# The Effects of ISI and Prime Modality in a Semantic Priming Task

The semantic priming paradigm is a widely used method of assessing both storage and retrieval of single words in the mental lexicon. Semantic priming typically consists of a lexical decision task in which participants make a word/nonword judgment based upon whether the second string of letters (target) is in fact a real word. This is typically accomplished by utilizing a button press task. Preceding the target is an initial string of letters (prime) which is designed to facilitate, inhibit, or have no effect on recognition of the target (Moss et al., 1995).

Priming effects have been found in numerous studies focusing on the semantic aspect of language. Semantics is the language realm dealing with meaning of language. Meaning of individual words is known as its semantic representation (Moss, et al. 1995). Primes sharing semantic similarities to target words have been found to facilitate more rapid reaction times in lexical decision. Priming effects also have been observed in morphology of language, focusing on word structure. The focus of the current study will be confined to the realm of semantics.

Numerous word recognition models have attempted to explain priming effects. One of the main points of debate is based on the presence and/or absence of automatic processes and strategic processes. Automatic processes are not believed to be under human control whereas strategic processes are thought to be volitional cognitive events. Automatic processing has been described as prime activation automatically spreading to target representation; less activation from the subsequent sensory input (prime) is required to bring it to response threshold (Collins & Loftus, 1975). Thus, a theory which advocates automatic processing is the spreading activation theory (Anderson 1983; Collins & Loftus 1975; Rumelhart & McClelland, 1982; Quillian, 1968; Roelofs, 1992) which hypothesizes complex associative networks distributed throughout the network with similar concepts being linked by association. Evidence for automatic nature of priming effects is revealed in studies manipulating inter-stimulus intervals (ISI). The ISI is the interval between prime and target. More rapid ISIs are believed to uncover automatic processes occurring during priming tasks. The premise behind this hypothesis is quite simple; with brief ISIs, strategic processes are not allotted necessary time to occur.

There is some evidence that slower, strategic processes aid in word recognition. The most frequently hypothesized strategic methods are expectancy-based processes. The participant, on hearing the prime, generates a set of related words that they think will include the target (Becker, 1979; 1980). When the target is presented, the expectancy set is searched before the entire lexicon, so if the target is a member, it will be recognized more rapidly.

Although debate continues regarding presence and absence of automatic versus strategic processing, growing consensus is that both processes occur depending upon the task utilized with regards to stimuli, ISIs, and a third variable, modality. Modality refers to presentation method of words/nonwords in lexical decision. Stimuli may be presented visually or via the auditory route. There are numerous studies which have focused on effects of manipulating prime modality (Moss et al. 1997); however, these studies have addressed only the morphological aspects of language. In addition, no study has examined effects of prime modality on automatic and strategic process mechanisms in a semantic priming task. Furthermore, no study exists which addresses the variables of ISI and prime modality. The current study sought to resolve this issue by combining short (0 ms) and long (400 ms) ISIs with visual and auditory prime words in a series of lexical decision tasks. Information on the interaction between these two factors enhances understanding of how single words are both stored and accessed in the cognitive-linguistic network.

## Method

Forty college students, aged 18-25 participated. All were native English speakers and exhibited receptive vocabulary standard scores (Peabody Picture Vocabulary Test-IV; PPVT-IV; Dunn & Dunn, 2007) and reading abilities (Test of Word Reading Efficiency; TOWRE; Torgeson et al., 1999) within normal limits (Table 1). All passed a hearing screening through the speech frequencies and had vision within normal limits with corrective lenses as needed.

The current study follows a 3 X 2 X 2 design. Independent variables (IV) are word pair type (related, unrelated, nonsense word), inter-stimulus interval (ISI) (0 ms, 400 ms), and prime modality (visual, auditory) with dependent variable as reaction time in milliseconds (ms). Participants completed four blocks of lexical decision tasks, consisting of a combination of the previously mentioned IVs. Stimuli for all blocks were adapted from Moss et al. (1995). Real word stimuli were word pairs shown to exhibit priming effects in the semantic priming paradigm used by Moss et al. (Table 2). Thirty three percent of the word pairs consisted of associated word pairs; 33 percent of non-associated word pairs; and 33 percent of a real word prime and a pronounceable nonsense word target. The experimental task was presented via Superlab Pro (Cedrus Corporation, 2007) which tracked reaction time and accuracy.

## Results

Reaction time measures (ms) were obtained on the lexical decision data (Table 3). A three factor ANOVA was conducted on the reaction time data to investigate the mean differences between reaction time as a function of ISI and prime modality. Accuracy proportions on the data also were obtained but were nonsignificant.

Reaction time results revealed a significant main effect of target word. Related prime-target pairs yielded faster reaction times. A significant interaction was found between ISI and prime modality. The visual prime modality condition yielded faster reaction times when accompanied by short ISIs. In contrast, the auditory prime modality condition yielded faster reaction times in the long ISI condition.

## Discussion

The purpose of this investigation was to enhance the understanding of how single words are both stored and accessed in the semantic network. The results yield valuable information on the automatic and strategic mechanisms which are in place in a cross-modal priming paradigm. This study is the first to yield results revealing semantic priming effects in this type of paradigm. As previously stated, priming effects found in previous research have been attributed to morphological influences (Moss et al., 1995). The current results indicate the preponderance of strategic processes over automatic processes in the auditory modality. It is suggested that the auditory modality/short ISI condition rendered the participant unable to recruit strategic processes in order to complete the task. Furthermore, the participants were not capable of fully recruiting beneficial automatic processes either due to absence of the ISI. Thus, the findings indicate that there are differences in the storage and access of single words as a function of modality.

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Table 1. Participant performance on pre-experimental standardized tests

| | TOWRE | PPVT-IV |
|---|---|---|
| **Mean** | **15.3** | **112*** |
| **S.D.** | **1.17** | **5.88** |
| **Range** | **12 – 18** | **96 – 125** |

*Standard Score

Table 2. Stimulus examples for types of word pairs

Related: Thunder: lightning; lettuce: cabbage; measles: mumps

Unrelated: Brother: Hat; square: comb; king: axe

Nonsense: latin: engloyed; lettuce: klup; soldier: chimdruff

Table 3. Means and standard deviations for reaction time (msec) for word pair type as a function of ISI (0, 400) and prime modality (visual, auditory)

| Word Pair Type | Unrelated | Related | Nonsense |
|---|---|---|---|
| **Short ISI: Visual** | **1235/122** | **783/89** | **1342/289** |
| **Long ISI: Visual** | **1622/310** | **952/172** | **1890/422** |
| **Short ISI: Auditory** | **1515/271** | **1073/187** | **1975/433** |
| **Long ISI: Auditory** | **1199/211** | **792/107** | **1442/291** |