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The Effect of Semantic Relatedness on EFL Learners' Cognitive Processing of L2 Words

Vahid Rahmani Doqaruni, Ph.D.
Department of English Language and Literature, University of Gonabad, Iran

Abstract

Due to both experimental and theoretical controversies on semantic relatedness research in second/foreign language (L2) education, the present study investigated English-as-a-foreign-language (EFL) learners' cognitive processing of semantically related and unrelated words in an attempt to provide an alternative approach. The participants were 38 Iranian EFL learners from upper intermediate classes at a private language school. Employing a semantic priming experiment, the EFL learners saw a pair of words, and were asked to decide whether or not the target word (i.e. an adjective) was related in meaning to the preceding word (i.e. a noun). A two-way Repeated Measure ANOVA was run on reaction time (RT) and error rate (ER) data. Results of the study showed that semantically related words induced faster RTs than semantically unrelated ones confirming the positive effect of the semantic relatedness in cognitive processing of L2 words. However, higher ERs in related conditions in comparison to unrelated conditions refer to a kind of confusion on the part of EFL learners.

Keywords: cognitive processing, error rate, reaction time, semantically related/ unrelated words, semantic priming experiment

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Corresponding Author: Vahid Rahmani Doqaruni
Email: rahmani@gonabad.ac.ir

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Introduction

The major stakeholders in the field of second/foreign language (L2) education, including researchers, teachers and learners, have always been interested in the effect of semantic relatedness on learning words. This interest is reflected in L2 course books which have mainly supported presenting semantically related words as an effective technique for developing vocabulary (Finkbeiner & Nicol, 2003; Ibarrola & Gordo, 2015). In these books, L2 words which share common semantic features are packaged under a certain subject (e.g., jobs, clothes, body parts) and are presented to L2 learners. As this technique is in line with the principles of the communicative language teaching approach (Folse, 2004), both students and teachers have considered it effective and useful. This is due to the fact that "teaching vocabulary in semantically related sets follows the communicative needs of EFL learners…[and] it is simply much easier for teachers to teach words that are semantically related at the same time" (Ibarrola & Gordo, 2015, p. 34).

However, despite the fact that presenting semantically related words has been accepted as a productive means of L2 vocabulary development by teachers and students, the efficiency of this technique has been doubted as mixed results have emerged in previous studies. On one hand, there are researchers who

have argued that semantic relatedness hinders vocabulary learning and have proposed that it makes learning L2 words more difficult (e.g., Erten & Tekin, 2008; Finkbeiner & Nicol, 2003; Papathanasiou, 2009; Tinkham, 1993, 1997; Waring, 1997; Wilcox & Medina, 2013). On the other hand, some researchers have provided evidence in favor of presenting L2 vocabulary in semantically related sets (e.g., Hashemi & Gowdasiaei, 2005; Hoshino, 2010; Jullian, 2000).

Due to both experimental and theoretical controversies in these two opposing camps, thus, the idea of presenting vocabulary in semantic sets calls for further research in the field of L2 education. As Papathanasiou (2009, p. 315) pointed out, "we do not have enough convincing evidence to decide which of the two contrasting approaches to learning vocabulary is the more useful and appropriate for L2 vocabulary teaching". In addition, the limitations identified in the previous studies warrant the need for further exploration into semantic relatedness. For example, many previous studies (e.g., Finkbeiner & Nicol, 2003; Tinkham, 1993, 1997; Waring, 1997) have used artificial words which questions the generalizability of the findings and restricts the conclusions. As there is a big difference between these artificial words and the real-world language with respect to both their meaning and rules for creating them, authentic responses from participants cannot be expected. According to Jiang et al. (2020, p. 202), "artificial words, to a great extent, can hurt the authenticity of the materials and consequently the content validity of the tests". Moreover, surprisingly, some of the studies have used monolingual subjects (e.g., Finkbeiner & Nicol, 2003; Tinkham, 1993, 1997), and have extended their results and conclusions to L2 learners. Yet another limitation is that most of the previous studies on semantic relatedness have focused mainly on nouns, and the effect of semantic relatedness on other word classes, such as adjectives, has not been investigated (Jiang et al., 2020; Papathanasiou, 2009). Therefore, finding out whether the effect of semantic relatedness on other word classes corroborates the previous findings on nouns can be of particular interest. In order to address these limitations, this study not only uses natural words with L2 learners, in contrast to artificial words with monolinguals, but also extends the boundaries of word limitations by including adjectives, in addition to nouns.

Moreover, in order to get a new insight into semantic relatedness research, the current study presents a totally different approach from the previous studies as it looks at the issue from a cognitive perspective. More specifically, this alternative approach investigates L2 learners' cognitive processing of semantically related and unrelated words. It is believed that studying the cognitive behavior of L2 learners regarding semantic relatedness leads to a better understanding of this topic. To achieve this aim, a cognitive experiment was specifically designed to look into the cognitive word processing of L2 learners. In this experiment, a target adjective, which was loaded with positive or negative valence, was preceded by a prime noun. Hopefully, this particular semantic priming task designed in the present study would shed more light on the semantic relatedness research from a cognitive perspective.

To fulfill the aims of the present study, the following research questions were posed:

1) Are there any cognitive processing differences between L2 semantically related and semantically unrelated words?
2) What might be the possible reasons behind the potential differences in cognitive processing of L2 semantically related and semantically unrelated words?

Theoretical Foundation

The opponents of semantic relatedness support their argument by specifically referring to the *interference theory* which proposes that similar words or the words which share the same features may interfere with each other, and consequently their learning is difficult (Baddeley, 1997). It is argued that interference is inevitable because the previously learned information is "mixed up with new and somewhat similar information" (Slavin, 2003, p. 189). Another piece of evidence against semantic relatedness is the *distinctive hypothesis* (Eysenck, 1979). According to this hypothesis, items that are distinct or dissimilar are easier to be learned by learners. This hypothesis gained its reputation as "experiments exhibited greater recall of the distinct lexical items in comparison with the semantically interrelated words of the lists" (Gholami & Khezrlou, 2013, p. 156).

In contrast to the opponents of semantic relatedness, the proponents have attempted to provide evidence for the efficiency of presenting semantically related sets with reference to the *semantic field theory* (Lehrer, 1974). According to this theory, the mental lexicon is organized in semantic fields, and the appropriate semantic field is activated, when it is needed, to remember conceptually mapped words (Aitchison, 1994). In this way, as it is possible to form patterns of interrelated words in mind, teachers are advised to teach vocabulary items to their students that belong to the same semantic field (Haycraft, 1993). Additional theoretical support is provided by the *levels-of-processing theory* (Craik & Lockhart, 1972). With respect to this theory, as the information is processed at

a variety of levels, the quality of the retention is affected by the amount of cognitive effort that is given to the process. Considering that it is easier for learners to organize or chunk words that are semantically related, it is argued that "it would be more likely that words are processed at a deeper cognitive level in the LS [lexical-set] method than in the SU [semantically-unrelated], in which words are presented sporadically, irrespective of other semantically-related items" (Hashemi & Gowdasiaei, 2005, p. 343).

Literature Review

Despite the popularity of presenting semantic related words in L2 classrooms and among material designers, the findings of a body of empirical studies on the effect of this method have been controversial. Interested in how nicely semantic clusters fit into most L2 programs from language-centered to learner-centered approaches, Tinkham (1993) decided to test the hypothesis that whether L2 learners learn new words more easily if those words are packaged in unrelated sets rather than semantic clusters. The results showed that grouping new L2 words into semantic clusters impedes their learning. More specifically, the subjects learned unrelated words more quickly and more easily in comparison to semantic related words. In a follow-up study, Tinkham (1997) further explored the effects of semantic clustering on vocabulary learning in comparison to thematic clustering. The same results were obtained as the data revealed that it was more difficult for the subjects to learn L2 vocabulary items in semantic clusters than L2 vocabulary items in unrelated sets. However, it was found that L2 thematic related words were learned more easily than L2 words in unassociated sets. With respect to these findings, he concluded that semantic clustering of vocabulary items is an obstacle for learning new L2 words while thematic clustering facilitates their learning. Waring (1997) closely replicated Tinkham's (1993) study with Japanese English-as-a-foreign-language (EFL) participants. He obtained the same results as he found a main effect against learning semantically related words. The findings implied that presenting wordlists in semantic clusters should be avoided as it interferes with learning, and instead words could be mixed into thematic clusters or a master list of words could be created.

Finkbeiner and Nicol (2003) attempted to find out whether grouping words into semantic sets had any effect on their participants' performance in translation tasks. They recorded the reaction time of translation tasks and found that participants were significantly slower in articulating the target word correctly in semantic sets. In other words, it was found that participants took longer when translating semantically related words in comparison to their semantically unrelated counterparts. In line with the previous research, they concluded that presenting L2 semantically related words has a negative effect on their learning. Erten and Tekin (2008) reported the results of a quasi-experimental study on the effect of two different methods of presenting words (i.e. semantically related sets or semantically unrelated sets) on vocabulary recall in a Turkish EFL setting. In this way, they obtained the participants' word-picture matching scores and their completion time. Both of the immediate and delayed tests revealed that learning words in semantically unrelated sets is significantly better than learning words in semantically related sets. Meanwhile, the longer completion time of the semantically related vocabulary items was inferred as their slower recall. With reference to their results, they questioned the current practice in L2 course books and asked for developing alternative methods to teach vocabulary in unrelated sets in order to help students learn L2 words with more ease. Papathanasiou (2009) compared the effectiveness of semantically related and semantically unrelated sets by focusing on the level and age variables. In this way, English words with their Greek equivalents in semantically related and unrelated sets were presented to two groups of Greek EFL learners (i.e. intermediate children and beginner adults) during three weeks. Both groups took immediate test at the end of the third week and delayed test two weeks later. Although no significant difference in test scores was found for the intermediate children, the results demonstrated that presenting new words in semantically related sets impeded L2 vocabulary learning of the adult beginners.

Wilcox and Medina (2013) studied the simultaneous effect of semantic and phonological clustering on novice learners of Spanish as a Foreign Language. Both the immediate and delayed tests showed that participants had difficulty in learning words when they were presented in semantic sets without phonological similarities. However, the results did not show any significant effect of semantic relatedness on the participants' performance for similar phonological words. They attributed their findings to the particular function of mind which may initially prefer to organize words in semantic fields, but the already semantically pre-organized words need not to be received. Ibarrola and Gordo (2015) tested the effectiveness of teaching vocabulary in semantically related sets by comparing it to presenting unrelated vocabulary. Partially replicating the Papathanasiou's (2009) study, they took into account the L2 learners proficiency level (beginner vs. intermediate) as an additional variable. Their results showed that presenting L2 words in unrelated sets was

favored in comparison to related sets, especially with higher level students.

Although few studies have found results in favor of semantic relatedness, convincing evidence has been gathered on its efficiency. To help advanced Chilean learners of EFL deal with their somewhat limited and restricted vocabulary, Jullian (2000) conducted a classroom activity on the study of word meaning which explicitly taught semantically related vocabulary. She argued that this type of classroom activity helps students to gain linguistic awareness with reference to word meaning so that they are able to distinguish related words with deep insight into their semantic information. The findings showed that teaching words in lexical-sets enhanced the students' vocabulary knowledge as they understood the meaning of the related words better and incorporated them into their L2 lexicon faster. Also, Hashemi and Gowdasiaei (2005) investigated the effectiveness of vocabulary instruction through semantically related and semantically unrelated sets, and assessed the differential effects of the two methods on students with different proficiency levels (i.e. lower vs. upper) in an Iranian EFL context. Each group received its own special instruction in vocabulary and then the students' vocabulary breadth and depth were measured by using the Vocabulary Knowledge Scale. Their findings suggested that even though both instructional methods improved the students' vocabulary knowledge, students in the semantically related group surpassed their peers in the semantically unrelated group. Moreover, the upper level students in the semantically related group made greater gains than their lower level counterparts. Considering their results, they ask for organizing related words under topics as advance organizers so that they can be taught more effectively. Dissatisfied with the fact that few studies on the efficacy of word lists are based on research in classroom settings, Hoshino (2010) compared five types of word lists (synonyms, antonyms, categorical, thematic, and arbitrary) in a Japanese EFL classroom context to find out which of them facilitated L2 vocabulary learning. The participants were further classified into four clusters of learning styles to investigate the potential effect of different types of word lists on different types of learners. It was found that learning the words in the categorical list (i.e. related set) was more effective than other lists, regardless of the individual student's learning style. It is then suggested that learning from related word lists, rather than unrelated lists, should be encouraged as it helps learners to acquire both broader and deeper vocabulary knowledge.

More recent studies on semantic relatedness have used new methodological designs to gather behavioral and cognitive data in order to look at the issue from a new perspective. For example, Khateb et al. (2016) were interested in finding out why word processing in bilinguals generally was faster with respect to response times for first than for second language words. They used behavioral data and event-related potentials collected from bilinguals while performing a semantic categorization task on visual word pairs to investigate the role of language effect. The results of response times revealed both language and semantic relatedness effects. In another study, Jiang et al. (2020) tried to find out whether semantic relatedness facilitated or impeded the learning of English collocations by conducting two experiments on Chinese EFL learners. Each experiment had a reading session followed by productive and receptive tests. The participants were asked to read 28 paired-up words and their collocations in sentence context in Experiment 1. Results of the productive test showed that the participants performed better on test items that were semantically related. However, the participants scored significantly higher on semantically unrelated items in the receptive test. Experiment 2 was similar to Experiment 1 except that the word pairs selected were only semantically related and did not have any shared morphemes. Experiment 2 also revealed similar results. Considering the results, it was concluded that semantic relatedness had a positive effect on language output but a negative effect on the process of language input.

Method

Design

This study used a semantic priming experiment (for a review of this experiment in L2 research, see McDonough & Trofimovich, 2009) to examine the cognitive processing of semantically related and semantically unrelated words. In this task, participants see a pair of words presented one after each other, and are asked to decide whether or not the second word is related in meaning to the preceding word. The first word is referred to as the *prime* and the second one is called the *target*. In order to design and perform the experiment, PsychoPy (Peirce, 2007, 2009), version 3, was employed.

Participants

The participants were Iranian EFL learners from upper intermediate classes at a private language teaching school in Mashhad, northeastern Iran. Their ages ranged from 14 to 20 and were recruited for the study through invitation. In order to make sure that the participants in the study had the same proficiency level, a modified paper-based proficiency test of TOEFL (consisting of

only structure and written expression and, reading comprehension sections) was taken from 45 students. The main reason for choosing the TOEFL is that it is one of the most well-known and broadly recognized tests of English proficiency all around the world. In addition, as most of the Iranian students are familiar with the testing format of the TOEFL, it was thought as the best choice for revealing the proficiency of the participants in the present study.

Following the test results, 38 students (23 female and 15 male) were selected and signed the informed consent form to participate in the present study. All of the participants were aware of the voluntary nature of the study and were provided with the information related to the purpose of the research project. They were also assured of their anonymity.

All of the participants were right-handed and reported either normal vision or corrected normal vision, using glasses. All of them were born and lived in Iran at the time of the experiment and spoke Persian as their native language. In a pre-experimental session, participants were asked to fill in the Language History Questionnaire (Li et al., 2014), version 3, in which the global proficiency ratings and other measures for the EFL population were collected. They reported using Persian on everyday basis in both formal and informal contexts, with English being spoken mostly at the educational context. Participants' biographical and linguistic information is presented in Table 1.

Table 1
Participants' Biographical and Linguistic Information

	Measure[a]
Age	18.5 (.81)
L1 self-rated proficiency[b]	6.8 (.62)
L2 self-rated proficiency	5.7 (.17)
Age of L2 acquisition	14.2 (.51)

[a] The measures provided correspond to means. The measures provided in brackets reflect standard error of the mean (SEM).

[b] Global proficiency rating was measured with a 7-point Likert scale on the basis of reading, writing, speaking, and listening skills, where 1 = very poor, 7 = excellent.

Stimuli

The aim of the present study was to investigate the cognitive processing of semantically related and semantically unrelated words by upper intermediate L2 learners. To achieve this aim, a prime word (a noun) preceded the target word (an adjective). This resulted in congruent noun-adjective dyads, e.g. *Massage-Relaxed* (positive prime, positive target) or *Slaughter-Cruel* (negative prime, negative target). To prevent students from guessing the relationship between the prime noun and the target adjective, the affective valence of the prime was additionally manipulated by putting neutral nouns before the same target adjectives. Using this strategy, equally meaningful noun-adjective pairs were formed, e.g. *Mattress-Relaxed* (neutral prime, positive target) and *World-Cruel* (neutral prime, negative target). In this way, meaningful noun-adjective dyads in the present study consisted of either a positive or a negative prime noun followed by an affectively congruent target adjective, or a neutral prime noun followed by the same target adjective.

In the context of the present study, unrelated noun-adjective dyads were constructed by preceding target adjectives with semantically unrelated prime nouns of opposite valence (positive condition: *Crisis-Relaxed*; negative condition: *Birthday-Cruel*), and neutral valence (positive condition: *Notebook-Relaxed*; negative condition: *Soil-Cruel*). In other words, the noun-adjective dyads that were unrelated in meaning consisted of either a positive or a negative prime noun that was affectively and semantically incongruent with the following target adjective, or a neutral prime noun that was semantically incongruent with this target adjective.

Following the mentioned procedure, a set of 120 nouns (30 positive, 30 negative, 60 neutral) and 30 adjectives (15 positive, 15 negative) were paired into 120 noun-adjective dyads in this study. Half of the noun-adjective pairs were related in meaning (n = 60: 30 positive and 30 negative) and half unrelated in meaning (n = 60: 30 positive and 30 negative). The noun-adjective dyads used in the present study were adopted and adapted from Jonczyk (2016).

The prime nouns and target adjectives were matched regarding the variables of valence, arousal, concreteness, frequency, and word length. The mean valence and arousal ratings were obtained from Warriner et al. (2013), the frequency norming data were collected from the SUBTLEX-US (Brysbaert et al., 2012), and concreteness ratings were collected from Brysbaert et al. (2014). The stimuli characteristics for prime nouns and target adjectives are presented in Tables 2 and 3, respectively.

Table 2
Stimuli Characteristics for Prime Nouns

	F	p	η^2	Positive	Negative	Neutral
Valence	621.425	.030	.61	7.65	3.31	5.23
Arousal	82.103	.010	.43	4.23	4.08	2.89
Concreteness	42.907	.000	.28	5.16	5.75	4.70
Frequency	53.873	.000	.30	4.66	4.41	3.18
Word length	8.745	.025	.18	5.63	6.59	6.26

Table 3
Stimuli Characteristics for Target Adjectives

	F	p	η^2	Positive	Negative
Valence	771.371	.000	.83	7.09	3.77
Arousal	32.703	.033	.28	5.22	5.83
Concreteness	21.243	.020	.15	4.39	4.61
Frequency	12.475	.031	.06	5.44	5.12
Word length	67.834	.289	.00	6.23	6.78

Considering relatedness, before the experiment, 49 upper intermediate EFL learners from the same private language school rated the relatedness of all noun-adjective dyads on a Likert scale from 1 (not related at all) to 6 (totally related). The results showed that related noun-adjective dyads were highly related (positive dyads: M = 5.30, SEM = .02; negative dyads: M = 5.64, SEM = .05), and unrelated noun-adjective dyads were highly unrelated (positive dyads: M = 1.21, SEM = .01; negative dyads: M = 1.41, SEM = .07).

Procedure

Participants were seated in a comfortable chair 100 cm away from a laptop monitor in a quiet room. They were asked to read a sequence of two words appearing on the screen (first, a noun and then, an adjective) and decide upon the presentation of the second word whether or not the two words were semantically related or unrelated, by pressing an appropriate button on the keyboard. To make sure that the participants understood the procedure, prior to the experiment, a practice session was performed on 15% of similar data in the presence of the experimenter. In the actual experiment, participants completed one block of trial in their L2 (i.e. English). During the experiment, the researcher was present at all times.

The block of trial consisted of 120 noun-adjective dyads (60 related and 60 unrelated in meaning). None of the noun-adjective dyad was repeated in the course of the experiment. Each noun-adjective dyad was preceded by a fixation point that lasted 2000 ms. Subsequently, a prime noun was presented for 1000 ms in the center of the screen followed by a target adjective. The target adjective stayed on the screen until participant responded, but no longer than 2000 ms. The whole experimental session consisted of 120 trials presented in randomized order in white letters (font Times New Roman, size 20) over grey background. The whole data gathering process took almost 15 minutes for each participant.

Data Analysis

To find out about the potential interaction between the relatedness of noun-adjective dyads, a 2 (relatedness: related, unrelated) × 2 (target valence: positive, negative) two-way repeated measure ANOVA was run on reaction time (RT) and error rate (ER) data. As the purpose of the present study was to compare the mean differences between groups that have been split on two within-subjects factors, the two-way repeated measure ANOVA was considered the best statistical procedure. SPSS (version 24) was used for data analysis.

Results

Table 4 shows the means and standard deviations of RTs (in millisecond) and ERs (in percentage) for different conditions of relatedness-target valence.

Table 4
Means and Standard Deviations of RTs and ERs for Relatedness-Target Valence

	RT(ms)	SD	ER(%)	SD
Related-Positive	.901	.14	14.4	.10
Related-Negative	.966	.15	24	.15
Unrelated-Positive	.993	.14	13.5	.10
Unrelated-Negative	.995	.15	14.3	.12

The Repeated Measure ANOVA on RT (Table 5) revealed a main effect of relatedness, F(1, 37)=24.947, p=.000, η^2=.40, whereby faster RTs were reported to related (M=.934ms, SE=.022) compared to unrelated (M=.994ms, SE=.024) target adjectives. The analysis further showed a main effect of target valence, F(1, 37)=5.420, p=.025, η^2=.12, where participants responded faster to positive target adjectives (M=.947ms, SE=.023) than negative target adjectives (M=.980ms, SE=.024). Considering the interaction between relatedness and target valence, the data revealed a main effect of relationship, F(1, 37)= 10.577, p=.002, η^2=.22, as the analysis showed that responses to both positive and negative target adjectives were faster in related conditions (Related-Positive: M=.901ms, SE=.023; Related-Negative: M=.966ms, SE=.025) compared to unrelated conditions (Unrelated-Positive: M=.993ms, SE=.024; Unrelated-Negative: M=.995ms, SE=.026).

Table 5
Tests of Within-Subjects Effects for RT

	df	Mean Square	F	Sig.	Partial Eta Squared
Relatedness	1	.139	24.947	.000	.403
Target Valence	1	.041	5.420	.025	.128
Relatedness * Target Valence	1	.038	10.577	.002	.222

The Repeated Measure ANOVA on ER (Table 6) displayed a main effect of relatedness, F(1, 37)=5.062, p=.030, η^2=.12, with more errors to related (M=19.2%, SE=.018) compared to unrelated (M=13.9%, SE=.017) target adjectives. Also, the analysis revealed a main effect of target valence, F(1, 37)=9.758, p=.003, η^2=.20, showing that participants were less accurate at identifying negative target adjectives (M=18.8%, SE=.018) relative to positive target adjectives (M=14.4%, SE=.011). Further, the data showed that the interaction between relatedness and target valence was statistically significant, F(1, 37)=15.190, p=.000, η^2=.29, such that participants made more errors to related positive and negative target adjectives (Related-Positive: M=14.4%, SE=.017; Related-Negative: M=24%, SE=.025), compared to unrelated conditions (Unrelated-Positive: M=13.5%, SE=.018; Unrelated-Negative: M=14.3%, SE=.020).

Table 6
Tests of Within-Subjects Effects for ER

	df	Mean Square	F	Sig.	Partial Eta Squared
Relatedness	1	.109	5.062	.030	.120
Target Valence	1	.073	9.758	.003	.209
Relatedness * Target Valence	1	.103	15.190	.000	.291

Discussion

The most interesting finding of the present study is that L2 learners are faster when they respond to related target words compared to unrelated target words. In accordance with the present results, previous research in the general field of cognition has demonstrated that semantically related words provoke faster RTs than semantically unrelated ones (e.g., Khateb et al., 2000, 2003, 2016; Nieto et al., 1990; Walker & Ceci, 1985). According to the *spreading activation theory of semantic priming* (Collins & Loftus, 1975), this can be attributed to the facilitatory effects of spreading activation among words with similar meaning in semantic priming tasks. With respect to this theory, it is proposed that semantic concepts are represented as interconnected nodes in mind. In case a semantic concept is activated, similar concepts which are closer together in the web of interconnected nodes receive larger amounts of activation in comparison to more dissimilar ones. In this way, as Finkbeiner and Nicol (2003, p. 377) pointed out, "the locus of the facilitation may be best characterized as due to the 'preactivation' of semantic features of the target due to the activation of the shared semantic features of the prime". This view has gained support by different theories of lexical representation in the mind (e.g., de Groot, 1992; Levelt et al., 1999). Considering easier organization of the words that are semantically related, Hashemi and Gowdasiaei (2005, p. 343) have argued that "it would be more likely that words are processed at a deeper

cognitive level in the LS [lexical-set] method than in the SU [semantically-unrelated], in which words are presented sporadically, irrespective of other semantically-related items".

More effective processing of L2 words in related conditions can also be linked to the participants' high proficiency level in the present study. More specifically, it has been proposed that high proficiency could result in direct and strong relationships between L2 words and their corresponding semantic concepts (Kroll & Stewart, 1994). According to some models of the organization of the bilingual lexicon (see Kroll & Tokowicz, 2005), the mental lexicon of L2 users tends to unite with the mental lexicon of the native language as proficiency develops. These models suggest that when highly proficient L2 speakers use an L2 word, it automatically activates the mental representation of the corresponding word in the first language. In this way, as the proficiency increases, many aspects of L2 processing become more native-like (Birdsong & Molis, 2001).

In line with this proposition, Hashemi and Gowdasiaei (2005) showed that upper level intermediate participants in their study made greater gains than their peer lower level ones in the semantic related group. According to Wilcox and Medina (2013), this might be attributed to the fact that beginning L2 learners have little background knowledge in L2 which makes it difficult to relate the new linguistic information to the previously learned information, especially when most of the L2 information is new. On the other hand, as Papathanasiou (2009, p. 319) argued,

an intermediate (or more advanced) learner would probably already know many words from the semantic groups, and when presented with new words may only need to add new words to an existing store, rather than create a new one from scratch.

Higher ERs in related conditions in comparison to unrelated conditions are consistent with the attractor dynamics view of neighborhood effects (for an introduction to attractor dynamics in cognition, see Spivey, 2007). Attractor models of semantic cognition (e.g., Cree et al., 1999; O'Connor et al., 2009; Rogers et al., 2004) define attractors as stable states that share features of specific semantic concepts. The model state tends to move toward the nearest stable state or states when it is activated. However, the neighboring semantic concepts have a negative effect on processing because they act as competitors (Mirman, 2011). In other words, multiple candidates of semantically related concepts are activated and the control mechanism needs to choose the most appropriate one from these candidate competitors. In case the number of activated candidates increases or no one candidate is more active than the others, the response selection process becomes more difficult and leads to increased number of errors (Mirman, 2011). In the present study, this negative effect is reflected in higher ERs in related semantic words. The results of the present study, thus, support the attractor dynamics view of neighbor effects in language processing by providing evidence on negative effects of near semantic neighbors in a semantic priming task.

In the same vein, higher number of errors in related conditions in comparison to unrelated conditions can be attributed to the *conflict hypothesis*. According to this hypothesis, the occurrence of error is inevitable due to response conflict that emerges when multiple responses struggle to be selected (Botvinick et al., 2001). In other words, as there are several conflicting responses, errors are likely to occur. The same idea can be applied to the results of the present study as the participants had to choose the appropriate response from many others in semantically related conditions which consequently led to higher number of errors in their responses. This finding is supported by previous research in the field as Erten and Tekin (2008) found that learning words in semantically unrelated sets is significantly better than learning words in semantically related sets. Similarly, Wilcox and Medina (2013) also found that participants had difficulty in learning words when they were presented in semantic sets without phonological similarities.

The data further showed that L2 learners' responses were slower and less accurate to negative target adjectives in comparison to positive target adjectives in both related and unrelated conditions. Examining the ER data revealed an obvious inclination toward positivity as positive words brought about the least and negative words the highest rate of errors. Similarly, Conrad et al. (2011) also found "a clear positivity bias with positive words provoking the least and negative words the highest amount of errors" (p. 6). The RT data also showed that positive words result in faster responses and negative words elicit slower responses. These findings are supported by two related hypotheses, namely, *attentional vigilance* (Pratto & John, 1991) and *negativity bias* (Ito et al., 1998). Both of these hypotheses converge on the idea that, in comparison to positive or neutral words, negative stimuli are given more attention so that it is almost impossible to dismiss them. These hypotheses are reflected in delayed processing of negative words as well as less accurate responses to these words in the present study.

Conclusion

In the last 30 years, teachers have received contradictory advice on the use of semantic related materials and activities in L2 classroom contexts. This is

due to the fact that the previous studies have yielded mixed results and there is no general agreement on whether it is more effective to present words in semantically related sets or vice versa. Moreover, despite strong theoretical frameworks that support these contradictory views, some of the previous studies are not trustworthy and are limited in scope, as they have mainly focused on using artificial language and nouns as their sole research material. This paper aimed to address this controversy, however, from a new perspective. More specifically, the main aim of the present study was to extend the current semantic relatedness research by looking into cognitive processing of related or unrelated words in linguistic contexts. This is of particular importance because the effectiveness of any procedure of vocabulary learning or teaching is analyzed with respect to its power to stimulate the lexical items (Laufer & Hulstijn, 2001; Schmitt, 2008), which can be measured by designing and conducting cognitive studies.

The results of the present cognitive study showed that semantically related words induce faster RTs than semantically unrelated ones, which confirms the positive effect of the semantic relatedness in cognitive processing of L2 words. Considering this finding, one important implication of the present study is that it would be more beneficial to package words of related meaning together in textbooks as presenting words in semantically related sets, rather than semantically unrelated sets, may be cognitively more facilitating for L2 learners.

However, higher ERs in related conditions in comparison to unrelated conditions refer to a kind of confusion on the part of L2 learners. Considering this finding, it can be assumed that "the obvious way of reducing the risk of erroneous cross-associations between related words is to learn one word well first and only learn the other word later" (Boers, 2013, p. 217). Hopefully, further research in the future would shed more light on the findings of the present study. In this way, it is suggested that future studies design new methodologies to study the delayed effect of semantic relatedness on cognitive processing of L2 words. This surely would be a step forward as the results of the present study have paved the way to gain insight into such an effect in immediate tests, investigating this effect in delayed tests would result in revealing more interesting findings.

Conflicts of interest

The authors declared no conflicts of interest.

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