Elsa Skënderi-Rakipllari[1]

UDC 81'23
UDC 81'367.62

SEMANTIC PRIMING EFFECTS OF SYNONYMS, ANTONYMS, FRAME, IMPLICATION AND VERB-OBJECT CATEGORIES

Abstract: *Semantic priming has been a major subject of interest for psycholinguists, whose aim is to discover how lexical memory is structured and organized. The facilitation process of word retrieval through semantic priming has long been studied. The present research is aimed to reveal which semantic category has the best priming effect. Through a lexical decision task experiment we compared the reaction times of masked primed pairs and unprimed pairs. In addition, we analyzed the reaction times and priming effect of connected semantic relations: antonymy, frame, synonymy, implication and verb-object. The data collected and interpreted unveiled that the mean reaction times of primed pairs were shorter than those of unprimed pairs. As to semantic priming, the most significantly primed pairs were those of implications and verb- objects, and not those of synonymy or antonymy as it might be expected*

Keywords: *psycholinguistics, priming, lexical decision task, semantics, reaction time*

Introduction

The fast pace at which humans choose from approximately 30,000 words in the mental lexicon to produce more than 150 within one minute, has lead to vast research and numerous experiments aimed at figuring out how words in the mental lexicon are organized and whether there are any specific relationships among them.

The human brain seems to be able to search for a certain word within a significantly short time. Psycholinguists have developed several techniques to provide evidence on how fast and how efficient is the ability to search and produce words. One of these techniques is well-known: Lexical Decision Task. In this task, the subject has to decide whether a string of letters presented to him/her, is a word or a non-word of a specific language. The evidence collected from this experimental technique has been helpful in evaluating the mental accessibility of the word and the time needed to process the word.

[1] Lecturer at the Faculty of History and Philology, University of Tirana, Albania.

Numerous experiments based on Lexical decision tasks have shown that the inclusion of priming facilitates the task. "For example, in a seminal study, Meyer and Schvaneveldt (1971) demonstrated that people were faster to decide that butter is a word in English when it was preceded by the word bread than when it was preceded by the word nurse" (González and Márquez 2007: 203).

Lexical decision task is often combined with the experimental technique of priming, where the TARGET word is preceded by a prime, which is a word, related or unrelated to the target. There is a priming effect whenever the prime facilitates the retrieval of the target word.

To eliminate any memory trace and the conscious operation of activating the target word through the prime, Forster and Davis developed the paradigm of masked priming in 1984. In masked priming the prime is shown between the mask and the target, and for a shorter time than the mask. This prevents the prime to reach consciousness, but still seems to produce the priming effect. Some scholars refer to masked priming as purer priming, since subjects are mostly unable to notice it. "It seems clear that any observed priming effects cannot be a result of any conscious appreciation of the relationship between the prime and the target stimulus" (Forster 1997).

The primes that are semantically related have been found to facilitate the lexical decision task. What we wanted to unveil was which semantic relations between the prime and the target have more priming effect and lead to faster Reaction Times (henceforth RT).

In the experiment we used a visual mask. We did so based on the fact that "evidence from visual masking supports the view that readers process a word at many different levels – feature, letter and whole word. Briefly shown a word on a screen, subjects find it more difficult to report what the word is if it is immediately followed by another stimulus" (Field 2005: 171).

Experiment

The experiment tested the priming effect in a lexical decision task, where the primes and targets had certain semantic relation. The first condition was that the prime and the target had to have had an Antonymic relation. In the second condition, the prime and the target were synonyms of each other. The third

condition was a Frame condition, the fourth was the implication condition, whereas the fifth one was the verb-object condition, in which the prime was a verb and the target was the direct object of that verb. There was also an unrelated condition (ord), in which there was no semantic relation between the prime and the target, since they had no semantic relationship. The last condition was that of nonwords.

Method

Subjects: 24 people participated in the experiment. They all claimed to be native speakers of Norwegian and 23 of them were university students. The subjects were not paid and they participated voluntarily. In addition, they were told that if, for any reason, they felt uncomfortable, they could quit the experiment. All of them completed the experiment from the beginning to the end.

Materials and Design

The wordlist used for the experiment was created by the experiment designers. This wordlist had two main groups. The first group was "Words" and the second ones "Non-words". In the words group there were 5 categories of prime-target: antonyms, synonyms, frame, implications, and verb-object. In each of the categories there were 10 pairs; on the other hand, in the second group, there were 50 non-words.

The experiment had four blocks: An introduction text block, a warm up block, the experiment block, and a final thank-you block, which notified the subjects that the experiment was over.

The word non-word targets were shown randomly, and the same was true for the antonymic, synonymic, frame, implication and verb-object pairs.

The experiment was designed through the program "Superlab". The subjects saw the word strings on a computer screen and had to answer through a control box designed with two response keys: a green one for yes, and a red one for no.

Procedure

The subjects were presented with the task of the experiment: to decide whether the string of letters shown to them on the monitor, was a word or a non-word in Norwegian.

They were also told that this experiment's aim was not to measure their intelligence, nor to test their knowledge.

After the first block of introduction, there were some warm-up pairs of words shown to the subjects. The reaction times to these pairs were not taken into consideration in the final results.

The mask which was a single asterisk (*), stayed on the screen for 1000 milliseconds. Then the prime, with small letters appeared on the screen for 50 ms. As to the target that was shown for 1000 milliseconds, or for a shorter time, in case that the subject pressed a button before that time. The randomized pairs of prime-target were the same for all subjects.

Results

As it was expected after finishing the experiment, most of the subjects were not aware of the primes, the words in small letters. This was likely to happen since the experiment dealt with masked priming.

The data collected and statistically analyzed showed that the primed conditions had shorter reaction times than the unprimed ones (ord). In addition, the response latencies for antonymic, synonymic and frame pairs were almost the same. The priming effect was noticed on implications and verb-object pairs.

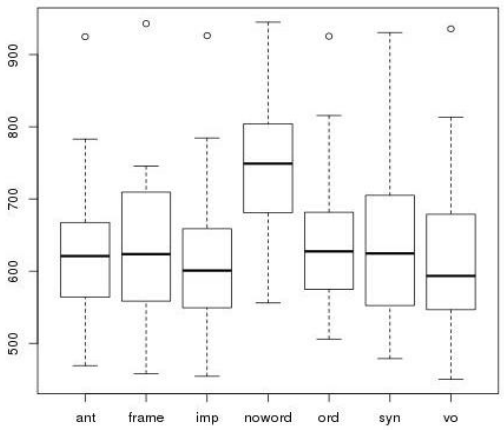

Figure 1

		Mean reaction time
condition	Ant	601.166
	Frame	606.154
	Imp	562.362
	noword	611.064
	Ord	603.187
	syn	594.708
	VO	595.183

Table 1

It is clear that all primed mean RTs are below the RTs of the unprimed category nonword.

Different processes take different time to complete. By manipulating the variable "baseline times" (unprimed word) with the control over the condition, we can obtain the reaction times. The reaction times for each of the conditions are as follows and they are plotted with a histogram. These histograms indicate the Confidence interval, and the normal distributions. As it can be seen, the curves of the implications and verb-object scoops miss zero. This indicates that the data can be explained by the variation at the rejection level of 5%.

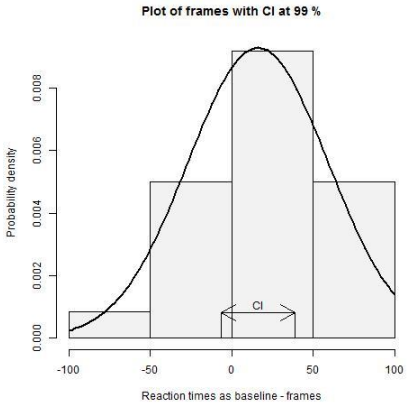

Figure 2

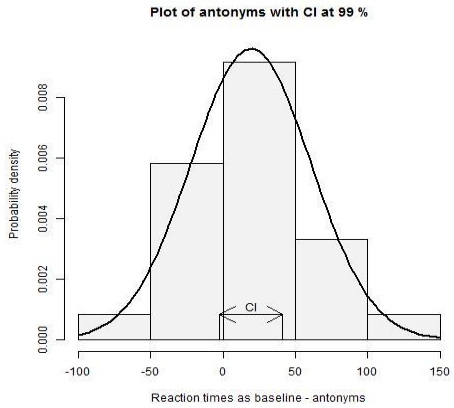

Figure 3

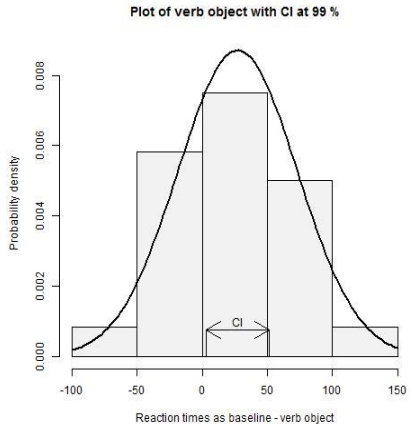

Figure 4

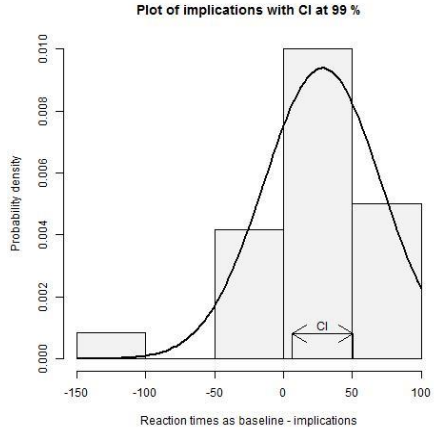

Figure 5

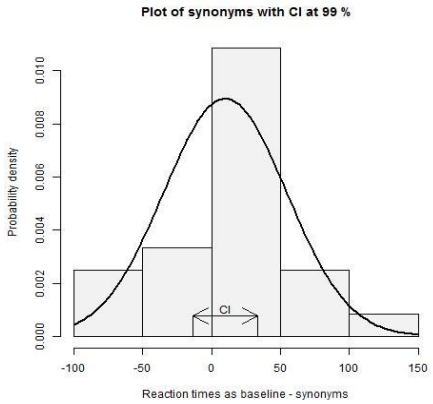

Figure 6

In the cases when the curves scoop up to zero, the differences are too small to reject the null hypothesis (the hypothesis that there is no difference in the reaction time for all semantic categories).

The Confidence Interval due to Bonferroni corrected, was 99% and not 95%, since there were 5 hypotheses and the rejection level of 5 %, was turned into a rejection level of 1%. For this reason the CI in our plots were set at 99%.

The significance of each condition was tested via the pairwise t-test for each category.

T-test	p-value
(frame.o)	0.079
(syn.o)	0.293
(imp.o)	0.003
(ant.o)	0.033
(vo.o)	0.008

Table 2

There are three p-values under 5%, for Imp., V-O and ant. However, due to Bonferroni correction, we had to adjust for the number of comparisons, which brings the 5% significance level down to 1%, and only Imp. and V-O are still below that, i.e. show significance.

What can be concluded is that there is a priming effect for implications and verb-objects – these two conditions showed significance p<0. 1.

Error-codes of the experiment and their interpretation

To determine the priming effect of different categories, the error codes representation was chosen to shed light on our results.

type	C	E	NR
ant	229	2	9
frame	229	3	8
imp	216	4	20
noword	965	42	193
ord	212	11	17
syn	225	1	14
vo	230	2	8

Table 3

Table no. 3 shows the number of Correct answers (C), Wrong answers (E) or No responses (NR) for each category. As it is seen for the non-word category, there are 42 errors, more than all other semantic categories altogether, 23. In addition, there are 193 No responses for the non-words, even less than the sum of NR-s of all remaining categories, 76.

Statistically, the data from the error codes can be explained by the chi-square test. This test provides an explanation on whether (C), (E) or (NR) are in the proportions as expected by chance.

Test between all with baseline "ord"

chisq.test(type.code[c("ant","frame","imp","syn","vo","ord"),])

p-value=0.001193 <---- on the level 0.001

Test only between the priming pairs

chisq.test(type.code[c("ant","frame","imp","syn","vo"),])

p-value=0.1519 <---- 15% no significance

These chi square tests show that the primed conditions have the expected distribution, and, on the other hand, the unprimed (ord) have a significant low p-value.

As it can be seen from the graph and the chi-square tests run in R, RTs in general are faster for primed versus unprimed words (non-words). But only implications and verb-objects show a significant difference, thus a priming effect.

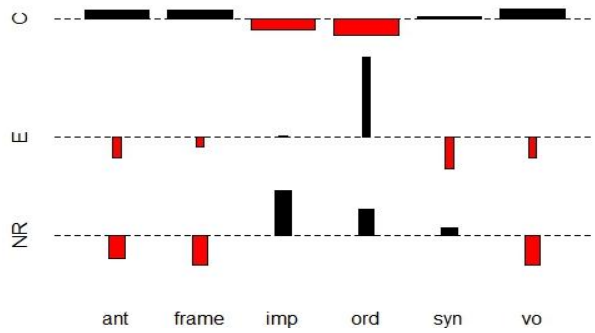

Figure 7

As shown on graph 8, the error-codes group the primed words together as a cluster with respect to the unprimed one, keeping the non-words out of the equation.

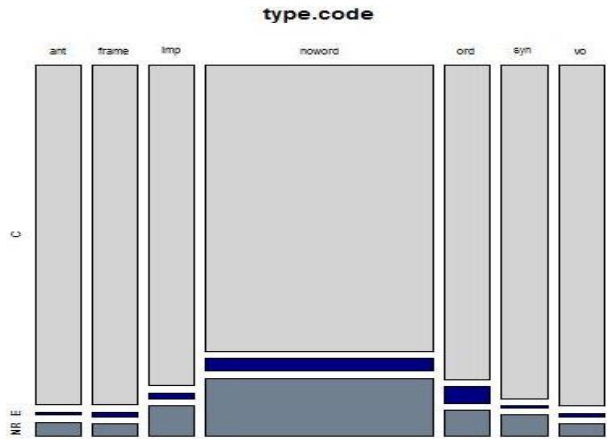

Figure 8

To conclude, the reaction times show a general tendency towards faster times for primed words. In the primed categories only the implication category and the verb-object category were significantly primed when compared to the other ones. As to

what the analysis of the error-codes indicates, there is a priming effect for words and non-priming effect for non-words.

Discussion

In psycholinguistics research the term "semantic priming" refers to the facilitating effect of word retrieval when it is preceded by another word that belongs to the same semantic field. The semantic priming phenomenon might suggest that concepts in the lexicon are related to one another, and that the mental lexicon is not a randomized entity.

Via the lexical decision task, Meyer and Schvaneveldt (1971) showed that lexical decision responses have shorter reaction times when the target word and the previous (prime) one are related. Moreover, Levelt (2001) assumes that a word from a certain semantic field activates related concept nodes. "HORSE also sends part of its activation to semantically related concept nodes, such as those for ANIMAL and GOAT. In turn, these spread part of their activation to their lemma nodes, animal and goat" (13466).

Researchers have suggested using masked priming to minimize the expectancy effects or memory traces and to avoid any strategy in word retrieval (Forster 1997). They also found that the reaction times in the lexical decision task were faster for the primed Targets than for the unprimed ones.

What we were aiming to find out was whether the primed categories had faster reaction times than the unprimed ones. In addition, we wanted to discover which of the semantic categories had a more facilitating effect in the lexical naming task and shorter reaction times. For this reason we analyzed the data collected from the experiment built on five semantic categories: antonyms, frame, implications, synonyms and verb-object.

The results of the experiment showed, as it was expected, that there were shorter reaction times for the primed condition than for the unprimed ones, as stated in the studies by Neely (1977) Aitchison (1987), Ortells et. la (2006), etc. In a similar study Radford (1999) argues that the difference in the reaction-times is a result of the lexicality. "Both are pronounceable English words, but there is still a significant reaction-time difference: the rejection of a non-word takes longer than the acceptance of a real word. This is called lexicality effect." (Radford 1999: 241). The so-called lexicality effect can be

observed at the mean reaction time for each condition of the experiment (Table 1& Figure 1).

The mean RT for non-words was 611.064 ms, but the mean RT for unprimed words (ord) was shorter – 603.187. (+8ms longer for non-words). In addition, we noticed a significant difference between the unprimed condition (ord) and the mean reaction time for all other 5 semantic categories -- 591.914 ms (11.272 ms shorter than for the unprimed ones). This figure clearly confirms the priming effect for the semantic categories.

A salient result from our experiment was that of priming effect related to different semantic categories. There are several papers on this topic, which have investigated the most effective semantic relation that has a stronger priming effect. Authors like Moss et al. (1995), Bueno and Frenck-Mestre (2002), Smith et al. (2004), among others, did similar research, focusing on the investigation of masked semantic priming and the variance of priming effect due to various semantic relationships.

The statistical analysis of our experiment data and the mean reaction times presented a significant priming effect for the categories of implication and verb-object. Surprisingly, the priming effect was higher than the priming effect for the other categories such as synonyms, antonyms and frames.

In a similar study, Lund et. al (1995) suggest that there is no significant priming effect for associations. Our frame condition is comparable to the association condition. Even when priming effect was noticed, it was not as significant as in the cases of implications and verb-object. The mean RT for this condition was the second slowest, after the non-word condition.

In a semantic categorization task, Bueno and Frenck-Mestre (2002) found out that the priming effect for the synonyms was almost constant and higher than that of associates. They explained such result by the fact that synonyms are "semantically closer" to each-other. As for antonyms Murphy (2003) provides a similar explanation, by stating that "Antonym canonicity or goodness of opposability is the extent to which antonyms are both semantically related and conventionalized as pairs in language" (31). In our results synonyms and antonyms have similar mean RT, which supports the view of the conceptual basis of antonymy and synonymy (Murphy and Andrew 1993).

The implication category showed surprising results by being highly primed. When having pairs such as pregnant and woman in a kind of tautological relationship, the concepts 'pregnant' and 'woman' seem to be more strongly related to each other, than when dealing with a synonymic or antonymic pair. If we refer to Levelt's Theory of Lexical Access (2001) word retrieval starts by lexical selection, our experiment results indicate that the retrieval of a target which has an implication relationship with the prime is easier.

As to the verb-object condition, there a significant priming effect was noticed. The primes were verbs and the targets direct objects; an example from these pairs is that of read - book. This kind of condition actually resembles to creation of simple syntactic structures. In these pairs the verbs themselves have argument structures. They are all verbs that require a direct object, thus containing the crucial information of valency. As Aitchison (1987) suggests, having in se this kind of knowledge may facilitate the retrieval of the target. "Verbs, on the other hand, need at the very least to specify the constructions which must, or must not, follow them in a sentence, which often involves reference to other parts of speech: we cannot say *Stella put, • Stella put the cat, or Stella put outside: it has to be Stella put the cat outside" (Aitchison 1987: 101).

Among expected findings for this research, we faced an unexpected one: getting a more significant priming result on implications than on synonyms. We were expecting the opposite to be true. This finding reveals the need for other similar experiments and research to be conducted. The results of this experiment are not enough to claim absolute validity of our findings. Other possible experiments might include testing the same categories, but through unmasked priming or a different task such as picture naming, then a conclusion may be drawn, whether these phenomena occur exclusively at a lexical decision task. Comparisons of this present research to future experiments and studies could help in making reliable generalizations on semantic priming.

References

Aitchison, Jane. *Words in the Mind - An Introduction to the Mental Lexicon* Oxford: Basil Blackwell Ltd, 1987.

Bueno, Steve, and Cheryl Frenck-Mestre. "Rapid activation of the lexicon: A further investigation with behavioral and computational results." *Brain and Language*, 81.1 (2002): 120-130.

Field, John. *Psycholinguistics, the Key Concepts.* London: Routledge, 2004.

Forster, Kenneth I., and Chris Davis. "Repetition priming and frequency attenuation in lexical access." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 10 (1984): 680-698.

Forster, Keneth I. "The Pros and Cons of Masked Priming. The pros and cons of masked priming". *Journal of Psycholinguistic Research*, 27.2 (1997): 203-233.

González-Márquez, Monica. *Methods in Cognitive Linguistics.* Amsterdam: John Benjamins Publishing, 2007.

James, Carlton. T. "The role of semantic information in lexical decisions." *Journal of Experimental Psychology Hitman Perception and Performance* 1 (1975): 130-136.

Levelt, Willem JM. "Spoken word production: A theory of lexical access." *Proceedings of the National Academy of Sciences 98.*23 (2001): 13464-13471.

Levelt, Willem JM, Herbert Schriefers, Dirk Vorberg, Antje S. Meyer, Thomas Pechmann, and Jaap Havinga. " The Time Course of Lexical Access in Speech Production: A Study of Picture Naming". *Psychological Review* 98. 1 (1991): 122-142.

Lund, Kevin, Curt Burgess, and Ruth Ann Atchley. "Semantic and Associative Priming in High-Dimensional Semantic Space". *Proceedings of the 17th annual conference of the Cognitive Science Society*. 17 (1995): 660-665.

Meyer, David E., and Roger W. Schvaneveldt. "Facilitation In Recognizing Pairs Of Words: Evidence of a Dependence Between Retrieval Operations." *Journal of Experimental Psychology* 90. 2 (1971) 227-234.

Moss, Helen E., Ruth K. Ostrin, Lorraine K. Tyler, and William D. Marslen-Wilson." Accessing different types of lexical semantic information: Evidence from priming." *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21.4 (1995): 863-883.

Murphy, Gregory Leo, and Jane M. Andrew. "The conceptual basis of antonymy and synonymy in adjectives." *Journal of Memory and Language* 32.3, (1993): 301-319.

Murphy, M. Lynne. *Semantic relations and the lexicon*. Cambridge: Cambridge University Press, 2003.

Neely, James H. "Semantic Priming and Retrieval from Lexical Memory: Roles of Inhibitionless Spreading Activation and Limited-Capacity Attention." *Journal of Experimental Psychology General* 106.3 (1977): 226-254.

Ortells, Juan J., Concepción Vellido, María Teresa Daza, and Carmen Noguera. "Semantic priming effects with and without perceptual awareness" *Psicológica* 27 (2006): 225-242.

Schriefers, Herbert, Antje S. Meyer, and Willem JM Levelt. "Exploring the Time Course of Lexical Access in Language Production: Picture-Word Interference." *Studies Journal of Memory and Language* 29 (1990): 86-102.

Smith, Marilyn Chapnik, Derek Besner, and Hiroto Miyoshi. "New limits to automaticity: context modulates semantic priming." *Journal of Experimental Psychology: Learning, Memory & Cognition* 20.1 (1994): 104-115.