L1 and L2 Processing of Chinese Separable VO Compounds

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Abstract

This research explores the processing of Chinese separable VO compounds by L1 and L2 speakers. While Chinese separable VO compound verbs are categorized as words, they also occur as phrases via syntactic reanalysis. However, such syntactic reanalysis is not applicable to most VV compound verbs due to lack of syntactic relation between the two constituent morphemes. Given this, this research employs a lexical decision task to examine the underlying structure of VO compounds in L1 and L2 lexicon based on their response times for VO and VV compounds. The results of the analysis suggest that while both VO and VV compounds are processed as whole-word by L1 speakers due to word superiority effect in Chinese, L2 speakers seem to make distinctions between VO and VV compounds via decomposition as the effect of morpheme frequency was more pronounced for VO compounds.

1 Introduction

There has been an ongoing debate on whether the underlying structure of Chinese separable VO compounds should be identified as word or phrase due to its unique structure that licenses syntactic reanalysis. While Chinese separable VO compound verbs (帮忙 , *bangmang*, ‘to help’) are listed in dictionaries as words, they can also be analyzed into phrases as they allow insertion of a suffix on the head verbal morpheme or insertion of a modifier on the object nominal morpheme as in (1).

(1) Separable VO word
帮了 他 的 忙
Bang-le ta de mang.
to help-LE he-DE business
‘to help him’

Except for highly lexicalized compounds such as *danxin* (担心, ‘to worry’) and *touzi* (投资, ‘to invest), separable VO compounds cannot be followed by another nominal phrase because their argument structure is fulfilled internally by the thematic relation between the two constituent morphemes. As in (1), what is interpreted as the object of the compound is realized as a possessive nominal phrase to the second constituent, which is syntactically analyzed as a theme argument to the head verbal morpheme. With the second constituent functioning as a theme argument to the main predicate, having another object nominal phrase at the end of the compound would result in ungrammaticality because more than one constituent cannot occur in the same phrase as suggested by Phrase Structure Condition (Huang, 1984).

Regarding the identity of separable VO compounds, Huang (1984) favors the point of view of the underlying structure as phrases based on Phrase Structure Hypothesis. Because PSC assumes that verbs can be followed by one constituent at most, VO compounds should be identified as ‘idiomatic phrases’, and they are analyzed as words only when followed by a noun phrase. While Huang (1984) identifies VO compounds as phrases that are analyzed as words only when filtered out by PSC, Packard (2000) proposes a differing view which treats VO compounds as underlyingly words but reanalyzed as phrases when required by context. Packard (2000) claims that VO compounds are stored as words once entered into lexicon, and they are only being reanalyzed into phrases depending on syntactic and semantic requirements.

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Unlike separable VO compounds, inseparable VV compound verbs are perceived clearly as words because separation of constituents cannot be licensed on them. Suffixation on VV is attached at the end of the entire compound, and the word order is relatively straightforward for VV compound words as they follow the canonical SVO sentence structure.

(2) VV word
帮助 他 了
Bangzhu *ta* *le.*
to help him LE
'to helped him'

If VO compounds are stored as phrases in L1 mental lexicon as suggested by Huang (1984), it can be assumed that VO and VV compounds may have different representations in L1 mental lexicon because the latter would be recognized strictly as words by native speakers. On the other hand, if the underlying structure of VO compounds is stored as word in the mental lexicon, it is expected that both VO and VV compounds would be stored as words, and hence would be processed in virtually the same pattern regardless of different internal structures of the compounds (VO vs VV).

The unique identity of Chinese VO compound verbs presents difficulties to L2 learners because most learners are not aware of syntactic constraints associated with VO compounds. Because they have insufficient knowledge with respect to the syntactic constraints of VO compounds, they often create ungrammatical sentences by placing another noun phrase after a separable VO compound (Yang & Han, 2016). The L2 error pattern is illustrated in (3). The main reason for the high error rates by L2 learners is that they are inclined to treat them exclusively as words and apply the general suffixation rule and word order as they would do for inseparable VV compounds.

(3) Frequent L2 error on VO
*我帮忙了他。
Wo bangmangle ta.
I help-ASP him

Shallow Structure Hypothesis (Clashen, 2006) claims that L2 learners rely more on semantic and lexical cues than syntactic information during sentence processing, but a similar tendency can also be observed in the L2 processing of structurally complex compound words. Clashen (2015) found that L2 learners are more dependent on semantic information than native speakers when dealing with morphologically complex compound words and prefer a simpler structural reading of the compounds. Combined with the frequent errors made by L2 learners on VO compounds, it can be assumed that L2 learners may tend to analyze VO compounds based on the meaning of the whole compound and choose to process them as structurally simpler forms, which are fully lexicalized inseparable compounds.

In order to provide empirical evidence regarding how VO compounds are processed by L1 and L2, a lexical decision task experiment was conducted to compare separable VO and inseparable VV compounds are processed by L1 and L2 speakers. This study first attempts to examine whether different compound types (separable VO vs inseparable VV) provide L1 and L2 speakers with different processing costs, and then the current study also delves into the detailed investigation of which factors has significant impact on the processing of VO compounds for L1 and L2 speakers.

2 Hypotheses and Research Questions

Following questions will be addressed in this paper based on the results from lexical decision task:

a) Do separable VO and inseparable VV compounds present different processing costs for L1 and L2 speakers?

b) Would separable VO and inseparable VV compounds be processed as decomposition or as whole word during lexical decision task?

For the first research question, L1 and L2 reading times for VO and VV compounds would be compared using a mixed random effect model with subject as a random effect. As for the second question, a mixed random effect model will be run individually on L1 and L2 reading times data to measure the effect of various factors on the processing of VO and VV compounds to examine whether decomposition occurs on each compound type for L1 and L2 speakers. VO and VV test items were selected from HSK (standardized Chinese proficiency test) vocabulary list.

It is not yet clear how VO compounds are stored in L1 and L2 lexicon. As mentioned earlier, there are two possible scenarios as to how separable VO compounds are stored in L1 mental lexicon. The one explanation is that the underlying structure of VO compounds is stored as phrases in the mental lexicon based on Huang (1984), and the other view based on Packard (2000) proposes that VO compounds are stored as word by default in the lexicon. The current study proposes that if VO compounds are processed as underlyingly phrases, it is possible that L1 speakers may demonstrate different reactions for VO compounds from VV compounds because it may require native speakers to perform both syntactic and lexical readings of VO compounds while only lexical reading is needed for VV compounds. On the contrary, if VO compounds are processed strictly as words by L1 speakers, there should be no difference in reading time between VO and VV compounds during lexical decision task when all other variables are controlled because only lexical reading would be activated for both types of compounds.

Furthermore, representations of VO compounds in mental lexicon can be tested by whether they are decomposed or processed as whole words during lexical decision task. In order to test whether VO compounds are decomposed or processed as full-form, the effects of morpheme frequency and whole-word frequency on response time need to be examined. Previous studies on the processing of compound words suggest that while effects of morpheme frequency should be taken as evidence of decomposition, effects of the whole-word frequency should be interpreted as full-form access of compounds words (Andrews, Miller, & Rayner, 2004; Baayen, Dijkstra, & Schreuder, 1997; Taft & Forster, 1976).

If Chinese VO compounds are stored as phrases in lexicon as suggested by Huang (1984), it can be assumed that VO compounds may be more susceptible to decomposition if processed as phrases because L1 processors may opt for compositional route for which they have to retrieve meaning from each individual morpheme. If compositional processing is actually employed by L1 processors on VO compounds during lexical decision task, reading times on VO compound would be modulated mainly by individual morpheme frequency while reading times for VV compounds whose meaning is less transparent would be affected by the whole word frequency (hereby bigram frequency).

However, if VO compounds are processed strictly as words during lexical decision task, it is expected that decomposition may not be operated on VO compounds at the conceptual level because the whole word representation is enforced on VO compound so strongly that decomposition will be suppressed at this level. Given this, it is expected that whole word representations rather than decomposition would be activated or both VO and VV compounds at the conceptual level, and L1 reading times on the two types of compounds would be modulated mainly by bigram frequency during lexical decision task.

L2 speakers, on the other hand, are expected to prefer simpler reading of VO compound structure and rely heavily on available semantic cues as suggested by Clashen (2015). Given this, it is expected that L2 learners may rely more on the meaning of VO compounds and process them as inseparable compounds which are the most common compound type in Chinese. Hence, L2 learners are expected to demonstrate no difference in their reading times between VO and VV compounds when all other variables controlled. Furthermore, L2 reading times for both VO and VV compounds would be affected by bigram frequency rather than individual morpheme frequency because L2 speakers are expected to recall only whole word representations for both compound types.

3 Methods

In order to compare the effect of VO structure for the processing of Chinese words by L1 and L2 groups, a lexical decision task was conducted to measure the L1 and L2 participants' response times to VO and VV compound verbs. The task was administered using Paradigm software.

3.1 Participants

12 native speakers of Mandarin Chinese were recruited in Beijing as the control group. All L1 participants were 18 years or older. 24 L2 learners were also recruited from universities located in Beijing as the experiment group. All L2 participants were advanced level Chinese learners certified by HSK (Level 6: 21 participants, Level 5: 3 participants) to avoid the chance level accuracy rate. L1 backgrounds were various among the L2 group with 17

L1 Korean, 4 L1 Turkish, 1 Burmese and 2 L1 Arabic. All L2 participants are currently enrolled in an undergraduate or a graduate program in China. The mean age of the L2 participants were 27.79, and their total length of residence in the country was 7.5 years on average.

3.2 Materials

24 separable VO words and 24 inseparable VV words were selected from the HSK vocabulary list as test items with controlled bigram frequency, individual morpheme frequency, stroke number and neighbor size. Each pair of separable VO and VV compound verbs share the identical first constituent, but only differed in their second constituent. Following are the examples of test items.

(4) Test Items

VO	**VV**
离婚	离开
li-hun	*li-kai*
to leave-marriage	to leave-to open
‘to divorce’	‘to leave’

Based on the frequency measures from BCC Chinese Corpus, VV and VO items were controlled in terms of their bigram frequency, individual morpheme frequency and stroke numbers as well as neighborhood size. Two sample independent t-tests were conducted to ensure that all factors are controlled. The mean bigram frequency for VO items was 53,775.79 (SD = 89.957.74), and it was 47,799.96 (SD = 65,599.67) for VV items; t(42.07) = 0.26, $p = 0.79 > 0.05$). As for the individual morpheme frequency, only the frequency of the second constituents were considered because all test pairs have the same first constituent. As a result, the mean frequency of the individual morpheme for the VO compounds was 543,823.38 (SD = 808,011.9), and it was 437,275.71 (SD = 574,478.9) for the VV compounds; t(41.52) = 0.53, $p = 0.60 > 0.05$. In order to control for the visual complexity, stroke numbers were also measured for the second constituent of each test item. The mean stroke number of the VO items was 8.75 (SD = 2.82), and it was 8.29 (SD = 2.68) for the VV items; t(45.89) = 0.58, $p = 0.57 > 0.05$).

Furthermore, the lexical neighborhood size (the total number of words sharing either the first or the second constituent) was also controlled to prevent the number of lexical neighbors from affecting the processing of test items to a significant extent. Because each pair of test items shares the same initial constituent, only the number of words sharing the second constituent was controlled. The mean lexical neighborhood size for VO and VV compounds were 38.88 (SD = 27.00) and 30.88 (SD = 15.97), and the difference across compound types was not significant in a two sample independent t-test (t(37.33) = 1.25, $p = 0.22 > 0.05$).

48 nonwords were also included in a full list of items as distractors. Along with the nonwords, 24 real words were also included in the list. It was made sure that all real word fillers are nouns to avoid possible confounding effects that may be caused by the overlapping word class. With test items and nonwords combined, a full list of experiment items contains 120 items in total, which will be presented in 12 separate blocks in randomized orders. The VO and VV test items will allow us to examine whether syntactic processing of VO compounds has any significant impact on the processing of compounds for L1 and L2 by comparing their reading times to VV compounds. Furthermore, the effects of various factors such as bigram frequency, morpheme frequency and stroke number will be measured to examine whether VO and VV compounds are processed as whole words or decomposition by L1 and L2 speakers. Also, it should be noted that the effect of morpheme frequency only refers to the effect of the second constituent morpheme because VO and VV conditions share the identical first constituent morpheme.

3.3 Procedures

Participants performed a lexical decision task administered by Paradigm Software installed on a personal laptop at a closed space. Subjects were instructed to read a two-character Chinese compound on the screen and judge as fast as possible whether it is a legitimate Chinese word or not by pressing the left and right arrow keys representing real word and nonword respectively. For each trial, a fixation point (“##”) was presented for 1000ms, and then a two-character Chinese compound appeared on the screen. Before the test session begins, participants completed a practice session with 8 sample items to become familiar with the task format. The entire test session lasted for less than 10 minutes for both L1 and L2 participants.

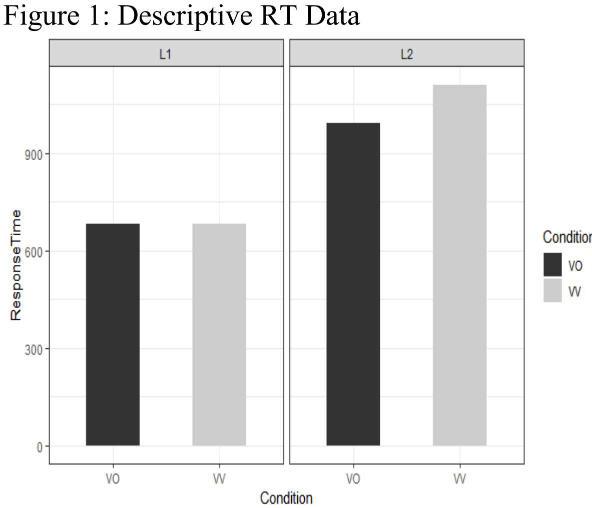
4 Results

Test items answered by L1 and L2 participants (1728 observations) were examined for the analysis. RT outliers were removed from each dataset if they were out of 2.5 SD from the mean RT. For the RT analysis, incorrect responses were further removed. As a result, 2.7% of data was excluded from the experiment dataset for the accuracy rates analysis, and only 5.4% (91 observations) of the accuracy rates data was further removed for the RT analysis. Both accuracy rates analysis and response times analysis were conducted using R.

4.1 Descriptive Analysis

First, the mean accuracy rates and the mean response times for the L1 group was calculated. The mean accuracy rates by the L1 group for VO and VV conditions were 99.30% (SD = 0.08) and 98.61% (SD = 0.12), and the mean response times for VO and VV compounds were 681.12ms (SD = 257.21) and 681.14ms (SD = 220.22). As for the L2 group, the mean accuracy rates for VO and VV compounds were 93.35% (SD = 0.25) and 91.29% (SD = 0.28), and the mean response times for VO and VV compounds were 991.76ms (SD = 422.04) and 1111.53ms (SD = 468.94) respectively. The descriptive data for the mean RT is plotted in Figure 1.

Figure 1: Descriptive RT Data



4.2 Inferential Statistics

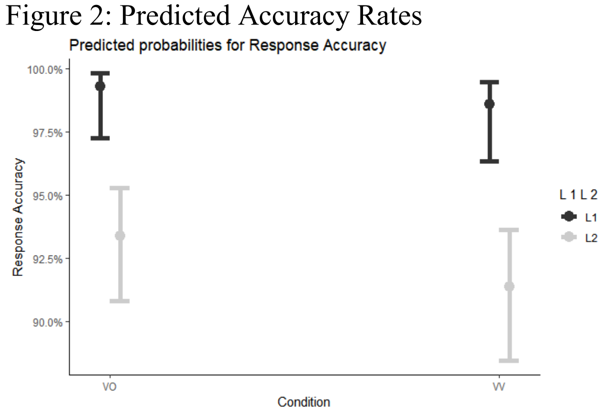
A binomial logistic regression with subject as a random effect was run by using the *glmer*() function of the *lme4* package to examine if the effects of compound type and L1/L2 status. Models with and without an interaction were compared based on the *anova*() function fo the *lme*4 package and their AIC value, and the one including the interaction was selected as best fitting model for the analysis. The results of the binomial logistic regression model are summarized in Table 1.

Table 1: Binomial Logistic Results for Accuracy Rates

	Estimate	SE	z value
Intercept	5.03 ***	0.72	6.98
VV condition	-0.71	0.87	-0.82
L2 Status	-2.35 **	0.73	-3.23
ConditionVV:L2	0.42	0.90	0.47
Signif. codes: 0 '***' , 0.001 '**', 0.01 '*', 0.05 '.', 0.1, ' ' 1			

The results revealed that the effects of L1/L2 status (Estimate = -2.35, SE = 0.73, z = -3.23, $p < 0.05$) was significant while the effect of condition (Estimate = -0.71, SE = 0.87, z = -0.82, $p > 0.05$) was not. However, no interaction of compound type and L1/L2 status (Estimate = 0.42, SE = 0.90, z = 0.47, $p > 0.05$) was found in the results. As in the plot in Figure 2, while there appears to be a noticeable difference between L1 and L2 groups, the effect of compound type was not significant for both participant groups.

Figure 2: Predicted Accuracy Rates



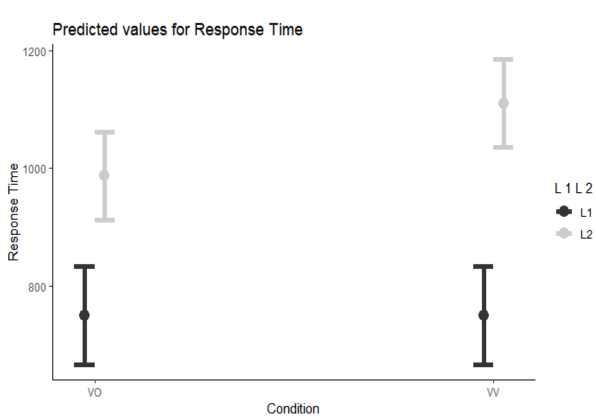
A mixed random effects model with subjects as a random effect ((1 | Subject)) was run to measure the effect of compound type and L1/L2 status for a broader population using the *lmer* () function of the *lmerTest* package. In order to select the best fitting model for the analysis, linear models with and without an interaction of the two variables were compared based on the result of the *anova*() function in the *lme4* package and the r squared value. As a result, a model including the interaction of compound type and bigram frequency was selected for the analysis because it did not only yield a significant ANOVA result ($p < 0.05$) but also had a higher R^ value compared to the non-interaction model.

Table 2: Mixed Random Effects Model Results for Response Time

	Estimate	SE	Df	t-value
Intercept	750.95 ***	42.28	50.29	17.76
VV condition	0.363	29.04	1,558.61	0.01
L2	236.39 ***	30.73	1,522.20	7.69
Condition:L2	122.25 ***	36.24	1558.75	3.37
Signif. codes: 0 '***' , 0.001 '**', 0.01 '*', 0.05 '.', 0.1, ' ' 1				

The results of the mixed random effects model are summarized in Table 2. The mixed random effects model found a significant effect of L1/L2 status (Estimate = 236.39, SE = 30.73, df = 1,522.20, t = 7.69, $p < 0.001$) while the effect of compound type did not reach statistical significance (Estimate = 0.363, SE = 29.04, df = 1,558.61, t = 0.01, $p > 0.05$). The model predicts that L2 speakers' overall mean response times for the test items would be delayed by 236.39ms compared to the baseline condition. A significant interaction of compound type and L1/L2 status (Estimate = -1.228e-02, SE = 3.323e-04, df = 1,317, t = -4.37, $p < 0.001$) was also observed in the model.

Figure 3: Predicted Response Times



Furthermore, mixed random models with subject as a random effect were run on L1 and L2 RT data individually to examine the effect of following factors: Compound type, Bigram frequency, Morpheme frequency, lexical neighbor size and stroke number.

Table 3: Analysis of L1 RT

	Estimate	SE	Df	t-value
Intercept	911.45 ***	91.75	472.61	9.93
Condition:VV	-77.43	109.72	537.03	-0.71
Bigram Frequency	-53.92 ***	16.14	537.05	-3.34
Morpheme Frequency	-10.90	13.67	537.17	-0.80
Neighbor Size	0.11	0.34	537.05	0.31
Stroke	3.07	3.03	537.00	1.01
Condition*Bfreq	31.20	23.60	537.03	1.32
Condition*Stroke	-4.77	4.32	537.01	-1.10
Signif. codes: 0 '***' , 0.001 '**', 0.01 '*', 0.05 '.', 0.1, ' ' 1				

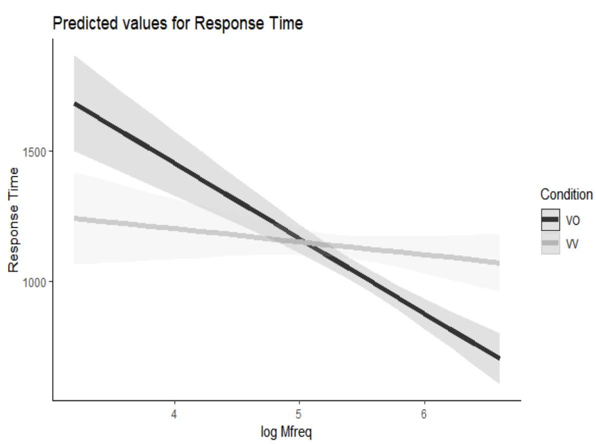
First, only the main effect of bigram frequency (Estimate = -53.92 SE = 16.14, df = 537.17, t = -3.34, $p < 0.001$) was found from the result of the L1 random effect model while the compound type, morpheme frequency, stroke number and neighbor size were not significant predictors for the L1 RT. Also, there was no interaction between different factors found from the L1 RT data analysis.

Table 4: Analysis of L2 RT

	Estimate	SE	Df	t-value
Intercept	2933.15 ***	261.18	1022.82	11.23
Condition:VV	-1118.68 ***	344.16	1004.68	-3.25
Bigram Frequency	-236.51 ***	38.98	1004.22	-6.10
Morpheme Frequency	-192.20	48.21	1004.84	-4.00
Neighbor Size	0.97	0.81	1004.52	1.20
Stroke	17.31	7.17	1004.37	2.41
Condition*Mfreq	171.91	57.14	1004.81	3.01
Condition*Bfreq	90.71	58.28	1004.23	1.56
Condition*Stroke	-10.68	10.32	1004.23	-1.04
Signif. codes: 0 '***' , 0.001 '**', 0.01 '*', 0.05 '.', 0.1, ' ' 1				

Unlike the L1 data, various effects were found from the L2 random effect model on the RT data. In the L2 RT data, main effects of the compound type (Estimate = -1118.68, SE = 344.16, df = 1,004.68, t = -3.25, p = 0.001), bigram frequency (Estimate = -236.51, SE = 38.98, df = 1,004.22, t = -6.10, p < 0.001), morpheme frequency (Estimate = -192.20, SE = 48.21, df = 1,004.84, t = -4.00, p < 0.001) and stroke number (Estimate = 17.31, SE = 7.17, df = 1,004.37, t = 2.41, p < 0.05) were found. Furthermore, there was a significant interaction of compound type and morpheme frequency (Estimate = 171.91, SE = 57.41, df = 1,004.81, t = 3.01, p < 0.01) meaning that the effect of morpheme frequency became more pronounced when the compound type changed from the VO to the VV structure as shown in the figure below.

Figure 4: Interaction of condition and morpheme frequency for L2 RT



The interaction graph shows that while the effect of morpheme frequency has little influence on the response times for VV compounds, the increase in the morpheme frequency facilitates the L2 processing of VO compound to a significant degree.

5 Discussion

The results of accuracy rates analysis found no interaction of compound type and L1/L2 status as the effect of compound type was not significant for both L1 and L2 groups while a significant between-group difference was observed in the overall mean accuracy rates. The lack of compound type effect for both experiment group suggests that VO and VV test items were processed with equal amount of difficulty for L1 and L2 participants. Based on the accuracy rates analysis, it is difficult to tell which compound type presented more processing cost for each participant group.

Contrary to the prediction, the result of the RT data analysis shows that the effect of compound types was significant for L2 speakers while it was virtually absent in the L1 RT data. The absence of the compound type effect from the L1 RT data seems to provide supporting evidence that VO compounds are stored exclusively as words in the L1 mental lexicon because both VO and VV compounds were answered at virtually the same speed. Also, the results of the mixed random model on the L1 RT data provides further supporting evidence for VO compounds as words because the reading times of VO and VV compounds were modulated by bigram frequency while the effects of morpheme frequency were not found in the analysis. The result of L1 RT analysis also provides supporting evidence for the word superiority effect in Chinese (Mattingly & Xu, 1994; Shen & Li, 2012), in which the whole word frequency was found to be predominant independently of morpheme frequency. The fact that L1 processors relied less on morpheme frequency in the processing of both VO and VV compounds in the current study lends support for the lexical processing of VO compounds suggested by Packard (2000).

However, it is still questionable as to why L2 speakers were faster to process the VO compounds than the VV compounds considering that nonnative speakers are assumed to be less sensitive to the difference in the internal structures of the compounds due to insufficient L2 knowledge. While L1 response times provided evidence for the word superiority effect, L2 speakers failed to demonstrate the same effect as they engaged in more analytic reading of compound words written in a less familiar language. One possible explanation is that L2 speakers may have been more sensitive to differences in semantic properties between nominal and verbal morphemes contained in VO and VV compounds. While word superiority effect prevents L1 speakers from further analysis of individual constituents of VO and VV compounds, L2 speakers may have made distinctions between VO and VV compound based on the decompositional processing. Previous studies on the processing of different parts of speech have reported that nouns may be processed with more ease compared to verbs due to factors such as higher imaginability and simple meaning structure (Cordier et al., 2013; Kauschke and Stenneken 2008; Sereno 1999). Given this, it is possible that L2 speakers may have benefited from the processing advantage presented by a nominal constituent in VO compounds, and hence, the effect of morpheme frequency appeared more pronounced for VO compounds than VV compounds. While the word superiority effect prevents compounds from decomposition in the L1 processing, L2 speaker may have opted for compositional processing and make distinctions between VO and VV compounds based on the semantic information presented by different parts of speech (noun vs verb).

6 Conclusion

The results of the analysis of L1 response time data provide supporting evidence for word superiority effect in Chinese as their response times for VO and VV compounds were affected only by bigram frequency. However, despite being advanced level Chinese speakers, L2 speakers in this study tend to be more analytic of reading VO and VV compounds and distinguish the two compound types based on the difference in the second constituent morpheme (noun vs verb).

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