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Abstract

We report the results from two experiments investigating how referential context information affects native and non-native readers' interpretation of ambiguous relative clauses in sentences such as *The journalist interviewed the assistant of the inspector who was looking very serious.* The preceding discourse context was manipulated such that it provided two potential referents for either the first (*the assistant*) or the second (*the inspector*) of the two noun phrases that could potentially host the relative clause, thus biasing towards either an NP1 or an NP2 modification reading. The results from an offline comprehension task indicate that both native English speakers' and German and Chinese-speaking ESL learners' ultimate interpretation preferences were reliably influenced by the type of referential context. In contrast, in a corresponding self-paced-reading task we found that referential context information modulated only the non-native participants' disambiguation preferences but not the native speakers'. Our results corroborate and extend previous findings suggesting that non-native comprehenders' initial analysis of structurally ambiguous input is strongly influenced by biasing discourse information.

Keywords

Second language, sentence processing, ambiguity resolution, referential context, relative clause, self-paced reading

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Introduction

A growing body of second language (L2) processing research has investigated the way non-native comprehenders resolve structural ambiguities in real time. Many of these studies have focused on the question of whether or not the same structure-based parsing principles are applied during native (L1) and non-native sentence processing (e.g. Dussias, 2001; Felser, Roberts, Gross, & Marinis, 2003; Frenck-Mestre, 1997; Papadopoulou & Clahsen, 2003; Rah & Adone, 2010; Witzel, Witzel, & Nicol, 2012), whereas others have investigated L2 learners' sensitivity to lexical information such as verb subcategorisation biases (e.g. Frenck-Mestre & Pynte, 1997; Juffs & Harrington, 1996) or semantic fit (Roberts & Felser, 2011).

Comparatively few studies have examined non-native comprehenders' ability to make use of discourse-level cues to interpretation such as the information provided by the extra-sentential context (e.g. Dekydtspotter & Outcalt, 2005; Hopp, 2009; Pan & Felser, 2011; Roberts, Gullberg, & Indefrey, 2008). Whilst some approaches to L2 processing predict learners' online sensitivity to discourse-level constraints to be reduced in comparison to that of native speakers, others predict the opposite. The central issue addressed in the present study is whether native and non-native readers' ambiguity resolution preferences are affected by contextual biases in the same way.

According to the discourse-sensitive processing models such as the *Referential Theory* proposed by Altmann and Steedman (1988) and Crain and Steedman (1985), referential context information can affect comprehenders' initial analyses of structurally ambiguous input. Consider, for example, the ambiguous sentence in (1) below, which contains two noun phrases (*the assistant* and *the inspector*) that could each potentially host the bracketed relative clause (RC) following them.

(1) *The journalist interviewed [$_{NP1}$ the assistant] of [$_{NP2}$ the inspector] [$_{RC}$ who was looking very serious].*

Restrictive RCs normally serve to identify a specific referent from a set of possible referents. From the perspective of processing models which allow for referential information to affect initial parsing decisions, the number of possible discourse referents for the noun phrases *the assistant* and *the inspector* should influence comprehenders' online disambiguation preferences. The presence of more than one referent for *assistant* in the discourse should make *the assistant* (= NP1) the more likely host for the RC, whereas prior mention of more than one inspector should favour the alternative interpretation that *the inspector* (= NP2) was the one looking serious.

Keeping track of information provided by the preceding discourse context and integrating this with bottom-up information accrued during incremental sentence processing may present more of a challenge for language learners than it does for mature native speakers processing their L1. The *Interface Hypothesis* (e.g. Sorace & Filiaci, 2006), for example, claims that even highly advanced L2 learners may show persistent difficulty integrating syntactic and discourse-level information. If this is also the case in online processing, then we might expect non-native comprehenders to rely less on referential context information than native speakers when resolving structural ambiguities in real time. Clahsen and Felser's (2006) *Shallow Structure Hypothesis*, on the other hand, predicts that non-native comprehenders' sensitivity to non-structural cues to interpretation might be enhanced, possibly helping them compensate for problems with real-time structure-building during L2 processing.

The latter prediction has been confirmed in a reading-time study reported by Pan and Felser (2011). Native Chinese speakers were found to be highly sensitive to referential context information when processing ambiguous prepositional phrases (PPs) in English, whereas the native English-speaking controls were not. The current study examines whether Pan and Felser's findings extend to other types of ambiguity and to learners from L1 backgrounds typologically less remote

from English. To this end, we carried out both an offline sentence completion and an online self-paced reading task investigating native and non-native readers' preferred interpretations of ambiguous RC modifiers as in (1) above.

Sensitivity to contextual biases in native and non-native ambiguity resolution

Sentences containing RC ambiguities such as *Someone shot the servant of the actress who was on the balcony* have featured prominently in both monolingual and L2 processing research. RC ambiguity resolution preferences can be affected by a variety of factors, including the preceding discourse context (Papadopoulou & Clahsen, 2006), and have also been found to differ cross-linguistically (e.g. Carreiras & Clifton, 1999; Cuetos & Mitchell, 1988).

In native sentence processing, sensitivity to referential information is rather well attested, with several monolingual processing studies reporting context effects during modifier ambiguity resolution (e.g. Altmann & Steedman, 1988; Papadopoulou & Clahsen, 2006). Other L1 processing studies, however, have found context effects to be absent or delayed (e.g. Desmet, De Baecke, & Brysbaert, 2002; Zagar, Pynte, & Rativeau, 1997), findings which are more in line with informationally encapsulated or "syntax-first" processing models (e.g. Frazier, 1987). Comparatively little is known about the extent to which syntactic ambiguity resolution is influenced by the extra-sentential context in a non-native language, however.

Dekydtspotter, Donaldson, Edmonds, Liljestrand Fultz, & Petrush (2008, Task 3) examined how native English speakers processed ambiguous RCs in L2 French in different context conditions. Using a segment-by-segment self-paced reading (SPR) task, they had participants read globally ambiguous sentences such as *Luc accuse le banquier du coiffeur qui revient du Japon* (' Luc accuses the banker of the hairdresser who comes back from Japan'). These were preceded by short context paragraphs which were constructed so as to be pragmatically congruent with either NP1 or NP2 modification. After each experimental trial, participants were asked to decide whether or not the last sentence was a correct description. Neither less advanced (second-semester) learners nor the native French or native English-speaking comparison groups showed any significant difference between the two context conditions in their end-of-trial responses, however. Fourth-semester learners, in contrast, accepted the critical sentences significantly more often in an NP1 supporting than in an NP2 supporting context. This indicates a preference for an NP1 modification reading in the more advanced learners' final interpretations. The analysis of the learners' reading-time data revealed a processing advantage for RCs contextually disambiguated towards NP2 modification instead, which the authors took to reflect the relatively lower processing cost associated with attaching ambiguous RCs to the most recent noun phrase. French and English native speakers, in contrast, showed a processing advantage for sentences that were preceded by an NP1 supporting context.

Dekydtspotter et al.' s results show that both the learners' and native speakers' reading times, as well as the fourth-semester learners' end-of-trial evaluations, were influenced by the type of referential context. Since in their experiment the factor context was not manipulated independently of the RC' s disambiguation (NP1 vs. NP2), we cannot tell whether the observed effects were the result of a mismatch between a preferred syntactic analysis and the information provided by the context, or the result of the two context types creating modification biases or expectations of different strengths, however.

The question of how biasing extra-sentential context interacts with non-native readers' disambiguation preferences was investigated by Pan and Felser (2011). They used both an offline sentence completion task and an online SPR task to examine the way referential context information

affects PP ambiguity resolution in L1 Chinese/L2 English speakers. Their experimental sentences contained PPs that were semantically disambiguated either towards verb phrase (VP) modification (2a), where the PP could only be understood as modifying the action described by the verb, or towards NP modification (2b).

(2) a. VP MODIFICATION
Bill [$_{VP}$ glanced at the customer [$_{PP}$ with strong suspicion]] and then walked away.

b. NP MODIFICATION
Bill glanced at [$_{NP}$ the customer [$_{PP}$ with ripped jeans]] and then walked away.

Each critical sentence was preceded by one of two types of context, one biasing towards VP modification by providing only a single referent for the preceding NP *the customer* and the other biasing towards NP modification by providing two potential referents.

The results from the offline task showed that both native and non-native participants' disambiguation choices were significantly affected by the referential context, with the number of VP modification choices decreasing significantly for sentences preceded by an NP supporting context. Clear L1/L2 differences were observed in the online reading task, however. Here only the Chinese participants showed sensitivity to contextual biases, such that their reading times of the critical PP segment increased significantly for VP-disambiguated PPs preceded by an NP supporting context, and for NP-disambiguated PPs preceded by a VP supporting context, compared with PPs whose disambiguation was congruent with the context. The context-dependent reversal of the L2 group' s online disambiguation preferences indicates that referential information affected the non-native readers' initial analysis of the PP, in line with the predictions made by the Referential Theory. The native English control group, in contrast, showed evidence for a general VP modification preference that was not modulated by the type of context.

Pan and Felser' s (2011) results lend support to the hypothesis that L2 processing is guided more strongly by semantic and pragmatic cues to interpretation than native language processing (e.g. Clahsen and Felser, 2006). However, it remains unclear whether these findings generalise to other types of ambiguity and to other L1/L2 combinations. It is conceivable, for example, that the strong L2 context effect seen in Pan and Felser' s study is at least partly due to L1 influence. There is evidence that reading comprehension in L1 Chinese is more semantics driven compared with reading comprehension in, for example, L1 English (e.g. Li, Bates, & MacWhinney, 1993; Zhang, Yu, & Boland, 2010). If this is correct, then it is possible that the learners examined by Pan and Felser simply used a Chinese-type reading comprehension strategy when reading in English. The present study further examines the role of L1 influence in L2 ambiguity resolution by comparing learners from typologically different L1 backgrounds.

The current study

The current study investigates how proficient L2 learners of English process RC modifiers in different kinds of referentially biasing contexts. Experiment 1 examined participants' interpretation preferences using an offline questionnaire task, and Experiment 2 investigated their online disambiguation preferences using a segment-by-segment SPR task (Just, Carpenter, & Woolley, 1982). To assess the possible role of L1 influence on readers' interpretation preferences, we recruited learners from two typologically different language backgrounds, German and Chinese. Note that German has RC ambiguities that are similar to their English counterparts, as illustrated in (3) below.

(3) *Jemand* *erschoss* *den Diener* *des Schauspielers,* *der* *auf* *dem* *Balkon*
someone shot [the servant]$_{ACC}$ [the actor]$_{GEN}$ who on the balcony
war.
was
‘ Someone shot the servant of the actor who was on the balcony.”

In the absence of any biasing context, German native speakers have been found to prefer associating ambiguous RCs with NP1 rather than NP2 (Hemforth, Konieczny, Scheepers, & Strube, 1998), in contrast to the NP2 preference that is typically observed in native speakers of English (e.g. Carreiras & Clifton, 1999; Cuetos & Mitchell, 1988; Felser, Roberts, et al., 2003 – but cf. Felser, Marinis & Clahsen, 2003a; Mendelsohn & Pearlmutter, 1999; Traxler, 2007, for evidence that NP1 may sometimes also be preferred in English).

In Chinese, RC attachment ambiguities are more restricted. As modifiers in Chinese must precede the constituent they modify, an NP1 modification reading will be excluded if the RC immediately precedes NP2 and follows NP1, as in (4a) below. Note that, because the complex NPs in (4) are left-branching structures, NP2 (‘the servant’) rather than NP1 (‘the actress’) is the head of the overall NP here. An NP1 modification reading can only be obtained if the RC precedes the entire NP complex, as in (4b). Whilst the word order in (4b) renders the RC technically ambiguous, native Chinese speakers preferentially interpret this word order as signalling NP1 modification, or local attachment (Shen, 2006).

(4) a. 有人 射擊 那個女演員的 在台上的僕人
Someone shot the actress’s ‘who was on the balcony’ servant.

b. 有人 射擊 那個在台上的女演員的 僕人
Someone shot the ‘who was on the balcony’ actress’s servant.

The general predictions for RC ambiguity resolution in L1 and L2 processing are summarised below:

- Discourse-sensitive models such as the Referential Theory predict that contextual biases should affect not only comprehenders’ final interpretations but also their online disambiguation preferences.
- Serial or syntax-first models of parsing, in contrast, predict that referential context effects might affect comprehenders’ final interpretations but not necessarily their online processing patterns.
- If L2 processing is generally more semantics driven than L1 processing (as predicted for example by the Shallow Structure Hypothesis), then we expect context effects to be stronger and/or to show up earlier during L2 than during L1 processing.
- Conversely, the Interface Hypothesis would predict that context effects should be stronger, or show up earlier, in the native group. The L2 speakers’ initial disambiguation preferences may instead be determined by a general preference for local attachment (favouring NP2) or a preference for attaching ambiguous RCs to the head of the overall NP complex (i.e. NP1).
- If the learners RC disambiguation preferences are influenced by the preferences found in their L1, then the German learners might show a general NP1 preference whilst the Chinese group might show a preference for local (NP2) attachment.

Experiment 1

Our first experiment was a binary-choice questionnaire task investigating whether native and non-native readers' interpretations of structurally ambiguous RCs are influenced by referential context information in a similar way. An additional purpose was to test the effectiveness of the context manipulations in the materials used in Experiment 2, which examined readers' sensitivity to contextual biases during online processing.

Method

Participants. Twenty-eight native Chinese-speaking learners of English (13 males, mean age: 22.9, range: 18–32), 18 German-speaking learners of English (four males, mean age: 20, range: 17–29) and 26 native British English speakers (eight males, mean age: 30.8, range: 19–55) participated in this experiment. They took part in the experiment either on a voluntary basis or for course credit. All participants had normal or corrected-to-normal vision, had never been diagnosed as dyslexic, and were naïve about the ultimate purpose of the experiment. The native speakers were recruited from universities across the UK, either working or studying at university at the time of testing. The Chinese group was recruited from the student populations of the University of Essex in the UK and Chun-Shan Medical University in Taiwan, and the German group from the undergraduate student population of the University of Osnabrück in Germany. All of the Chinese participants had an English proficiency level equivalent to or beyond IELTS 5.5 ('modest/competent user'), and the German ones all scored above 68/100 points ('upper intermediate') on the grammar part of the Oxford Placement Test (OPT) (Allan, 2004).

Materials. The critical ambiguous sentences were adapted from Felser, Roberts, et al. (2003). They all contained a complex object NP followed by a RC that could modify either the head of the overall object NP (= NP1 disambiguation) or the NP inside a prepositional phrase headed by the preposition *of* (= NP2 disambiguation). Both NP1 and NP2 involved human referents and were presented in the singular form, thus rendering the experimental sentences globally ambiguous. The experimental sentences were embedded in a short discourse context which biased either towards NP1 or NP2 disambiguation, as shown in (5a,b). The discourse contexts preceding the experimental sentences were manipulated by providing two potential referents for either NP1 (= NP1 supporting context) or NP2 (= NP2 supporting context).

(5) a. NP1 SUPPORTING CONTEXT

A journalist was writing a report on an engineering project. Two assistants were happy to be interviewed, fully supervised by an inspector. One assistant had been involved at the planning stage, whilst the other one was monitoring the building work. *The journalist interviewed the assistant of the inspector who was looking very serious.*

b. NP2 SUPPORTING CONTEXT

A journalist was writing a report on an engineering project. An assistant was happy to be interviewed, fully supervised by two inspectors. One inspector had been involved at the planning stage, while the other one was monitoring the building work. *The journalist interviewed the assistant of the inspector who was looking very serious.*

Table 1. Proportion of NP2 modification choices (in percent, SDs in parentheses) per participant group and condition.

	English group	Chinese group	German group
NP1 context	48 (27)	23 (21)	27 (20)
NP2 context	67 (22)	35 (28)	50 (30)

The head nouns of NP1 and NP2 were matched for frequency (see Felser, Roberts, et al., 2003). Each paragraph was followed by a comprehension question (e.g. *Who was looking very serious?*) asking participants to which of two possible referents (e.g. the assistant or the inspector) they thought the action or property described by the RC might be attributed.

Each critical sentence appeared in two experimental conditions, preceded either by an NP1 supporting (5a) or by an NP2 supporting context (5b). To prevent participants from being exposed to the same critical sentence twice, two balanced presentation lists were created. The order of the two answer options was counterbalanced across each list. Each presentation list comprised 48 items in total, including 24 experimental and 24 filler items, with the item order pseudo-randomised.

Procedure. For the English and Chinese participants, the offline comprehension task was administered as a web-based questionnaire on an online survey website. Participants were given the link to the questionnaire via email. Those who clicked on the link would first see a written instruction paragraph (in English) on the first page of the questionnaire which asked them to read each of the text paragraphs carefully for meaning, and then to tick the answer options they considered the most likely interpretation choice in the context of the preceding paragraph. Although participants were given no time limit for completing the task, they were instructed to complete the questionnaire in a single uninterrupted session, and were specifically told not to revise their choices once a decision had been made. The final page of the questionnaire included questions about participants' age, gender, and language background. After answering these questions, they had to click on the 'Submit' button at the bottom of the page to submit the data. The German participants received the same instructions and materials in a paper-and-pencil-based version. The questionnaire took the native English participants approximately 20 minutes to complete and the non-native participants approximately 30 minutes.

Results

A summary of the results is provided in Table 1. All three groups were affected by the context manipulation in a similar way such that their proportions of NP2 choices were higher in an NP2-supporting compared with an NP1-supporting context. The three participant groups did, however, show different numerical baseline disambiguation preferences, with the native English speakers favouring NP2 modification (58%) but the Chinese and German speakers both favouring NP1 modification overall (with 29% and 39% NP2 choices, respectively).

A mixed repeated-measures analysis of variance (ANOVA) was carried out with the within-subjects factor Context (*NP1 supporting, NP2 supporting*) and the between-subjects factor L1 (*English, Chinese, German*). The results showed a main effect of L1 ($F1(1, 69) = 12.15$, $p < .05$; $F2(1,69) = 33.91$, $p < .05$). To further explore this effect, we tested for each participant group whether the baseline preference differed significantly from chance level for each modification type. The NP1 modification preference was significant in both the Chinese ($t1(27) = 5.86$, $p <$

.001; t2(23) = 10.57, $p < .001$) and the German group (t1(17) = 2.18, $p < .05$; t2(12) = 4.05, $p < .001$). In the English group, the preference for NP2 modification was significant in the item analysis only (t1 (25) = 1.67, $p = .1$; t2 (23) = 3.18, $p < .005$). Most importantly, however, there was a significant main effect of Context (F1(1, 69) = 32.78, $p < .05$; F2 (1, 69) = 45.00, $p < .05$), confirming that the proportion of participants' NP2 modification choices was significantly higher in the NP2 supporting context condition. No interaction between the factors Context and L1 was observed (F1 < 1, F2 < 1.2).

Discussion

The results from the offline comprehension questionnaire show that our context manipulation was effective in all three participant groups, in that the proportion of NP2 choices was significantly higher when the preceding context was pragmatically congruent with the NP2 modification reading. The absence of an interaction with the factor L1 moreover confirms that the learners did not statistically differ from the native speakers in the degree to which their disambiguation choices were affected by the referential context.

Whilst both non-native participant groups showed an overall preference for NP1 modification (as did the fourth-semester learners in Dekydtspotter et al.'s 2008 study), the native group numerically preferred NP2 modification. The latter observation is in line with the results reported in many previous studies on RC ambiguity resolution in L1 English (e.g. Cuetos & Mitchell, 1988). Although it may be tempting to interpret the German group's overall NP1 preference as reflecting the transfer of L1 disambiguation preferences, the fact that the Chinese group showed the same preference even though Chinese native speakers have elsewhere demonstrated a preference for local attachment (Shen, 2006) suggests that this may be a general learner effect instead.

The non-native participants might have considered NP1, the semantic head of the NP-*of*-NP complex, the more salient potential host for the RC. A preference for associating ambiguous RCs with the head of the overall NP complex has also previously been observed in native sentence comprehension in several languages, and has been argued to reflect the tendency to construe ambiguous constituents as being relevant to a sentence's main assertion (Frazier, 1990) or as modifying the local predicate's arguments (e.g. Gibson, Pearlmutter, Canseco–Gonzalez, & Hickok, 1996).

Experiment 2

The results from Experiment 1 only tell us about participants' final interpretation preferences, which were likely to be based on a conscious evaluation of the referential context, but do not reveal anything about their initial processing preferences upon encountering the ambiguity. Our second experiment investigated whether, and how, native and non-native readers' online ambiguity resolution preferences are influenced by contextual biases. The experimental sentences contained temporarily ambiguous RCs and were each preceded by a referentially biasing context paragraph. If referential context information has an immediate effect on participants' ambiguity resolution preferences, then their reading of RCs disambiguated towards NP1 attachment should be facilitated in an NP1-supporting context, and their reading of those disambiguated towards NP2 attachment should be facilitated in an NP2-supporting context. If, on the other hand, referential context effects are delayed, then participants might show either no preference, or a general preference for either NP1 or NP2 disambiguation that is not modulated by the type of context.

Table 2. Summary of non-native participants' biodata and OPT scores.

	Chinese group		German group	
	Mean	*SD*	*Mean*	*SD*
Age (in years)	22	4.07	24	3.54
Age of first exposure	11	2.33	10	1.79
Length of immersion (in weeks)	12	20	15	20
OPT grammar score (in %)	78	6.97	79	8.11

Method

Participants. Twenty-seven Chinese-speaking (five males, mean age: 22, range: 18–33) and 22 advanced German learners of English (seven males, mean age: 24, range: 19–32), as well as 30 native English-speaking controls (eight males, mean age: 26, range: 18–53) took part in the experiment on a voluntary basis or for course credit. All participants had normal or corrected-to-normal vision, and none of them had ever been diagnosed dyslexic. They were naïve regarding the ultimate purpose of the experiment.

The native controls were all speakers of British English, 28 of whom were working or studying at the University of Essex at the time of testing. One was visiting and one working at the University of Osnabrück in Germany. The Chinese-speaking participants were recruited from the undergraduate and postgraduate student communities at the University of Essex, and the German-speaking participants from the undergraduate student population of the University of Osnabrück.

Of the 30 native English controls, nine participants reported that they had learned to speak languages other than their native language (Italian, Spanish, German, French and/or Bulgarian), but none of them considered themselves bilingual. Of the 27 Chinese participants, only one reported that she could speak another foreign language (Japanese) besides English; the others did not report that they were fluent in any other foreign languages. Of the 22 German learners, all participants reported that they had learned one or more foreign languages other than English in school (French, Italian, Spanish and/or Norwegian), but none considered themselves bilingual or multilingual. The Chinese participants were all living in the UK at the time of testing, and the German participants were tested in Germany. Twelve of the German participants reported that they had never been immersed in English at all, whilst the remaining 10 had spent eight months on average (range: 3–17 months) in an English-speaking country in the past.

The L2 participants were asked to complete the grammar part of the OPT. All participants achieved a score of 68/100 or higher and can thus be classified as upper intermediate (B2) or above according to the OPT scale (Chinese group mean: 78.3, range: 68–94, German group mean: 79.1, range: 68–93). The L2 participant information is summarised in Table 2.

Materials. The materials for Experiment 2 consisted of 16 experimental and 24 filler items. The experimental sentences were unambiguous versions of a subset of the materials used in Experiment 1, each of which became temporarily ambiguous at the relative pronoun *who.* NP number marking was manipulated such that either NP1 or NP2 appeared in the plural and the other in singular form. The sentences were disambiguated by number marking on the auxiliary (*was* vs. *were*) in the RC. They were preceded by a context paragraph that provided two potential referents for either NP1 (= NP1 supporting context) or NP2 (= NP2 supporting context).

A 2×2 design was adopted with Context (*NP1 supporting, NP2 supporting*) and Attachment (*NP1 attachment, NP2 attachment*) as within-subjects factors, yielding four experimental conditions. Each critical sentence was segmented into five presentation segments as indicated by slashes in (6a,b) below.

(6) a. NP1 SUPPORTING CONTEXT

A journalist was writing a report on an engineering project. Two assistants were happy to be interviewed, fully supervised by the inspectors. One assistant had been involved at the planning stage, while the other one was monitoring the building work. *The journalist interviewed* | *the assistant of the inspectors* | *who* | *was/were* | *looking very serious*.

b. NP2 SUPPORTING CONTEXT

A journalist was writing a report on an engineering project. An assistant was happy to be interviewed, fully supervised by the inspectors. Some of the inspectors had been involved at the planning stage, while the other ones were monitoring the building work. *The journalist interviewed* | *the assistant of the inspectors* | *who* | *was/were* | *looking very serious.*

The experimental items were distributed across four counterbalanced presentation lists using a Latin Square design and were pseudo-randomised with the filler items in each list.

Procedures. A non-cumulative SPR task was conducted using the DMDX experimental software package (Forster & Forster, 2003). The stimulus materials were presented on a 15-inch computer screen in white letters on a black background in size 14 Arial font. The presentation of each stimulus item began with a context paragraph that was displayed on the screen as a whole, followed by a critical sentence presented segment by segment. The presentation rate was controlled by the participants themselves by pressing a pacing button on a PC game pad. At the end of each experimental and half of the filler stimuli, a *yes/no* comprehension question would appear, which participants answered by pressing the appropriate button on the game pad. The comprehension questions did not directly probe participants' interpretation of the RC and also frequently asked about information provided in the context paragraph. Their primary purpose was to ensure that participants actively tried to read the entire stimulus texts for meaning. Participants' reading times for each segment and their responses to the end-of-trial comprehension questions were recorded.

Participants were all tested individually in a quiet room. The native English participants were tested in a single session and the non-native participants in two separate sessions as they additionally had to fill out a paper-and-pencil proficiency questionnaire (OPT) and a vocabulary checklist. The SPR task took the native speakers about 20 minutes and the non-native speakers between 20 and 40 minutes to complete.

Results

Participants' accuracy in answering the end-of-trial comprehension questions was 82% for native and 83% for non-native participants overall. This indicates that participants paid attention to the task and made an active effort to comprehend the stimulus items. Statistical analyses of the reading-time data were performed for correctly answered trials only, and extreme reading times of

Table 3. Participants' mean reading times (SDs in parentheses) per condition for all presentation segments.

		subject + verb	complex object	RC pronoun	auxiliary	verb phrase
L1 Chinese	*NP1 context, NP1 attachment*	1496 (707)	2180 (941)	751 (398)	659 (397)	1817 (926)
	NP1 context, NP2 attachment	1488 (643)	2056 (807)	740 (507)	671 (443)	1932 (1132)
	NP2 context, NP1 attachment	1612 (915)	2128 (828)	718 (329)	740 (534)	2000 (1177)
	NP2 context, NP2 attachment	1384 (511)	2437 (1094)	764 (545)	806 (747)	1913 (999)
L1 German	*NP1 context, NP1 attachment*	1073 (391)	1448 (625)	605 (240)	466 (149)	1114 (631)
	NP1 context, NP2 attachment	1133 (436)	1484 (669)	551 (126)	534 (308)	1433 (905)
	NP2 context, NP1 attachment	1207 (450)	1441 (643)	585 (245)	492 (178)	1400 (655)
	NP2 context, NP2 attachment	1019 (324)	1694 (973)	564 (187)	508 (336)	1173 (616)
L1 English	*NP1 context, NP1 attachment*	872 (423)	1102 (673)	606 (310)	484 (236)	974 (546)
	NP1 context, NP2 attachment	840 (340)	1107 (785)	577 (263)	471 (161)	958 (517)
	NP2 context, NP1 attachment	846 (277)	1083 (574)	670 (510)	496 (213)	870 (482)
	NP2 context, NP2 attachment	875 (248)	1046 (575)	627 (370)	516 (303)	972 (570)

more than six seconds were removed from the remaining raw data sets (L1 data: two cases, L2 data: 10 cases). An overview of participants' mean reading times for all sentence regions is provided in Table 3. Statistical results will be reported for the prefinal segment containing the disambiguating auxiliary and for the final segment. The results from the non-native participants will be presented first.

Non-native speakers. The Chinese participants read the experimental sentences more slowly than the German participants overall, as might be expected given that the former were reading in a non-native script. At the final segment, the VP following the disambiguating auxiliary, the Chinese and German readers showed a qualitatively very similar pattern, with the two congruent conditions eliciting shorter reading times than two incongruent ones (see Figure 1).

To establish whether or not the two non-native participant groups showed different reading-time patterns across our experimental conditions, we carried out mixed ANOVAs with the factors Context (*NP1 supporting, NP2 supporting*) and Attachment (*NP1 disambiguation, NP2 disambiguation*) as within-subject factors and L1 (*German, Chinese*) as a between-subjects factor. At the prefinal segment there was a main effect of L1 reflecting the fact that the Chinese participants read the disambiguating auxiliary more slowly than did the German participants ($F1(1,41) = 6.16$, $p < .05$, $F2(1,12) = 53.11$, $p < .001$). There was a marginal main effect of Attachment in the subject analysis ($F1(1,41) = 3.04$, $p = .089$, $F2(1,12) = 1.65$, ns) that was due to slightly faster reading times for NP1 compared with NP2 disambiguation. We also found a marginally significant interaction of

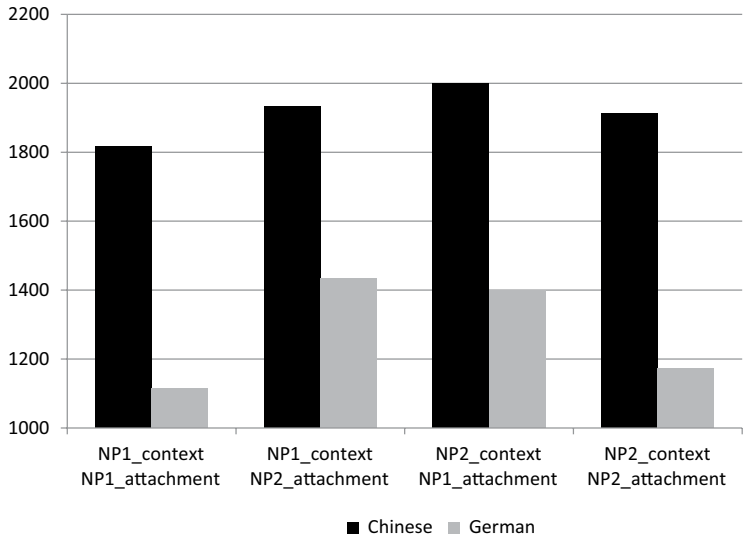

Figure 1. Non-native speakers' mean reading times (in milliseconds) at the verb phrase for the four experimental conditions.

Context and L1 in the item analysis (F1(1,41) = 1.96, ns, F2(1,12) = 3.40, $p = .09$), reflecting the fact that the Chinese, but not the German group, showed slightly faster reading times in NP1-supporting compared with NP2-supporting contexts. There were no other significant effects or interactions (all F values < 1). At the final segment there was again a main effect of L1 (F1(1, 41) = 17.67, $p < .001$, F2(1,12) = 38.52, $p < .001$) due to the Chinese group's generally slower reading speed. The two-way-interaction between Context and L1 was not significant in the subject analysis, and marginally significant in the item analysis (F1 < 1, ns, F2(1,12) = 4.18, $p = .064$). Importantly, there was a significant interaction between the factors Context and Attachment (F1(1,41) =8.51, $p < .01$, F2(1,12) = 15.42, $p < .005$). The three-way-interaction between Context, Attachment and L1 was non-significant in the subject analysis and marginally significant in the item analysis (F1 < 1, ns, F2(1,12) = 3.34, $p = .093$). There were no other significant effects (all F1s < 1, all F2s < 2.8, all p values > .1), in particular, no interaction between Attachment and L1 (both Fs < 1).

Subsequent pairwise comparisons on the collapsed L2 data showed that the interaction between Context and Attachment reflected the fact that in NP1 supporting contexts, the final segment was read significantly faster when the RC was disambiguated towards NP1 modification (t1(48) = 2.68, $p < .05$, t2(15) = 2.75, $p < .05$), whereas in NP2-supporting contexts, the non-native speakers' reading times were marginally faster when the relative clause modified NP2 (t1(48) = 1.78, $p = .082$, t2(15) = 1.8, $p = .092$).

Native speakers. The native speakers' reading-time data were analysed using ANOVAs with Context (*NP1 supporting, NP2 supporting*) and Attachment (*NP1 disambiguation, NP2 disambiguation*) as within-subject factors. No significant effects were found on the disambiguating auxiliary (all F1s < 1.8, all F2s < 1). Unlike the pattern we saw in the two non-native groups, the final segment was read particularly quickly where an NP1 disambiguation was forced in an NP2-supporting context, with little difference between the remaining three conditions. The interaction between

Context and Attachment reached marginal significance in the item but not the subject analysis ($F1(1, 25) < 1$, ns, $F2(1,12) = 3.6$, $p = .08$). There were no significant main effects of Context or Attachment (all F values < 1).

To confirm whether the native and non-native speakers' reading-time patterns on the final segment also differed statistically, we carried out mixed 2×2×2 ANOVAs with Learner Status (*native, non-native*) added as a between-subject factor. General L1/L2 differences in reading speed were reflected in a main effect of Learner Status ($F1(1,70) = 40.16$, $p < .001$, $F2(1,12) = 120.79$, $p < .001$). The two-way interaction between Context and Attachment was marginally significant in the item analysis ($F1(1,70) = 2.75$, $p = .1$; $F2(1,12) = 3.37$, $p = .09$) and was further modulated by a significant three-way interaction between Context, Attachment and Learner Status ($F1(1,70) = 5.92$, $p < .05$, $F2(1,12) = 16.45$, $p < .005$). There were no other significant effects (all F values < 1).

Discussion

Our results show that manipulating the extra-sentential referential context affected both native and non-native speakers' RC interpretation preferences in the offline task (Experiment 1) but influenced only the non-native participants' reading-time patterns in Experiment 2. In the SPR task, longer reading times at or following the disambiguating segment (compared with the same segment in another condition) indicate that an initially dispreferred interpretation was forced, which then required a partial revision of the previously constructed sentence representation. The analysis of the Chinese and German participants' reading-time patterns revealed that in an NP1-supporting context, the NP1 modification reading was initially preferred, whereas in an NP2-supporting context, temporarily ambiguous RCs were initially associated with NP2. The native English-speaking controls, on the other hand, were not measurably affected by biasing context information during their reading of the experimental sentences.

The context effects seen in our non-native participants are unusually strong in that we actually saw the Chinese and German readers' online disambiguation preferences reverse in NP1 vs. NP2-supporting contexts. A similar reversal pattern was also observed in the Chinese-speaking ESL learners' reading times in Pan and Felser's (2011) study of syntactically ambiguous PP modifiers. In monolingual processing studies, in contrast, contextual biases have typically been found to attenuate – rather than reverse – readers' baseline attachment preferences at best (e.g. Papadopoulou & Clahsen, 2006). Our learners' reading-time patterns are consistent with the predictions made by discourse-sensitive processing models such as the Referential Theory. In contrast, the absence of any online context effects in our native group replicates earlier findings by Desmet et al. (2002), Pan and Felser (2011), and Zagar et al. (1997), and indicates that modifier ambiguity resolution in L1 sentence processing is not necessarily affected by contextual biases.

The analysis of the L2 data also showed that the online context effects were not significantly modulated by the learners' language background (Chinese vs. German). This indicates that the learners' heightened sensitivity to referential information was unlikely to reflect the L1 transfer of Chinese native speakers' supposedly more 'semantics-driven' processing strategy in either the current or Pan and Felser's earlier study. Given that the Chinese and German learners patterned alike despite significant differences in their general reading speed, the observed L2 context effects are also unlikely to be a consequence of learners' comparatively slower reading or processing speed, or of having to read in a less familiar script.

Irrespective of the observed context effects, we also found some L1/L2 differences in participants' baseline disambiguation preferences in the offline questionnaire task. The native speakers showed a general numerical preference for NP2 modification, in line with many (albeit not all) previous studies' findings on RC ambiguity resolution in L1 English. The L2 speakers, on the other

hand, showed an overall preference for NP1 modification (compare also Dekydtspotter et al., 2008). As noted earlier, this preference may be due to NP1's comparatively greater semantic salience. It is conceivable that the presence of additional semantic and pragmatic information in the context led our non-native participants to focus more on the critical sentence's main assertion, i.e. on the main predicate-argument relations, than would have been the case if no context were present (as, for example, in Felser, Roberts, et al.'s 2003, study). No evidence for an overall NP1 or NP2 disambiguation preference was seen in our participants' online reading times, however.

Although the current study was designed to investigate effects of context rather than participants' baseline ambiguity resolution preferences, one might ask why the English native speakers did not show an overall preference for NP2 disambiguation in the online task. Since our materials did not include a neutral or 'no context' condition, we can only speculate that the lack of an overall preference might be due to the fact that our stimulus materials were different from those used in previous studies. Unlike in earlier studies which used single sentence stimuli (e.g. Felser et al., 2003), our stimulus texts required participants to remember groups and subgroups of people from the preceding discourse context, and many of the end-of-trial questions did in fact probe the initial context sentences. This might have increased the processing or working memory load relative to the shorter stimuli used in previous studies, which has been shown elsewhere to shift adult native English speakers' preferences more towards NP1 disambiguation (Felser, Marinis & Clahsen, 2003; Mendelsohn & Pearlmutter, 1999; Traxler, 2007). Working memory strain might lead readers or listeners to focus primarily on the verb and its arguments, thus increasing the relative salience of NP1, according to Mendelsohn and Pearlmutter (1999).

Taken together, our results confirm and extend those reported by Pan and Felser (2011) and suggest that non-native ambiguity resolution is more strongly affected by extra-sentential context information compared with native ambiguity resolution. This supports the hypothesis that structural and non-structural cues to sentence interpretation are differently weighted in L1 vs. L2 processing (Clahsen & Felser, 2006) and/or differ in their relative timing (Felser & Cunnings, 2012). Whilst non-native speakers can make rapid and efficient use of discourse-level (but not necessarily structural) information during ambiguity resolution, native speakers often show some delay in their sensitivity to discourse information. Clearly though, more research is needed to examine how L2 comprehenders' sensitivity to discourse cues is affected by factors such as L2 proficiency, age of onset, or task complexity.

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