

Authors: Milena Jakić¹, Aleksandar Kostić¹ and Dušica Filipović-Đurđević^{1,2}

Affiliation: ¹Laboratory of Experimental Psychology, Faculty of Philosophy, University of Belgrade, ²Department of Psychology, Faculty of Philosophy, University of Novi Sad

Email addresses: xmile@eunet.yu, akostic@f.bg.ac.yu, dmfilipo@f.bg.ac.yu

The Influence Of The Word Connection Type On The Facilitation Effect In The Lexical Decision Task

Introduction

The results of numerous studies indicate that word recognition is faster when a target word is preceded by the associatively or semantically connected prime word (cf. Meyer & Schvaneveldt, 1971; Koriat, 1981; Neely, Keefe, & Ross, 1989; Schelton & Martin, 1992; Thompson-Schill, Kurtz & Gabrieli, 1998). The aim of this study is to answer two questions: a) is there a facilitation effect that derives from the type of word relation over and above the effect of associative connection, and b) is the facilitation effect between associatively connected words symmetrical, or put differently, will the effect change if we change the positions of the prime and target stimulus. In order to answer these questions we performed two experiments in which we examined the facilitation effect among two groups of word pairs: pairs in which the connection is purely associative and pairs with an associative and semantic type of connection (synonymy, antonymy, hyponymy). In order to compare different types of relations among the stimuli we have chosen the theory of lexical semantics: *componential analysis*. Experiments will also test the predictions of this theory.

Method

Twenty-eight participants (Experiment 1) and twenty-seven participants (Experiment 2) were tested in Lexical decision task (lexical priming paradigm). All the participants were first-year psychology students from the University of Belgrade. The pairs of stimuli were presented on the computer screen (SOA period was 750 ms), and the participants had to decide if the second stimulus was a word of Serbian language or not (choosing a YES/NO button). The dependent variable was the reaction time, which was measured from the beginning of the presentation of the second stimulus until the response.

In each experiment 100 pairs of stimuli were presented, half of which were pseudoword-targets. Both word- and pseudoword-targets were preceded either by neutral context (*****)¹ or by the words (counterbalanced in Latin square design). Word pairs were taken from the list of associative norms, i.e. *The Associative Dictionary of Serbian Language* (Piper, Dragicević & Stefanović, 2005), while the word-primers for pseudoword-targets were chosen to be unassociated to any of word-targets. In the first experiment the word targets were stimuli from the word-association test, while the primers were their most frequent² associates. In the second experiment primers and targets

¹ Since the strong facilitation effect is obtained even if the target is preceded by the unrelated word, we decided to measure the facilitation effect of the related word comparing to the neutral context, which should represent the reaction time for a discrete target word.

² Frequency of associates was taken from the test of free associations (Piper et al, 2005), in which 800 students took part. Most frequent associates were the words that most participants gave as the response to the stimulus given in a test, and the frequency is the number of participants that had given it.

reversed their positions. There were five groups of associatively connected stimuli pairs. Three of them were also semantically connected: synonymy (*kuca – dom* meaning *house – home*), antonymy (*noc – dan* meaning *night – day*) and hyponymy (*jabuka – vočka* meaning *apple – fruit*). Two groups were not semantically connected: a stronger contextual (*majmun – banana* meaning *monkey – banana*) and weaker contextual connection (*svada – tašta* meaning *quarrel – mother-in-law*). The difference between the stronger and weaker contextual connection was based upon the associative frequency, whose average values were significantly different. The criteria for the selection of the stimuli concerning the relation of synonymy and antonymy was based upon the primary lexical definitions from the dictionary of Serbian language (Recnik MS). Since the criteria for the hyponymy was more clear than the criteria for the synonymy and antonymy relation, it wasn't necessary to base the choice of the stimuli on the primary lexical definitions.

Results and discussion

The analysis of variance established the 57 ms effect of primed context comparing to the neutral: $F(1, 49)=47,414, p<0.0001$. The rest of the analyses were performed on the facilitation effect which was calculated by subtracting reaction times for the target preceded by neutral context and the target preceded by related prime. In table 1 the average values for the five types of relation between primes and targets are given. It is obvious that the five groups of stimuli are very different with regard to distributional statistics, but this couldn't be avoided because of the criteria of stimuli selection.³ However the differences between the groups were partialled out by means of the analysis of covariance. The analysis of covariance performed on items showed that the facilitation effect was significantly stronger when in addition to associative connection word pairs were also semantically connected (the average difference was 35 ms; figure 1): $(F(1, 43)=7.03, p<0.01)$.

Table 1. Average values for the stimuli in first experiment

relation type	rating of associative connection	target freq	prime freq	associative prime freq	Rt on target (ms) in neutral context (*****)	Rt on target in related context (ms)	Facilitation effect (ms) ANOVA	Facilitation effect (ms) ANCOVA ⁴
Antonymy	4,669	1317	1209	200	584	532	52	61
Hyponymy	5,741	47	57	110	627	562	65	55
Strong context	5,994	397	622	145	605	568	37	40
Weaker context	4,370	367	150	79	638	615	23	25
Synonymy	5,380	122	452	139	732	624	108	91

³ Besides the fact that there is a limited number of synonyms, hyponyms and antonyms in language, it was also necessary to find the confirmation of strong associative connection between them (in Associative dictionary).

⁴ Notice that facilitation effect ANCOVA is not simply obtained by subtracting reaction time on target preceding neutral and connected prime, but also by partialling out (in analysis of covariance) factors known to affect facilitation (frequency of prime and target, associative frequency of prime, rated associative connection, length (number of graphemes) of the target).

The results of the first experiment also indicated that the relation type between words (synonymy, antonymy, hyponymy, stronger contextual and weaker contextual

Figure 1. Average facilitation effect for different type of connections

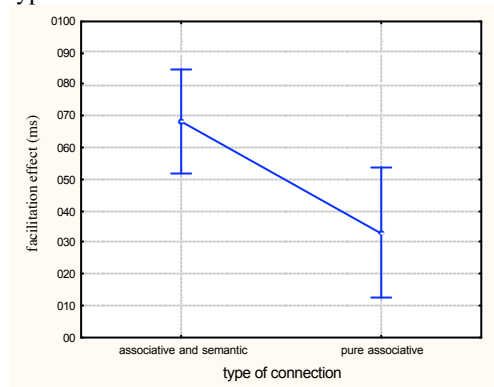
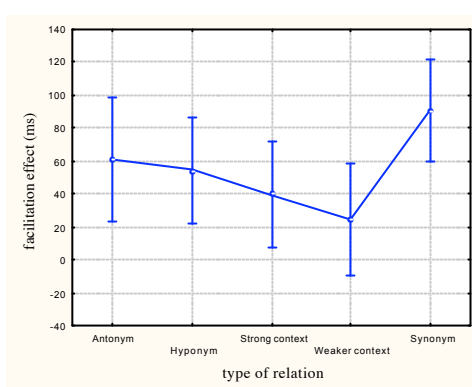


Figure 2. Average facilitation effect for different types of relation



connection) has a significant influence on the facilitation effect: $F(4,40)=2.62$, $p<0.05$ even if we partial out factors known to affect facilitation (lexical frequency of the prime and target (taken from the Kostic, 1999), associative frequency of prime (taken from Piper et al. 2005), target length, rated associative relation between prime and target) figure 2). The strongest facilitation effect was in the group of synonymy. Note that the average lexical frequency for the targets of the synonymy group is higher than average lexical frequency for the targets of the hyponymy group, while the effect is much higher for the synonymy group. On the other hand, the effects of hyponymy and antonymy groups are almost the same, but the average frequency of targets is dramatically different (see Table 1). These outcomes indicate that the observed effects were not due to target frequency.

The differences in the facilitation effect among the five experimental situations, observed ordinally, can be accounted for in terms of *componential analysis* (Lyons, 1977), a linguistic theory that describes the number of common semantic components between words in different lexical relations. For example: synonymy pairs will have the biggest percentage of common semantic components, then antonymy, hyponymy, stronger contextual connection and the last will be the weaker contextual connection group. From the perspective of componential analysis, using the Spearman's correlation coefficient, we explained the significant percentage of the facilitation effect variance: ($r=-0.38$, $t(3)=2.81$, $p<0.01$). By the prediction of componential analysis, the facilitation effect will be the same no matter of the direction of the association (forward or backward). The second experiment tested this prediction.

The outcome of the second experiment indicates that the facilitation effects are not symmetrical (table 2). This could be expected on the basis of the associative norms, but it is not in accordance with previous studies. Some authors claimed that, unlike associative relations, semantic relations are symmetrical (cf. Thompson-Schill et al, 1998). However, in the present study, although the overall facilitation effect is roughly the same in both experiments (53 ms versus 54 ms) the correlation of the facilitation effects in two experiments (including semantic relations) was not significant ($r = 0.54$, $p > 0.05$).

Table 2. Average values for the stimuli in second experiment

relation type	Rt on target (ms) in neutral context (*****)	Rt on target in related context (ms)	Facilitation effect (ms) ANOVA	Facilitation effect (ms) ANCOVA
Antonymy	583	525	58	82
Hyponymy	625	583	42	32
Strong context	605	565	40	38
Weaker context	632	584	48	45
Synonymy	644	569	75	66

The results of the present study indicate that the strength of the facilitation effect depends not just upon the connection type between words (pure associative or associative and semantic connection) but also upon the relation type between them (synonymy, antonymy, hyponymy, stronger or weaker contextual connection). The fact that the type of word relation accounts for facilitation effect over and above the effect obtained by the factors known to affect priming (frequency of target and prime, rated associative connection between prime and target, associative frequency of the prime, length of the target) suggests that the semantic (lexical) relations are cognitively relevant. Furthermore, the theory of lexical semantics (i.e. componential analysis) provides good predictions of the facilitation variation among different types of relations. However, the facilitation effect is not symmetrical and varies in the direction of both the associative and semantic relation. This, on the other hand, is not in accordance with previous studies and the predictions of componential analysis.

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