

Caspian Journal of Neurological Sciences "Caspian J Neurol Sci"

Journal Homepage: http://cjns.gums.ac.ir

Research Paper: Preferred Lexical Access Route in Persian Learners of English: Associative, Semantic or Both



Zeinab Ghanbaryan¹, Fatemeh Nemati^{1*} (0), Nasim Ghanbari¹ (0)

1. Department of English Language and Literature, Faculty of Humanities, Persian Gulf University, Bushehr, Iran.



Citation Ghanbaryan Z, Nemati F, Ghanbari N. Preferred Lexical Access Route in Persian Learners of English: Associative, Semantic or Both. Caspian J Neurol Sci. 2021; 7(2):84-98. https://doi.org/10.32598/CJNS.7.25.3

Running Title Preferred Lexical Access Route

doj https://doi.org/10.32598/CJNS.7.25.3



© 2018 The Authors. This is an open access article under the CC-By-NC license.

Article info: Received: 04 Dec 2020 First Revision: 08 Jan 2021 Accepted: 24 Feb 2021 Published: 01 Apr 2021

ABSTRACT

Background: Words in the Mental Lexicon (ML) construct semantic field through associative and/ or semantic connections, with a pervasive native speaker preference for the former. Non-native preferences, however, demand further inquiry. Previous studies have revealed inconsistent Lexical Access (LA) patterns due to the limitations in the methodology and response categorization.

Objectives: To fill the gap, we employed a primed Picture Naming (PN) task for investigating the relations between concepts in the ML of Iranian EFL (English as a foreign language) learners. We also explored whether conscious priming at a long prime-target stimulus onset asynchrony affected the naming latency of the learners with different proficiency levels.

Materials & Methods: The participants were 31 EFL learners (11-16 years old) at A1 and A2 levels based on the Common European Framework of Reference for languages. They were recruited in summer 2020 from language institutes in Bushehr and Kazeroon cities, Iran, through a convenience sampling method. They performed a PN task, including 66 prime-target pairs presented in associative, semantic, both semantic and associative, or unrelated conditions. The mixed-effects modeling was used for data analysis.

Results: Based on the likelihood ratio test of model comparisons for condition effect ($\chi^2_{(1)}$ =9.07, P=0.002), the interaction of condition, frequency, and length was significant in the semantic condition (t=2.72, P=0.008). A slight effect was also observed from the prime frequency in the associative condition (t=1.82, P=0.07).

Conclusion: Results indicate one-level access to the ML, which is indeed a function of language proficiency. Findings are further discussed in terms of ML structure and patterns of LA.

Keywords: Reaction time; Mental processes; Association; Semantics; Vocabulary

* Corresponding Author:

Fatemeh Nemati

Address: Department of English Language and Literature, Faculty of Humanities, Persian Gulf University, Bushehr, Iran. *Tel:* +98 (912) 8027039, *Fax:* +98 (77) 33444575 *E-mail:* nemati@pgu.ac.ir

Highlights

• The preferred access route in the young Iranian EFL (English as a foreign language) learners to their L2 mental lexicon is mostly through semantic relations.

- The frequency with which words occur to the L2 learner determines the association strength in the mental lexicon.
- Language proficiency is indispensable for strengthening the links in the lexical network.
- An increase in the length of words negatively influences naming latency in the lexical access process.

Introduction

ental Lexicon (ML) is a two-level structure, including lexical and conceptual networks [1-8]. Their interaction determines how languages and language features are organized in mind and accessed. Two

views exist about the interconnection of words: spreading activation and modular theories. According to the spreading activation theory, the lexical and conceptual levels are interrelated, and activation at any level spreads to the other level. Hence, Lexical Access (LA) happens automatically in a short time, both for semantic and associative relations [9]. The modular theory, on the other hand, suggests that since semantically related words find their links in the conceptual network, it is harder to access them, and LA takes up more time [10, 11] as a result of subjects' strategies in post-lexical processes [9, 10, 12].

Automatic processes provide us with experimental grounds to test the assumption of these two theories about form and meaning relations. The time frame for automatic processing has a 40-400 ms Stimulus Onset Asynchrony (SOA), beyond which active attention processes are used [13-15]. If automatic priming occurs only for associatively-related concepts, the priming effect will only tap word forms and spreads activation among a small subset of a highly interconnected network [10, 13-18]. Nevertheless, if automatic priming results from semantic relations, the activation spreads among the concepts or word nodes that possess similar features in semantic memory [19-21].

Word association behavior and lexical priming have been extensively used to examine ML organization and LA processes [7, 8, 20, 22-29]. Meyer and Schvaneveldt were pioneers in examining the priming effect [30]. Nonetheless, priming has yielded inconsistent results regarding the progressive development of the second language (L2) ML. While most studies argue for the strength of associative and associative plus semantic relations [21, 31-33], some others

[8, 24, 34-38] uphold the semantic strength view, declaring that the depth of individual word knowledge is the determining factor. Wolter believed that creating associative links is a higher-order mental process that demands modification of lexical knowledge and ML restructuring [3, 39].

According to a meta-analysis on lexical priming by Lucas, many discrepancies pertain to the SOA at which associative and semantic relations are involved [12]. In addition, results are partly task-dependent. Among the behavioral tasks probing into the structure of ML, Word Association Tests (WAT) are the most prevalent [22, 28, 33, 40-42]. However, while they are easy to execute, responses given to WATs are ambiguous in the extent they refer to group behavioral patterns or personal word associations. They lack response diversity and only take a quick, shallow glance into the ML [8, 26, 34]. On the contrary, PN tasks tap various connection types at form and meaning levels [13, 34]. Hence, we employed a masked-priming PN task to capture the reliable LA route Persian learners of English as a Foreign Language (EFL) take.

One impeding factor in having a comprehensive model for association effect is the lack of clear-cut boundaries between associative relations and semantic relations in the previous studies [21, 44]. To clarify the real effect of these relations, it seemed logical to consider each of the two relations once separately and another time together and subsume different categories in each relation type. Last but not least, investigating the structure of ML in Persian EFL learners is highly underestimated, more specifically with teenage novice learners. In addition, in this shortlist, most investigations on Iranian English learners have employed WATs [32, 38, 45].

Our main aim in the present study was to explore which relation types boost access to the content of L2 English ML. Based on the more general view of L2 ML, a shift occurs from syntagmatic to paradigmatic connection strength with an increase in proficiency [3, 38, 45, 46]. Accordingly, we hypothesized that syntagmatic relations prevail in novice English L2 learners' ML rather than the conceptual packag-



ing. Moreover, we investigated if conscious priming showed a lasting effect in any of the three intended lexical relation types with a long SOA.

Materials and Methods

Study design and sampling

In the present study, we employed a within-group factorial quasi-experimental approach to investigate the possible effect of various lexical relation types on lexical access in Persian EFL learners. For this reason, a group of 35 teenagers, 28 girls and 7 boys, aged 11 to 16 years (Mean±SD=13.82±1.20 years), participated voluntarily in the experiment. They were selected by the convenience sampling method. They were recruited from English Language Institutes in Bushehr and Kazeroon cities, Iran, in summer 2020. The volunteers were included if they were 11-16 years old and had beginner or elementary level (A1-A2) knowledge according to the Common European Framework of Reference (CEFR). For the latter requirement, the Oxford Placement Test (OPT) was administered, and the participants were grouped based on their scores. To reassure about the proficiency level difference between the groups, their OPT scores were compared. The learners at the elementary level (Mean±SD= 21.09±4.23) gained significantly higher proficiency scores ($t_{(30.901)}$ =7.978, P < 0.01) than the beginner level (Mean \pm SD= 12.85 \pm 1.81). They were all Persian native speakers learning English for about three years and reported normal or corrected-to-normal vision. Before the test and the subsequent experiment, they signed a consent form for participation in the study. They were assured that data would be used anonymously and analyzed in an aggregate form.

We designed a primed picture naming task. The experiment included 66 pairs of prime words and target pictures. The pairs were selected from the Postman-Keppel Norms of Word Association [47]. The words were associatively related if they had these co-occurrence patterns: encapsulation (incorporation of the meaning of one item into another as in kick and foot), collocation (the arbitrary tendency of words to co-occur in a common environment like salt and vinegar), or syntagmatic lexical relations (i.e., relations based on collocational restrictions where explaining the meaning of one is impossible without the other one, such as bark and dog). The words were considered semantically related if the following relations existed between them: congruence (members of the same semantic category as pig and horse), hyponymy (relation of inclusion as in dog and animal), meronymy (a partwhole relationship as in page and book), or antonymy (having opposite meaning like hot and cold). If a pair of concepts had one characteristic from each group, it was tagged to have both relation types [21, 48-50].

The word pairs consisted of 17 associatively related pairs (including encapsulation, collocation, syntagmatic lexical relation, both syntagmatic lexical relation, and collocation), 18 semantically related pairs (including congruence, hyponymy, meronym, and antonymy), and 16 both associatively related and semantically related pairs (including encapsulation, collocation, syntagmatic lexical relation, and both collocation and syntagmatic lexical relation). Another 15 unrelated pairs were included to provide us with a baseline for comparison among the experimental conditions. The criteria to include pairs in each condition were based on the Edinburg Associative Thesaurus (EAT) index for associative strength [51] and the HSO index for semantic relatedness, which is based on the WordNet [52-54]. The average associative and semantic indices were 0.07 and 4.44 for semantic relations, 0.22 and 0.11 for associative relations, 0.22 and 4.87 for both relation types, and 0 and 0.73 for the unrelated condition, respectively. The words were chosen to match our intended participants' level of knowledge. Thus, the word log of their books and their teachers were consulted (Appendix 1). We took our color pictures from Duñabeitia et al.'s [55] norm (http:// www.bcbl.eu/databases/multipic) and the International Picture Naming Project (IPNP) database [56] (Appendix 2).

We extracted the internal lexical features of the words, such as frequency, length, and syllable numbers, from the English Lexicon Project (ELP) [57]. It is of great value to extract such data from a lexicon for Persian EFL learners. However, to the best of our knowledge, no such lexicon has been developed so far. Such a lexicon might give us a different frequency effect, but other measures such as length and syllable numbers would be the same in both lexicons. On the other hand, the present study aimed to gain insight into the developmental structure of the mental lexicon, which is logically possible only when compared to the native speakers' patterns. Therefore, inevitably, we took the features from the native-registered ELP.

Study procedure

The primed picture naming experiment was conducted online due to the COVID-19 pandemic, using the highlyreliable, open-source jsPsych v. 6.2.0 program [58] on the free platform of Cognition (https://www.cognition.run/). The participants were asked to do the naming task individually in a quiet room, and their voices were recorded to be checked for accuracy later. They were given full instructions about the experiment's procedure in Persian in a training video in advance. However, they did not have any information about the words they are going to encounter.

The main phase of the experiment was preceded by four training trials to familiarize the participants with the task demands. Each trial started with the presentation of a fixation cross for 500 ms to focus on the place where the stimuli were going to be presented. It was followed by the word prime for a duration of 350 ms. After that, a series of six hashtags were presented for 50 ms as the mask to cover the prime. The picture target was then presented and remained on the screen until being named by the participant. A time out of 3000 ms was set in case of no response. They proceeded to the subsequent trial by pressing the space tab. An inter-stimulus interval of 2000 ms was set to provide the naming time and a shift in the attention to the subsequent trial. The presentation order of items was randomized, and each prime-target pair was presented once for all participants. Therefore, each participant received 66 prime-target experimental trials, giving a total of 2046 data points.

Statistical analysis

Data collected from one group for multiple conditions violates the independence assumption used for calculating least square measures (e.g. ANOVA, linear regression). Failing to recognize these hierarchical structures leads to underestimating the standard errors of regression coefficients, especially for the higher-level predictor variables, and overestimating statistical significance (Type I). In other words, it confounds dummy variables (subgroups) effects with the group-level predictors. A multi-level model takes account of random effects (namely individual-level factors) and fixed effects (including higher- and lower-level types of variables). To avoid Type I error, the correlation coefficient was calculated to obtain the percentage of variance related to the subgroups. The result (ICC_{3,4}=0.976, %95CI: 0.963-0.987) indicated that a multi-level analysis is relevant [59, 60].

Thus, we measured the influence of various lexical relation conditions through the Linear Mixed-effects Model (LMM) [61] using the lme4 package in R statistical software. LMM is a generalization of the standard multiple regression to account for both random effects (variations due to the random differences between the participants and the stimuli) and fixed effects or predictor variables. This statistical procedure encompasses both by item and by subject analyses in one model [62]. LMM also uses a restricted maximum likelihood method rather than the least-squares method [63]. It allows for the inclusion of random intercepts of random effects and the random slopes of the fixed (independent) variables. The model selection proceeded by entering the random effects and fixed effects stepwise and inspecting the model fit based on Akaike Information Criterion (AIC) [64, 65].

Results

The participants' naming latencies were recorded in milliseconds. First, those participants with a naming accuracy of lower than 80% were removed. In the second step, a trial was scored an error and omitted from more calculations if (a) the responses were not accurate or no responses were given at all and (b) the data points were not between 100 and 3000 ms and were 3 standard deviations longer or shorter than the mean score. By the first step of the exclusion criteria, 4 participants out of 35 outscored the bound, and through the second stage of data cleaning, 264 error data points out of the total 2046 data cells (roughly 13% of the total data) were removed. Ultimately, the analysis was done on 1798 data points. Table 1 represents the descriptive statistics of the data for each condition and the two levels after stage 2(b) of data cleaning.

The residual plot demonstrated a well-behaved dispersion of residuals around zero line, and the Q-Q plot manifested that the sample quantiles assemble into a straight line which satisfied both the normality and constant variances assumptions, justifying the appropriateness of the linear regression model in our study [64].

For analyzing the Naming Latency (NL) data, we fitted a linear mixed-effects model using the lmer function (lme4 package). Initially, the simplest model was built with the random effect for the participants (AIC=27167). The model became more complex in each step by including the random intercept of the target (AIC=27137), the fixed effects, and their interactions (e.g. M5: ID+ Condition × Level + Condition × Target_Frequency: AIC=27155, P=1.00; or M7: ID + Condition × Level + Condition × Target Frequency+ Target Length + Condition × Prime Frequency: AIC= 27151, P=0.01). The fixed effect of condition was included as a both within- and between-subject variable with four levels (unrelated, semantic, associative, and both relation types) and proficiency level as a between-subject variable with two levels (elementary and beginner). Finally, the internal language effects, i.e., target frequency, length, syllable number of the target, and prime frequency, were added as the control variables. The likelihood ratio test was used to select the best-fitted model through model comparison. The best-fitted model with a higher number of parameters included and the lowest AIC (= 27144, P=0.002) was as follows:

Naming Latency Model <- lmer (Naming Latency ~ Conditions × Level + Conditions × scale (log (frequency)) + Conditions × scale (log (Prime_ frequency)) + scale (length) + (1| ID) + (1|Target), data=Cleaned Data, REML=FALSE)



Condition	N	Mean±SD (NL)
Unrelated	385	1500.056±599.77
Semantic	508	1453.272±587.58
Associative	467	1443.312±585.19
Both	438	1407.567±588.17
Beginner	748	1478.504±586.03
Elementary	1050	1434.660±598.36
		CINS

Table 1. Descriptive statistics of data in stage 2(b) for the conditions and the levels

The results from the best-fitted model revealed that the estimated variance for the random effects of the participant and the target could explain 40.75 (SD=381.4) and 2.81(SD=100.3) of the total variation in the naming latency, respectively. The model showed the significant interaction of frequency and the semantic relation condition; the increase in frequency lowered the naming latency by 110.8 ms (t=2.72, P=0.008) if the prime and target were semantically related. It also showed the interaction of the associative condition and the frequency of the prime word as the naming latency lowered by 76 ms (t=1.82, P=0.07) when the participants named the target words that were associatively related with a high-frequency prime.

The slope for both relations in the condition variable did not display a significant change compared to the unrelated condition. It was expected that if either semantic or associative relation causes a boost in LA, the effect will strengthen both relation types. However, neither the interaction between both relations and length (t=.81, P=0.41>0.05) nor the interaction between both relations and prime frequency (t=1.43, P=0.15>0.05) showed any effects.

To determine the effect size of the length that decreased the likelihood, the model with the length effect was compared against the model without the length effect. The test revealed a significant effect incurred by length ($\chi^2_{(1)}$ =17.93, P=0.003), increasing the naming latency by 26 ms. The positive slope for length by NL (Figure 1a) indicates this effect. However, the t value for this fixed effect was near significant (t=1.75, P=0.08). On the contrary, as Figure 1b indicates, we observed no effect from the proficiency level factor in any conditions. The results of the model have been presented in Table 2. Figure 1A, B, C, and D), drawn by the effects package [66], visualizes the significant effects in the model.

Models for analyzing the naming accuracy were built using the glmer function (lme4 package) by moving from the simplest to the most complex model. The best-fitted model based on the lowest AIC in likelihood ratio model comparisons was as follows:

Naming Accuracy Model<-glmer (correct ~Conditions×L evel+Conditions×scale (log [frequency])+(1|ID)+(1|Target), data=Cleaned Accuracy Data, family="binomial", control=glmer Control (optimizer="bobyqa", optCtrl=list [maxfun=2e5])

The model results (Table 3) showed the significant effect of the proficiency level and the significant effect of the semantic condition and the logarithmic frequency of target words. The random effects of the participants and the target words explained 63.7±1.0% and 36.3±0.76% of the variance in the naming accuracy, respectively. The results of the ratio likelihood test of this model against the model without such an interaction showed a significant difference ($\chi^2_{(3)}$ =14.93, P=0.008), increasing the naming accuracy in the semantic relation condition for highly frequent words (estimate=1.47, z=2.86, P=0.004). The model also showed a near-significant effect of the associative condition on the naming accuracy (estimate=0.9, z=1.71, P=0.08). The result for the effect of the proficiency level was in line with the effects of the proficiency level on naming latency, which was visualized using the R package "effects" [66]. It showed a significant decrease of accuracy in the picture naming by the elementary level participants (estimate=-1, z=-2.19, P=0.02), mirroring the increase in their naming latency. The summary of the model and the illustration for the observed effects in this model using the "effects" R package [66] are given in Table 3 and Figure 2.

The post hoc pairwise comparisons were made using the Tukey method from the "emmeans package" [67] to find contrasts between the NLs in the different conditions and the two levels under study. The results indicated no significant difference between the conditions and the proficiency levels in pairwise comparisons (Table 4). Since both groups



Figure 1. Condition, level, length, frequency, and prime frequency effect plots

A: Length effect plot; B: Condition by level effect plot; C: Condition by frequency plot; D: Condition by prime-frequency plot.

belonged to a starter level of language proficiency in the language learning process and their level of knowledge and language exposure have been little up to this level, the result is not far from expectations.

Discussion

This study examined the effect of various lexical relation types, more precisely semantic, associative, and both, on the speed and accuracy of LA in Iranian novice EFL learners. To this end, we analyzed the NLs taken from the primed picture naming experiment we administered with the inclusion of language internal variables. Multi-level analysis revealed ease of access for semantically-related words when they are highly frequent and also for shorter words. Thus, at the starter levels of L2 learning, LA to words with semantic relations is established in the ML if the target concept is highly frequent to the learner. Furthermore, we observed a near significant effect for the interaction of associative relations and the frequency of the prime words. Although the effect is small, it shows that even with little experience in L2 and the consideration of age (i.e., early teenage years), associative links start to be created early in the L2 learning process in the ML. However, no significant effect was observed when both associative and semantic relations existed between the primetarget pairs.

One reason for this finding might be the SOA where each relation type manifests an effect. Even though these results differ from some earlier naming studies that showed semantic relations effect at SOAs shorter than 250 ms (Alario et al. [68] [114 ms]; Perea and Gotor [69] [67 ms]; Warren [70] [150 ms]; Williams [71] [150 ms]; a meta-analysis on 26 studies by Lucas [12] [<250 ms]); they are consistent with those that proved an effect with SOAs longer than 250 ms (e.g. La Heij et al. [72] [400 ms]; Hutchison [73] [>250 ms]). Concerning the effect of associative relations at the SOA, the finding contradicts most research findings. They have shown that associative relations are facilitative only at short SOAs, i.e., below 150 ms (Perea and Gotor [69] [67 ms]; Perea and Rosa [21] [83 ms]; Brunellièrea et al. [74] [166 ms]). However, similar results have been substantiated in some works like Thompson-Schill et al. [19] (200 ms) and Alario et al. [68] (243 ms).

Returning to the hypothesis posed at the beginning of this study, the results do not confirm that associative/syntagmatic relations form the prevailing connection in the L2 learners' ML, at least for Iranian novice English learners. The reason is that connections to real-world referents, which cause associative links, are not yet structured in the novice L2 learner's ML [75]. Regarding semantic relations, since only concrete word pairs were included in this study, they have already pegged

Duadiatau	Fatimata	65	95%	95%CI			
Predictor	Estimate	SE	Lower	Upper	ar	τ	٢
Intercept	1511.01	111.99	1291.57	1730.32	39.77	13.492	< 2e-16***
Semantic relation	- 32.23	57.71	-145.35	80.89	168.61	-0.558	0.57731
Associative relation	-26.92	56.74	-138.14	84.29	179.64	-0.474	0.63574
Both	-12.06	59.87	-129.40	105.28	169.82	-0.201	0.84060
Level	-25.99	143.88	-307.99	256.01	36.72	-0.181	0.85765
LogFreq	37.30	32.49	-26.39	100.99	67.05	1.148	0.25510
PrimeFreq	42.79	36.04	-27.85	113.42	68.88	1.187	0.23919
Length	26.08	63.06	-3.01	55.17	1.757	1.757	0.08375
Sem.*level	-19.61	61.79	-140.70	101.49	1701.97	-0.317	0.75103
Ass.*level	-35.37	62.76	-158.38	87.65	1703.05	-0.563	0.57318
Both*level	-51.80	63.70	-176.64	73.05	1700.96	-0.813	0.41621
Sem.* LogFreq	-110.77	40.72	-190.58	-30.97	65.31	-2.721	0.00834**
Ass.* LogFreq	-59.61	47.39	-152.49	33.27	63.99	-1.258	0.21298
Both*LogFreq	-55.10	43.44	-140.24	30.04	68.10	-1.268	0.20898
Sem.* LogPrimeFreq	-83.53	50.08	-181.68	14.62	66.12	-1.668	0.10003
Ass.* LogPrimeFreq	-76.28	41.76	-158.13	5.58	68.73	-1.826	0.07214
Both* logPrimeFreq	-79.13	55.18	-187.29	29.02	67.80	-1.434	0.15616
* P<0.05· ** P<0.01· ***	P<0.001						CJNS

Table 2. The model output for condition, level, frequency, prime-frequency, and length effect

* P<0.05; ** P<0.01; *** P<0.001.

LogFreq: The logarithm of target word frequency; PrimeFreq: The logarithm of prime word frequency; Sem.*level: Interaction of semantic relation and proficiency level; Ass.*level: Interaction of associative relation and proficiency level; Sem.*LogFreq: Interaction of semantic relation and the logarithm of target word frequency; Ass;*LogFreq: Interaction of associative relation and the logarithm of target word frequency; Both*LogFreq: Interaction of both semantic and associative relation and the logarithm of target word frequency; Sem.*LogPrimeFreq: Interaction of semantic relation and the logarithm of prime word frequency; Ass.*LogPrimeFreq: Interaction of associative relation and the logarithm of prime word frequency; Both*LogPrimeFreq: Interaction of both semantic and associative relation and the logarithm of prime word frequency.

themselves to their Persian equivalents because of their full conceptual overlap. So an increase in their frequency implies more familiarity with that concept and their higher relevance to their life experiences. This effect is well defined in the "distributed feature model" [76] that specifies L2 words to be equivalents, partial equivalents, or non-equivalents. L2 equivalents are added to an already existing concept in L1, the partial equivalents undergo modifications, and a new entry is defined for a non-equivalent [76, 77].

The frequency effect and the concreteness effect are completely entangled in the semantic relation condition, and they cannot be separated. But both support our conclusion regarding the faster naming of the words in this condition. Hollis and Westbury have found that frequency is a main semantic dimension, and the semantic content of a word might influence its usage, as some specific types of meanings are used more [78]. The concreteness advantage has also been pointed by Dual Coding Theory [79] that posited concrete words have both verbal and image-based representations, and they could be accessed faster. The frequency effect and the concreteness advantage have also been demonstrated by Imbault et al. [80] in processing emotional words by L2 learners. Thus, the previous studies highlight the easier access of frequent and concrete words from the conceptual store.

It is crucial to note that our study failed to account for the syntagmatic-to-paradigmatic shift in the developmental structure of L2 ML. It provides additional support for Mc-Carthy [81], Khazeenezhad and Alibabaee [45], Ghaemi and Halimi Pasand [38], Wolter B. [3], Wolter [35], arguing that paradigmatic relations are caused by semantic knowledge which could be similar between languages, but syntagmatic relations endure lexical interaction. However, it contradicts

Predictors	Estimate	SD Error	Z value	Р
Intercept	2.75867	0.48082	5.737	9.61e-09***
Semantic	0.91041	0.55795	1.632	0.10275
Associative	0.60404	0.53916	1.120	0.26257
Both	0.42918	0.53179	0.807	0.41964
Level (Elementary)	-1.06225	0.48612	-2.185	0.02888*
LogFreq	0.07267	0.32543	0.223	0.82330
Semantic*Level	0.67681	0.45541	0.45541	0.13723
Associative*Level	0.03232	0.43215	0.075	0.94038
Both*Level	0.35073	0.43743	0.802	0.42267
Semantic*LogFreq	1.45265	0.51018	2.847	0.00441**
Associative*LogFreq	-0.52475	0.51158	-1.026	0.30502
Both*LogFreq	0.47791	0.44993	1.062	0.28815
*P<0.05· ** P<0.01· *** P<0.001				CJNS

Table 3. The accuracy model output for condition by level and frequency

*P<0.05; ** P<0.01; *** P<0.001.

Both: Both Semantic and Associative Relation; LogFreq: The logarithm of target word frequency; Semantic*Level: Interaction of semantic relation and proficiency level; Associative*Level: Interaction of associative relation and proficiency level; Both*Level: Interaction of both associative and semantic relation and proficiency level; Semantic*LogFreq: Interaction of semantic relation and the logarithm of target word frequency; Associative*LogFreq: Interaction of associative relation and the logarithm of target word frequency; Both*LogFreq: Interaction of both semantic and associative relation and the logarithm of target word frequency.

results by Piper and Leicester [39], Söderman [82], and Barrow [83], putting that syntagmatic knowledge is based on form relations and easier to construct than creating semantic relations.

The results about the interaction of the study variables corroborate the line of Altarriba and Mathis [2], Ferrand and New [84], and Heyman, Hutchison, and Storms [85], in favor of the spreading activation theory [9]. To put it more precisely, although it takes time and experience to create connections in the lexical level of the ML, novice L2 learners manifested a tendency towards this developmental process. However, concerning the observed frequency effect, since the nature of each word in the individual's ML determines the activation and processing mechanism, the predictions made by the "depth of individual world knowledge model" [35] are supported. The model presupposes connection strength to be dependent upon how much the individual knows a word. The case was also observed in the study by Rahimi and Haghighi [32]. They elaborated that association types cannot be simply treated as a "factor of respondent level or word characteristic alone but rather of the frequency with which respondents actively had used the stimulus word" (p. 1). Nonetheless, this field needs more research.

It is reasonable that several limitations may have influenced our results. To begin with, pairs in each relation type comprised the various subgroups. These variations may reveal different patterns of access and organization (Hutchison [73] for a meta-analysis). However, a comparison between the







Contrast Level	Estimate	SE	df	t. Ratio	Р	Lower CL	Upper CL
Unrelated- semantic	163.36	75.1	82.2	2.175	0.1388	-33.6	360
Unrelated- associative	133.41	66.6	84.0	2.002	0.1954	-41.2	308
Unrelated- both	126.23	65.8	82.8	1.919	0.2280	-46.2	299
Semantic- associative	-29.95	64.0	80.2	-0.468	0.9658	-197.8	138
Semantic- both	-37.13	63.6	79.0	-0.584	0.9366	-203.9	130
Associative- both	-7.18	53.1	80.1	-0.135	0.9991	-146.4	132
Beginner- elementary	52	142	33.2	342	0.7176	-238	342
							CJNS

Table 4. The post hoc pairwise comparisons of the conditions and the levels

subgroups in each relation type is possible when the number of pairs in each subgroup counts to a reasonable number. Because of the proficiency level of the participants in our study, the experiment was limited to a shortlist of well-known pairs. Additionally, the number of participants was few.

Further data collection is required to determine the most facilitative priming effect precisely. The prime-target pairs also included some prime (word) – target (picture) pairs that are not culturally relevant for Iranian EFL learners and might have influenced the results. This gap can be bridged by further studies aimed at developing culturally validated normative databases of pictures for psycholinguistic studies of Iranian EFL learners.

Since semantic and associative effects show up at different SOAs, varying and lowering the duration of the prime presentation appear to provide promising information regarding the time course of activation. Also, it is a helpful analogy to collate data from varying age ranges and different L2 proficiency levels. Furthermore, few studies have investigated Persian bilingual ML organization, and the literature lacks a comparison between L1 Persian and L2 English LA.

Conclusion

This research enriches the knowledge of L2 ML structure and development. Naming latency in different experimental conditions indicates the effect of word frequency on both semantic and associative relations. Therefore, the frequent exposure of learners to language forms guarantees a more profound knowledge of the word and its stabilization, and accordingly, facilitates lexical processing and access.

Ethical Considerations

Compliance with ethical guidelines

Participation in the study was voluntary. All participants were assured that their information would remain anonymous and would be reported in an aggregate form. Before the experiment, their consent was obtained.

Funding

This research was funded by the Cognitive Science and Technologies Council (CSTC) of Iran (grant No. 7887). This paper is part of Zeinab Ghanbaryan's MA thesis with code '2303015' at the Persian Gulf University, Bushehr City, Iran.

Authors' contributions

Conceptualization, methodology, software, validation, formal analysis, resources, visualization, and funding acquisition: Zeinab Ghanbaryan, Fatemeh Nemati; Investigation, data curation, writing - original draft, and project administration: Zeinab Ghanbaryan; Writing - review and editing: All authors; Supervision: Fatemeh Nemati and Nasim Ghanbari.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgments

We thank the audiences at the first National Student Congress of Cognitive Science (NSCC). Also, we appreciate the language instructors who assisted us in the sampling process and the teenage English learners for their participation.



References

- Jiang N. Form-meaning mapping in vocabulary acquisition in a second language. ERIC. 2002; 24(4):617-37. https://eric. ed.gov/?id=EJ657494
- [2] Altarriba J, Mathis KM. Conceptual and lexical development in second language acquisition. J Mem Lang. 1997; 36(4):550-68. [DOI:10.1006/jmla.1997.2493]
- [3] Wolter B. Lexical network structures and l2 vocabulary acquisition: The role of L1 lexical/conceptual knowledge. Appl Linguist. 2006 27(4):741-7. [DOI:10.1093/applin/aml036]
- [4] Dufour R, Kroll JF. Matching words to concepts in two languages: a test of the concept mediation model of bilingual representation. Mem Cognit. 1995; 23(2):166-80. [DOI:10.3758/BF03197219] [PMID]
- [5] Kroll JF, Sunderman G. Cognitive processes in second language learners and bilinguals: The development of lexical and conceptual representations. In: Doughty CJ, Long MH, editors. The Handbook of Second Language Acquisition, Chapter 5. New Jersey: Wiley Online Library; 2003. [DOI:10.1002/9780470756492.ch5]
- [6] Kroll J, de Groot A. Lexical and conceptual memory in the bilingual. In: deGroot A, Kroll J, editors. Tutorials in bilingualism: Psycholinguistic perspectives. Mahwah, NJ: Lawrence Erlbaum; 1997. [DOI:10.4324/9781315806051]
- [7] Potter MC, So K-F, Von Eckardt B, Feldman LB. Lexical and conceptual representation in beginning and proficient bilinguals. J Verbal Learning Verbal Behav. 1984; 23(1):23-38. [DOI:10.1016/ S0022-5371(84)90489-4]
- [8] Fitzpatrick T, Izura C. Word Association in L1 and L2: An exploratory study of response types, response times, and interlingual mediation. Stud Second Lang Acquis. 2011; 33(3):373-98. [DOI:10.1017/S0272263111000027]
- [9] Collins AM, Loftus EFJPR. A spreading-activation theory of semantic processing. 1975; 82(6):407-28. [DOI:10.1037/0033-295X.82.6.407]
- [10] Fodor JA. The modularity of mind. Cambridge, MA: MIT press; 1983. [DOI:10.7551/mitpress/4737.001.0001]
- [11] Forster K. Levels of processing and the structure of the language processor. In: Walker E, Cooper WEC, editors.Sentence Processing: Psycholinguistic Studies Presented to Merrill Garrett (pp. 27-85). Hillsdale, NJ: Erlbaum; 1979. https://www.google.com/ books/edition/Sentence_Processing/9HZ9AAAAMAAJ?hl=en
- [12] Lucas M. Semantic priming without association: A meta-analytic review. Psychon Bull Rev. 2000; 7(4):618-30. [DOI:10.3758/ BF03212999] [PMID]
- [13] Lupker SJ. Semantic priming without association: A second look. J Verbal Learning Verbal Behav. 1984; 23(6):709-33. [DOI:10.1016/S0022-5371(84)90434-1]
- [14] Neely JH. Semantic Priming and retrieval from lexical memory: Roles of inhibitionless spreading activation and limited-capacity attention. J Exp Psychol Gen. 1977; 106(3):226-54. [DOI:10.1037% 2F0096-3445.106.3.226]
- [15] Posner MI, Snyder CR, Solso R. Attention and cognitive control. In: Balota DA, Marsh EJ, editors. Key Readings in Cognition. Cognitive psychology: Key readings (pp. 205–223). New York: Psychology Press; 2004. https://psycnet.apa.org/record/2005-07323-012

- [16] Plaut DC. Semantic and associative priming in a distributed attractor network. Paper presented at: 17th Annual Conference of the Cognitive Science Society. July 1995; Hillsdale, NJ: Lawrence Erlbaum Associates. https://ni.cmu.edu/~plaut/papers/pdf/ Plaut95CogSci.priming.pdf
- [17] Balota DA, Paul ST. Summation of activation: Evidence from multiple primes that converge and diverge within semantic memory. J Exp Psychol Learn Mem Cogn. 1996; 22(4):827-45. [DOI:10.1037/0278-7393.22.4.827]
- [18] Shelton JR, Martin RC. How semantic is automatic semantic priming? J Exp Psychol Learn Mem Cogn. 1992; 18(6):1191-210. [DOI:10.1037%2F0278-7393.18.6.1191]
- [19] Thompson-Schill SL, Kurtz KJ, Gabrieli JD. Effects of semantic and associative relatedness on automatic priming. J Mem Lang. 1998; 38(4):440-58. [DOI:10.1006/jmla.1997.2559]
- [20] McRae K, Boisvert S. Automatic semantic similarity priming. J Exp Psychol: Learn Mem Cogn. 1998; 24(3):558-72. [DOI:10.1037/0278-7393.24.3.558]
- [21] Perea M, Rosa E. The effects of associative and semantic priming in the lexical decision task. Psychol Res. 2002; 66(3):180-94. [DOI:10.1007/s00426-002-0086-5] [PMID]
- [22] Zareva A. Structure of the second language mental lexicon: how does it compare to native speakers' lexical organization? Second Lang Res. 2007; 23(2):123-53. [DOI:10.1177%2F0267658307076543]
- [23] Menenti L. L2-L1 word association in bilinguals: Direct evidence. Nijmegen CNS. 2006; 1:17-24. http://hdl.handle. net/11858/00-001M-0000-0013-1967-2.
- [24] Namei S. Bilingual lexical development: A persian-swedish word association study. Int J Appl Linguist. 2004; 14(3):363-88. [DOI:10.1111/j.1473-4192.2004.00070.x]
- [25] Fitzpatrick T. Word association patterns: Unpacking the assumptions. Int J Appl Linguist. 2007; 17(3):319-31. [DOI:10.1111/ j.1473-4192.2007.00172.x]
- [26] Fitzpatrick T. Habits and rabbits: Word Associations and the L2 Lexicon. EuroSLA Yearbook. 2006; 6(1):121-45. [DOI:10.1075/ eurosla.6.09fit]
- [27] Séguin M. Exploration of the relationship between word-association and learners' lexical development with a focus on American L1 and Croatian L2 Speakers. ExELL (Explorations in English Language and Linguistics). 2015; 3(2):80-101. [DOI:10.1515/exell-2017-0003]
- [28] Wright B. Word association and second language learners' responses [MA. thesis]. United Kingdom: Centre for English Language Studies, Department of English; 2001. https://www.birmingham.ac.uk/Documents/college-artslaw/cels/essays/lexis/ Wright3.pdf
- [29] Masson ME, Isaak MI. Masked priming of words and nonwords in a naming task: Further evidence for a nonlexical basis for priming. Mem Cognit. 1999; 27(3):399-412. [DOI:10.3758/ BF03211536] [PMID]
- [30] Meyer DE, Schvaneveldt RW. Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. J Exp Psychol. 1971; 90(2):227-34. [DOI:10.1037/h0031564] [PMID]
- [31] Ansarin AA. Masked semantic/associative and translation priming across languages. East European J Psycholinguistics. 2018; 5(1):7-15. [DOI:10.29038/eejpl.2018.5.1.ans]

- [32] Rahimi A, Haghighi H. How learners make mental links with words. California Linguistic Notes. 2009; 34(2):1-22. https:// www.researchgate.net/publication/274721437_How_learners_ make_mental_links_with_words
- [33] Sharifi S, Sabet MK, Tahriri A. A study on the way in which words are organized in Iranian EFL learners' mental lexicon. Int J English Lit. 2018; 7(6):80-5. [DOI:10.7575/aiac.ijalel.v.7n.6p.80]
- [34] Peppard J. Exploring the relationship between word-association and learners' lexical development [MA thesis]. Birmingham: University of Birmingham; 2007. https://www.birmingham. ac.uk/documents/college-artslaw/cels/essays/lexis/peppardmod2.pdf
- [35] Wolter B. Comparing the L1 and L2 mental lexicon: A depth of individual word knowledge model. Stud Second Lang Acquis. 2001; 23(1):41-69. [DOI:10.1017/S0272263101001024]
- [36] Meara P. Learners' word associations in French. Interlanguage Stud Bull. 1978; 3(2):192-211. https://www.jstor.org/stable/43136005.
- [37] Meara P. Word associations in a foreign language. Nottingham Linguist Circ. 1983; 11(2):29-38. http://www.lognostics.co.uk/ vlibrary/meara1983.pdf.
- [38] Ghaemi F, Halimi Passand S. The study of iranian efl learners' mental lexicon through word association tests. J Educ Health Commun Psychol. 2015; 4(2):105-18. [DOI:10.12928/jehcp.v4i2.3687]
- [39] Piper TH, Leicester PF. Word Association Behavior as an Indicator of English Language Proficiency. Washington, D.C.: Distributed by ERIC Clearinghouse; 1980. https://eric. ed.gov/?id=ED227651
- [40] Ohler LK, Goral M. The bilingual lexica. Leiden, Netherlands: Brill; 2007. Https://Brill.com/View/Book/9780080548692/ B9780080548692-S010.Xml
- [41] Kroll JF, Dijkstra T. The bilingual lexicon. In: Kaplan RB, editor. The Oxford Handbook of Applied Linguistics. Oxford: Oxford University Press; 2012. https://www.google.com/books/edition/The_Oxford_Handbook_of_Applied_Linguisti/i4dnIPvGx6 cC?hl=en&gbpv=1&dq=The+Oxford+Handbook+of+Applied+L inguistics:+Oxford+University+Press&printsec=frontcover
- [42] Sharif M, Sadighi F. Investigating the word association behavior of Persian Speakers: The Case of Iranian and adults. IJLLALW. 2013; 4(2):225-35. https://search.ricest.ac.ir/DL/Digitization/ TempDownload/AllPage992024073Limit.pdf
- [43] Indefrey P, Levelt WJ. The spatial and temporal signatures of word production components. Cognition. 2004; 92(1-2):101-44. [DOI:10.1016/j.cognition.2002.06.001] [PMID]
- [44] Roelke A, Franke N, Biemann C, Radach R, Jacobs AM, Hofmann MJ. A novel co-occurrence-based approach to predict pure associative and semantic priming. Psychon Bull Rev. 2018; 25(4):1488-93. [DOI:10.3758/s13423-018-1453-6] [PMID]
- [45] Khazaeenezhad B, Alibabaee A. Investigating the role of L2 language proficiency in word association behavior of L2 learners: A case of Iranian EFL learners. TPLS. 2013; 3(1):108-15. [DOI:10.4304/tpls.3.1.108-115]
- [46] Meara P. Vocabulary acquisition: A neglected aspect of language learning. Lang Teach Linguist: Abstracts. 1980; 13(4):221-46. [DOI:10.1017/S0261444800008879]

- [47] Postman L, Keppel G. Norms of word association. United Kingdom Edition ed. London: Academic Press Inc., Ltd.; 1970. https:// www.google.com/books/edition/Norms_of_Word_Association/B0G0BQAAQBAJ?hl=en
- [48] Saeed JI. Semantics. 4th edition. Hoboken, New Jersey: Wiley Blackwell; 2015. https://www.google.com/books/edition/Semantics/SYhxBgAAQBAJ?hl=en&gbpv=0
- [49] Cruse DA. Lexical semantics. Cambridge: Cambridge University Press; 1986. https://www.google.com/books/edition/Lexical_Semantics/xDSBaet2uSsC?hl=en&gbpv=0
- [50] Lyons J. Semantics. Volume I. Cambridge: Cambridge University Press; 1977. [DOI:10.1017/CBO9781139165693]
- [51] Konect. Edinburgh Associative Thesaurus [Internet]. 1973 [Updated: No date]. Available from: http://konect.cc/networks/ eat/
- [52] Budanitsky A, Hirst G. Semantic distance in wordnet: An experimental, application-oriented evaluation of five measures. Toronto: University of Toronto; 2001. https://dlwqtxts1xzle7. cloudfront.net/4162626/10.1.1.29.2985.pdf?
- [53] Fellbaum C. WordNet: An electronic lexical database. Cambridge, MA: MIT Press; 1998. [DOI:10.7551/mitpress/7287.001.0001]
- [54] Shima H. Ws4j. Pittsburgh: Carnegie Mellon University; 2015. http://ws4jdemo.appspot.com/
- [55] Duñabeitia JA, Crepaldi D, Meyer AS, New B, Pliatsikas C, Smolka E, et al. Multipic: A standardized set of 750 drawings with norms for six European languages. Q J Exp Psychol. 2018; 71(4):808-16. [DOI:10.1080%2F17470218.2017.1310261] [PMID]
- [56] Székely A, D'amico S, Devescovi A, Federmeier K, Herron D, Iyer G, et al. Timed picture naming: Extended norms and validation against previous studies. Behav Res Methods Instrum Comput. 2003; 35(4):621-33. [DOI:10.3758/BF03195542] [PMID]
- [57] Balota DA, Yap MJ, Hutchison KA, Cortese MJ, Kessler B, Loftis B, et al. The English lexicon project. Behav Res Methods. 2007; 39(3):445-59. [DOI:10.3758/BF03193014] [PMID]
- [58] De Leeuw JR. Jspsych: A Javascript library for creating behavioral experiments in a web browser. Behav Res Methods. 2015; 47(1):1-12. [DOI:10.3758/s13428-014-0458-y] [PMID]
- [59] Musca SC, Kamiejski R, Nugier A, Méot A, Er-Rafiy A, Brauer M. Data with hierarchical structure: Impact of intraclass correlation and sample size on type-I error. Front Psychol. 2011; 2:74. [DOI:10.3389/fpsyg.2011.00074] [PMID] [PMCID]
- [60] Beretvas SN, Pastor DA. Using mixed-effects models in reliability generalization studies. Educ Psychol Meas. 2003; 63(1):75-95. [DOI:10.1177%2F0013164402239318]
- [61] Baayen RH, Davidson DJ, Bates DM. Mixed-effects modeling with crossed random effects for subjects and items. J Mem Lang. 2008; 59(4):390-412. [DOI:10.1016/j.jml.2007.12.005]
- [62] Bicknell K, Elman JL, Hare M, Mcrae K, Kutas M. Effects of event knowledge in processing verbal arguments. J Mem Lang. 2010; 63(4):489-505. [DOI:10.1016/j.jml.2010.08.004] [PMID] [PM-CID]
- [63] Larson-Hall J. A guide to doing statistics in second language research using SPSS and R. 2nd edition. Milton Park: Routledge; 2015. https://www.routledge.com/A-Guide-to-Doing-Statistics-

in-Second-Language-Research-Using-SPSS-and/Larson-Hall/p/book/9781138024571

- [64] Winter B. Statistics for linguists: An introduction using R. New York: Routledge; 2019. [DOI:10.4324/9781315165547]
- [65] Bates D, Maechler M, Bolker B, Walker S, Christensen RHB, Singmann H, et al. Linear mixed-effects models using 'Eigen' and S4 [Internet]. 2021 [Updated: 2021 June 22]. Available from: http://dk.archive.ubuntu.com/pub/pub/cran/web/packages/ lme4/lme4.pdf
- [66] Fox J, Weisberg S, Friendly M, Hong J, Anderson R, Firth D, et al. Effect displays for linear, generalized linear, and other models [Internet]. 2020 [2021 August 11]. Available from: https://cran.rproject.org/web/packages/effects/effects.pdf
- [67] Lenth RV, Buerkner P, Herve M, Love J, Riebl H, Singmann H. Estimated marginal means, aka least-squares means [Internet]. 2021 [Updated 2021 June 1]. Available from: https://cran.r-project.org/web/packages/emmeans/emmeans.pdf
- [68] Xavier Alario F, Segui J, Ferrand L. Semantic and associative priming in picture naming. Q J Exp Psychol A. 2000; 53(3):741-64. [DOI:10.1080/713755907] [PMID]
- [69] Perea M, Gotor A. Associative and semantic priming effects occur at very short stimulus-onset asynchronies in lexical decision and naming. Cognition. 1997; 62(2):223-40. [DOI:10.1016/s0010-0277(96)00782-2]
- [70] Warren RE. Time and the spread of activation in memory. J Exp Psychol Hum Learn. 1977; 3(4):458. [DOI:10.1037/0278-7393.3.4.458]
- [71] Williams JN. Is automatic priming semantic? Eur J Cogn Psychol. 1996; 8(2):113-62. [DOI:10.1080/095414496383121]
- [72] La Heij W, Dirkx J, Kramer P. Categorical interference and associative priming in picture naming. Br J Psychol. 1990; 81(4):511-25. [DOI:10.1111/j.2044-8295.1990.tb02376.x]
- [73] Hutchison KA. Is semantic priming due to association strength or feature overlap? A microanalytic review. Psychon Bull Rev. 2003; 10(4):785-813. [DOI:10.3758/BF03196544] [PMID]
- [74] Brunellière A, Perre L, Tran T, Bonnotte I. Co-occurrence frequency evaluated with large language corpora boosts semantic priming effects. Q J Exp Psychol. 2017; 70(9):1922-34. [DOI:10.1080 /17470218.2016.1215479] [PMID]
- [75] Pavlenko A. The bilingual mental lexicon: Interdisciplinary approaches. In: Pavlenko A, editor. Bilingual Education & Bilingualism. Multilingual Matters; 2009. [DOI:10.21832/9781847691262-008]
- [76] De Groot AM. Bilingual lexical representation: A closer look at conceptual representations. Adv Psychol. 1992; 94:389-412. [DOI:10.1016/S0166-4115(08)62805-8]
- [77] De Groot AM. Word-type effects in bilingual processing tasks. Biling Lex. 1993. 27-51. [DOI:10.1075/sibil.6.04gro]
- [78] Hollis G, Westbury C. The principals of meaning: Extracting semantic dimensions from co-occurrence models of semantics. Psychon Bull Rev. 2016; 23(6):1744-56. [DOI:10.3758/s13423-016-1053-2] [PMID]
- [79] Clark JM, Paivio A. Dual coding theory and education. Educ Psychol Rev. 1991; 3(3):149-210. [DOI:10.1007/BF01320076]

- [80] Imbault C, Titone D, Warriner AB, Kuperman V. How are words felt in a second language: Norms for 2,628 English words for valence and arousal by L2 speakers. Bilingualism: Language and Cognition. 24(2):281-92. [DOI:10.1017/S1366728920000474]
- [81] Mccarthy M. [Language Teaching. Vocabulary (Russian)]. Oxford: Oxford University Press; 1990. https://www.twirpx.com/ file/1812406/
- [82] Soderman T. Word associations of foreign language learners and native speakers- different response types and the irrelevance to lexical development. In: Hammarberg B, editor, Problems, process, and product in language learning. Stockholm: University of Stockholm; 1993. https://www.ling.su.se/polopoly_ fs/1.14163.1320939589!/problem_process_product_language_ learning_1992.pdf
- [83] Barrow S. First and second language word association. A study of how native English speakers and Esl learners make mental links between English words they have learnt [Unpublished MA thesis]. Birmingham: University of Birmingham; 2011. https:// www.birmingham.ac.uk/documents/college-artslaw/cels/essays/appliedlinguistics/sarahbarrowdiss.pdf
- [84] Ferrand L, New B. Semantic and associative priming in the mental lexicon. In: Bonin P. editor, Mental Lexicon: Some words to talk about Words. Hauppauge, New York: Nova Science Publishers; 2004. https://psycnet.apa.org/record/2004-15128-002
- [85] Heyman T, Hutchison KA, Storms G. Uncovering underlying processes of semantic priming by correlating item-level effects. Psychon Bull Rev. 2016; 23(2):540-7. [DOI:10.3758/s13423-015-0932-2] [PMID]



Prime	Target	Prime	Target
Semantically related pairs		Associatively re	elated pairs
Suitcase	Bag	Office	Desk
Dress	Skirt	Goat	Milk
Steak	Meat	Pilot	Plane
Dinner	Chicken	Dentist	Teeth
Bath	Swim	Time	Watch
Yellow	Blue	Sea	Boat
Fox	Donkey	Umbrella	Rain
Square	Circle	Foot	Shoe
Hen	Duck	Bee	Honey
Horse	Camel	Hand	Glove
Hat	Sweater	Scarf	Neck
Tiger	Lion	Green	Grass
Truck	Car	Curly	Hair
Morning	Night	Web	Spider
Coin	Money	Farm	Animals
Fruit	Orange	Banana	Monkey
Eagle	Bird	Carrot	Rabbit
Unrelated p	Unrelated pairs Doc		Кеу
Еуе	Ear	Dath compatizely, and consistively related price	
Day	Sofa	Both semantically and asso	
Bathroom	Ruler	Knife	Fork
Shirt	Мар	Salt	Pepper
Nine	Fan	King	Queen
Camera	Elephant	Arm	Leg
Picture	Cloud	Table	Chair
Forty	Pig	Moon	Sun
Red	Square	Man	Woman
Library	Kite	Paper	Pencil
Student	Doll	Mouth	Nose

$\ensuremath{\textbf{Appendix 1.}}\xspace$ A log of the word pairs used in the primed picture naming task





Prime	Target	Prime	Target
Globe	Frog	Onion	Potato
Head	Bicycle	Sky	Star
Heart	Farmer	School	Teacher
Wall	Bear	Mouse	Cat
Ant	Cup	Apple	Pear
		Sheep	Cow
	Traini	ng trials	
Pen	Book	Cats	Dogs
Red	Tree	Chocolate	Candy



Appendix 2. Pictures used in the primed picture naming task taken from Duñabeitia et al.'s [55] norm and the IPNP database [56]

