Iranian EFL Learners' Processing of English Derived Words

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Abstract
An interesting area of psycholinguistic inquiry is to discover the way morphological structures are stored in the human mind and how they are retrieved during comprehension or production of language. The current study probed into what goes on in the mind of EFL learners when processing derivational morphology and how English and Persian derivational suffixes are processed. 60 Iranian EFL learners at intermediate and advanced levels of proficiency whose proficiency level were determined through Oxford Quick Placement Test, participated in masked priming experiments using E-prime software. Two separate priming tasks in Persian and English were conducted during the course of this study. The target words were primed in three ways: identity (careful→careful), related (care→careful) and control primes (desire→careful). Participants' reaction times were measured by E-prime software and were fed into SPSS software for further analysis. The results indicated that proficiency plays a role in the way derivational morphology is processed, because at lower proficiency levels more decomposition was detected while more proficient participants utilized more whole-word representation. Furthermore, Persian learners of English processing of the derived words could not be assigned strictly to decomposition or whole-word representations in the mind. What seems more plausible to assume is that highly frequent words (whether base or suffix frequency) as well as derived words with more productive suffixes are stored as whole words but lower base and morpheme frequency ones and those with suffixes having less productivity are decomposed. These findings lend further support to dual route model.
Keywords: morphological word, derivational affixes, processing, frequency, dual-route model

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INTRODUCTION

Language, the indispensible part of human society, is believed to be a natural predisposition in the mind. This predisposed phenomenon, called universal grammar (UG), is placed in the language acquisition device (LAD) and is known to be responsible for the acquisition of first language (Chomsky, 1965). However, controversies exist as to the availability or non-availability of UG in second language acquisition (e.g. Platzack, 1996; Schwartz & Sprouse, 1996). What has been apprehended from some of the surveys comparing L1 and L2 acquisition is that L1 and L2 users not only learn these languages in dissimilar manners, but they also process and use them by different approaches. Hence, both grammar and the underlying system, controlling and handling the acquisition and use of languages, may differ to a large extent. Differences have been put forward for the ways L1 and L2 are acquired and processed and as Zubizarreta and Nava (2011) have pointed out, learning a second language involves replacing dissimilar native algorithms by the new algorithm in the target language, making a hindrance in learning and by contrast, for the similar non-competing structures, L2 will be learned at ease.

Several structures have been compared regarding their acquisition across L1 and L2. One issue which is a plausible area to probe into is how derivational morphology is processed in both first and second languages which may lend further credence to the (dis)similarities found between L1 and L2 processing. Due to the scarcity of studies on clarifying the similarities between L1 and L2 underlying processes, this study attempts to shed light on the (in)availability of UG for L2 acquisition.

So far, opposing theories have been set forth by scholars regarding the way derived words are processed; however, to be confirmed, each of them is in need of further evidence (Clahsen & Neubaur, 2010). However, deciding on a unified framework for morphological processing is a controversial issue which requires confirmation from different languages (Silva & Clahsen, 2007). Additionally, previous studies have been conducted on a few languages like Dutch (De Jong, Shrueder, & Baayen, 2000), Finnish (Jarviniki, Bertram, & Neimi, 2006), French (Giraudo & Grainger, 2000) and Korean (Kim, Wang, & Ko, 2011). Therefore, studies about how English polymorphemic words are processed in other languages are called for. Research into the effects of variables like base and surface frequency, family size, productivity, allomorphy and phonological alternations in the stem, on lexical processing of derived words, is then a necessity. The salience of the derivational suffix is under question in the present study. This study attempts to resolve the ambiguities regarding how derivational morphology is processed in L1 and during the course of learning English as the second language by Persian EFL learners and the dissimilarities between Persian and English that may hinder acquiring this form for L2 learners.

LITERATURE REVIEW

The way morphological words are stored in and retrieved from memory has been of great concern to those studying psycholinguistics and neurolinguistics. Several frameworks have been put forward by specialists in the field four of which are described as follows:

Full Listing Hypothesis

This hypothesis is based on the assumption that for every word a person knows, a mental representation is created in his mind, which is stored as a separate lexical entry (Butterworth, 1983). No morphological unit is believed to be accessed during the procedures in which words are retrieved or produced and each complex word has its own place in the mind. The morphological constituents are excluded both at the prelexical level and the word level (Dominguez, Cuetos, & Segui, 2000). In other words, a completely whole form representation of a morphologically complex word is utilized and morphological decomposition is set aside entirely.

Full Parsing Model

This model is on the other side of the continuum. In this framework, there is a complete use of rules and regularities and the morphological structure of the word is broken into subparts to make word recognition happen. The process may take more time than Full Listing Model to operate, but its contribution to correct understanding of the word will be more appreciated.

Obligatory Decomposition Model

This model was first introduced by Taft and his colleagues in several studies (e.g. Taft, 1979, 2004; Taft & Ardasinski, 2006; Taft & Forster, 1975). This model holds that for most words constructed through morphological structures, decomposition is necessary. The morphological word is not stored as a whole word. The information contained in the stem is taken care of first and later on the meaning of the affix and the whole word meaning comes into view.

Dual Pathway Account/Dual-Route Model

This model claims that decomposition processing always takes place, but a holistic processing accompanies it (Pinker, 1991). In this framework, decomposition is so slow that a holistic approach will always be completed first (Jarvikivi, Bertram, & Niemi, 2006). The choice of using a whole word form or the decomposition depends largely on two factors, regularity of the affix and its frequency. This model is further supported by Baayen, Dijkstra, and Schreuder (1997).

Experimental Studies

The way morphologically complex words are processed in the mind and what goes on during this matter has opened new avenues for inquiry. Throughout the literature, several factors have been introduced to be effective in the way morphologically complex words are processed. Variables like base frequency, surface frequency, family size and family frequency as well as affix productivity and affix allomorphy are among these variables. The empirical investigations into such variables are briefly reviewed in what follows.

Bertram, Schrueder, and Baayen (2000) conducted a study in which the family size effect was taken to be an effective agent in processing complex words besides their effect in processing simplex words. What was an undeniable factor in such an effect was the semantically transparent family member which was further limited by the semantic selection restriction of the affix in the word. The concept studied was that the family size is not only a factor in processing complex words, but the family size of the base word of the complex word can also have a role. To prove this notion, a number of experiments were conducted which examined past tense inflected verbs with high and low family sizes for their base word, while keeping the base and surface frequency constant, comparative suffix –*er* as an inflectional suffix and *–er* in its derivational role as in the word *baker*. The possible effect of base word family size was more influential for processing inflected words and less for derived words.

Martin, Kostic, and Baayen (2004) commented on several type and token-based counts on processing morphologically complex words. Token based concept was defined as counting the number of reoccurrences of a word, the base form or the root which has an influence on the response latencies in visual lexical decision tasks.

According to Martine, Kostic, and Baayen (2004), surface frequency is correlated negatively with response latencies to morphologically simple words in visual lexical decision tasks. Additionally, base frequency has an effect on response latencies even after removing the effects of surface frequency (Baayen, Dijkstra, & Schreuder, 1997). Still, other factors have been mentioned to affect response latencies. Other researchers also discovered that the ratio between surface frequency and base frequency has a negative effect on response latencies (e.g. Hay, 2001).

The next study to take into account is the research conducted by Ford, Davis and Marslen-Wilson (2010). Ford and his colleagues endeavored to figure out the effects of base frequency and family size on processing derived words and whether these variables were affected by the productivity of the affix. Three experiments were conducted. The first one examined the effect of base frequency and family size on lexical decision response time. The results turned out that an interaction existed between base frequency of a derived word and its affix productivity. Considering this fact, in the second experiment, a larger set of data was used with the productivity of the affixes specified. The second experiment revealed that the family frequency affects both more and less productive suffixes but the base frequency only affects highly productive ones. The absence of any base frequency effect for affixes with less productivity led the researchers to conduct the third experiment to detect the possible effect of base morpheme frequency on affix productivity. To do so, a large set of derived words with less productive affixes were the targets of the lexical decision tasks while the base frequency was factored out. The results showed that this effect was not much reliable. The authors concluded that among the competing variables, namely base morpheme frequency and family size, the former was a good predictor of response times but along with an interaction with the productivity of the affix. Besides that, the family size was also proved to be influential in response time but irrespective of productivity (Ford, Davis, & Marslen-Wilson, 2010).

Studies on morphological processing are not limited to isolated items used in priming tasks. Cole, Bouton, Leuwers, Casalis, and Charolles (2011) investigated how complex words are identified in context. The identification of morphological words in reading tasks by participants had been the target and the format these words have on the paper, whether it is typed in four ways, namely syllabic, morphological, morphological+ one grapheme and unsegmented, and the ability of the learners to figure them out as morphological words were among the other aims of the study. The findings showed that beginning French readers could identify morphological units (both stems and derivational suffixes) to process new words and syllables and also morphemes and unsegmented forms had similar effects on distinguishing words.

Kim, Wang, and Ko (2011) investigated how Korean L2 learners process English derivational morphology to show whether decomposition takes place during cross-language activation while derived words are processed. Several priming tasks were conducted to this aim. The primes in unmasked priming tasks were real derived words, derived non-morphological ending pseudo-words, and non-interpretable derived pseudo-words. The reason behind this selection was to compare the effects of lexicality and interpretability on morphological decomposition. The findings indicated that there was a priming effect of interpretable and non-interpretable derived pseudo-words on target stems. This was an indicator of decomposition taking place with no interference of lexicality and interpretability factors. The obligatory decomposition model was confirmed while by taking other factors such as frequency issues into consideration, other facts about the processing of derived words could be revealed.

The languages that have been under study were mainly Dutch, Finnish, Spanish and Korean. Further support from other languages is called for (Clahsen & Neubaur, 2010). This review brings up the need to study how English polymorphemic words are processed in SLA.

The results obtained from the information provided in the present study can provide more evidence for the proposed models of processing derivational morphology which are in need of further theoretical and empirical support.

PURPOSE OF THE STUDY

The purpose of the present research was to study how derivational morphology is processed both in English and Persian and how the factors of base frequency, surface frequency and suffix productivity play a role in such processing. Masked priming tasks were designed to investigate such effects.

In order to figure out how the initial states of L2 acquisition may differ from the later stages and to understand the effect of exposure to more input and accumulating more knowledge of the target language, the role of English proficiency level was also scrutinized. Besides these issues, the role of L1 transfer was accounted for by comparing the data acquired from both of languages processed by the same learners to see how the reaction latencies of the learners would differ or be the same in both their L1 and L2 while processing derivational suffixes in different contexts explained so far. The possible differences between L1 and L2 derivational processing could lend further support to the procedural/declarative knowledge distinction proposed by Ullman (2001).

The current research was conducted to address the following research questions:

1. What is the role of surface frequency in processing derived words by Persian EFL learners?
2. What is the role of base frequency in processing derived words by Persian EFL learners?
3. What is the role of suffix productivity in processing derived words by Persian EFL learners?
4. What is the role of proficiency in derivational morphology processing by Persian EFL learners?
5. What are the differences in processing derivational morphology in L1 and L2?

METHOD

Participants

The participants of the study included 30 advanced and 30 intermediate female B.A. and M.A. Persian learners. They were between 18-28 years old and were studying English as their foreign language without being exposed to natural English environment. None of them were informed about the purpose of the study. The proficiency level of the participants was measured by Oxford Quick Placement Test (OQPT) which is a standardized placement test in English. The scores ranging from 28-40 indicated the intermediate level and those above 48 were indicative of the advanced proficiency level.

Instruments

The main instrument used for the data collection was a masked priming task using E-prime 2.0 professional software. Many psycholinguistic studies are carried out using this software due to the preciseness and accuracy of the results as well as the conductibility of the task using a PC and a special USB key. Six applications are determined for this software: Codec Configuring, E-data aid, E-merge, E-recovery, E-run and E-studio. E-studio, E-data aid and E-merge were used in the present study. E-studio is the part in which the main task was specified and conducted. The other two applications, E-data aid and E-merge, were utilized in the data analysis part.

The materials for the masked priming task consisted of 6 contexts for both Persian and English. Surface frequency, base frequency and suffix productivity were the broadest categories for both languages in each of which, 20 words were selected (See the Appendix). Then, each of these categories was divided into two levels: 10 high vs. 10 low frequency words for each category totaling 60 target words for each language.

English words frequencies were determined by the BNC website (British National Corpus) which is a recent corpus of spoken and written British English data. The corpus consisted of 1 million words and phrases. Alger and Cordon (1999) stated that the words for which the frequency criterion was 6 or below in 1 million words is considered as low frequency and the frequency above that can be regarded as high frequency. In the present study, 15 per million was considered as the border line and those below-were considered as low frequency. All the target words for the English masked priming tasks consisted of four syllables to avoid the effect of word length on the reaction time of the participants.

Frequencies in Persian were determined by the two questionnaires which were distributed among 30 Persian native speakers. Each questionnaire consisted of a list of 40 derived words. In one questionnaire, participants were asked to determine the frequency of the whole words as having high frequency, low frequency or moderate frequency, and in the other one, they were asked to determine the frequency of the stems of the derived words by marking them to be of low frequency, high frequency or moderate frequency. Each list was later analyzed and the words were ordered from the lowest to the highest frequency according to their frequency rate determined by native speakers of Persian. The 10 highest and 10 lowest words in each list were determined as the target for the masked priming task. All the Persian target words consisted of three syllables in order to prevent the effect of the length of the words on the reaction times. The words for the suffix productivity category were taken from a book written by Fatemi (2007) in which a list of Persian bound morphemes are given and the productivity or non-productivity of each one is determined.

Later, each target word was preceded by three prime types: identity (*e.g.desirable→desirable*), related (*e.g. desirable→desire*) and control (*e.g. desirable→symphony*). In order to avoid careless and haphazard answers by the participants, non-words were added to each list in both languages. The list of non-words in English was adopted from Taft (2004) and Persian non-words were the illegal combination of stems and suffixes.

Data Collection Procedure

The course of this study can be divided into several stages. In the first stage, a placement test was conducted a week before the main task and the proficiency level of the participants was determined. Stage two was a practice session which was arranged for each individual to avoid delays in the reaction times due to unfamiliarity with the task and to make sure that all of the participants were fully familiar with the task.

Stage three was the main task in which the prime lasted on the screen for 100 milliseconds. After the prime, the fixation point (+) appeared on the screen and following that, the target word was displayed with 28 Courier New font in black ink on white background. The prime is presented on a PC screen for 100 milliseconds, hence called masked priming task. It is later followed by a fixation point (+). The target word appears and the participant is to decide whether it is a word or non-word and has to press 'M' key on the keyboard if it is and 'Z' if it is not. The reaction latency is measured from the onset the target word appears on the screen to the time the relevant key is pressed. In the main task, each participant had to do the task individually for about 30 minutes.

Data Analysis

After the experiment was conducted, the reaction times of the subjects were saved using E-merge and E-data aid and were fed into SPSS for further analysis. Descriptive statistics, mixed between-within ANOVA, repeated measure ANOVA, Post-hoc comparisons and paired samples T-test were conducted for analyzing the data.

RESULTS

The reaction times (RTs) of each participant for each word were measured by E-prime software and each specific context and each individual prime had an influence on the reaction time of the participants. The mean RTs and standard deviations were calculated and the outliers, whose RTs were ± 2.5 standard deviations below or above the mean, were removed from the main analysis.

English Surface Frequency

In addressing the first research question, in the English task, the surface frequency for each word was controlled and the words were assigned high and low frequency values along with three types of primes. Proficiency level was another variable in English contexts. The descriptive statistics of the RTs are depicted in Table 1 below.

Table 1: Descriptive statistics for English surface frequency across proficiency levels

Context	Proficiency	Mean	SD	Mean difference
High Surface Frequency-identity	**Advanced**	757.04	157.81	-71.62
	Intermediate	829.02	230.48	
	Total	793.03	199.17	
High Surface Frequency-related	**Advanced**	744.83	157.96	-94.56
	Intermediate	838.56	226.55	
	Total	791.69	199.31	
High Surface Frequency-control	**Advanced**	858.07	146.78	-131.94
	Intermediate	990.01	267.01	
	Total	924.04	223.74	
Low Surface Frequency-identity	**Advanced**	1135.10	361.08	-97.74
	Intermediate	1232.84	341.09	
	Total	1183.97	351.71	
Low Surface Frequency-related	**Advanced**	1099.92	229.12	-168.74
	Intermediate	1268.39	401.06	
	Total	1184.15	334.79	
Low Surface Frequency-control	**Advanced**	1191.96	274.47	-113.03
	Intermediate	1304.99	306.08	
	Total	1248.47	293.81	

As displayed in Table 1, it is clear that lower surface frequency contexts, regardless of their prime-type, led to longer reaction latencies than the higher surface frequency ones. The mean differences were 390.67, 392.46 and 324.43 for high and low surface frequency contexts in identity, related and control prime types, respectively. The mean differences between the two proficiency levels are indicated in Table 1, which proves differences in each context since higher proficiency levels led to shorter RTs.

A mixed between-within subjects ANOVA was conducted to investigate the significance of such differences. The assumptions of normality and homogeneity of the variances, using Kolmogorov Smirnov and Leven's test of homogeneity of variances respectively, were met.

The output generated was analyzed to investigate the effect of proficiency on each of the contexts of high versus low surface frequency words each with three types of primes. There was a statistically significant effect for context, Wilk's Lambda=0.14, F (5, 54)= 63.55, *p*=0.000, eta squared =.85 indicating a large effect size.

This data revealed that in each of these six contexts, the type of word or prime had an influence on the reaction latencies of the participants, but there was no significant interaction between context and proficiency level, Wilk's Lambda=.92, F(5,54)=.86, *p*=.50. Additionally, a paired sample T-test was conducted to see whether there was any difference between the reaction times for high versus low surface frequency words without taking the role of proficiency or prime type into consideration. The results indicated that there was a statistically significant difference between RTs in high versus low surface frequency contexts, t (59)=-29.12, *p*=0.001. In addition, the results indicated that, regarding the proficiency level of the participants, there existed a statistically significant difference, F (1, 58)=3.68, *p*=0.06.

English Base Frequency

Table 2 shows descriptive statistics for the three prime types, two proficiency levels as well as high versus low base frequency.

Table 2: Descriptive statistics for English base frequency across proficiency levels

Context	Proficiency	Mean	SD	Mean difference
High Base Frequency-identity	**Advanced**	799.86	160.56	-145.32
	Intermediate	945.18	256.96	
	Total	872.52	224.71	
High Base Frequency-related	**Advanced**	792.32	142.52	-127.41
	Intermediate	919.73	257.18	
	Total	856.02	215.92	
High Base Frequency-control	**Advanced**	871.97	168.29	-155.33
	Intermediate	1027.30	255.05	
	Total	949.63	228.10	
Low Base Frequency-identity	**Advanced**	969.86	218.07	-141.22
	Intermediate	1111.08	279.71	
	Total	1040.47	258.65	
Low Base Frequency-related	**Advanced**	979.62	237.51	-173.93
	Intermediate	1153.55	318.53	
	Total	1066.59	292.05	
Low Base Frequency-control	**Advanced**	1027.29	224.97	-174.14
	Intermediate	1201.43	307.07	
	Total	1114.36	280.95	

As can be inferred from the reaction times in Table 2, it took longer for lower base frequency words to be processed. The proficiency levels also had an effect on the reaction times since the lower proficiency level led to longer reaction times. The mean differences are provided in Table 2.

A mixed between-within ANOVA was conducted to find out whether these inferred differences between the proficiency levels among the six contexts in base frequency manipulation were statistically significant or not. Inspection of the underlying assumptions manifested the normal distribution (sig>0.05) and the homogeneity of the data (sig>0.05). There existed no interaction effect between English base frequency context and proficiency level, Wilk's Lambda=0.97, $F(5, 54)=0.26$, $p=0.93$. Additionally, there was a significant main effect for context, Wilk's Lambda=0.24, $F(5, 54)=32.99$, $p=0.001$, partial eta squared=0.75 indicating a large effect size. Results further revealed that proficiency level had a role in the reaction latencies of the subjects, $F(1, 58)=8.02$, $p=0.006$ with partial eta squared=0.12 which is a small effect size.

English Suffix Productivity

Besides the surface and base frequency, for the third research question, productivity of the suffix was manipulated in order to see whether it caused any change in the behavior of the participants in the two proficiency levels. Descriptive statistics were computed the results of which are presented in Table 3.

Table 3: Descriptive statistics for suffix productivity across proficiency levels

Context	Proficiency	Mean	SD	Mean Difference
High Suffix Productivity-identity	**Advanced**	899.80	218.05	-137.31
	Intermediate	1037.11	335.57	
	Total	968.45	288.99	
High Suffix Productivity-related	**Advanced**	932.15	222.56	-194.12
	Intermediate	1126.27	373.38	
	Total	1029.21	320.08	
High Suffix Productivity-control	**Advanced**	1018.68	227.08	-110.23
	Intermediate	1128.91	304.56	
	Total	1073.80	272.08	
Low Suffix Productivity-identity	**Advanced**	891.58	224.35	-135.03
	Intermediate	1026.61	301.27	
	Total	959.10	272.01	

Low Suffix Productivity-related	**Advanced**	944.00	234.99	-90.20
	Intermediate	1034.20	282.12	
	Total	989.10	261.40	
Low Suffix Productivity-control	**Advanced**	1023.10	200.37	-133.18
	Intermediate	1156.28	363.11	
	Total	1089.69	298.41	

The mean comparison for these contexts revealed some differences in the behavior of the participants. Unlike base and surface frequency contexts, English suffix productivity context did not yield shorter RTs for high and longer RTs for lower productive suffixes. In spite of this fact, proficiency level acted in this context similar to the two previous contexts with lower proficiency participants spending more time processing the data.

A mixed between-within subjects ANOVA was conducted to see whether these differences were significant or not. The normality and homogeneity of the data was inspected using Kolmogorov Smirnov and Levene's test of homogeneity of variances both of which were assumed at sig>0.05 level. First of all, no interaction was found between context and proficiency, Wilk's Lambda=0.92, $F(5, 54)=0.89$, $p=0.49$. Additionally, different contexts yielded totally different reaction times, Wilk's Lambda= .005, $F(5, 54)=10.51$, $p=0.000$. The partial eta squared equaled 0.49 indicating a large effect size. The results also proved that the proficiency level had an influence on the RTs for this context, $F(1, 58)=4.20$, $p=0.04$ with partial eta squared=0.06 indicating a small effect size.

Comparison of the Three Contexts in English

The three contexts, namely the base frequency, surface frequency and suffix productivity, gave rise to different RTs and each one had differences between high and low levels. Descriptive statistics of these contexts along with their two levels are presented in Table 4 below.

Table 4: Descriptive statistics for the three contexts in English

Context	Mean	Std. Deviation	N
High Surface Frequency Mean	836.26	191.18	60
Low Surface Frequency Mean	1205.54	293.89	60
High Base Frequency Mean	892.73	201.00	60
Low Base Frequency Mean	2478.52	590.39	60
High Suffix Productivity Mean	1023.82	273.07	60
Low Suffix Productivity Mean	1012.63	254.86	60

The data presented in Table 4 indicate that higher surface and base frequency contexts led to shorter reaction times than their low counterparts (-369.28 and -1585.79 respectively) but the suffix productivity context proved the reverse (mean difference between high and low suffix productivity=11.19). The ANOVA results indicated a statistically significant difference between high versus low values of these contexts substantiating the effect of frequency on processing all derived words, Wilk's Lambda=0.52, $F_{(5,55)}= 1.75$, $p \leq 0.005$.

Persian Surface Frequency

In Persian, the first context under investigation was surface frequency in which two groups of words were presented to the learners. The words were high versus low surface frequency derived words which followed three prime types: identity, related and control. The descriptive statistics for the Persian surface frequency are presented in Table 5.

Table 5: Descriptive statistics for Persian surface frequency

Context	N	Min.	Max.	Mean	Std. Deviation
Persian High Surface Frequency-identity	60	314.30	847.22	486.48	105.38
Persian High Surface Frequency-related	60	322.70	1283.22	514.14	145.26
Persian High Surface Frequency-control	60	314.30	920.11	566.44	123.17
Persian Low Surface Frequency-identity	60	294.40	1328.77	623.52	193.66
Persian Low Surface Frequency-related	60	315.50	1214.00	659.83	202.45
Persian Low Surface Frequency-control	60	326.50	1309.62	758.69	215.42

This data reveals the overall shorter mean RTs for higher surface frequency contexts than the lower surface frequency ones. A repeated measure ANOVA was conducted to investigate the significance of these differences between the mean RTs in this context. Levene's test of equality of variances and Kolmogorov Smirnov tests were at sig>0.05 level, indicating that the assumptions were assumed. The results proved a statistically significant difference among these six contexts: Wilk's Lambda=0.30, $F_{(5, 55)}$, 24.65, p=0.000, partial eta squared=0.69 which is indicative of a large effect size.

Persian Base Frequency

Besides the surface frequency manipulation, another issue was tested for figuring out the processing of derivational morphology in L1 for the Persian EFL learners. The mean RTs for each context are presented in Table 6 below.

Table 6: Descriptive statistics for Persian base frequency

Context	N	Min.	Max.	Mean	Std. Deviation
Persian High Base Frequency-identity	60	320.80	703.00	487.08	90.94
Persian High Base Frequency-related	60	313.80	790.50	510.90	107.45
Persian High Base Frequency-control	60	373.10	911.30	599.95	107.37
Persian Low Base Frequency-identity	60	296.80	942.20	508.64	134.21
Persian Low Base Frequency-related	60	320.60	898.50	538.17	126.07
Persian Low Base Frequency-control	60	332.00	806.50	610.95	101.43

Taking into account the overall context in Persian, higher base frequency items were processed faster than the lower frequency ones. To make sure of the amount of difference across the contexts, a repeated measure ANOVA was conducted. Levene's test of equality of variances and Kolmogorov Smirnov tests had sig>0.05 values, denoting the observance of the underlying assumption for analysis of variance. Results indicated that there was a statistically significant difference among the RTs in these six contexts, Wilk's Lambda=0.26, $F(5, 55)$, p=0.000, partial eta squared=0.73 showing a large effect size.

Persian Suffix Productivity

The next factor under consideration was the frequency of the suffix or suffix productivity. The descriptive statistics for RTs is presented in Table 7 below.

Table 7: Descriptive statistics for Persian suffix productivity

Context	N	Min.	Max.	Mean	Std. Deviation
Persian High Suffix Productivity-identity	60	311.20	884.88	503.20	116.56
Persian High Suffix Productivity-related	60	326.60	798.00	521.73	117.89
Persian High Suffix Productivity-control	60	336.10	887.40	604.34	115.48
Persian Low Suffix Productivity-identity	60	256.20	975.70	495.24	129.31
Persian Low Suffix Productivity-related	60	286.80	980.20	548.31	127.64
Persian Low suffix Productivity-control	60	317.20	931.75	597.62	113.59

Unlike the two previous contexts in Persian, mean RTs do not show shorter reaction times for higher suffix productivity environment and longer reaction latencies for lower productive suffixes. To investigate the significance of such differences, repeated measures ANOVA was carried out. All the assumptions pertaining to the homogeneity of the variances and the normality of the distribution were assumed (sig>0.05). Results indicated that there was a significant difference among the 6 contexts, Wilk's Lambda=0.27, $F(5, 55)=29.77$, $p=0.000$, partial eta squared=0,73 indicating a large effect size.

Comparison of the Three Contexts in Persian

In Persian, base frequency, surface frequency and suffix productivity led to different RTs and they differed with regards to their high and low levels. Descriptive statistics of these contexts are presented in Table 8 below.

Table 8: Descriptive statistics for the three contexts in Persian

Context	Mean	Std. Deviation	N
Persian High Surface Frequency-Mean	522.36	112.44	60
Persian Low Surface Frequency-Mean	680.69	182.88	60
Persian High Base Frequency-Mean	532.64	88.13	60
Persian Low Base Frequency-Mean	552.59	106.44	60
Persian High Suffix Productivity-Mean	543.09	105.04	60
Persian Low Suffix Productivity-Mean	547.06	108.67	60

An inspection of the data in Table 8 reveals some differences in the behavior of Persian participants with regards to the three contexts in their native language. For these three contexts, higher frequency items were processed faster than their lower frequency counterparts with the mean differences of -158.33, -19.95 and -3.97 for surface frequency, base frequency and suffix productivity respectively. A repeated measure ANOVA results revealed that there was a statistically significant difference between high versus low values of these contexts, Wilk's Lambda=0.32, $F(5, 55)=22.98$, $p<0.005$.

Comparison of Three Contexts in Both Languages

The findings of the masked priming task for both Persian and English surface frequency revealed that the participants' reaction latencies were shorter for higher surface frequency contexts. For the ease of access, surface frequency means RTs for both languages are presented in Table 9 below.

Table 9: Surface frequency contexts in English and Persian

Context	Min.	Max.	Mean	Std. Deviation
English High Surface Frequency	491	1458	836.26	191.18
English Low Surface Frequency	499	1874	1205.54	293.89
Persian High Surface Frequency	371	1003	522.36	112.44
Persian Low Surface Frequency	359	1148	680.69	182.88

The above table indicates that the lower frequency contexts in both languages were processed with greater difficulty. Mean differences between high and low levels are -369.25 for English and -158.33 for Persian. Additionally, both high and low surface frequency contexts in Persian were processed faster than the corresponding contexts in English (mean differences are -313.9 and -524.85, respectively). This fact can be traced back to the idea that L1 is processed with much more automaticity and ease.

To compare base frequency data for both languages, descriptive statistics are provided in Table 10 below.

Table 10: Base frequency contexts in English and Persian

Context	Min.	Max.	Mean	Std. Deviation
English High Base Frequency	492	1409	892.73	201
English Low Base Frequency	1363	3725	2478.52	590.39
Persian High Base Frequency	379.83	740.14	532.64	88.13
Persian Low Base Frequency	322.43	859.23	552.59	106.44

The data presented in Table 10 suggests that both languages required less time for higher base frequency items than the lower ones (mean RTs are -1585.79 for English and -19.95 for Persian) to be processed by the participants. The difference for English data, as indicated in Section 4 above, was statistically significant but for Persian, it was not. It is also apparent that Persian items, in both high and low base frequency items, were processed in less time with the mean differences of -360.9 and -1925.93, respectively.

Descriptive statistics for high versus low suffix productivity for both languages are provided in Table 11 below.

Table 11: Suffix productivity contexts in English and Persian

Context	Min.	Max.	Mean	Std. Deviation
English High Suffix Productivity	592	1710	1023.82	273.07
English Low Suffix Productivity	528	1627	1012.63	254.86
Persian High Suffix Productivity	355	852	543.09	105.04
Persian Low Suffix Productivity	326	963	547.06	108.67

The data in the above table suggests that unlike base and surface frequency contexts, it took longer for higher suffix productivity contexts to be processed in both L1 and L2 (mean differences are 3.96 and 11.19, respectively) although the mean differences were not significant based on the statistical analysis conducted. In addition, it took shorter for Persian items to be processed with the mean differences of -480.73 and -951.57 for high and low suffix productivity items in Persian and English, respectively.

DISCUSSION

The current study was an attempt to probe into the processing of Persian and English derivational morphology by Persian learners of English. In what follows, English and Persian derivational morphology processing are presented followed by the contrastive remarks regarding this type of processing in both L1 and L2. The possible role of L1, different frequency effects and role of proficiency are further elaborated on in this part.

Surface Frequency

The findings of the masked priming task for both Persian and English surface frequency revealed that the participants' reaction latencies were shorter for higher surface frequency contexts.

The answer to the first research question on the role of surface frequency on processing derivational morphology is that in both languages, surface frequency manipulation accounts for the whole word access of the derived words for which this type of frequency is controlled. This finding is in line with what Martine, Kostic, and Baayen (2004) have commented on the role of surface frequency which is negatively correlated with response latencies to morphologically simple words in visual lexical decision tasks. This idea can be explained by the familiarity of the learners with the whole word, saving extra time to extract the constituent of the morphological parts. For whole word access, comprehension takes place with much ease and little time is required to retrieve items from the memory. Surface frequency effects are believed to challenge the full-parsing models (Baayen, McQueen, Dijkstra, & Shreuder, 2003). Bybee and Hopper (2001) mentioned that more frequent morphologically complex words are accessed more efficiently as units than being decomposed into their constituents. Such frequency effects have affected both English and Persian derivational morphologies which can be assigned to the similarity of the underlying mechanisms in this respect.

Proficiency level also was proved to be an important factor in determining the reaction times since the advanced participants were much faster on their reaction latencies regarding English surface frequency context (as indicated in section 4). Therefore, with higher proficiency levels, which denote more exposure to language input, more whole word representation will take place.

Base Frequency

The next issue of concern is the effect of base frequency manipulation on how derived words are processed in L1 and L2. To address the second research question focusing on the effect of base frequency manipulation on derivational morphology processing, it can be said that in English, this manipulation accounts for the decomposition of derived words whose stems are less familiar to the learners. This effect was also proved by Ford, Davis, and Marslen-Wilson, (2010) where they figured out that base frequency predicts reaction latencies better than family size in reaction time experiments.

For Persian, this idea does not hold true, hence base frequency has a neutral effect on processing derived words in L1. In parsing mechanism, the mind should be allotted enough time to decompose the constituents, activate the semantic part of each one from the mental lexicon and then decompose them again to be able to comprehend them.

The role of proficiency level indicated much ease for advanced learners of L2 in processing items for which base frequency was controlled for, due to their familiarity with more morphological items in L2.

Suffix Productivity

Suffix productivity was the last context in Persian and English which was taken into consideration. Bertram, Baayen, and Schrueder (2000) have figured out the effect of this factor on the way both inflectional and derivational affixes are comprehended in L2 acquisition.

The third research question which took into account the role of suffix productivity can be addressed by the fact that suffix productivity does not seem to have any role in the way derivational morphology is processed in L1 and L2. In spite of this finding, the proficiency level led to different reaction latencies in suffix productivity context which, along with the other two contexts, can offer an account for the fourth research question. The advanced learners, with more exposure to L2 input, are much more able to process L2 items with greater automaticity and less difficulty.

Regarding the fifth research question on the differences between processing L1 and L2 derivational morphology, it should be stated that the underlying mechanisms do not differ, and both L1 and L2 learners utilize a dual-route system. The only difference lies on the speed and automaticity of such processing since L1 processing occurs faster and easier.

Comparison of English and Persian Results

The findings of the present study reveal differences between L1 and L2 processing since L1 was processed with greater ease and automaticity while L2 processing lacked such automaticity. The speed at which L1 and L2 learners process derivational words also differ as the native speakers process their mother tongue in a faster speed than the L2 learners (Clahsen & Neubaur, 2010; Silva & Clahsen, 2007). Frost, Deutsch and Forster (2000) also stated that native speakers of a language possess abstract representational knowledge of the linguistic system of their language with which the processing of different items takes place with greater ease.

For years, it was believed that fundamentally different mechanisms are applied for processing between L1 and L2. The mere discrepancies which were reported between L1 and L2 processing speed were taken to mean that there are underlying differences between the processing of the two systems as maintained in the Fundamental Difference Hypothesis proposed by Bley-Vroman (1990). This idea was later questioned and the counterclaim was that the fundamental mechanisms in processing are the same and the slow processing of non-natives cannot be attributed to the existence of different underlying mechanisms (Dekydtspotter, Schwarts, & Sprouse, 2006). Therefore, in the findings of the present study, the slow rate at which L2 learners process L2 structures cannot be a manifestation of underlying differences.

Several reasons have been provided for the slower processing of L2 learners the most significant of which are "non-target-like prosody, overlearned vs. underlearned lexical access routines, heteromorphy of semantic fields and the possibility that RT differences reflect different computational moments" (Dekydtspotter, Schwarts, & Sprouse, 2006, p. 35).

The first reason postulates that L2 learners never reach the native-like prosody even at the advanced levels. This problem leads to non-native like outcomes which are mistakenly regarded as a manifestation of underlying differences between the mechanisms of L1 and L2 processing. The second reason focuses on the differences that native and non-natives are faced with in their lexical access. Native speakers develop overlearned items whereas non-natives have problems with underlearned lexical items which lead to slower processing. The third reason goes back to the time when one is learning the lexical items of L2. While a learner is faced with a new word, he tries to search in L1 lexicon to find instances of the same meaning in L1 which may have discrepancies with the main meaning. This issue may lead to heteromorphy which causes slower processing time. The last reason can be traced back to the semantic, pragmatic or prosodic difficulties found in accessing a lexical item, which may contribute to differences in L1 and L2 processing. None of these discrepancies can indicate that there are fundamental differences in L1 and L2 processing. The slower processing observed in the current study can be attributed to the second and third reasons mentioned above.

Native speakers rely mostly on their lexical storage since they have passed the maturational stages. In other words, native speakers utilize their procedural knowledge while L2 learners, due to less exposure to native input and largely beginning their learning in later stages than the native speakers, use their declarative knowledge. These results fit the concept of declarative/procedural knowledge advocated by Ullman (2001). This use of declarative knowledge by L2 learners and the lack of sufficient access to procedural knowledge can provide further evidence for the asymmetry observed between L1 and L2 processing.

CONCLUSION AND IMPLICATIONS

The overall findings of the current research substantiate the claim that Persian EFL learners apply a dual-route mechanism, proposed by Pinker (1999) and further supported by its proponents (Pinker &

Ullman, 2002), which utilizes two distinct representations for the underlying mechanism of derivational morphology processing. The role of frequency is proved since it reveals an influential account for the variances observed in lexical decision measures (Howes & Solomon, as cited in Lignos & Gorman, 2012). Clahsen and Neubaur (2010) have stated that frequency is a criterion which explains why one form is learnt with greater ease, is easier to recognize and takes less time to process.

All in all, the findings of the current research giving further credence to the dual-route model are in line with the results obtained from the studies conducted by Baayen, Dijikstra and Shreuder (1997), Dominguez, Cuestos and Segui (2002), Frost, Deutsch and Forster (2000), Marslen-Wilson and Tyler (2003), Nuebaur and Clahsen (2010), Pinker and Ullman (2002), Silva and Clahsen (2007), Stemberger and MacWhinny (1986), and Ullman (2001).

The current study sheds light on the underlying mechanisms for processing Persian and English derivational morphology by Persian EFL learners. From the theoretical vantage point, the results prove a similar processing framework for both native and second language derivational structure. From the practical point of view, by having a grasp of the cognitive mechanisms utilized by the second language learners in processing derivational morphology, language instructors can be aware of the reasons underlying the difficulties to which learners are faced during the comprehension or production of L2 morphological structures. More repetition can lead to stronger memory traces and the knowledge can lead to the procedural side of the declarative procedural continuum.

L2 learners can also benefit from such results since by getting familiar with highly frequent morphological words, they can generate new words. In this situation, care should be exercised and instructors should warn them against the overgeneralizations and generation of non-existing items.

Bio-data

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References

Baayen, R. H., Dijkstra, T., & Schrueder, R. (1997). War and peace: Morphemes and full forms in a non-interactive parallel dual-route model. *Journal of Memory and Language, 37*(1), 94-117.

Baayen, R. H., McQueen, J., Dijkstra, T., & Schreuder, R . (2003). Frequency effects in regular inflectional morphology: Revisiting Dutch plurals . In R. H. Baayen (Ed.) *Morphological structure in language processing* (pp. 355-390). Berlin: Mouton.

Bertram, R., Baayen, R. H., & Shreuder, R. (2000). Effect of family size for complex words. *Journal of Memory and Language*, *42*(3), *390-365.*

Bley-Vroman, R. (1990). The logical problem of foreign language learning. *Linguistic Analysis*, *20*(1-2), 3-49.

Bradly, C. (1979). Lexical representation of derivational relation. In M. L. Kean (Ed.). *Juncture*. Cambridge: MA: MIT Press.

Burani, C., & Caramazza,A. (1987). Representations and processing of derived words. *Language and Cognitive Processes*, *2*(3-4), 217-227.

Burani, C., Salmaso, D., & Caramazza, A. (1984). Morphological structure and lexical access. *Visible Language, 18*(4), 348-358.

Butterworth, B. (1983). Lexical representation. In B. Butterworth (Ed.). *Language production* (vol. 2, pp. 257-294). London: Academic Press.

Bybee, J. L. (1995). Regular morphology and the Lexicon. *Language and Cognitive Processes, 10*(5), 425-55.

Chomsky, N. (1965). *Aspects of the theory of syntax* . Cambridge, MA: MIT Press.

Clahsen, H., & Neubaur, K. (2010). Morphology, frequency and processing of derived words in native and non-native speakers. *Lingua, 120* (11), 2627-2637.

Cole, P., Beauvillain, C., & Segui, J. (1989). On the representation and processing of prefixed and suffixed derived words: A differencial frequency effect. *Journal of Memory and Language, 28*(1), 1-13.

Cole, P., Bouton, S., Leuwers, C., & Charolles, L.S. (2011). Stem and derivational-suffix processing during reading by French second and third graders. *Applied Psycholonguistics Journal, 33*(01), 97-120.

De Jong, H. N., Schreuder, R., & Baayen, H. (2000). The morphological family size effect and morphology. *Language and Cognitive Processes, 15*(4/5), 329-365.

Dekydtspotter. L., Schwartz. B. D., & Sprouse. R. A. (2006). Comparative fallacy in L2 processing research. *Proceedings of the 8th Generative Approaches to Second Language Acquisition Conference* (pp. 33-40). Somerville, MA: Cascadilla Proceedings Project.

Dominguez, A., Cuetos, F. & Segui, J. Y. (2002). The time course of inflexional morphological priming. *Linguistics, 40*(2), 235-259.

Ford, M. A., Davis, M H., & Marslen-Wilson, M D. (2010). Derivational morphology and base morpheme frequency. *Journal of Memory and Language, 63*(1), 117-130.

Frost, R., Deutsch, A., & Forster, K. I. (2000). Decomposing morphologically complex words in an nonlinear morphology. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*(3), 751–765.

Giraudo, H., & Grainger, J. (2000). Effects of prime word frequency and cumulative root frequency in masked morphological priming. *Language and Cognitive Processes,15* (4/5), 421-444.

Hartsuiker, R. J., Pickering, M. J., & Veltkamp, E. (2004). Is syntax seperate or shared between languages? Cross-linguistic syntax priming in Spanish/ English bilinguals. *Psycho. Sci, 15*(6), 409-414.

Hay, J. (2001). Lexical frequency in morphology: Is everything relative? *Linguistics, 36*(9), 1041-1070.

Howes, D. H., & Solomon, R. L. (1951). Visual duration threshold as a function of word-probability. *Journal of Experimental Psychology, 41*(6), 401-410.

Jarvikiv, J., Bertram, R., & Neimi, J. (2006). Affixal salience and the processing of derivational morphology: The role of suffix allomorphy. *Language and Cognitive Processes, 21*(4), 394-431.

Kim, S. Y., Wang, M. & Ko, Y, I. (2011). The processing of derivational morphology in bilingual Korean-English readers. *Bilingualism: Language and Cognition, 14*(4), 437-488.

Lignos, C., & Gorman, K. (2012). Revisiting frequency and storage in morphological processing. *The 48th Annual Meeting of the Chicago Linguistic Society.*

Lukatela, G., Gligorijevic, B., & Kostic, A. (1980). Representation of inflected nouns in the internal lexicon. *Memory and Cognition, 8*(5), 415-423.

MacWhinny, B. (2005). Unified model of language acquisition. In A. D. J. Kroll (Ed.). *Handbook of bilingualism: psycholinguistcs approaches* .Oxford: Oxford Universtiy Press.

Marslen-Wilson, W.D., & Tyler, L. K. (2003). Capturing underlying differenciation in the human language system. *Trends in Cognitive Sciences, 7*(2), 62-80.

Martin, F.M.D., Kostic.A., & Baayen.R. (2004). Putting the bits together: an information theoretical perspective on morphological processing. *Cognition, 94*(2004), 1-18.

Platzack, C. (1996). The initial hypothesis of syntax. In H. Clahsen (Ed.). *Generative perspectives on language acquisition* (pp. 369-414). Amsterdam: John Benjamins.

Pinker, S. (1991). Rules of language. *Science, 253*(5019), 530-535.

Pinker, S., & Ullman, M. T. (2002). The past and future of the past. *Trends in Cognitive Sciences, 6*(11), 456-463.

Schreuder, R., & Baayen, R. (1995). Modeling morphological processing. In L. Feldman (Ed.). *Morphological aspects of language processing* (pp. 131-154). New Jersey, United States: Lawrence Erlbaum.

Shreuder, R., & Baayen, R.H. (1997). How complex simplex words can be. *Journal of Memory and Language, 37*(1), 118-139.

Shwartz, B., & Sprouse, R. (1996). L2 cognitive status and the Full Transfer/Full Access model. *Second Language Research, 12*(1), 40-72.

Silva, R., &. Clahsen, H. (2007). Morphologically complex words in L1 and L2 processing: evidence from masked priming experiments in English. *Bilingualism: Language and Cognition, 11*(02), 245-260.

Stemberger, J. P., & MacWhinny, B. (1986). Frequency and the lexical storage of regularly inflected forms. *Memory and Cognition, 14*(1), 17-26.

Taft, M., & Ardasinski, S. (2006). Obligatory decomposition in reading prefixed words. *Mental Lexicon, 1*(2), 183-199.

Taft, M., & Forster, K. (1975). Lexical storage and retreivial of prefixed words. *Journal of Verbal Learning and Learning Behavior, 14*(6), 638-647.

Taft, M. (1979). Recognition of affixed words and the word frequency effect. *Memory and Cognition, 7*(4), 263-272.

Taft, M. (1994). A morphological decomposition model of lexical representationsl. *Linguistics, 26*(4), 657-667.

Taft, M. (2004). Morphological decomposition and the reverse base frequency effect. *Quarterlu Journal of Experimental Psychology, 57A*(4), 745-765.

Ullman, M. T. (2001). The declarative/procedural model of lexicon and grammar. *Journal of Psycholiguitic Research, 30*(1), 37-69.

Zubizarreta, M. L., & Nava, E. (2011). Encoding discourse-based meaning: Prosody vs. syntax. Implications for second language acquisition. *Lingua*, *121*(4), 652-669.

Appendix

Sample of the materials for masked priming tasks

Context	Target word	Identity prime	Related prime	Control prime
English low surface frequency	Acclimatize	Acclimatize	Acclimate	Social
English high surface frequency	Accidental	Accidental	Accident	Distinguish
English low base frequency	Comportment	Comportment	Comport	Show
English high base frequency	Adjectival	Adjectival	Adjective	Circumstances
English low suffix productivity	Totalitarian	Totalitarian	Total	Video
English high suffix productivity	Recognizable	Recognizable	Recognize	Class
Persian low surface frequency	پیل آسا	پیل آسا	پیل	صفا
Persian high surface frequency	همراهی	همراهی	همراه	قرارداد
Persian low base frequency	آمایش	آمایش	آمای	سیما
Persian high base frequency	روزگار	روزگار	روز	سوزش
Persian low suffix productivity	گربه سان	گربه سان	گربه	معمولی
Persian high suffix productivity	مردانه	مردانه	مردانه	شیشه