The Comprehension of English Garden-path Sentences by Mandarin and Korean Learners of English as a Second Language

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Abstract

How the properties of a first language (Mandarin, Korean) influence the comprehension of sentences in a second language (English) was investigated in a series of self-paced reading time studies. Native Mandarin- and Korean-speaking learners of English were compared with native English speakers on how they resolved a temporary ambiguity about the relationship between a verb and the noun following it in a sentence (e.g., *The club members understood [that] the bylaws would be applied to everyone.*). Frequency biases of verbs' subcategorization structure (direct-object-bias vs. sentential-complement-bias) was manipulated in Experiment 1. Results showed that L1-Mandarin learners of L2-English were able to use both the verb bias and the complementizer cue, and their usage of these cues was not modulated by proficiency. L1-Mandarin learners' use of the verb bias cue contrasts with previously reported findings with L1-Korean learners of L2-English, who showed sensitivity to verb bias only in higher proficiency learners (Lee, Lu, & Garnsey, 2013). The difference between L1-Mandarin and L1-Korean learners suggests that L1 word order (Mandarin & English, SVO; Korean SOV) influences how quickly L2 learners learn word-order-dependent cues about structures in the L2. Experiment 2 added plausibility manipulation (e.g., *The club members understood the bylaws/the pool…*). Neither the native speakers or the L2 groups (L1-Mandarin L2-English & L1-Korean L2-English) used plausibility to disambiguate sentences, challenging the claims that L2 learners rely more heavily on plausibility than syntactic cues during sentence processing.

Keywords: verb bias; plausibility; garden-path sentences, L2 sentence processing

Introduction

Consider (1),

(1) *The scientist read the article…*
    (a)…………………………*at lunch time.*
    (b)…………………………*had been published two months ago.*

The syntactic role of *the article* is temporarily ambiguous between being the direct object of the preceding verb *read* or the subject of an upcoming embedded clause. In (1a), *the article* turns out to be the direct object of *read*, and the scientist did read the article. In (1b), however, *the article* turns out to be the subject of the embedded clause, and the scientist read something about the article, but not necessarily the article itself. Such temporary ambiguity at the ambiguous noun (*the article*) arises because English allows the complementizer *that* to be dropped. Sentences like (1b) can be disambiguated by adding a complementizer *that* after the main clause verb, as shown in (2).

(2) *The scientist read that the article had been published two months ago.*

Readers typically slow down at reading *had been* in (1b) than in (2), because they have initially analyzed *the article* as the direct object of *read*. At the position of *had been*, they realize that this analysis is incorrect, and thus start to revise that interpretation. Such slowing down in reading time is termed garden-path effect, and has been taken to reflect reanalysis processes.

Another cue native English speakers have been found to rely on to avoid garden-pathing is verb bias, which refers to the frequency with which a particular verb takes a particular structure, such as direct object (DO) or sentential complement (SC) (Garnsey, Pearlmutter, Myers, & Lotocky, 1997; Trueswell & Kim, 1998; Wilson & Garnsey, 2009). Consider (3) and (4),

(3) *The club members understood the bylaws would be applied to everyone.* (DO-bias verb)
(4) *The ticket agent admitted the mistake might be hard to correct.* (SC-bias verb)

Understand biases towards taking direct objects, and *admit* towards sentential complements. In (3), the parser anticipates a direct object after encountering *understood*, and thus experiences garden-path effect at *would*, where such interpretation turns out to be incorrect. In contrast, the parser experiences less difficulty processing *might* in (4),

because it anticipates an embedded clause after reading the sentential-clause-biased verb *admit*, and the sentence turns out to have the embedded clause structure.

Previous studies have shown that verb bias has a rapid effect on the processing of direct object/sentential complement (DO/SC) ambiguous sentences, and that either the complementizer *that* cue or the verb bias cue alone is sufficient for native English speakers to avoid garden-pathing. For instance, Garnsey et al. (1997) found that native speakers were slower at reading the disambiguating verb (e.g., *would*) after DO-bias verbs (e.g., *understand*), but not after SC-bias verbs (e.g., *admit*). After SC-bias verbs, the reading times at the disambiguating verb in sentences without the complementizer *that* (i.e., ambiguous) were just as fast as those with the complementizer *that* (i.e., unambiguous). This is the optimal efficient pattern of using the two cues. How about non-native speakers? Are they able to learn to use verb bias that is specific to the L2? Are they able to learn the complementizer *that* cue if such cue is not available in their native language?

A prevailing view in second language sentence processing literature claims that while L2 learners are capable of using lexical-semantic information during online parsing, they cannot use syntactic information in the way that native speakers do (i.e., the Shallow Structure Hypothesis; Clahsen & Felser, 2006). What has not been considered on this view is L2 learners' use of lexically-associated syntactic cue, such as verb bias. On the one hand, verb bias is lexically-associated information that is stored in the lexicon and retrieved when words are recognized. Such information might be considered to be part of the lexical information the Shallow Structure Hypothesis claims that L2 learners rely on. On the other hand, verb bias is about structure, so L2 learners may not use it to the extent that native speakers do. Studies thus far have revealed that L2 learners are able to learn L2-specific verb bias cue and use it fast enough to guide on-line parsing in the L2 (Dussias & Cramer Scaltz, 2008; Dussias, Marful, Gerfen, & Bajo Molina, 2010; Frenck-Mestre & Pynte, 1997), even if such information cannot be used in the same way in their L1 because L1 and L2 use different word orders (Lee, Lu, & Garnsey, 2013).

English follows SVO word order to place verbs early in the sentence, and therefore verbs provide useful information about the upcoming syntactic structure. In Korean, however, since the word order is SOV, verbs appear at the ends of clauses, and therefore are not useful in the same way as in English. In addition, unlike in English, where the complementizer *that* is optional, a clause-final complementizer particle *ko* is obligatory in Korean. Thus L1-Korean speakers do not have L1 experience with predicting upcoming structure based on either verb bias or the complementizer, but they do have experience with an end-of-clause complementizer that is a perfect cue to an embedded clause. Since the complementizer is a perfect cue on its own, it is possible that Korean speakers would never learn to associate structural biases with verbs, which is a much less reliable cue. Lee et al. (2013) compared L1-Korean L2-English speakers of higher proficiency with those with lower proficiency on their use of verb bias and the complementizer in reading ambiguous and unambiguous DO/SC ambiguous sentences that contained DO-bias or SC-bias verbs. Results showed that lower proficiency L2-learners must rely on the presence of the complementizer to use the verb bias cue, but higher proficiency group could use the two cues interactively, just like native speakers. However, higher proficiency learners did not achieve the optimal efficient pattern seen in the native speakers.

The fact that higher proficiency L1-Korean learners did not achieve the optimal native pattern might well be true for any L2 learners, simply because they don't have as much experience as native English speakers. Alternatively, however, it is possible that the fact that verb bias is not available early enough in the sentence to base predictions on in Korean is responsible for the failure to achieve the native pattern, making it important to test L2-English learners whose L1 has a word order placing verbs earlier in the sentence. Mandarin places verbs early in the sentence, with the same SVO order as English, and native speakers of Mandarin has been found to use verb bias to develop expectations about the upcoming structure (Qian, 2015). Mandarin has no complementizer in the type of DO/SC sentences used in this study. These differences between Korean and Mandarin suggest that L1-Mandarin learners of L2-English might use verb bias and complementizer cues differently from L1-Korean learners. L1-Mandarin learners may find it easier to learn and use the biases of English verbs earlier. As for their ability to use the complementizer *that*, it is not clear what to predict. Given that *that* is a frequent word, it may be easy for them to learn. Alternatively, the fact that the English cue *that* has many other usages besides a complementizer (pronoun, demonstrative, relative pronoun,…) may make it a difficult cue for Mandarin-L1 learners to rely on. Experiment 1 aims to test these predictions.

Previous research comparing the use of verb bias and plausibility cues in resolving DO/SC ambiguity by native English speakers found that plausibility did not have a chance to influence parsing in the presence of verbs with strong biases (Garnsey et al., 1997; Trueswell, 1996). It is possible that the same would not be true for L2 learners because L2 learners have been argued to rely heavily on lexical-semantic information rather than structure. Lee et al. (2013) has already shown that L1-Korean learners of L2-English did learn to make use of verb bias in such sentences. However, they did not also consider the role that plausibility might play. In Experiment 2, verb bias and plausibility were both manipulated and pitted against each other to examine the relative importance of plausibility and verb bias in L2-English sentence processing. Native English speakers rely more heavily on verb bias than plausibility, but the opposite might be true for L2-English learners.

Experiment 1

Participants

32 native English speakers (22 male, mean age 20) and 78 L1-Mandarin learners of L2-English (26 male, mean age 24) participated in Experiment 1. The native English control group was the same group as in Lee et al. (2013).

L2 proficiency was assessed using a cloze test (i.e., fill-in-the-blanks) that contained 40 blanks. The L2 group was divided into higher and lower proficiency groups based on median split (lower<32, higher≥32). Additional background information of the L2 group is summarized in Table 1.

Table 1. Language background information of the L1-Mandarin L2-English group in Experiment 1.

	All Learners	Lower Proficiency Group	Higher Proficiency Group
# of Participants	78	40	38
Age	24(18-37)	23(18-37)	24(18-35)
Proficiency score	31(21-37)	28(21-31)	34(32-37)
Age of classroom instruction	10(4-16)	10(5-16)	10(4-16)
Age start residence in English countries	21(15-33)	21(15-33)	22(15-30)
Duration of L2 country residence (months)	30(6-60)	28(6-60)	32(6-60)
Daily use of English (%)	50(5-95)	47(10-85)	4(5-95)

Materials and Design

Ten DO-bias and ten SC-bias verbs were each used four times to create 80 sets of sentences, with each set containing ambiguous and unambiguous versions of the same sentence (disambiguated by using *that*), as shown in (5). All disambiguating verbs and the words immediately following them were auxiliary verbs, so that the properties of the disambiguating words did not differ between items with DO-bias and SC-bias verbs. All critical items ended with embedded clauses.

(5) Example stimuli in Experiment 1:
DO-bias verb *The club members understood (that) the bylaws <u>would be</u> applied to everyone.*

SC-bias verb *The ticket agent admitted (that) the mistake <u>might be</u> hard to correct.*

DO- and SC-biased verbs were selected based on a norming study reported in Garnsey et al. (1997). DO-bias verbs were followed at least twice as often by direct object completions as by sentential complement completions in a sentence production task. The reverse was true for SC-bias verbs. DO- and SC-biased verbs used in the present study were matched on the number of letters, *F*<1, and frequency

(Francis & Kucera, 1982) *F*<1. Verb properties are summarized in Table 2.

Table 2. Properties of the verbs used in the experiments.

	DO bias strength (%)	SC bias strength (%)	Mean length	Mean log frequency
DO-verb	76	13	8.1	1.9
SC-verbs	17	59	7.9	1.7

To ensure that any effect found at the disambiguating region was caused only by the biases of the verbs, two plausibility norming tasks were conducted to examine whether the ambiguous nouns were equally plausible as the direct object of the preceding verb and as the subject of the embedded clause between DO-bias and SC-bias items. The plausibility of the ambiguous noun as the direct object was rated by asking a separate group of 56 native speakers of English to judge the plausibility of the subject, verb and ambiguous noun combinations on a 1 (very implausible) to 7 (very plausible) scale, as shown in (6).

(6) *The club members understood the bylaws.*
    The ticket agent admitted the mistake.

(7) *The club members understood that the bylaws were…*
    The ticket agent admitted that the mistake was…

Ambiguous nouns following DO-bias verbs were rated as slightly more plausible than those following SC-bias verbs (6.5 vs 6.2, *F*(1,78)=5.4, *p*<.05). This replicated previous findings that plausibility ratings of the ambiguous noun as the direct object were affected by biases of the verbs (Garnsey et al., 1997). However, the small difference in plausibility is unlikely to have a detectable effect in sentences with strongly biased verbs, given previous findings from studies specifically manipulating plausibility (Garnsey et al., 1997).

A separate norming study that assessed the plausibility of the ambiguous noun as the subject of the embedded clause was conducted with 12 native English speakers, who rated on a 1 (very implausible) to 7 (very plausible) scale the plausibility of sentence fragments such as (7) as the beginning of a sentence. The ambiguous nouns for both DO- and SC-items were both rated as highly plausible (mean DO: 6.1; mean SC: 6.1) and did not differ between verb types, *F*<1. The properties of the ambiguous nouns in Experiment 1 are summarized in Table 3.

Table 3. Properties of the ambiguous nouns used in Experiment 1.

	Mean length	Log frequency	Plausibility as the direct object	Plausibility as the clause subject
DO-items	7.4	1.3	6.5	6.1
SC-items	7.1	1.4	6.2	6.1

Critical sentences were distributed over two lists according to a Latin Square design. 80 distractors were added to each list for a total of 160 trials per list. A comprehension question was asked following each sentence, and the question targeted the content of various parts of the sentences (e.g., *Were the bylaws applied fairly?*).

Procedure

Participants sat in a dimly lit and sound-attenuated booth in front of a 23-inch LCD monitor. 160 sentences were presented one word at a time in white 26-point Arial font on a black background in a non-cumulative moving window self-paced reading paradigm. Each time participant pressed a button on a Cendrus-830 response box, the next word appeared and the previous word reverted to the mask character. Following each sentence, a comprehension question was presented and participants press one of two buttons to indicate *yes* or *no* answers. Feedback about question accuracy was given. A "too slow" feedback message was presented if participants did not make a response within four seconds. The sentences were divided into four blocks with forty sentences each. The experiment began with a practice block of five sentences, and the entire session took 30-45 minutes to complete. L2 learners completed the cloze test after the self-paced reading experiment.

Results

Comprehension Accuracy On average, the accuracy rate for native English speakers was 92% (range 87%-96%) and for L1-Mandarin learners of L2-English was 86% (74%-96%). Higher proficiency learners answered comprehension questions to critical trials more accurately than lower proficiency learners (88% vs. 85%, *p*<.01).

Reading Times To remove individual differences in reading speed, statistical results reported below were based on length-corrected residual reading times computed separately for each participant. Reading times in the disambiguating region were averaged across two words (e.g., *would be*) and were then analyzed using linear mixed-effect models with maximal random effects structure (Barr, Levy, Scheepters, & Tily, 2013). *T*>2 is interpreted as significant. Raw reading times are summarized in Table 4.

Table 4. Raw reading times at the disambiguating region in Experiment 1.

	DO-bias verbs		SC-bias verbs	
	Ambig	Unambig	Ambig	Unambig
L1-English	362	343	341	342
L1-Mandarin	469	454	444	436

The disambiguating region. The multi-level model at this region that included ambiguity, verb bias, language group (native vs. non-native, high proficiency L2 group vs. low proficiency L2 group) and their interactions as fixed effects, and random intercepts and random slopes of the ambiguity factor for subjects and items revealed a main effect of ambiguity, with ambiguous sentences being read slower than unambiguous sentences (425 vs 414 ms; β=10, *SE*=3, *t*>3), an interaction between verb bias and ambiguity, with the ambiguity effect of DO-items (15 ms) being larger than that of SC-items (5 ms; β=11, *SE*=5, *t*>2), and an interaction between verb bias and language group (native vs. non-native; β=15, *SE*=8, *t*>2), with the difference between DO- and SC-items being bigger in the non-native speakers group (21 ms) than the native speakers group (10 ms).

Since there was no effect associated with the comparison between the higher proficiency and lower proficiency L1-Mandarin L2-English groups, further analyses did not break down into higher and lower proficiency groups. Analysis with the native speakers group showed a main effect of ambiguity (ambiguous 352 ms; unambiguous 342 ms; *t*>2) and an interaction between verb bias and ambiguity, which resulted because the disambiguating region was read slower in ambiguous than in unambiguous sentences only when the main clause verb had DO bias (ambiguity effect 19 ms; β=18.53, *SE*=5.61, *t*=3.30), but not when it had SC bias (ambiguity effect -1 ms; β=.43, *SE*=4.39, *t*<1), as shown in Figure 1.

Analyses on the L1-Mandarin L2-English group revealed a main effect of verb bias, with DO items read slower than SC items (461 vs 440 ms; β=23, *SE*=11, *t*>2) and a main effect of ambiguity (455 vs 445 ms; β=11, *SE*=4, *t*>2). Although the disambiguating region of ambiguous sentences were read slower than unambiguous sentences only after DO-bias verbs (*t*=2.74) but not after SC-bias verbs (*t*=1.55), this difference was not big enough to produce an interaction between verb bias and ambiguity. These results indicated that L1-Mandarin learners of L2-English were able to use verb bias and complementizer cues, but that neither cue alone was sufficient in the way that it is for native speakers.
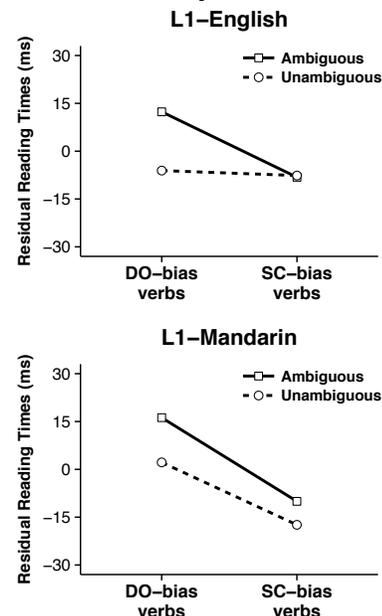

Figure 1: Reading time at the disambiguating region in Experiment 1.

Discussion

Experiment 1 manipulated verb bias and the presence of the complementizer *that* to compare the use of these two cues by L1-Mandarin speakers of L2-English and native English speakers. Native speakers showed the usual interaction between verb bias and ambiguity, suggesting an optimal, efficient and interactive use of the two cues. L1-Mandarin learners have learned to use verb bias, and their use of verb bias information was not modulated by proficiency, suggesting that even lower proficiency L1-Mandarin learners of L2-English have learned to use verb bias information. Perhaps, this is because they already do the same in their L1. Given that Mandarin does not have a complementizer that functions similarly to the complementizer *that* in English to signal an upcoming embedded clause, the prediction was that L1-Mandarin learners of L2-English might not be sensitive to such a cue. Contrary to that prediction, L1-Mandarin learners did use the complementizer cue. The use of complementizer was also not modulated by proficiency. Presumably, this is because the complementizer *that* cue is a salient cue and therefore is easy to learn.

Experiment 2

Experiment 1 showed that L1-Mandarin learners of L2-English were able to use both verb bias and complementizer cues to anticipate upcoming syntactic structure. The next question is how their usage of those cues compares with the usage of the kinds of lexical-semantic cues that have been proposed to be especially important for second language sentence processing. To evaluated that, Experiment 2 added plausibility manipulation, and tested native English, L1-Mandarin L2-English, and L1-Korean L2-English speakers.

Participants

65 native English speakers, 70 L1-Mandarin speakers of L2-English, and 69 L1-Korean speakers of L2-English participated in Experiment 2. L2 groups were divided into higher and lower proficiency groups based on median split in each group (L1-Korean: lower proficiency group<33, higher proficiency group≥33; L1-Mandarin: lower<35; higher≥35). Additional language background information are not provided here due to limit of space.

Materials and Design

The same 10 DO-bias and 10 SC-bias verbs were each used four times to construct 80 sets of sentences that fully crossed plausibility and ambiguity, as shown in (8). Plausible sentences were identical to sentences used in Experiment 1, for the most part.

As in Experiment 1, the ambiguous nouns were rated for their plausibility as the direct object of the main clause verb and as the subject of the embedded clause. Properties of the ambiguous nouns are summarized in Table 5. Plausible nouns in sentences with DO-bias verbs did not differ from those in SC-bias sentences in the number of letters (F<1)

and log frequency (F<1). The same was true for implausible nouns (Fs<1). As in Experiment 1, 80 distractors were added to each list for a total of 160 trials per list. The procedure for Experiment 2 was exactly the same as Experiment 1.

(8) Example stimuli for Experiment 2:
DO-bias verb
Plausible: *The club members understood (that) the bylaws would be applied to everyone.*
Implausible: *The club members understood (that) the pool would be closed on Mondays.*

SC-bias verb
Plausible: *The ticket agent admitted (that) the mistake might be hard to correct.*
Implausible: *The ticket agent admitted (that) the kiosk might be difficult to find.*

Table 5. Properties of the ambiguous nouns used in Experiment 2.

	Plausibility as the direct object	Plausibility as the clause subject
DO-items		
Plausible Noun	6.5	6.1
Implausible Noun	2.3	5.2
SC-items		
Plausible Noun	6.2	6.1
Implausible Noun	1.9	5.3

Results

Comprehension Accuracy On average, the accuracy rate to comprehension questions was 93% for native speakers, 87% for L1-Mandarin group and 85% for L1-Korean group. Higher proficiency L1-Mandarin group was more accurate than lower proficiency L1-Mandarin group (89% vs 85%, p<.01), and higher proficiency L1-Korean group was more accurate than lower proficiency L1-Korean group (87% vs 83%, p<.01).

Reading Times At the disambiguating region, analysis on the residual reading times for native speakers revealed a main effect of ambiguity, with ambiguous sentences being read slower than unambiguous sentences (356 vs 349 ms; β=8, SE=3, t>2), and an interaction between verb bias and ambiguity (β=13, SE=5, t>2). The interaction resulted because ambiguous sentences were read slower than unambiguous sentences only after DO-bias verbs (364 vs 351 ms, β=20, SE=7, t>2) but not after SC-bias verbs (348 vs 347 ms; β=2, SE=4, t<1), as shown in Figure 2. There was no effect involving the plausibility factor (ts<1.6). This is consistent with a previous finding that plausibility of the noun as a direct object had no effect on disambiguation region reading times in native English speakers when verbs were strongly biased (Garnsey et al., 1997).

For L1-Mandarin group, there was a main effect of ambiguity, with ambiguous sentences being read slower than unambiguous sentences (447 vs 425 ms; β=21, SE=4,

t>5), a main effect of proficiency, with the higher proficiency group reading faster than the lower proficiency group (421 vs 451 ms; β=16, *SE*=5, *t*=3), and an interaction between verb bias and ambiguity (β=18, *SE*=8, *t*>2), which was caused by the ambiguous sentences being read slower than unambiguous sentences after DO-bias verbs (462 vs 432 ms; β=40, *SE*=9, *t*>4), but not after SC-bias verbs (433 vs 419 ms; β=13, *SE*=7, *t*<2), as shown in Figure 2. There was no effect involving the plausibility factor (*t*s<2).

For L1-Korean group, there was a main effect of ambiguity (482 vs 460 ms, *t*>5), and a main effect of verb bias (DO 479 ms vs SC 463 ms, *t*>2). There was no interaction between verb bias and plausibility, nor were there any effects involving the proficiency and plausibility factors (*t*s<2).

There was a numeric pattern in both the native speakers and the L2 learners' data that reading times were slower on the disambiguation following a DO-bias verb and an implausible noun. This tendency was not significant in any language groups, and this effect was hypothesized to be spill over from reading the implausible noun itself. Due to the length limit of this paper, data analyses at the ambiguous noun region were not included.
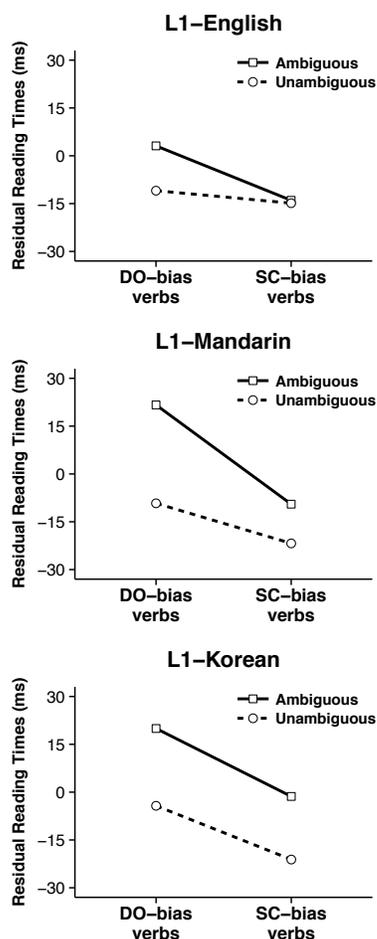

Figure 2: Residual reading times at the disambiguating region, collapsing over plausibility, in Experiment 2.

Conclusion

The present study investigated L2 learners' use of verb bias, complementizer *that*, and plausibility cues to predict upcoming syntactic structure. Results showed that L1-Mandarin speakers combined the verb bias and complementizer cues interactively, though they did not show the optimally efficient pattern seen in native speakers. In addition, even lower proficiency L1-Mandarin learners have learned to use verb bias and the complementizer, suggesting that verb bias and complementizer were not hard to learn for L1-Mandarin learners, perhaps because they use verb bias in the same way in their L1, and the complementizer *that* cue is a salient cue that is easy to learn. Moreover, just like native speakers, both L1-Mandarin and L1-Korean learners of L2-English did not use plausibility in their processing of DO/SC ambiguous sentences, contrasting the claims that L2 learners rely more heavily on semantic cues. Perhaps it may simply take too long, even for native speakers, to put the verb and noun meanings together in the way that is required for it to influence parsing decisions.

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