejected than illegal nonwords, as legal nonwords would first undergo an attempted morphological analysis before beginning a failed search for the root of the nonword in the lexical bins.

3 Semantic Priming Experiment

3.1 Introduction

Priming is the general psychological phenomenon observed when two stimuli frequently co-occur and consequently thinking of one facilitates quicker thoughts of the other. This effect has been observed in non-linguistic contexts, but notably has also been observed to occur between words; that is, thinking of or hearing a word can speed up recall times for similar words (Swinney 1979, Weber&Cutler 2004).
If we hypothesize that priming effects will occur, then we should predict that stimuli that are primed by semantically related words will be recognized faster, while words with semantically unrelated primes will not be sped up. We also should not expect any priming effects on nonwords. If, on the other hand, there is no such process, then there should be no difference in reaction time prompted by a semantically related prime.

3.2 Methods

3.2.1 Participants

The participants were the same as the participants in the previous experiment.

3.2.2 Stimuli

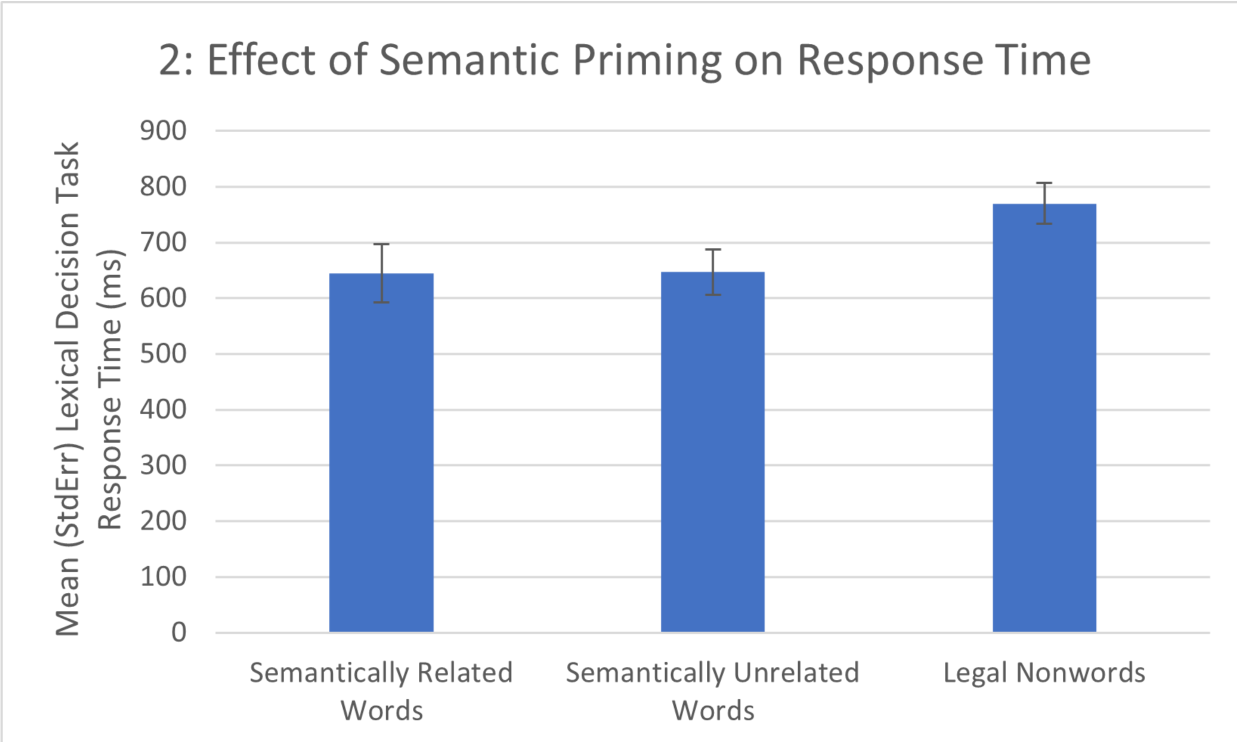
There were 120 pairs of primes and stimuli. For 60 of the pairs, the stimulus was a nonword from the same source as in experiment 1. For the 60 pairs where the stimulus is a word, the 30 pairs where the prime is semantically related to the stimulus were adapted from Perea and Gotor (1997), while the 30 unrelated pairs were taken from Random Noun Generator.

3.2.3 Procedures

A masked priming paradigm was used for this experiment. Like experiment 1, a fixation point was displayed for 500ms. Then a mask preceded the prime for 500ms, the prime was displayed for 50ms, and finally the target stimulus was displayed for up to 500ms. The procedure was otherwise similar to experiment 1, with the participants instructed to press one of two buttons on their computer to indicate a stimulus' word or nonword status, with accuracy and response times similarly recorded and applied (the response times of 319 trials or 10% of trials were discarded for inaccurate responses). The second experiment was also less than 5 minutes.

3.3 Results

Figure 2 contains the aggregated results from all participants of experiment 2:



Notably, there is no difference measured between the Semantically Related Words condition and the Semantically Unrelated Words condition, which goes against the hypothesis outlined in the introduction to this sentence.

Additionally, this supports the observation from experiment 1 that reaction times are generally longer for nonwords than for words, this time with statistical significance.

3.4 Discussion

Most mainstream models of lexical access have a mechanism enabling semantic priming, such as the context input in the Logogen model or the interactive nature of the trace model, in particular that neighboring lexical entries accessed can directly increase the activation of similar lexical entries.. These mechanisms are based on the previous findings within and outside of linguistics that suggest the existence of a priming effect. It is interesting that our study did not find evidence supporting a priming effect, as it fails to reject the null hypothesis that there is no difference between response times for a target word primed by a semantically related word vs that of a target word primed by a semantically unrelated word. It is possible that this is an experimental error, or that there is simply too much noise. Swinney (1979) found, for example, that word meanings had shifted detectably within only 2 years, so it is possible that in the 25 years since Perea & Gotor's 1997 publication that some meanings have shifted, but this cannot explain all the noise that would be required to conflate the two categories so neatly. Additionally, because these stimuli were translated from stimuli used in a Spanish-language study originally, it is possible that some similarities were lost in translation, or that other controls, such as word length, were neutralized during the translation process. We also do not have language backgrounds on all participants, which means that it is likely that many if not all of them will be unpredictably affected by various non-English vocabulary items. Finally, although Perea & Gotor found evidence for priming effects with such a short priming interval (50ms), ours would not be the first to fail to replicate those results, suggesting that perhaps this is too short an interval. Follow up studies could evaluate the English translations of the Perea & Gotor stimuli or the 50ms prime interval.

4 General Discussion

Even though not all of the elsewhere-attested predictions made by our hypotheses were borne out in the data, these experiments highlight the utility of the lexical decision task by illustrating how exposes statistically significant differences between response times for different categories of words, nonwords, and contexts.

5 References

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