Rethinking Transfer Effects:
Evidence from Ambiguity Resolution in Mandarin

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1. Introduction

In the field of second language (L2) research, an essential question that remains unresolved is whether and to what extent the properties of learners' L1s influence L2 processing (i.e., forward transfer), and vice versa (i.e., backward transfer). However, the experimental results available to date are still inconclusive to answer this question.

Although the Shallow Structure Hypothesis (Clahsen & Felser, 2006) predicts the absence of forward transfer effects, a number of other studies (e.g., Frenck-Mestre & Pynte, 1997; Juffs, 1998, 2005; etc.) suggest that learners' L1 background may play an important role in L2 processing. These results have demonstrated that adult L2 learners may apply L1 processing strategies when parsing an L2. When such strategies are inappropriate for processing their L2s, it may result in non-native-like parsing decisions. In addition, L1 transfer effects are also predicted and explained by experience-based models of language acquisition and processing (e.g., MacWhinney, 1997; Liu et al., 1992; etc.)

As one of the common parsing processes in natural language processing, ambiguity resolution may give us insight into the question of if and how native speakers and L2 learners process language differently and whether transfer effects exist. A number of studies have investigated the processing differences of syntactic ambiguity resolution in L1 and L2 speakers of various Indo-European languages (e.g., Clahsen & Felser, 2006; Dussia, 2003; Felser, et al., 2003; Frenck-Mestre, & Pynte, 1997; etc.), but few have examined the transfer effects on processing typologically different L2s (e.g., Mandarin Chinese). Therefore, comparisons between Mandarin native speakers' and L2 learners' parsing decisions in ambiguity resolution may add a new perspective in addressing the issues of transfer effects as well as the differences between L1 and L2 processing.

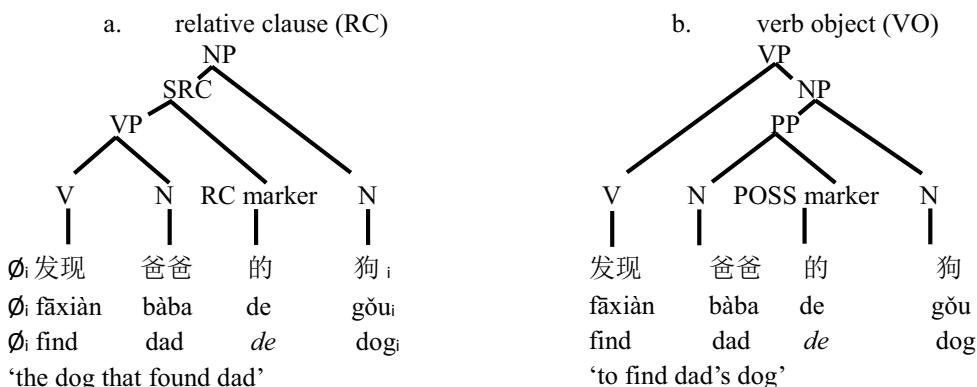## 2. The ambiguous 'Verb NP1 *de* NP2' structure in Mandarin Chinese

Figure 1. The Tree Stucture of RC (1a) and VO (1b)

The Chinese 'Verb NP1 *de* NP2' construction is temporarily ambiguous between a relative clause (RC) analysis and a verb object (VO) analysis. As seen in Figure 1, the phrase *fā xiàn bà ba de gǒu* 'find dad *de* dog' can be interpreted as either an RC structure – 'the dog that finds dad' (as in 1a) or a VO structure – 'to find dad's dog' (as in 1b).

According to Hsieh, Boland, Zhang, and Yan's (2009), the ambiguity of this construction is mainly caused by the lexical ambiguity of the homograph *de*. In (1a), *de* serves as an RC marker in a head-final RC, whereas it is a possessive marker in (1b).

3. Ambiguity resolution by Mandarin native speakers
3.1. Rationale and predictions for Mandarin native speakers

There are several factors that may explain why the previous findings (Hsieh et al., 2009; Zhang et al., 2000) indicate that the RC analysis is preferred by Mandarin native speakers.

3.1.1. Empty categories

Ng and Fodor (2011) argue that readers encountering sentences beginning without overt nouns face uncertainty both with respect to its structure and the interpretation of its empty category.

As seen in (1), the empty category in the RC analysis is a trace, whereas the VO analysis requires the interpretation of a null-subject sentence, hence the corresponding empty subject is *pro*. According to Ng and Fodor (2011), if a clause with an empty subject occurs without discourse context or in a discourse context that offers no suitable antecedent for a *pro*, the balance may be tipped toward preferring a complement clause with a recoverable subject (i.e., the RC analysis in this case). This claim was supported by Ng and Fodor's (2011) research on processing null-subject main clauses in native speakers of Chinese.

(1) Fragment: fāxiàn bàba de gǒu …
  a. [e_i fāxiàn bàba de] gǒu$_i$ hěn cōngming
      e_i find dad de dog$_i$ very smart
    'The dog that found dad was very smart.'
  b. e fāxiàn bàba de gǒu
      e find dad de dog
    'He/she found dad's dog'

3.1.2. The Tuning Hypothesis

According to the Tuning Hypothesis (Mitchell et al., 1995), the human language processors resolve structural ambiguity on the basis of the frequencies of parsing decisions in unambiguous conditions. Mitchell et al.'s (1995) findings have demonstrated that there are positive correlations between RC attachment preferences obtained in experimental studies and the frequency distributions of RC attachments observed in corpus data.

Regarding the ambiguous "Verb NP1 *de* NP2" construction investigated in the present study, Zhang, Zhang and Shu (2000) randomly selected 1,000 "Verb NP1 *de* NP2" phrases from *the Corpus for Studies of Modern Chinese* and did frequency count on the occurrence of the two possible interpretations. Their results have showed that 70% of the selected phrases were RC structures.

Therefore, we may suspect that Mandarin native speakers may have been tuned to the RC analysis for two reasons: First, it is possible that the RC interpretation is the default analysis in Mandarin. Second, it is also possible that native speakers prefer the RC analysis over the VO analysis because the former occurs more frequently in the real-language use.

3.1.3. Backward transfer effects

Does native speakers' competence in an L2 (i.e., English) influence their parsing decisions in L1 processing? According to Liu, Bates, and Li (1992), backward transfer is a process in which learners

apply L2 processing strategies to L1 comprehension. Liu et al. (1992) further contend that the semantic strategy is one of the most frequently used strategies in processing Chinese, while the word-order strategy is often used in processing English.

Regarding the present study, the backward transfer theories predict that the Mandarin native speakers who are relatively proficient in English will be more likely to apply the word-order strategy to ambiguity resolution and in turn compute the simplest syntactic representation (i.e., the VO analysis). Those who have little knowledge of English, on the other hand, will be less likely to make use of the word-order strategy and thus possibly prefer RCs more strongly.

3.2. Previous studies on Mandarin native speakers

Although no previous studies have looked at how L2 learners resolve temporary ambiguity in Mandarin, two studies (i.e., Zhang et al., 2000; Hsieh et al., 2009) investigating how native speakers process the 'Verb NP1 *de* NP2' construction have reported that the RC analysis is the default analysis.

In Zhang et al.'s (2000) study, 46 native speakers of Chinese were instructed to read sentences which were plausibly biased towards an RC analysis (2a) or a VO analysis (2b), or remained neutral (2c) on a word-by-word moving window. The results indicate that Mandarin native speakers take the RC analysis as the default.

(2) Example stimuli from Zhang et al. (2000)
   a.   RC-biased disambiguated as VO
     怠慢客人的孩子以后，周丽心里有些懊悔。
     Dàimàn kèrén de háizi yǐhòu, Zhōu Lì xīnlǐ yǒuxiē àohuǐ.
     Slight guest de (POSS) child after, Zhou Li heart in somewhat regretful
     'After slighting the guest' child, Zhou Li felt somewhat regretful.'
   b.   VO-biased disambiguated as RC
     指责报社的记者认为新闻报道必须客观。
     Zhǐzé bàoshè de jìzhě rènwéi xīnwén bàodào bìxū kèguān.
     Criticize newspaper office de (RC) journalist think news reports must objective
     'The journalist who criticized the newspaper office thought news reports must be objective.'
   c.   Balanced disambiguated as VO
     撞倒肖明的车子之后，两个孩子非常害怕。
     Zhuàngdǎo Xiāo Míng de chēzi zhīhòu, liǎnggè háizi fēicháng hàipà.
     Knock down Xiao Ming de (POSS) bicycle after two children very scared
     'After knocking down Xiao Ming's bicycle, the two children were very scared.'

Hsieh et al. (2009) tested 24 Mandarin native speakers' online interpretation of the "Verb NP1 *de* NP2" construction by using the stop-making-sense paradigm (Boland, Tanenhaus, Garnsey, and Carlsen, 1995) and eye-tracking technique. Their findings indicate that Chinese native speakers maintain multiple alternatives at varying levels of activation throughout the ambiguous region, with the RC analysis ranked the highest. The re-ranking of alternatives could be very low-cost if the dispreferred interpretation receives enough activation early within the ambiguous region. In other words, when a semantic cue (e.g., an inanimate noun supporting the VO analysis) was available prior to syntactic disambiguation, the garden path effect is eliminated and the processing cost for revising an RC structure into a VO structure is relatively low. Hsieh el al. (2009) also suggest that native readers utilize all available information on a word-by-word basis to determine the ranking of structural alternatives of an ambiguous item and they do not commit to a single analysis until they reach the disambiguation point.

4. Ambiguity resolution by Mandarin L2 speakers

In addition to the factors influencing native speakers' ambiguity resolution decisions, there are several other factors that may be relevant specifically to L2 learners of Mandarin Chinese.

4.1. Forward transfer effects
4.1.1. The Shallow Structure Hypothesis

The Shallow Structure Hypothesis (Clahsen & Felser, 2006) argues against strong L1 influences on L2 processing. According to this theory, L2 learners' non-native-like processing patterns are mainly due to their failure to adopt structure-based parsing strategies.

Much of the work supporting this hypothesis has focused on processing RC attachment (e.g., Dussias, 2003; Felser et al., 2003; Papadopoulou & Clahsen, 2003, etc.). Since RC attachment preferences vary across languages, examining L2 learners' parsing decisions may shed light on the issue of forward transfer effects. In sum, these studies report no evidence that L2 learners' parsing behaviors are guided by L1 processing strategies. It is thus hypothesized that, compared with the syntactic representations computed by native speakers, the representations of L2 sentences are much shallower and less detailed. L2 learners are thus less able to apply structure-based ambiguity resolution strategies. Contrary to native speakers, they are largely restricted to lexical-semantic processing and often attempt more direct form-function mappings.

As for the current study, Figure 1 shows that the RC analysis is cognitively more demanding than the VO analysis, since the former involves a filler-gap dependency (i.e., a subject-extracted RC) and thus requires more detailed computations of the hierarchical syntactic structures. Therefore, the Shallow Structure Hypothesis will predict that the syntactically simpler representation – the VO analysis in this case – will be preferred by adult L2 learners, regardless of their L1s.

4.1.2. Experience-based models

The Competition Model, which views L2 acquisition as a constructive, data-driven process, holds different views on the issue of forward transfer in L2 acquisition (MacWhinney, 1997, 2002).Specifically, the connectionist view suggests that both L1 processing and L2 processing use the same set of cognitive structures which are interconnected. Therefore, L1 transfer is evitable in the process of L2 acquisition, especially in the early stage. L2 learners often attempt to map L2 forms onto the linguistic territory occupied by their L1s. Although such transfer effects are particularly salient in arenas of phonology and lexicon, the areas of sentence interpretation and learners' acquisition of morphosyntax are also pervasively affected (MacWhinney, 2002).

A number of studies investigating learners' sentence comprehension performance in the L2 have shown that L2 learners tend to apply L1-specific processing strategies to L2 processing (e.g., Liu, Bates, & Li, 1992; etc.). McDonald's (1987) study investigating English-Dutch and Dutch-English learners also demonstrates the gradual process of learning L2 sentence processing strategies. Although the sentence processing cues available to L2 beginners are very close to those for their L1, L2 learners gradually reset those cues towards the direction of the native speakers' parsing patterns.

In addition, several other researchers examining L2 learners' online processing also report similar transfer effects (e.g., Frenck-Mestre & Pynte, 1997; Juffs, 1998, 2005; etc.).

4.2. Rationale and predictions for Mandarin L2 learners

As seen in Table 1, if L2 learners' preference for optimizing empty category interpretation overrides their preference for syntactic simplicity, the balance will be tipped toward the RC analysis.

On the other hand, the VO analysis seems to impose a less processing burden on the parser, because it does not involve filler-gap dependencies and requires a simpler computation. Therefore, if L2 learners are not able to use syntax-driven strategies and only compute shallow representations, they will be likely to favor the VO analysis.

Regarding transfer effects, if the properties of learners' L1s influence the way they process L2 Mandarin, Mandarin learners from head-initial L1s (i.e., languages such as English and French, in which the head noun precedes the modifier in an RC) will make different parsing decisions than those from head-final L1s (i.e., language such as Japanese and Korean, in which the modifier follows the

head noun in an RC). In other words, learners speaking head-initial L1s may find the head-final Chinese RCs difficult to process and thus prefer the VO analysis, whereas those speaking head-final L1s may be more likely to display native-like behaviors, given their previous experience in processing head-final RCs in their L1s.

Table 1. *Predications on ambiguity resolution in L2 learners of Mandarin*

Preference	Supporting theories and studies	
RC	Optimizing empty category interpretation	Ng and Fodor (2011)
	The Tuning Hypothesis	Mitchell et al. (1995); Zhang et al. (2000)
	L1 transfer effects (for the HFG group)	e.g., Frenck-Mestre & Pynte (1997); Juffs (1998, 2005); etc.
VO	The Shallow Structure Hypothesis	Clahsen and Felser (2006)
	L1 transfer effects (for the HIG group)	e.g., Frenck-Mestre & Pynte (1997); Juffs (1998, 2005); etc.

5. The present study

As discussed above, although both Hsieh et al.'s (2009) and Zhang et al.'s (2000) experiments were well designed and carefully administered, neither of them documented their native speaker participants' English proficiency. Given the fact that backward transfer effects may significantly influence the way native speakers process their L1 (Liu et al., 1992), the lack of such information made it impossible to investigate the relationship between native speaker participants' L2 competence and their ambiguity resolution decisions.

In addition, only Mandarin native speakers have been tested in the previous studies. Although results consistently indicate that the RC analysis is the default, it remains unknown how L2 learners interpret the 'Verb NP1 *de* NP2' construction. It is still not clear whether L2 learners can make native-like parsing decisions, and whether their processing strategies are influenced by their L1s.

Intending to fill these gaps, this study aimed to address the following three research questions:

1) What is Mandarin native speakers' and L2 learners' default analysis of the ambiguous 'Verb NP1 *de* NP2' construction?
2) Are L2 learners' processing patterns different from those of Mandarin native speakers? Are L2 learners sensitive to lexical-semantic information? Do they also use structure-based parsing strategies to resolve syntactic ambiguity?
3) Do the properties of L2 learners' L1s influence the way they process Mandarin input?

6. Method

A questionnaire experiment was conducted to investigate how native and nonnative Mandarin speakers resolved syntactic ambiguity. A norming task was administered prior to the experiment.

6.1. Norming study
6.1.1. Participants

Nine functionally monolingual native speakers of Mandarin Chinese, who resided in China and had little knowledge of foreign languages, participated in the norming study to ensure that all the stimulus sentences were comparably felicitous in terms of grammaticality and plausibility. These participants did not participate in the experiment.

6.1.2. Materials and procedures

The norming study was administered via an *Excel* spread sheet. The participants were instructed to read the sentences one by one and rate them on two 0-10 scales of grammaticality and plausibility.

172 sentences typed in simplified Chinese were included. All the sentences were generated by the

investigator based on a Chinese textbook *Chinese Link[1]* (Wu et al., 2008), so that all the participants (including Mandarin L2 learners) could comprehend the stimuli used in the experiment.

Of all the sentences appeared in the norming study, 20 sets (i.e., 160 sentences) were potential experimental sentences and consisted of 'Verb NP1 *de* NP2' constructions, while the other 12 sentences consisted of various structures and served as distractors.

6.1.3. Outcome

Of the 20 sets of sentences that appeared in the norming study, the best rated 15 sets (i.e., 120 sentences) that received highest scores on both grammaticality and plausibility were chosen as stimuli for the experiment. On average they received 6.28/10 on grammaticality (SD = 1.26), and 6.93/10 on plausibility (SD = 3.91)[2].

6.2. Main experiment
6.2.1. Participants
6.2.1.1. Mandarin native speakers

24 Mandarin native speakers residing in China participated in the experiment to provide a baseline for comparison. They were between the ages of 20 and 35 and had some knowledge of English. 13 of them were university students and 11 were company employees. None of them reported to have lived in an English immersion environment before.

In order to assess the Mandarin native speakers' experience with head-initial languages (i.e., English) and the possible relation between their English proficiency and their performance on the experiment, they were instructed to take an English proficiency test (EPT) after the experiment. The EPT was administered in the written modality and was divided into a vocabulary section and a grammar section, with each section consisting of 15 multiple choice questions. On average the native speakers scored 71.46% (SD = 12.77).

6.2.1.2. Mandarin L2 learners

Table 2. *Mandarin L2 Participant Background Information*

		Head-initial Group (N = 17)	Head-final Group (N = 8)
L1		ENG, FR, SPAN	JAPN, KOR
gender		9 males, 8 females	3 males, 5 females
Avg. age	M	23.47	28.25
	SD	6.04	7.38
Avg. leng. of study (years)	M	2.91	3.71
	SD	1.24	1.80
Avg. age of first exposure (weeks)	M	14.71	20
	SD	8.45	8.50
Avg. weekly use	M	29.54%	33.75%
	SD	36.86%	39.17%
Avg. CPT score	M	65.10%	75.86%
	SD	20.19%	12.51%
Avg. EPT score	M	N/A	72.67%
	SD		19.78%

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[1] Since *Chinese Link* is one of the most widely-used Chinese language textbooks in the United States., it was possible that some of the participants might have used it before.
[2] The overall ratings were not very high for two main reasons: First, the choice of words was very limited, since we only used the vocabulary items listed in the intermediate textbook *Chinese Link*. Second, as Zhang et al. (2000) suggest, the "Verb NP1 *de* NP2" construction is ambiguous only when both NP1 and NP2 satisfy specific semantic restrictions. Therefore, the ambiguous "Verb NP1 *de* NP2" structures investigated in the present study are not particularly frequent in the real-life language use of Mandarin native speakers.

As for the L2 learner group, 25 Mandarin learners participated in the experiment. Among them, the Head-initial Group (HIG) consisted of 17 learners, all of whom were native speakers of head-initial languages (i.e., 15 English native speakers, one French native speaker, and one Spanish native speaker); whereas the Head-final Group (HFG) consisted of 8 learners coming from head-final L1s (i.e., six native speakers of Korean and two native speakers of Japanese).

As seen in Table 2, the two learner groups were comparable in terms of average age ($p = .5920$), average length of Chinese study ($p = .5447$), average age of first exposure to Mandarin ($p = .6094$), and average weekly use of Mandarin ($p = .6072$).

In order to document the learners' Chinese proficiency, all of them were instructed to complete a Chinese proficiency test (CPT) after the experiment. The CPT was administered in the written modality and was divided into a vocabulary section and a grammar section, with each section consisting of 15 multiple choice questions. As seen in Table 2, on average the HIG learners scored 65.10%, whereas the HFG learners scored 75.86%. An independent sample t test showed that there was no significant difference between the two groups ($p = .4112$).

6.2.2. Materials and procedures

The 15 sets of ambiguous 'Verb NP1 *de* NP2' constructions selected based on the norming study results were presented along with competing interpretations as well as 30 fillers of various structures. The position of the NP1s and the NP2s were switched across the two lists as a result of counterbalancing. As seen in (3), the participants were instructed to circle the appropriate number on a 1-7 scale based on their interpretation. Choosing 1 reflected that the participant believed that the construction was a typical RC, while choosing 7 indicated that the VO analysis was strongly preferred.

(3) Example question from the main experiment

找到老师的司机 find-teacher-de-driver							
找到老师 To find the teacher	1	2	3	④	5	6	7	找到司机 To find the driver

6.2.3. Data analysis

Although the positions of the two possible readings (i.e., 'to find the teacher' vs. 'to find the driver' in the above example) were counterbalanced in the experiment, for the purpose of statistical analysis, all the answers were recoded so that 1 reflected the strongest preference for the RC analysis and 7 the strongest preference for the VO analysis. After coding the data, planned t tests, ANOVA tests, and correlation tests were conducted.

6.2.4. Results
6.2.4.1. Mandarin native speakers

On average the native speakers rated 2.90 (SD = 1.06) on the scale of 1-7. A t test showed that the RC analysis was preferred among all the native speakers ($p < .0001$). The same tendency was observed in the by-item analysis – on average all the items received 2.91 (SD = 1.01) on the scale of 1-7, suggesting that the RC analysis was preferred across all the items ($p = .0009$).

In addition, a correlation test further showed that there was a significant correlation between the native speakers' EPT scores and their offline ratings ($r = .694$, $p = .003$). As seen in Figure 2, the native speakers who performed better on the EPT tended to maintain two possible analyses when processing the ambiguous constructions, whereas those who had little knowledge of English strongly preferred the RC analysis over the VO analysis.
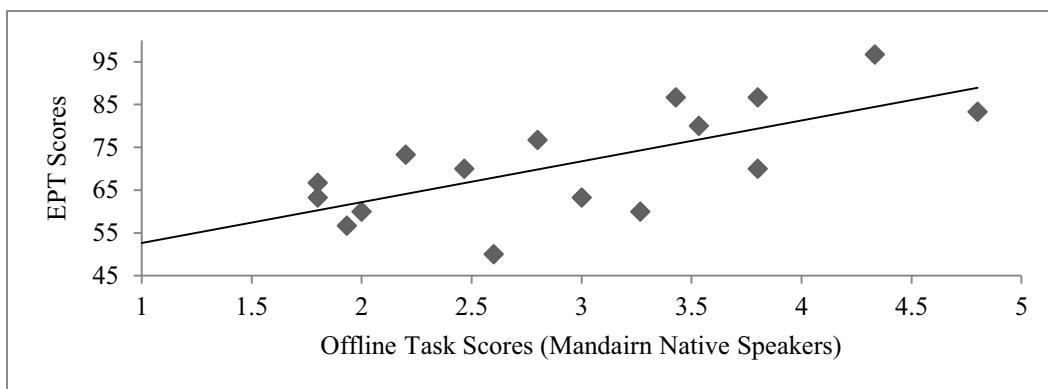
Figure 2. Correlation between EPT Scores and Offline Task Scores.

6.2.4.2. Mandarin L2 learners

As seen in Figure 3, the L2 learners significantly preferred the VO analysis (p = .0163). An independent sample *t* test further showed that the ratings of the native and nonnative speakers were reliably different (p < .0001).

The L2 learners' strong preference for the VO analysis was also observed in the by-item analysis. On average all the items received 5.16 (SD = 0.88) on the scale of 1-7, which showed that the VO analysis was preferred across all the items (p < .0001).
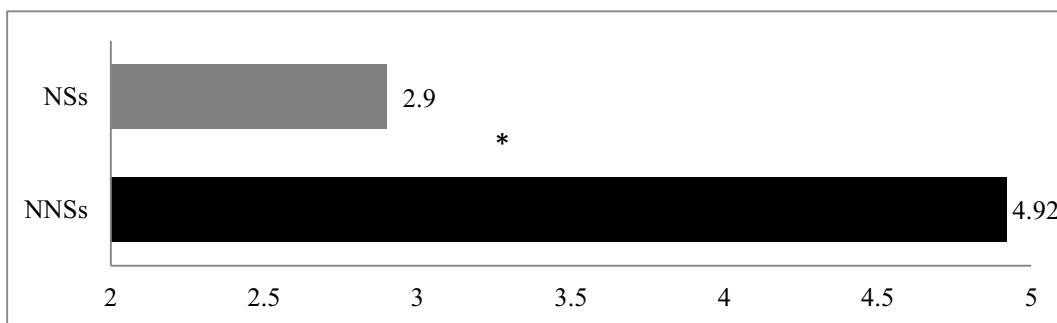
Figure 3. Offline Rating Scores by Participant

As seen in Figure 4, with regard to the HIG participants, their offline ratings were significantly different from those of the native speakers (p = .0015), since the former strongly preferred the VO interpretation (p = .0005). However, the HIG group's ratings were not different from those of the HFG participants (p = .0708).

As for the HFG participants, their offline ratings were also reliably different than those of the native speakers (p < .0001). The VO analysis was again strongly preferred (p < .0001).
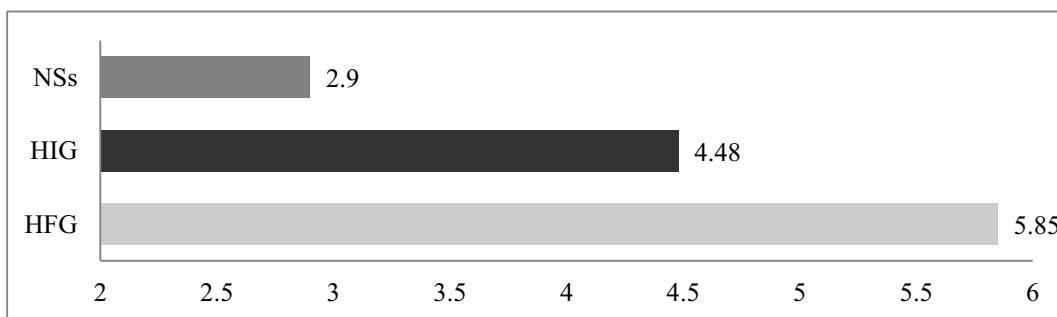

Figure 4. Offline Rating Scores by Group

7. Summary and discussion

The experimental results may be summarized as follows. First, when coming across 'Verb NP1 *de* NP2' constructions, the Mandarin native speakers' default analysis appeared to be the RC analysis, which was consistent with the previous findings (Hsieh et al., 2009; Zhang et al., 2000) and the predictions of the Tuning Hypothesis (Mitchel et al., 1995; Zhang et al., 2000). Second, the L2 learners' default analysis was different than that of the native speakers. In addition, the properties of the learners' L1s (i.e., the headedness of their L1s) did not influence L2 processing. These findings were compatible with the predictions of the Shallow Structure Hypothesis (Clahsen and Felser, 2006), but inconsistent with those reporting L1 transfer effects (e.g., Frenck-Mestre & Pynte, 1997; Juffs, 1998, 2005; MacWhinney, 1997, 2002; etc).

7.1. Mandarin native speakers

The results demonstrated that the RC analysis was preferred by the native speakers. These findings were consistent with the predictions of the Tuning Hypothesis (Mitchel et al., 1995; Zhang et al., 2000) and theories suggesting native speakers' preference for optimizing empty category (Ng and Fodor, 2011).

Specifically, the finding that the Mandarin native speakers' default interpretation of the ambiguous "Verb NP1 *de* NP2" construction was the RC analysis was consistent with Ng and Fodor's (2011) proposal that the parser prefers a complement clause with a recoverable subject when encountering a clause with an empty subject in a discourse context that offers no suitable antecedent for a *pro*. In addition, the fact that the RC analysis was preferred also lent evidence to the Tuning Hypothesis (Mitchel et al., 1995; Zhang et al., 2000) that native speakers tend to process structurally ambiguous sentences on the basis of the frequencies of parsing decisions they make in unambiguous conditions. In addition, the finding that, the higher the native speakers' English proficiency level was, the more likely they would maintain two alternative analyses was consistent with the backward transfer theory (Liu et al., 1992). In Liu et al.'s (1992) study, the results show that late bilinguals display strong evidence for forward transfer, while early bilinguals tend to display backward transfer patterns. However, the information about the native speakers' onset age of learning English was not available in the current study, thus it was not clear whether the correlation between their parsing preferences and their English proficiency level was a function of their exposure age to the L2. A future study taking into account the participants' L2 exposure age may be useful to overcome such limitation.

7.2. Mandarin L2 learners

The Mandarin L2 learners were found to behave differently than the native speakers in ambiguity resolution. In addition, no L1 transfer effects were observed – neither the HIG participants nor the HFG participants were able to use structure-driven strategies and made non-native-like parsing decisions, regardless of their L1s.

These findings were consistent with the predications of the Shallow Structure Hypothesis (Clahsen & Felser, 2006) that adult L2 learners' non-target-like parsing decisions are not attributable to L1 transfer effects, but rather to their difficulty in using structure-based processing strategies and their shallower representation of the syntactic structures.

A future study investigating how Mandarin L2 learners resolve syntactic ambiguities online may be useful to help us replicate the current results and further explore the differences between L1 and L2 processing.

8. Conclusion

Regarding the question on transfer effects raised at the beginning of the discussion, the evidence presented in this paper suggested that the Mandarin L2 learners made non-native-like parsing decisions regardless of the properties of their L1s. This was likely due to the learners' inability to integrate syntactic information when resolving L2 ambiguities. These results on L2 processing in the head-final

language Mandarin Chinese added a new perspective to the evidence of the Shallow Structure Hypothesis accumulated from studies investigating L2 processing in Indo-European languages.

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