Short or long distance? The processing of simple reflexive *ziji* by English learners of Chinese

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The candidate confirms that the work submitted is her own, and that appropriate credit has been given within the thesis where reference has been made to the work of others.

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Abstract

The interpretation of the Chinese simple reflexive *ziji* can be ambiguous between local vs. long-distance interpretation. Chinese features three verb types in relation to the interpretation of *ziji*: the introverted/self-oriented verb (VT1) only allow a local interpretation; the extroverted/other-oriented verb (VT2) only allow a long-distance interpretation; the ambiguous/context-dependent verb (VT3) allow both interpretations depending on the discourse-context. Hence, the current work focuses on how factors such as verb-semantic and discourse-context information influence the interpretation of *ziji* by a corpus study and a self-paced reading study.

The corpus study examines the distribution of the three verb types, indicating that compared with VT1 and VT3, VT2 is used less with *ziji*. Because only VT2 provides unambiguous evidence for a long-distance interpretation of *ziji*, the variations of the three verb types in the input of Chinese will result in a protracted acquisition of the long-distance interpretation of *ziji*. Also, the role of verb-semantic orientation and discourse prominence affecting the interpretation of *ziji* is supported based on the corpus data.

The self-paced reading study investigates how verb-semantic and discourse-context information used as retrieval cues guide the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese. The findings are as follows. English-speaking learners of Chinese are able to acquire the long-distance interpretation of *ziji*, even if the long-distance interpretation is ruled out by their L1 (English). With Chinese proficiency increasing, they allow less long-distance interpretation of *ziji* with VT1. In addition, although native Chinese speakers and English-speaking learners of Chinese are sensitive to both cues, they do not weigh the two cues in an equal way. In particular, native Chinese speakers rely more on the verb-semantic cue to interpret *ziji*, however, the discourse-context cue can over-rule the verb-semantic cue. Whereas English-speaking learners of Chinese rely more on the discourse-context cue (less on the verb-semantic) to interpret *ziji*. Also, with

Chinese proficiency increasing, they become more reliance on the verb-semantic cue, however, their reliance on the discourse-context cue is not decreased. Moreover, English-speaking learners of Chinese are generally slower than native Chinese speakers during real-time processing of *ziji*. English-speaking learners of Chinese process more when they encounter the verb before *ziji*, while native Chinese speakers take longer time to process *ziji* and onwards. Furthermore, English-speaking learners of Chinese are more susceptible than native Chinese speakers to the retrieval interference when there is a conflict between the two cues.

In conclusion, L2 acquisition of the long-distance interpretation of *ziji* by English-speaking learners of Chinese supports a probabilistic approach to L2 parameter (re)setting. Also, the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese supports a cue-based approach to language processing and comprehension.

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List of Abbreviations

AGR	Agreement
AIC	Akaike Information Criterion
ANT	Attention Network Test
CAM	Content-addressable memory
Cox PH modelling	Cox Proportional Hazard modelling
DB	Digits Backwards
DF	Digits Forwards
DP	Determiner Phrase
Event-Related Potentials	ERPs
GCP	Governing Category Parameter
INFL	Inflection
L1	First Language
L2	Second Language
LF	Logic Form
MR	Mean Rank
MR-SAT	Multiple-response Speed-accuracy Trade-off
NNS	Non-native Speaker
NP	Noun Phrase
NS	Native Speaker
SVO	Subject Verb Object
UG	Universal Grammar
VP	Verb Phrase
VT1	Verb Type 1
VT2	Verb Type 2
VT3	Verb Type 3
WM	Working Memory

Chapter 1 Introduction

1.1 The broad questions in the dissertation

Successful language comprehension requires readers or listeners to rapidly understand meaning by combining knowledge from a variety of language modules including syntax, semantics, and discourse (Politzer-Ahles et al., 2013, p. 135). As an important linguistic tool in both written and oral language comprehension, referential expressions, such as reflexives (e.g. *himself*, *herself*, etc.), pronouns (e.g. *he*, *him*, etc.), and R-expressions (e.g. *a man*, *the man*, *that man*, *this man*, *proper names*, etc.), allow people to refer back to an earlier-mentioned entity, and thereby, a coherent sentence or discourse is created (Fukumura and Van Gompel, 2010, p. 52). This dissertation focuses on reflexives.

A reflexive generally follows its antecedent (i.e. the earlier-mentioned entity referred by the reflexive) in the same sentence, and is semantically determined by the antecedent. In most languages, reflexives are subject to Principle A of Chomsky's (1980, 1981, 1986) Binding Theory, that is, a reflexive must be bound in its binding domain. For example, English reflexives require their antecedents to be locally bound within the same clause, as shown in the following sentence (1), that is, the antecedent of *himself* must be *John*. However, reflexives in languages such as Chinese, Japanese, and Korean, do not abide this principle. For instance, the antecedent of the Chinese simple reflexive *ziji* is permitted to be locally bound in the same clause as well as long-distance bound in a different clause, as shown in the following sentence (2). When *ziji* refers to the local antecedent *Lisi*, then, the sentence has the meaning of *Zhangsan thinks that Lisi trusts Lisi*. When *ziji* refers to the long-distance antecedent *Zhangsan*, then, the sentence has the meaning of *Zhangsan thinks that Lisi trusts Zhangsan.* Thus, discourse/pragmatic (i.e. context) information is required to define which antecedent is referred by *ziji*. Hence, as a long-distance reflexive, the Chinese simple reflexive *ziji* offers an opportunity to see what happens in a language where a different linguistic constraint governs the accessibility of potential

antecedents: in English, a structural boundary (local vs. non-local domain) is crucial, whereas in Chinese, non-structural constraints play a key role in defining potential antecedent candidates.

(1) Jack$_i$ thinks that [John$_j$ believes himself$^{*i/j}$].
(2) Zhangsan$_i$ renwei [Lisi$_j$ xiangxin ziji$_{i/j}$].
Zhangsan think Lisi trust self
Zhangsan$_i$ thinks that Lisi$_j$ trusts himself$_j$/him$_i$.

Over last thirty years, on the one hand, many theoretical works have tried to seek a purely syntactic characterization of the relation between *ziji* and its antecedent within the framework of Chomsky's (1980, 1981, 1986) Binding Theory (e.g. Manzini and Wexler, 1987; Pica, 1987; Battistella, 1989; Cole, Hermon and Sung, 1990; Huang and Tang, 1991; Progovac, 1992, 1993; Cole and Sung, 1994; Cole and Wang, 1996; see Hu, 1998 for a review). On the other hand, other theoretical research has focused on non-syntactic factors (i.e. semantic or discourse/pragmatic factors) that affect the antecedent of *ziji* (e.g. Huang, 1991, 1994, 2000; Chen, 1992; Xu, 1993, 1994; Pan, 1997, 2000; Pollard and Xue, 1998, 2001; see Hu and Pan, 2002 for a review). But up to now, none of them could give a satisfactory explanation on the long-distance binding of *ziji*. Moreover, as native Chinese speakers' intuition on the interpretation of *ziji* is not as clear-cut as predicted by those theoretical accounts, some psycholinguistic studies examining native Chinese speakers' real-time processing of *ziji* have provided evidence for that it could take more time to bind *ziji* to a long-distance antecedent than to a local antecedent (e.g. Gao, Liu and Huang, 2005; Liu, 2009; Li and Zhou, 2010).

Whether or not structural information guides real-time processing of reflexives has been extensively investigated, suggesting that the syntactic-binding constraint is not the sole determinant (e.g. Nicol and Swinney, 1989; Badecker and Straub, 2002; Sturt, 2003; Runner, Sussman and Tanenhaus, 2003, 2006; Kaiser et al., 2009). Recently, selecting a suitable antecedent for a reflexive is regarded as a problem of memory retrieval by researchers interested in memory mechanisms of language processing and comprehension. Within a content-addressable memory (CAM) architecture, the cue-based memory retrieval

mechanism assumes that stored linguistic representations are accessed directly based on their content. Thus, memory retrieval occurs when the content of a linguistic representation in memory matches with certain retrieval cues (e.g. McElree, 2000, 2006; McElree, Foraker and Dyer, 2003; Lewis and Vasishth, 2005; Lewis, Vasishth and Van Dyke, 2006; Van Dyke and McElree, 2006, 2011). Hence, a continual stream of studies have been conducted to investigate how different linguistic constraints, such as syntactic position, c-command, subject-hood, and person and number feature, are used as retrieval cues in interpreting reflexive dependencies (e.g. Chen and Vasishth, 2011; Chen, Jäger and Vasishth, 2012; Dillon et al., 2014; Jäger, Engelmann and Vasishth, 2015). Therefore, in order to enrich our understanding of real-time processing of reflexives from a cross-linguistic perspective, there is a need to further investigate how different kinds of linguistic constraints influence real-time processing of the Chinese simple reflexive *ziji*, and how they are used as retrieval cues.

In addition, cross-linguistic variation in reflexive binding also makes interesting predictions for second language acquisition. A considerable amount of studies have investigated L2 acquisition of English reflexives (e.g. Finer and Broselow, 1986; Thomas, 1989, 1991, 1993; Hirakawa, 1990; Finer, 1991; Lee, 1992; White, 1995, 2003; Hamilton, 1998; MacLaughlin, 1998; Yip and Tang, 1998; Demirci, 2000, 2001; Akiyama, 2002; Jiang, 2009), however, very few studies have investigated L2 acquisition of the Chinese simple reflexive *ziji* (e.g. Yuan, 1998; Ying, 1999; Huang et al., 2005; Dugarova, 2007; Zeng, 2012). In the framework of Universal Grammar (UG), Principles and Parameters (Chomsky, 1986), UG as a biologically-determined module of mind defines a set of principles for the construction of mental grammars, and allows some variation in the way that experience with language can be converted into grammatical representations. Principles are by hypothesis true for all languages, and do not have to be acquired. Possibilities for variation from language to language are standardly referred to as parameters, and by hypothesis the available options are highly restricted. Most parameters are assumed to be binary, that is, they have only two settings predetermined by UG. The central claim is that a single parameter setting brings together a cluster of apparently disparate syntactic properties

(Chomsky, 1981). Rather than learning a number of seemingly unrelated properties individually, the learner has only to discover the appropriate setting of a parameter and a range of associated syntactic properties follows automatically, thus, the acquisition task is severely reduced. In brief, given the Principles of UG and a set of unfixed parameters, the parameter setting will be triggered by the input that the learner is exposed to. Hence, native English speakers who set the parameter of binding to allow local binding only by their L1 (English) need to reset the parameter of binding to allow both local and long-distance binding triggered by the L2 (Chinese) input. Yang (2002) has proposed the Variational Learning Theory predicting that the clarity and consistency of available cues in the input has been shown to predict the speed of acquisition. Specifically, the more unambiguous the input is, the faster learners will converge on the target grammar. Conversely, the more ambiguous the input is, the longer learners will take to converge on the target grammar. Hence, it could predict that L2 acquisition of the Chinese simple reflexive *ziji* is protracted, as both local and long-distance binding of *ziji* are possible in the input. Therefore, there is also a need to better understand L2 acquisition of *ziji* under Yang's (2002) Variational Learning Theory.

Furthermore, whether or not non-native speakers are sensitive to the same linguistic cues as native speakers during language processing and comprehension is also debated. Compared with native English speakers, non-native English speakers rely more strongly on semantic and discourse cues, and comparatively less on syntactic cues during real-time processing of English reflexives (e.g. Felser and Cunnings, 2012). However, little to no research have investigated native and non-native speakers' sensitivity to different linguistic cues during real-time processing of the Chinese simple reflexive *ziji*. Therefore, the current study tries to complement a prior work on cue sensitivity in real-time processing of *ziji* by both native and non-native Chinese speakers.

To sum up, studying the Chinese simple reflexive *ziji* could not only reveal how comprehenders combine different linguistic modules/constraints/cues to

achieve successful language comprehension, but also gain new insights into real-time processing of reflexive binding across languages. Therefore, to fill a gap in the current research on reflexives, and to contribute to the understanding of language acquisition, processing and comprehension, this dissertation aims to investigate the interpretation and real-time processing of *ziji* by both native Chinese speakers and English-speaking learners of Chinese, taking non-syntactic (i.e. semantic and discourse/pragmatic) information into consideration.

1.2 Overview of the dissertation

This dissertation is organized as follows.

Chapter two reviews some representative theoretical explanations on the long-distance binding of *ziji* within syntactic, semantic, and discourse/pragmatic approaches, and provides a selective review of studies on real-time processing of English reflexives and *ziji* by native speakers from the perspective of structure-based and cue-based retrieval mechanisms in language processing and comprehension.

Chapter three first discusses Yang's (2002) Variational Learning Theory in language acquisition, followed by a selective review of studies on L2 acquisition of English reflexives and *ziji*, also with methodological implications. Then, relevant studies on L2 processing of English reflexives are also reviewed.

Chapter four reports a corpus study examining the variability of the three types of Chinese transitive verbs affecting the binding of *ziji* in the input of Chinese. Research questions, hypotheses, predictions are presented first, followed by research methods and results. On the basis of the corpus data, in order to investigate which the interpretative preference (i.e. local or long-distance) is for *ziji*, an exploratory mixed-effects modelling predicting the likelihood of the long-distance interpretation of *ziji* is built afterwards, followed by discussion.

Chapter five reports a self-paced reading study investigating effects of verb-semantic and discourse-context information in the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese within the framework of the cue-based retrieval mechanism. Research questions, hypotheses, research design and predictions are presented, followed by detailed research methodology. Data analysis and results are presented afterwards, followed by discussion.

Chapter six gives a general discussion on the corpus study (Chapter four) and the self-paced reading study (Chapter five), relating to linguistic accounts of the long-distance binding/interpretation of the Chinese simple reflexive *ziji*, and theories of language acquisition and processing of reflexive dependencies.

Chapter seven is the final chapter, which summarizes major findings and implications, and clarifies limitations of the current work. Also, suggestions for future work are proposed.

Chapter 2 Theoretical and experimental work on reflexives

2.1 Theoretical work on reflexives

2.1.1 Syntactic approach

2.1.1.1 The parameterization approach

Within the framework of Principles and Parameters, Manzini and Wexler (1987) constructed a constrained theory of parametric variation, which is compatible with existing cross-linguistic diversity. This theory argues that values of a parameter are associated not with particular grammars but with particular lexical items (Manzini and Wexler, 1987, p. 424). Hence, different types of reflexives rather than different grammars have different governing categories. Associated with Principle A of the Binding Theory (Chomsky, 1980, 1981, 1986), Manzini and Wexler (1987) proposed the Governing Category Parameter (GCP) as follows. Accordingly, English reflexives follow (a), the GC for English reflexives is always the minimal or local clause containing the reflexive, so English reflexives only can be locally bound, whereas the Chinese simple reflexive *ziji* follows (e), the GC for *ziji* is the matrix clause, so *ziji* can be both locally and long-distance bound.

'γ is a governing category for α iff

γ is the minimal category that contains α and a governor for α and has

(a) a subject (e.g. English); or

(b) an Infl (e.g. Italian); or

(c) a Tense (e.g. Russian); or

(d) a referential Tense (e.g. Icelandic); or

(e) a root Tense (e.g. Chinese).'

(Manzini and Wexler, 1987, p. 419)

Given the five different values of the GCP, a learning problem arises if the evidence available to the learner at a certain stage of development does not

unambiguously determine the correct parameter setting. In an attempt to solve this learning problem, Wexler and Manzini (1987, p. 425) proposed the Subset Principle saying that the learner selects the grammar that generates the smallest possible language that is compatible with the data. In a linguistic theory in which variation is described in terms of parameters, the set of possible languages is the set of languages generated under the different values of a parameter. Therefore, intuitively, given two or more values of a parameter, the learner selects the value of a parameter that generates the smallest language that is compatible with the data, and then, goes beyond that value only when positive evidence for a more inclusive grammar is available. Hence, for the GCP, the learner starts with a minimal local domain, and exhibit successful learning based on positive evidence.

However, Manzini and Wexler's (1987) parameterization approach of how properties of reflexive binding differ across languages faces considerable opposition. For example, it could not easily account for the relationship between reflexive morphology and the long-distance binding (Hermon, 1992, 1994). Thomas (1998, p. 269) comprehensively summarized the criticisms of this approach: (a) the atomization problem (i.e. the fact that binding principle parameter settings may account only for the properties of single lexical items, not of a class of grammatical phenomena); (b) the problem that there exist no principled restrictions on the range of governing category; (c) the problem that L1 as well as L2 acquisition data may not be accounted for the Subset Principle; and (d) the fact that a set of promising alternative proposals has emerged. Moreover, this approach has been superseded in more recent work assuming that the co-occurrence of the long-distance binding is not accidental, but is part of UG, and linking the morphological structure of reflexives to their interpretive possibilities.

2.1.1.2 The Move-to-INFL approach

To achieve the purpose of maintaining the familiar locality restriction found in English reflexive binding, one must find a way to bring the reflexive and the

remote together. A device readily available is the movement of reflexives at the abstract level of Logical Form (LF), a suggestion first made in Lebeaux(1983) and later adopted in Chomsky (1986). In view of this, the Move-to-INFL approach (e.g. Pica, 1987; Battistella, 1989; Cole, Hermon and Sung, 1990; Huang and Tang, 1991; Cole and Sung, 1994) claims that the GCs are not parameterized, instead, differences in binding domains derive from morphological properties of the polymorphemic reflexives (e.g. *himself* in English) versus the monomorphemic reflexives (e.g. *ziji* in Chinese).

Pica (1987) claimed that reflexives are defective and thus, must move at LF in order to get licensed: the monomorphemic reflexives are heads (i.e. X^0), and do not have features of person, number and gender. So, they can raise out of VP into INFL of the same clause by head-to-head movement, and are interpreted there (Pica, 1987). For example, *ziji* in the following sentence (3) moves from the object position in the embedded clause to the INFL of its own clause, from there to the INFL of the intermediate clause, and finally to the INFL of the root clause, explaining why it can have the matrix subject *Zhangsan* or the intermediate subject *Lisi* as a potential long-distance antecedent. In addition, after it raises out of VP into INFL, *ziji* is c-commanded by the subject NPs only, but not non-subject NPs, predicting a close link between *ziji* and the requirement of subject-only antecedence, which is known as subject orientation (see Battistella, 1989; Cole, Hermon and Sung, 1990; Huang and Tang, 1991; and Progovac, 1992, 1993 for a review). Hence, the long-distance binding of *ziji* and subject orientation of *ziji* are treated as two coherent outcomes of *ziji*-movement at LF.

(3) [Zhangsan$_i$ *ziji-INFL* renwei [Lisi$_j$ *t''-INFL* zhidao [Wangwu$_k$ *t'-INFL* xihuan *t*]]]

Zhangsan self think Lisi know Wangwu like

Zhangsan$_i$ thinks that Lisi$_j$ knows that Wangwu$_k$ likes ziji$_{i/j/k}$.

Cole, Hermon and Sung (1990) proposed that *ziji* undergoes INFL-to-COMP-to-INFL movement at LF. For example, in the following sentence (4), *ziji* first moves to the I position of the lowest clause, then to the C position of the same clause,

and the same cyclic movement of *ziji* occurs at the intermediate clause and the matrix clause.

(4) [Zhangsan *ziji* renwei [*t*'''' Lisi *t*''' zhidao [*t*'' Wangwu *t*' xihuan *t*]]]
Zhangsan self think Lisi know Wangwu like
Zhangsan$_i$ thinks that Lisi$_j$ knows that Wangwu$_k$ likes ziji$_{i/j/k}$.

Huang and Tang (1991) claimed that *ziji* adjoins to IP, a non-argument position. For instance, in the following sentence (5), *ziji* first adjoins to the IP position of the lowest clause, then to the IP position of the intermediate clause.

(5) [Zhangsan renwei [*ziji* Lisi zhidao [*t*' Wangwu xihuan *t*]]]
Zhangsan think self Lisi know Wangwu like
Zhangsan$_i$ thinks that Lisi$_j$ knows that Wangwu$_k$ likes ziji$_{i/j/k}$.

In contrast, as maximal phrases (X^{max}), the polymorphemic reflexives are unable to undergo head-to-head movement. When moved, they can only adjoin to the nearest maximal phrase containing them (namely, VP or PP) for an interpretation. This accounts for the fact that they require local antecedents, but are not necessarily subjects, since after adjunction to the maximal phrase, *himself* in the following sentence (6), for example, is still c-commanded by the non-subject NP *John*. However, in the following sentence (7) using *ziji*, *ziji* has to refer to the subject NP *Jack*.

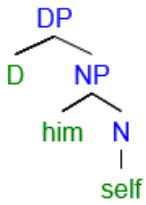
(6) Jack$_i$ told John himself$_j$ [$_{pp}$ about t_j]
Jack$_i$ told John$_j$ about himself$_j$.
(7) Jack$_i$ told John$_j$ about ziji$_i$.

In all, the movement of *ziji* is successive-cyclic, which ends up being long-distance bound. However, the fact that some European languages, such as German and Dutch, have monomorphemic reflexives requiring local binding seems problematic for this approach (Bennett and Progovac, 1993; Progovac, 1993; Bennett, 1994; Huang, 1994).

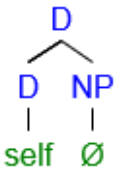
2.1.1.3 The relativized SUBJECT approach

By claiming that the long-distance binding is a reflexive-specific rather than language-specific property, Progovac (1992, 1993) proposed the relativized SUBJECT approach, which is a non-movement account. According to this approach, a reflexive and its binder must have the same X-bar status. The polymorphemic reflexives like *himself* in English are structurally DPs, as shown in (8a), hence, must be bound within the domain of a SUBJECT which is also a DP. In practice, this is the subject/object of the same clause or the subject of the same NP as the reflexive, which further defines that the polymorphemic reflexives always require local binding, and binding to subjects or non-subjects is allowed. However, the monomorphemic reflexives like *ziji* in Chinese are structurally D heads, as shown in (8b), hence, must be bound within the domain of a SUBJECT which is also a head. The only c-commanding head that has person features relevant for binding is AGR with person features inherited from the subject.

(8) a. The polymorphemic reflexive:



b. The monomorphemic reflexive:



It is well-known that Chinese does not have a morphological AGR in the sentence. However, Progovac (1992, 1993) argued that the absence of morphological AGR in Chinese does not entail the absence of syntactic AGR. Hence, *ziji* can have a long-distance antecedent when it is bound to a local AGR which is co-indexed with the AGR in higher clauses, thus creating an AGR-chain with the same index, and thus, the whole chain will become the subject. For example, in the following

sentence (9), *ziji* can have the matrix or intermediate subject as a potential long-distance antecedent through an AGR-chain ('-AGR' means morphologically null AGR; '+AGR' means morphologically overt AGR). Moreover, since *ziji* must be bound by AGR, due to co-indexation transitivity, it must refer to subjects (i.e. subject orientation).

(9) Zhangsan$_i$ renwei (-AGR) Lisi$_j$ zhidao (-AGR) Wangwu$_k$ xihuan (-AGR) ziji$_{i/j/k}$.
Zhangsan think Lisi know Wangwu like self
Zhangsan$_i$ thinks that Lisi$_j$ knows that Wangwu$_k$ likes ziji$_{i/j/k}$.

Thus, on the basis of the contrast in morphological structures between the polymorphemic reflexives (e.g. *himself* in English) and the monomorphemic reflexives (e.g. *ziji* in Chinese) via feature-sharing AGR, and a requirement of X-bar compatibility in binding, Progovac (1992, 1993)'s relativized SUBJECT approach has accounted for the possibility of the long-distance binding and subject orientation of *ziji*. However, this approach cannot explain the blocking effect, that is, if the AGRs co-indexed with the specifier of AGR (namely subject) in different clauses do not match with each other in person or number features, the long-distance binding of *ziji* is blocked, and therefore, a local antecedent is required. For example, in the following sentence (10), when the embedded subject is the first person pronoun *wo* (i.e. *I* in English) or the second person pronoun *ni* (i.e. *you* in English), only local binding is allowed, that is, *ziji* is bound by the embedded subject *wo*/*ni* but blocked from the matrix subject *John*. In contrast, in the following sentence (11), when the embedded subject is a third person referent *Bill*, both local and long-distance binding is allowed, that is, *ziji* can refer to either the embedded subject or the matrix subject. Hence, the blocking effect is asymmetric: an intervening first or second person pronoun blocks the long-distance binding whereas a third person referent does not, please see Tang (1989), Xu (1993), Hermon (1994), Cole and Wang (1996), Pan (1997, 2001), and Huang and Liu (2001) for a specific review.

(10) Zhangsan$_i$ renwei wo$_j$/ni$_j$ bu xihuan ziji$_j$.
Zhangsan think I/you NEG like self
Zhangsan$_i$ thinks that I$_j$/you$_j$ do not like myself$_j$/yourself$_j$.

(11) Zhangsan$_i$ renwei Lisi$_j$ bu xihuan ziji$_{i/j}$.
Zhangsan think Lisi NEG like self
Zhangsan$_i$ thinks that Lisi$_j$ does not like him$_i$/himself$_j$.

To summarize so far, no matter what stands they have, all these approaches have achieved a lot explaining the interpretation of *ziji*, however, none of them can fully account for the long-distance binding of *ziji* by purely syntactic analyses (Hu, 1998, p. 38). As a result, other scholars argue for the following non-syntactic (i.e. semantic, discourse/pragmatic) approaches.

2.1.2 Semantic approach: the role of predicates

Reinhart and Reuland (1993) interpreted the differences between long-distance reflexives (e.g. *ziji* in Chinese, also called SE or simplex anaphors) and local reflexives (e.g. *himself* in English, also called SELF or complex anaphors) according to their interaction with the predicate, and put forward a critical difference, that is, SELF anaphors function as 'reflexivizers', transforming a regular predicate into a 'reflexive predicate', while SE anaphors (and pronouns) do not have this function (Reinhart and Reuland, 1993, p. 659).

On the one hand, a predicate is reflexive if and only if (at least) two of its arguments are co-indexed. On the other hand, a 'reflexive predicate' is defined as one that is linguistically marked as reflexive, either the predicate's head is lexically reflexive (inherent/intrinsic), or one of the arguments of the predicate (non-inherent/extrinsic) is a SELF anaphor (Reinhart and Reuland, 1993, pp. 662-663). Specifically, the inherently/intrinsically reflexive predicate is purely reflexive, and is specified in the lexicon, like the verb *behave* in (12). Whereas the non-inherently/extrinsically predicate can be reflexive as the result of a pairing between a regular transitive predicate and a reflexively marked argument in the form of a SELF anaphor, like the verb *hate* in (13) which can be used as a reflexive predicate only with its argument is a SELF anaphor.

(12) Jack$_i$ behaved himself$_i$/him$_{*j}$.
(13) Jack$_i$ hates himself$_i$/him$_j$.

Accordingly, on the basis of the reflexivizing function, Reinhart and Reuland's (1993) approach reduces binding domains (i.e. local and long-distance) created by Chomsky's original binding conditions to two simplified domains. One is the domain of reflexivity, in which SELF anaphors must reflexivize a predicate, while SE anaphors (and pronouns) are excluded, so it is equivalent to the local domain. The other is simply stated as a domain that permits SE anaphors (and pronouns) as well as SELF anaphors. Therefore, this approach not only accounts for the cross-linguistic variation of reflexive binding throughout the world's languages, but also provide a plausible explanation for the patterning of inherently reflexive verbs.

In view of this, regarding Chinese predicates, Jin (2003) classified Chinese transitive verbs into three types according to whether these verbs can take *ziji* as an object in a simple subject-verb-object (SVO) sentence. Specifically, (a) a verb imposes a reflexive reading, that is, the agent and the patient of the verb must be the same person, for example, *Lisi$_j$ tanbai ziji$_j$*, when this sentence is used as an embedded clause in the following sentence (14), *ziji* must refer to the local antecedent *Lisi*; (b) a verb blocks a reflexive reading, that is, the agent and the patient of the verb cannot be the same person, for example, *Lisi$_j$ daiti ziji$_{*j}$*, when this sentence is used as an embedded clause in in the following sentence (15), *ziji* must refer to the long-distance antecedent *Zhangsan*; (c) if the agent and the patient of a verb can be either the same person or a different person in a SVO sentence, when this sentence is used as an embedded clause in the following sentence (16), *ziji* can refer to either the local antecedent *Lisi* or the long-distance antecedent *Zhangsan*, resulting in ambiguity. Hence, in terms of the inherent semantic orientation (Zheng, 2011), these three types of Chinese transitive verbs constrains the binding of *ziji* as follows: (a) the 1st verb type (henceforth, VT1) is the self-oriented/introverted verb expressing actions only performed on the agent, allowing *ziji* to have the local binding only, like the verb *tanbai* in the embedded clause of (14); (b) the 2nd verb type (henceforth, VT2) is the other-oriented/extroverted verb that expresses actions typically performed on somebody else rather than on the agent, allowing *ziji* to have the long-distance binding only, like the verb *daiti* in the embedded clause of (15); (c) the 3rd verb

type (henceforth, VT3) is the ambiguous verb which expresses actions performed either on the agent or on somebody else, allowing *ziji* to have both local and long-distance binding, like the verb *xiangxin* in the embedded clause of (16).

(14) Zhangsan$_i$ rang Lisi$_j$ tanbai ziji$_{*i/j}$.
Zhangsan ask Lisi confess self
Zhangsan$_i$ asks Lisi$_j$ to confess himself$_{*i/j}$.

(15) Zhangsan$_i$ rang Lisi$_j$ daiti ziji$_{i/*j}$.
Zhangsan ask Lisi replace self
Zhangsan$_i$ asks Lisi$_j$ to replace him$_{i/*j}$.

(16) Zhangsan$_i$ rang Lisi$_j$ xiangxin ziji$_{i/j}$.
Zhangsan ask Lisi trust self
Zhangsan$_i$ asks Lisi$_j$ to trust him$_i$/himself$_j$.

Li and Zhou (2010) conducted an Event-Related Potentials (ERPs) study to investigate the real-time processing of *ziji* in the common Chinese sentence structure, that is, *[NP$_1$ VP$_1$ [NP$_2$ VP$_2$ ziji]]*, with the above three verb types as VP2. Results showed that compared with the self-oriented/introverted verb favouring a local reading of *ziji*, the other-oriented/extroverted verb favouring a long-distance reading of *ziji* evoked a more pronounced positivity between 300-400ms and a subsequent P600. While the P300 effect might reflect the detection of incongruence between the mental representation dictated by Principle A and the representation based on the processing VP2, the P600 effect might be associated with a second-pass integration process that links *ziji* to its long-distance antecedent. Thereby, linking *ziji* to a long-distance antecedent engenders more processing demands rather than to a local antecedent, and hence, incurs processing costs. In addition, ERP responses to *ziji* with the ambiguous verb were at an intermediate level between the 300-400ms time window (i.e. P300 effect) and the 450-750ms time window (i.e. P600 effect).

In a word, the influence of distinct verb types with regard to the interpretation of *ziji* is affirmative, which therefore is pertinent to the current work.

2.1.3 Pragmatic/Discourse approach: discourse prominence

In order to interpret referring expressions, comprehenders also rely on background or situational knowledge, and the goals of the discourse (Heim, 1982; Kintsch, 1988; Tanenhaus et al., 1995; Arnold et al., 2000; Garnham, 2000). In particular, each sentence is interpreted relative to a propositional representation of the current state and situation of the discourse, including a set of discourse referents (i.e. the entities under discussion), and the propositions predicated over those referents (i.e. their properties, and their relationships with other referents) (Kamp and Reyle, 1993; Gordon and Hendrick, 1997, 1998; Garnham, 2000). This propositionally encoded discourse representation integrates discourse-provided information with background or situational knowledge, and aspects of the referential context. Also, discourse referents are ranked in terms of prominence, which is the fundamental insight of centering theory (Grosz and Sidner, 1986; Ariel, 1990; Gordon et al., 1993; Garrod and Sanford, 1994; Brennan, 1995; Walker et al., 1998; Arnold et al., 2000).

In general, entities that are highly prominent in the discourse representation are more easily identified as referents for pronouns by comprehenders, while less prominent referents tend to be invoked by more specific forms, such as definite noun phrases or proper names (Prince, 1992; Gundel et al., 1993; Almor, 1999; Ariel, 2001). What's more, discourse prominence of referents is also strongly influenced by the status of grammatical subject. Referents that have been established as subjects in sentences are more likely to be invoked again in subsequent sentences than are non-subject referents, and a repeated referent is more likely to be realized as a subject pronoun if it was the grammatical subject of the previous sentence (Prince, 1992; Brennan, 1995; Arnold, 1998). It is also easier to interpret a pronoun subject with the subject of the immediately preceding sentence (Gordon et al., 1993; Arnold et al., 2000). In addition, discourse-old, or given referents are more likely than new referents to appear early in sentences, especially in subject position, and to be pronominalized (Clancy, 1992; Prince, 1992; Chafe, 1994; Fisher and Tokura, 1995). Furthermore, referents that are the topic of a discourse, or mentioned more often, or mentioned in the beginning, are more easily understood as the referents

of pronouns (Clancy, 1980; Grosz et al., 1983; Garrod and Sanford, 1988; Brennan, 1995) (Song and Fisher, 2007, pp. 1962).

Hence, the essential role of the prominence or salience of various referents in the discourse context playing in pronoun interpretation can be taken as a strategy to deal with the interpretation of *ziji* with VT3 (i.e. the ambiguous verb) in the above sentence (16). In this sentence, both local and long-distance antecedents can be the referent of *ziji*. Specifically, if given a discourse context that *Zhangsan knows that Lisi is not very confident to win the competition*, then *ziji* only refers to the local antecedent *Lisi*. But if given a discourse context that *Lisi heard that Zhangsan revealed the company's confidential information for benefits*, then *ziji* only refers to the long-distance antecedent *Zhangsan*. Thus, in terms of the prominence of the two referents of *ziji* in different discourse contexts, the ambiguity of *ziji* is solved. Therefore, VT3 (i.e. the ambiguous verb) is also named the context-dependent verb.

(16) Zhangsan$_i$ rang Lisi$_j$ xiangxin ziji$_{i/j}$.
Zhangsan ask Lisi trust self
Zhangsan$_i$ asks Lisi$_j$ to trust him$_i$/himself$_j$.

Li and Kaiser (2009) investigated effects of context on the interpretation of *ziji* in an offline task by using a preceding discourse. Results showed that there is a strong preference for local binding in the neutral sentences, while in the biased sentences making the long-distance more prominent, the long-distance antecedent overcomes the preference for local binding. In conclusion, a discourse context can guide the interpretation of *ziji.*

In a word, besides syntactic factors (i.e. syntactic-binding), the long-distance binding of *ziji* can be better understood by taking pragmatic/discourse factors (i.e. discourse prominence of referents in a discourse context) into consideration.

2.2 Experimental work on reflexives

Apart from theoretical work on elaborating reflexives, there is a growing body of experimental work on reflexives. More recently, within a Memory Architecture approach to sentence processing and comprehension, researchers regard the question of antecedent selection for reflexives during real-time processing as a question of memory retrieval by general information-retrieval mechanisms, and put emphasis on (i) whether syntactic or non-syntactic information are used by comprehenders to guide antecedent retrieval, and (ii) how this retrieval is executed during real-time processing. Two main accounts have emerged, that is, structure-based and cue-based retrieval. The remainder of this section summarizes some of the key experiments that support these two accounts, and their claims.

2.2.1 Studies supporting the structure-based retrieval

The structure-based retrieval (e.g. Nicol and Swinney, 1989; Sturt, 2003) argues that syntactic information have some kind of priority over non-syntactic information. In particular, retrieving a reflexive's antecedent during real-time processing is limited to syntactic information as c-command within the reflexive's binding domain, without considering any other non-syntactic information.

Nicol and Swinney (1989) conducted a cross-modal priming experiment to investigate the reactivation patterns of syntactically appropriate (henceforth, accessible), and syntactically inappropriate inaccessible (henceforth, inaccessible) antecedents during the real-time processing of English reflexives. Specifically, participants heard target sentences like (17) (Nicol and Swinney, 1989, p. 12), which contains three antecedents (i.e. *the boxer*, *the skier*, *the doctor*) as below. The second embedded subject (i.e. *the doctor*) is the only licit antecedent for the reflexive *himself*. Immediately after participants heard the reflexive, a word appeared on the screen. Participants were asked to indicate whether or not the presented word on the screen was a real word, and their

responding times were recorded. Those words for the lexical decision task were either control words (e.g. *claim*) that were semantically unrelated to any of the three antecedents in the target sentence, or a word (e.g. *fight* for *the boxer*, *slope* for *the skier*, and *nurse* for *the doctor*) which was semantically related to one of the three antecedents. The results showed that correct responses to words that were semantically related to accessible antecedents (e.g. *nurse* for *the doctor* in (17)) were significantly faster than correct responses to both control words (e.g. *claim*) and words related to inaccessible antecedents (e.g. *fight* for *the boxer*, *slope* for *the skier* in (17)). Words related to inaccessible antecedents did not elicit faster responding times than control words. Hence, the lack of priming effects for inaccessible antecedents is taken as evidence for that inaccessible antecedents are not activated during the real-time processing of reflexives. Nicol and Swinney (1989) further claimed that the initial pool of antecedent candidates during the real-time processing of reflexives only includes antecedents that are licensed by the syntactic-binding constraint. Hence, the syntactic-binding constraint is an early filter that immediately blocks inaccessible antecedents from being considered by comprehenders, which is known as the binding-as-initial-filter hypothesis. However, Nicol and Swinney (1989) did not tell much about how the syntactic-binding constraint developed over time.

(17) The boxer_{i} told the skier_{j} that the doctor_{k} for the team would blame $\text{himself}_{*i/*j/k}$ for the recent injury.

This binding-as-initial-filter hypothesis was further investigated by Sturt (2003). Sturt adopted an eye-tracking study to examine comprehenders' eye movements during their readings of the following sentences like (18), (19), (20) and (21). In these four sentences, *surgeon* has a default assumption of being male, however, *surgeon* can also be female (Sturt, 2003, p. 546). The results of participants' early eye-movement data suggested that in the very initial stage of processing, participants' reading pattern was consistent with the syntactic-binding constraint. In other words, immediately after reading the reflexive, participants only considered accessible antecedents as suggested by their eye-fixation patterns. Whereas participants' late eye-movement data suggested that they

only considered discourse-prominent but binding-inaccessible antecedents during later processing stages. Hence, these findings led Sturt (2003) to propose the binding-as-defeasible-filter hypothesis, in which accessible antecedents are considered only at the initial stage of processing, but inaccessible can be taken into consideration at later stages of processing. In other words, the syntactic-binding constraint is applied at the earliest processing stage, but can be overridden when other kinds of constraints become available during subsequent stages of processing.

(18) accessible-match/inaccessible-match:

Jonathan$_i$ was pretty worried at the City Hospital. He$_i$ remembered that the surgeon$_j$ had pricked himself$^{*i/j}$ with a used syringe needle. There should be an investigation soon.

(19) accessible-match/inaccessible-mismatch:

Jennifer$_i$ was pretty worried at the City Hospital. She$_i$ remembered that the surgeon$_j$ had pricked himself$^{*i/j}$ with a used syringe needle. There should be an investigation soon.

(20) accessible-mismatch/inaccessible-match:

Jonathan$_i$ was pretty worried at the City Hospital. He$_i$ remembered that the surgeon$_j$ had pricked herself$^{*i/*j}$ with a used syringe needle. There should be an investigation soon.

(21) accessible-mismatch/inaccessible-mismatch:

Jennifer$_i$ was pretty worried at the City Hospital. She$_i$ remembered that the surgeon$_j$ had pricked herself$^{*i/*j}$ with a used syringe needle. There should be an investigation soon.

Xiang, Dillon and Phillips (2009) used ERPs to investigate the processing of reflexives in settings like (22), (23), and (24), and gave evidence for the effect of the binding-inaccessible antecedent during early processing stages. In (22), *soldier* is the syntactically licit antecedent for the reflexive *himself*, while a male-referring noun *Fred* matches with the reflexive *himself* in gender, but occurs inside a relative clause which modifies *soldier*, therefore, cannot be a legitimate antecedent. In (23) and (24), *soldier* is still the antecedent of the reflexive *herself*, but comprehenders may reanalysis at the reflexive because of the default assumption that *soldier* is male, however, *soldier* can also be female. The key difference between (23) and (24) is that a female-referring noun *Katie* matches with the reflexive *herself* in gender, but is an illegal licensor of the reflexive

herself in (23). The results of ERPs found that compared to (22), both (23) and (24) elicited a P600 effect for difficulty in syntactic processing or information integration. However, there was a non-significant positivity in the 800-1000ms window in (23) vs. in (24). If this effect was statistically significant, then it would be indicative of an interference effect. However, the increased positivity in the (23) indeed suggested a greater difficulty, which was interpreted as a late interference effect (Xiang, Dillon and Phillips, 2009). A marginal centro-anterior negativity in the 250-350ms interval was also found, but rejected as a possible evidence for an early effect of interference, because this effect was only found in a post-hoc analysis driven by visual inspection, and also, no previous ERP study relating to reflexives had found such an effect (Xiang, Dillon and Phillips, 2009, p. 50). Hence, Xiang, Dillon and Phillips (2009) concluded that if any interference effect does exist in the processing of reflexives, it would be potentially a late effect. In other words, only structural cues are considered to search the antecedent in the initial stages of processing.

(22) Congruent:

The tough soldier$_i$ that Fred$_j$ treated in the military hospital introduced himself$_{i/*j}$ to all the nurses.

(23) Intrusive:

The tough soldier$_i$ that Katie$_j$ treated in the military hospital introduced herself$_{i/*j}$ to all the nurses.

(24) Incongruent:

The tough soldier$_i$ that Fred$_j$ treated in the military hospital introduced herself$_{i/*j}$ to all the nurses.

Phillips, Wagers and Lau (2010) further argued for the syntactic configuration only with respect to reflexives, at least in English. The person, gender, and number features also influence retrieval, but for accessible antecedents only (Dillon et al., 2013). Moreover, structural cues only seems to be overridden if the local antecedent is a particularly poor feature match for the reflexive (Parker and Phillips, 2017).

2.2.2 Studies supporting the cue-based retrieval

Badecker and Straub (2002) argued that comprehenders also briefly considered antecedents that were not licensed by the syntactic-binding constraint during real-time processing. Using the word-by-word moving-window self-paced reading paradigm, also with a probe-recognition secondary task, Badecker and Straub (2002) investigated the processing of sentences like (25) and (26) (Badecker and Straub, 2002, p. 758). In both sentences, the embedded or local subject *Bill* is the only antecedent allowed by the syntactic-binding constraint. Although (25) and (26) both have only one accessible antecedent *Bill*, they differ crucially in the gender feature of the matrix or long-distance subject. In (25), the matrix subject *Jane* has a different gender from the embedded subject *Bill* and the reflexive *himself*, while in (26), the matrix subject *John* matches the embedded subject *Bill* and the reflexive *himself* in gender. Badecker and Straub (2002) hypothesized that if the syntactic-binding constraint immediately filtered out inaccessible long-distance antecedents, then reading times in the two sentences should not be different, because only accessible antecedents *Bill* was considered. Alternatively, if the syntactic-binding was not as an initial filter, both gender-compatible antecedents (i.e. *John* and *Bill* in (26)) were considered before the correct antecedent was chosen. As a result, there should be reading time slowdowns as it takes more time for comprehenders to select an antecedent from two antecedent candidates. Indeed, Badecker and Straub (2002) found that it was significantly slower to read sentences with two gender-compatible antecedents, such as (26), than to read sentences with the only gender-compatible antecedent as the accessible antecedent, such as (25). Therefore, the slower reading times is taken to be evidence for two antecedent candidates competing with each other, which further argues that the initial set of antecedent candidates includes both accessible and inaccessible antecedents. Thus, Badecker and Straub (2002) concluded that comprehenders also consider inaccessible antecedents during real-time processing, so the initial stage of processing is not constrained by the syntactic-binding constraint only, but also constrained by other non-syntactic constraints. Hence, Badecker and Straub (2002) proposed the interactive-parallel-constraint model, that is, both syntactic and non-syntactic constraints were applied in parallel throughout processing,

and interact, compete with each other to determine the outcome of antecedent selection. Runner, Sussman and Tanenhaus (2006) and Kaiser et al., (2009) also support this model by investigating the interplay of structural and non-structural constraints on the reference assignment of reflexives and pronouns in picture NPs (e.g. *the picture of him/himself*). Which antecedents are accessible for picture NPs is still debated, and also, this is beyond the current issue.

(25) Jane$_i$ thought that Bill$_j$ owed himself$_{*i/j}$ another opportunity to solve the problem.

(26) John$_i$ thought that Bill$_j$ owed himself$_{*i/j}$ another opportunity to solve the problem.

According to the interactive-parallel-constraint model, various constraints acting during the antecedent-evaluation process independently assign either positive or negative activation to a candidate antecedent. The total activation level of an antecedent is the sum of the positive and negative activation apportioned to it by separate parallel acting constraints. If a candidate antecedent receives positive support from one constraint (e.g. discourse-prominent) and inhibition from another (e.g. syntactic-binding), then the excitatory activation for that antecedent will be functionally cancelled out. This model not only fits with a multiple-constraint view of language processing arguing that all relevant constraints are simultaneously available, and the extent to which they influence processing depends on their relative strengths (e.g. MacDonald, Pearlmutter and Seidenberg, 1994; Spivey and Tanenhaus, 1998), but also is consistent with the recent cue-based retrieval suggesting that all available information is used for retrieving the antecedent, and only the item whose features provide a close match to retrieval cues is then retrieved (e.g. McElree 2000, 2006; McElree, Foraker and Dyer, 2003; Van Dyke and Lewis, 2003; Lewis and Vasishth, 2005; Lewis, Vasishth and Van Dyke, 2006; Van Dyke and McElree, 2006).

In recent years, interference effects (e.g. Lewis et al., 2006; Van Dyke and Johns, 2012) affecting the processing of reflexive dependencies have drawn considerable attention. On the one hand, as retrieval involves the matching a set

of retrieval cues with all items in memory in parallel, a distractor item that partially matches the retrieval cues may sometimes be retrieved instead of the intended retrieval target. Thus, an inhibitory interference effect occurs, which results in a slowdown in processing during retrieval because of the competition between the target antecedent and the distractor (Jäger, Engelmann and Vasishth, 2015). See the following sentences (27) and (28) (Jäger et al., 2015, p. 4) in antecedent-match conditions, here, the default assumption is that *surgeon* is male, however, *surgeon* can also be female. The inhibitory interference effect is predicted to occur in (27), because both the target antecedent *surgeon* and the distractor *Jonathan* matches with the reflexive *himself* in gender, which leads to the competition between the target antecedent and the distractor. Thus, longer retrieval latencies, and hence, longer reading times at the reflexive are predicted in (27) compared with (28). Also, the mis-retrieval of the partially cue-matching distractor *Jonathan* in (27) is predicted.

(27) antecedent-match; distractor-match:
The surgeon$_i$ who treated Jonathan$_j$ had pricked himself$_{i/*j}$ . . .
(28) antecedent-match; distractor-mismatch:
The surgeon$_i$ who treated Jennifer$_j$ had pricked himself$_{i/*j}$ . . .

Some studies also found the inhibitory interference effect, leading to increased processing difficulty in antecedent-match conditions, due to a cue-matching distractor (e.g. Badecker and Straub, 2002, Experiment 3 and 4; Clackson and Heyer, 2014; Jäger et al., 2015, Experiment 2). Whereas other studies observed no such interference effect (e.g. Badecker and Straub, 2002, Experiments 5 and 6; Sturt, 2003; Cunnings and Sturt, 2014; Kush and Phillips, 2014; Jäger et al., 2015, Experiment 1).

On the other hand, see the following sentences (29) and (30) (Jäger et al., 2015, p. 4) in antecedent-mismatch conditions. No inhibition or competition between the target antecedent *surgeon* and the distractor *Jennifer* or *Jonathan* is predicted because the target antecedent and the distractor do not match with any retrieval cues (i.e. neither the gender cue nor the structural cue (the syntactic-binding)). However, the interference effect is also predicted to occur in (29), because the

distractor *Jennifer* matches with the reflexive *herself* in gender, while in (30), the distractor *Jonathan* does not match with the reflexive *herself* in gender. Therefore, in spite of the absence of the inhibition or competition between the distractor and the target antecedent, due to the partially cue-matching distractor *Jennifer*, the mis-retrieval still sometimes occurs, which facilitates processing. Thus, shorter reading times at the reflexive are predicted in (29) compared with (30). Hence, this interference is referred as a facilitatory interference effect.

(29) antecedent-mismatch; distractor-match:
The surgeon$_i$ who treated Jennifer$_j$ had pricked herself$_{i/*j}$ . . .
(30) antecedent-mismatch; distractor-mismatch:
The surgeon$_i$ who treated Jonathan$_j$ had pricked herself$_{i/*j}$ . . .

In contrast, when different cues used for retrieval point to the same target item, then, a multiple-cue matching arises, resulting in a facilitatory effect. Thus, faster retrieval latencies, and hence, shorter reading times at the reflexive are also predicted.

In addition, Cunnings and Felser (2013) examined the role of working memory (WM) capacity in readers' application of the syntactic-binding constraint (i.e. the binding Principle A) during real-time processing of English reflexives. Specifically, whether the binding Principle A is reducible to a memory friendly 'recency' strategy, and whether WM capacity influences the degree to which readers create reflexive dependencies ruled out by binding theory. Their eye-tracking data showed that both low and high WM span readers applied the Principle A of Binding Theory early during processing. Also, low WM span readers showed immediate intrusion effects of a linearly closer but structurally inaccessible competitor antecedent. Thus, they claimed that although the relative prominence of a potential antecedent in WM can affect whether or not it was included in the candidate set of antecedents, it is not possible to reduce early effects of the Principle A to a processing or linear distance based 'least effort' strategy that merely attempts to keep reflexive dependencies as short as possible. However, Cunnings and Felser (2013) did not find any

inhibitory/facilitatory interference effect or facilitatory effect as mentioned above.

In sum, inhibitory/facilitatory interference effect, and facilitatory effect can be interpreted as informative evidence for a cue-based retrieval mechanism underlying real-time processing of reflexive dependencies. It is also worth noting that if syntactic constraints are weighted more heavily than non-syntactic ones, it is still possible to implement the structure-based retrieval within the cue-based retrieval mechanism (Dillon et al., 2013; Parker and Phillips, 2017).

2.2.3 Interpretation of *ziji*: preference and processing costs

Gao, Liu and Huang (2005) conducted a cross-modal priming experiment asking participants to disambiguate the antecedent of *ziji* in sentences without any discourse context, like (31), in which *ziji* is ambiguous in the sentence, and can be interpreted as referring to either the matrix subject *laoshi* (i.e. *teacher*) or the embedded subject *jizhe* (i.e. *reporter*). At the end of each sentence, participants were asked to name a visually presented target, which could be a word (e.g. *student*) relevant with the matrix subject, a word (e.g. *news*) relating to the embedded subject, or a neutral word (e.g. *bag*). The results showed that the naming latency was shorter for the word relating to the embedded subject than for the word relevant with the matrix subject. Such difference indicated that the local antecedent of *ziji* (i.e. the embedded subject) has a stronger preference for being selected. Hence, Gao, Liu and Huang (2005) concluded that *ziji* has a preference for the locally bound antecedent during the real-time processing.

(31) Laoshi$_i$ gaosu jizhe$_j$ zunzhong ziji$_{i/j}$.
teacher tell reporter respect self
The teacher$_i$ told the reporter$_j$ to respect him$_i$/himself$_j$.

A further experiment conducted by Liu (2009) used the same design and critical stimuli as Gao, Liu and Huang (2005) in a lexical decision task, but with different stimulus onset asynchrony (SOA, that takes for one stimulus to end and another to start) between *ziji* and the target. Specifically, here, the SOA refers to a time

interval between participants finishing reading the sentence ending with *ziji* and the target word presented on the screen. At the SOA of 0ms, the reaction time was shorter to the target word relating to the embedded subject than to the target word relevant with the matrix subject or the neutral word. At the SOA of 160ms, the reaction time was shorter to the target word relevant with the matrix subject than to the target word relating to the embedded subject or the neutral word. However, at the SOA of 370ms, there was no difference between the target word relevant with the matrix subject and the target word relating to the embedded subject, but responses to these two types of words were shorter than to the neutral word. Hence, the local binding between *ziji* and the local antecedent (i.e. the embedded subject) dominates over the long-distance binding between *ziji* and the long-distance antecedent (i.e. the matrix subject) at the earliest stage of processing, while the long-distance interpretation of *ziji* can take over at later stages of processing. In addition, Li and Zhou's (2010, reviewed in Chapter 2.1.2) ERPs study also found an increased processing demands (i.e. a larger P300/600 response) for the long-distance interpretation of *ziji*.

Besides Li and Kaiser's (2009) offline task (reviewed in Chapter 2.1.3) showing a preference for a local antecedent of *ziji* in neutral sentences could be overridden by a preceding discourse context biased for a long-distance antecedent, a follow-up study used a self-paced reading experiment to investigate real-time processing of *ziji*. In particular, whether the effect of context emerges early, or whether context only influences processing later on. The results showed that the activation of the long-distance antecedent was increased by the biased context, while both local and long-distance antecedents competed with each other in the neutral context, resulting in a slower processing at the reflexive *ziji* and during the following words after *ziji* (i.e. the spillover regions). Hence, Li and Kaiser (2009) suggested that although *ziji* has a default preference for a local antecedent in the neutral context, preceding discourse-contextual information can weaken this preference, and rapidly affects the interpretation of *ziji* at an early stage of processing.

Recently, Chen, Jager and Vasishth's (2012) study was the first one to test interference effects in the interpretation of *ziji*. The results of a self-paced reading task showed that question-response accuracy was higher, and question-response latency was shorter in conditions with a local antecedent, which indicated that processing a local antecedent of *ziji* was easier. More importantly, an effect of interference at the reflexive *ziji* and in the spillover regions was found in conditions with a long-distance antecedent, which was shown by retrieving the inaccessible antecedent, and also, slower reading times. Hence, the findings suggested that comprehenders do use non-structural information to determine whether an antecedent is the target one for *ziji*, consistent with the cue-based retrieval mechanism. (Here, note that it is not clear what structural information is used for guiding *ziji*, as reviewed in Chapter 2.1.1).

Dillon et al., (2014) investigated the nature of syntactic cues guiding retrieval operations, that is, whether syntactic cues refer only to the attributes of individual syntactic encodings (i.e. item information, such as case or thematic role), or whether syntactic cues distinguish constituents based on their hierarchical or linear distance from the retrieval site (i.e. position information). Also, Dillon et al., (2014) proposed the Local Search Hypothesis, which hypothesized that the cues guiding memory retrieval during parsing do include positional syntactic information, and positional information are used as retrieval cues to prioritize retrieval of constituents within the local syntactic domain (Dillon et al., 2014, p. 3). Accordingly, they examined the time course of antecedent retrieval for *ziji* by using the multiple-response speed-accuracy trade-off (MR-SAT) techniques. The MR-SAT technique involves eliciting behavioral responses at a series of pre-defined response deadlines, and importantly, the resulting SAT function may be separated into independent measures of processing speed and processing accuracy, so that using MR-SAT technique can give clear evidence for direct modelling of the time course of retrieval (McElree, 2006). The results showed that *ziji* was processed more quickly with a local antecedent than with a long-distance antecedent, which supports theories that attribute locality effects to a substantive bias to search syntactically local domains at retrieval, rather than theories that attribute

locality effects entirely to effects of decay or interference of items in working memory (MacDonald, Pearlmutter and Seidenberg 1994; Lewis and Vasishth 2005; Lewis, Vasishth and Van Dyke 2006). Hence, the locality advantage when retrieving an antecedent for *ziji* reflects an explicit local search strategy, that is, comprehenders prioritize retrieval of items within the local clause when retrieving an antecedent (Dillon et al., 2014).

Dillon, Chow and Xiang (2016) attempted to determine how generally the locality bias effect observed by Dillon et al. (2014) is during the processing of Mandarin Chinese reflexives. They used two self-paced reading experiments to investigate whether the locality bias effect is associated specifically with the morphologically simple reflexive *ziji*, or it also obtains for the morphologically complex reflexive *ta-ziji* yielding richer retrieval cues on potential antecedents, such as the gender cue. It was found that *ziji* showed a robust locality bias in reading time measures in Experiment 1, while *ta-ziji* showed a reduced locality bias in Experiment 2. Thus, Dillon, Chow and Xiang (2016) suggested the contrast between the two experiments was due to the difference in the number of morphological and semantic cues on *ta-ziji* compared with *ziji*. In particular, *ziji* with relatively fewer cues is more likely to access non-target antecedents during antecedent retrieval, which requires comprehenders to sample multiple antecedents in order to achieve an interpretation, resulting in the locality bias effect. However, the relatively more specified *ta-ziji* has more cues for antecedent retrieval, which makes it less susceptible to interference from non-target representations in memory, and allows it to more reliably access an antecedent regardless of its linear or structural distance. For this reason, the reduced interference in turn leads to a significantly diminished locality bias effect for *ta-ziji*. Hence, this finding was attributed to how the parser makes use of richer morphological cues of morphologically complex reflexives in retrieving an antecedent from memory (Dillon, Chow and Xiang, 2016).

In sum, all these experimental studies provide empirical evidence about the interpretation and processing of the Chinese simple reflexive *ziji*. Specifically, the

interpretation of *ziji* is not restricted to the local/embedded clause, however, a local interpretation of *ziji* is strongly preferred over a long-distance interpretation. What's more, the locality bias effect associated with *ziji* reflects an explicit local search strategy within the cue-based retrieval account. Furthermore, if a long-distance interpretation occurs, it takes more time, and also incurs higher processing costs. Finally, besides structural information, other non-structural (i.e. semantic, discourse-context) information are also used to interpret *ziji*.

2.3 Summary

Given the above, this current work aims to explore how non-structural (i.e. verb-semantic and discourse-context) information influence native Chinese speakers' interpretation of *ziji*, and also, to provide further experimental evidence (i.e. inhibitory/facilitatory interference effect, and facilitatory effect) for the cue-based retrieval mechanism involved in native Chinese speakers' real-time processing of *ziji*.

The next chapter will review the literature on L2 acquisition and processing on reflexive binding, and outlines the contribution of this work in that domain.

Chapter 3 L2 acquisition and processing on reflexives

3.1 A probabilistic approach to parameter resetting

On the basis of limited language evidence and little explicit instruction, a key question is how children know that certain structures and interpretations are not permitted, and finally get to master the language which is so complex. In other words, the mismatch between utterances that children are exposed to (i.e. the input) and grammatical knowledge that children acquire (i.e. the output) gives rise to the well-known problem of the 'logical problem of language acquisition' or the 'poverty of the stimulus' (Chomsky, 1965, 1986). In view of this, Universal Grammar (UG), an innate, biologically endowed language faculty, a system of linguistic principles and properties of all human languages (Chomsky, 1976, p. 29), is proposed to explain how children come to unconsciously know abstract, subtle and complex properties of grammar that go far beyond the L1 input in various respects. So, as a cornerstone, UG constitutes children's initial state, and the knowledge that children are equipped with (Chomsky, 1980), and therefore, permits children to arrive at the L1 grammar on the basis of the L1 language input or exposure. Regarding L2 acquisition, L2 learners face a situation parallel to that of L1 acquirers, that is, relying on insufficient L2 input, L2 learners have to arrive at a highly abstract unconscious linguistic system which allows them to comprehend and produce the L2. Given this similarity, Schwartz and Sprouse (1996) proposed the Full Transfer/Full Access model, assuming that the L1 grammar in its entirety is transferred into the initial state of L2 acquisition (i.e. Full Transfer). When the L2 input cannot be parsed by the current L1 grammatical representation, the current L1 parameters will be reset, or the current L1 rules will get unused or changed. Thus, the interlanguage grammar (ILG) will be restructured in response to properties of the L2 input interacting with UG. The resulting grammar of L2 learners is fully UG-constrained (i.e. Full Access).

Yang (2002) proposed the Variational Learning Theory for L1 acquisition to account for the fact that parameters are uniformly and instantaneously switched

on, and parameter (re)setting involves a stage of apparent optionality. From insights of biological evolution and experience-dependent language learning, development of the language learning mechanism is similar to other organic systems, requiring interaction between internal and external factors, that is, interaction between learners' internal knowledge of language and external language experience that acquirers receive. So, under the framework of Yang's (2002) Variational Learning Theory, language acquisition is modelled as a competition among a population of 'grammars' to vary adaptively in response to external language input. No matter how much innate knowledge of language acquirers are endowed with, language still must be acquired from experience or input, and therefore, variations in the terminal state of language acquisition are caused (Yang, 2002, pp. 4-6). Compared with L1 acquisition, there is more variability in L2 acquisition depending on a range of naturalistic or instructed L2 settings. So, Yang's (2002) Variational Learning Theory is logically extendable to explain L2 acquisition assuming Schwartz and Sprouse's (1996) Full Transfer/Full Access model (Slabakova, 2008, p.116). As the initial state or starting point of L2 learners, the L1 grammar leads to the competition with the L2 grammar. Although the L1 grammar owns a privileged status, when L2 learners' L1 grammar fails to analyse the incoming L2 input, the L2 grammar is accessed. In addition, the rise of the target L2 grammar to its top probability correlates with the percentage of sentences in the L2 input that unambiguously reward the target L2 grammar (Slabakova, 2008, pp. 117-120). In a word, according to Yang's (2002) Variational Learning Theory, language acquisition is a process of competition among the UG-defined grammars. The variability in the L2 input leads L2 learners to move from grammar to grammar, which further causes L2 learners' variable language production and expression.

Considering L2 acquisition of the Chinese simple reflexive *ziji*, learners whose L1 only allows local binding for reflexives need to reset the relevant parameter to extend the size of the binding domain, and thus, to allow long-distance binding as well as local binding. Specifically, at the initial state, English speakers are expected to access local binding based on their L1 grammar to parse the L2 Chinese input. However, when encountering the L2 input incompatible with a

local binding, the grammar of the long-distance binding will be reinforced. In terms of the inherent verb-semantic constraint on the binding of *ziji* (reviewed in Chapter 2.1.2), VT1 (i.e. the self-oriented/introverted verb) unambiguously rewards the local binding of *ziji*, and VT3 (i.e. the ambiguous/context-dependent verb) rewards both local and long-distance binding of *ziji*, while only VT2 (i.e. the other-oriented/extroverted verb) unambiguously rewards the long-distance binding of *ziji*. This variation in the input of Chinese is predicted to result in protracted resetting of the relevant parameter of binding of *ziji* for English speakers learning L2 Chinese.

3.2 Studies on L2 acquisition of reflexives

3.2.1 Studies on L2 acquisition of English reflexives

Since the early study of Finer and Broselow (1986) investigating L2 learners' interpretation of English reflexive binding under a UG paradigm, a large number of studies have been conducted to investigate to what extent UG, L1 transfer and the UG-constrained L2 parameter resetting involved in the acquisition of the locality constraint on English reflexive binding by speakers of languages (i.e. Chinese, Japanese, Korean, etc.) that instantiate long-distance binding (e.g. Cook, 1990; Hirakawa, 1990; Thomas, 1991; Finer, 1991; Eckman, 1994; Lakshmanan and Teranishi, 1994; Yuan, 1994; White, 1995; Wakabayashi, 1996; White et al., 1997; MacLaughlin, 1998; Wells, 1998; Yip and Tang, 1998; Akiyama, 2002; Jiang, 2009).

Hirakawa (1990) investigated L2 acquisition of syntactic properties of English reflexive binding by using a multiple-choice grammaticality judgment test. The results showed that Japanese learners of English allowed long-distance binding of English reflexives in both finite clauses like *John said that Bill hit himself* (Hirakawa, 1990, p. 70), and non-finite clauses like *Mary asked Ann to introduce herself* (Hirakawa, 1990, p. 70), which indicates that the L1 Japanese parameter setting of binding is transferred into L2 English, thus, supports Full Transfer. And a small percentage of those Japanese learners of English correctly interpreted

local binding of English reflexives in all the test sentences, suggesting that the parameter resetting of binding appears to be difficult but nevertheless possible at least for some L2 learners. Hence, Hirakawa (1990) argued for the availability of UG, L1 transfer and L2 parameter resetting in the acquisition process.

Reinterpreting the data on the acquisition of English reflexive binding by Chinese, Japanese and Korean learners of English, Yuan (1994) claimed that those results provide evidence for L1 transfer because of both local and long-distance binding in L2 learners' L1 languages, but could not tell the whole truth for the availability of UG or L2 parameter resetting. With respect to the asymmetry that long-distance binding has been found to be significantly more admissible in non-finite clauses than in finite clauses in the interlanguage, one possibility is a misanalysis of bi-clausal non-finite sentences as mono-clausal sentences (Yuan, 1994). Specifically, L2 learners either do not notice the existence of PRO sentences like *Mr. Fat asks Mr. Thin [PRO to paint himself]* (Yuan, 1994, p. 543), or incorrectly take the exceptionally case-marked NP in sentences like *Mr. Fat wants [Mr. Thin to paint himself]* (Yuan, 1994, p. 543) as an object. As a result, in which case, the structure forms a local binding domain within which both the matrix subject and the embedded subject are possible antecedents, which is taken to explain the higher incidence of long-distance binding out of non-finite clauses than out of finite clauses. Another possibility is that L2 learners may maintain two different parameter values at the same time, one in finite environments, and the other in non-finite environments (White, 1992). So, it is very likely that no parameter resetting is involved (Yuan, 1994, p. 544). Hence, Yuan (1994) argued for no L2 parameter resetting, but full transfer and partial access to UG via L1.

In order to test Yuan's (1994) claim that L2 learners are simply transferring their L1 knowledge to their L2, Yip and Tang (1998) investigated the interpretation of English reflexives by Cantonese-speaking learners of English by employing a sentence judgment task. They found that Cantonese-speaking learners of English initially identified English reflexives with the monomorphemic reflexive *zigei* in

their L1 language Cantonese, and as learners became more advanced, they were able to treat the binding property of their L2 English as an independent system consistent with UG. Also, MacLaughlin (1998) explored L2 acquisition of English reflexives by native Chinese and Japanese speakers. The results showed that some of the L2 learners acquired a reflexive binding system, neither found in the L1 language nor in the L2 language, but still constrained by UG. Therefore, Yip and Tang (1998) and MacLaughlin (1998) provided some counter evidence to Yuan's (1994) proposal, that is, L1-induced language mapping and UG-constrained L2 parameter resetting, consistent with Schwartz and Sprouse's (1996) Full Transfer/Full Access model.

In addition, Thomas (1989) and Demirci (2000, 2001) explored the role of pragmatic factors in L2 learners' acquisition of locality conditions on English reflexive binding, using pragmatically neutral and pragmatically biased sentences. Thomas (1989) showed that pragmatically biased sentences favoring a non-local NP affected L2 learners to choose a long-distance antecedent for English reflexives, which was different from native English speakers. Demirci (2000, 2001) showed that L2 learners selected the non-local antecedent a large majority of the time in pragmatically biased sentences favoring a non-local NP, and preferred the local antecedent overwhelmingly in pragmatically biased sentences favoring a local NP. Also, native English speakers selected a substantial percentage of the non-local antecedent in pragmatically biased sentences (Demirci, 2000, 2001). These results indicate that pragmatics might be at play in the interpretation of reflexives by native English speakers and might override their grammatical knowledge. In all, pragmatic information has a strong impact on L2 learners' interpretation of English reflexives, and also, on their acquisition of locality condition in English reflexives. Hence, Demirci (2000, 2001) concluded that L2 learners simply transfer their L1 principles of reflexive binding into L2, thus, they are not able to fully acquire the purely syntactic rule of English reflexive binding system. Therefore, syntactic knowledge of reflexive binding interacts with pragmatic knowledge in L2 parameter resetting of reflexive binding.

From a developmental perspective, Akiyama (2002) explored L2 acquisition of the locality condition on English reflexives by Japanese adult learners of English ranging from low to advanced level. The results showed that the locality condition was acquired significantly better with sentences containing embedded that-clause than with sentences containing embedded non-finite clause. Also, this asymmetry existed at the beginning stages of learning and even persisted through later stages, as there was an appreciable percentage (about 35%) of advanced learners failing to acquire the locality condition. Hence, Akiyama (2002) argued that it is extremely difficult to account for these contrasts within any UG model proposed so far. Also from a developmental perspective, Jiang (2009) used a story-based truth-value judgment task to test L2 acquisition of English reflexive binding by Chinese teenager and adult learners of English Those learners were divided into three groups: beginners, intermediate and advanced learners. The results showed that compared to beginners and advanced learners, intermediate learners were more sensitive to the asymmetry of long-distance binding in finite and non-finite clauses. Jiang (2009) attributed this finding to an initial misanalysis of *himself* as monomorphemes, due to not only transfer of L1 knowledge of the Chinese simple reflexive *ziji*, but also transfer the properties of tense in their L1 Chinese into L2 English. As a result, the inter-clausal movement of English reflexives was possible in both finite and non-finite sentences in their interlanguages, thereby, beginners showed no asymmetry of long-distance binding in finite and non-finite clauses. With proficiency increasing, learners realized that tense was realized morphologically in English finite clauses, but meanwhile failed to reanalyze English reflexives as morphologically complex. The absence of tense morphemes in a non-finite clause enables the long-distance binding possible for English reflexives, while the tense treated as morphologically overt in a finite clause prohibits the long-distance binding. In consequence, intermediate learners showed an asymmetry of long-distance binding in finite and non-finite clauses. For advanced learners who realized that English reflexives were polymorphemic and must be adjoined locally, as a result, they rejected long-distance binding in both finite and non-finite clauses, and thus, showed no asymmetry of long-distance binding in finite and non-finite clauses. Therefore, Jiang (2009) suggested that in the acquisition of English reflexives, Chinese learners are both transferring from the L1 and

resetting parameters, specifically, the reflexive-binding parameter and the tense parameter.

To summarize, it is difficult to draw firm conclusions with respect to L2 learners' access to UG and L1 effects in L2 acquisition of reflexive binding in English. Most researchers have claimed that UG is available and L2 parameter resetting is possible in the acquisition process, while some have argued for neither parameter resetting nor access to UG, but to a UG-permitted different value from both L1 and L2 in terms of transfer from the native language. Others have further argued that L2 learners appear to transfer their L1 value in the earlier stages of acquisition, but they are able to reset the parameter and eventually reach the correct L2 grammar, which exhibits a sequence of development from a superset (e.g. both local and long-distance binding) to a subset (e.g. only local binding) setting. In spite of some inconsistency, these findings not only suggest that L2 learners from long-distance binding backgrounds are able to acquire the locality requirement on English reflexive binding, but also reveal the relationship between syntax, semantics and pragmatics in L2 learners' interpretation of English reflexive binding.

3.2.2 Studies on L2 acquisition of *ziji*

By comparison, relatively limited research has been done on the acquisition of long-distance binding of the Chinese simple reflexive *ziji* by L2 learners from not only local binding backgrounds but also long-distance binding backgrounds.

Within the framework of Principles and Parameters, Chen (1995) investigated the L2 acquisition of *ziji* by English-speaking and French-speaking adult learners using a truth-value judgment task. Two issues were investigated: (i) on the basis of positive evidence in the language input of Chinese, whether L2 learners would be able to know that *ziji* is allowed to be long-distance bound; (ii) after acquiring long-distance binding of *ziji*, whether L2 learners would be able to know the blocking effect of *ziji* (reviewed in Chapter 2.1.1). The results showed that most learners preferred to bind *ziji* locally both for sentences requiring a long-

distance binding and for sentences with the blocking effect requiring a local binding (see sentence (10) in Chapter 2.1.1 as an example). However, few learners (24.26%) accept the long-distance interpretation of *ziji*, and among which only 9.31% answered correctly to questions concerning the blocking effect. Thus, L2 learners tested in this study did not acquire neither the long-distance binding of *ziji* nor the blocking effect. Chen (1995, p. 49) claimed that learners start with the local binding for *ziji*, and therefore, it is not surprising that learners have not acquired knowledge of the blocking effect if they have not acquired knowledge of long-distance binding. However, it is surprising that given enough positive evidence in the input of Chinese, learners have not acquired the long-distance binding of *ziji*. Hence, Chen (1995) claimed that it is possible that L2 learners in the early stage transfer the local domain of reflexive binding from their L1 to L2 Chinese sentences with *ziji*. As a result, local binding is favoured. However, if L1 plays an essential role, then English-speaking learners of Chinese should be expected to perform worse than French-speaking learners of Chinese, because English requires local binding only, whereas French has a mixture of both local and long-distance binding. As a matter of fact, results showed that there were no significant differences between English-speaking learners of Chinese and French-speaking learners of Chinese, and most of native Chinese speakers tested in the study also consistently bound *ziji* locally. Therefore, Chen (1995) suggested an alternative way to interpret the data concerning the consistent preference for the local binding of *ziji*, that is, when used in an isolated sentence without a clear context, *ziji* may require a local antecedent as a default interpretation, even though it can be grammatically long-distance bound. In other words, if there is no pragmatic context forcing *ziji* to have an antecedent beyond its local domain, it will be unambiguous and better for *ziji* to refer to the local antecedent only. Accordingly, both L2 learners and native speakers are more likely to bind *ziji* locally. This also brings up the issue of pragmatics in Chinese reflexivization, proposed by Huang (1994). In conclusion, Chen (1995) argued that although L2 English-speaking and French-speaking learners do not acquire the knowledge of long-distance binding of *ziji*, their interlanguages are actually constrained by UG. In addition, L1 does not play a role in the acquisition of *ziji*. Also, pragmatic factors should not be ignored.

Yuan (1998) explored the interpretation of *ziji* by English and Japanese speakers in a multiple-choice comprehension test. Also, Yuan (1998) used pragmatically neutral and biased sentences to ascertain whether L2 learners' interpretation of *ziji* reflects a formal syntactic constraint rather than a preference. The rationale is that if L2 learners observe the syntactic constraint, they should reject the syntactically impossible antecedent favored by the pragmatic constraint. Specifically, the following three questions were addressed in the study: (i) given the similarities between Chinese and Japanese on the one hand, and the differences between Chinese and English on the other hand, in the acquisition of the Chinese simple reflexive *ziji*, whether Japanese-speaking learners are in an advantageous position compared with English-speaking learners; (ii) whether there is a relationship between long-distance binding and subject orientation (reviewed in Chapter 2.1.1) of *ziji* in L2 learners' grammar of Chinese; (iii) whether L2 learners' grammar of *ziji* is under the sanction of UG. The results first showed that it was much easier for Japanese-speaking learners than for English-speaking learners to acquire long-distance binding of *ziji* due to that the Japanese reflexive *zibun* also has local and long-distance binding like *ziji*, which indicates that L1 transfer occurs in L2 acquisition of *ziji*, thus goes against the findings of no L1 effects in Chen's (1995) study. By comparison, only local binding is allowed in English-speaking learners' L1, so, this L1 interference not only delays English speakers' acquisition of long-distance binding of *ziji*, but also results in the asymmetry in their interpretation of long-distance binding of *ziji* in finite and non-finite clauses (Chinese does not have this distinction. Here, finite and non-finite clauses are differentiated according to their English translation.) Second, the local binding (i.e. the embedded subject) was incorrectly chosen by both English and Japanese speakers. However, this is not attributed to L1 interference, given the fact that as a counterpart of *ziji*, the Japanese reflexive *zibun* also shares the property of subject orientation. Also, Chien, Wexler and Chang (1993) found free orientation of *ziji* in child L1 acquisition of Chinese. Therefore, Yuan (1998) concluded that L2 learners of Chinese from different L1 backgrounds could diverge from each other in their acquisition of *ziji*, and no evidence was found that L2 learners could acquire all the properties (i.e. long-distance binding, subject orientation) of *ziji*. However, on the whole, the behavior of *ziji* in L2

learners' grammar of Chinese did not diverge from the possibilities allowed by UG.

Following Thomas (1989), Yuan (1998), and Demirci (2000, 2001), also using a multiple-choice comprehension task with pragmatically and semantically biased sentences, and pragmatically and semantically neutral sentences, Dugarova (2007, 2008) investigated how Russian- and English-speaking learners of Chinese acquire *ziji*, with an aim to examine whether L2 learners' interpretation of *ziji* is controlled by formal syntactic rules or affected by pragmatic considerations. The results showed that Russian-speaking learners interpreted long-distance binding in finite clauses at rather low rates (5% - 28%), but at higher rates (36% - 51%) in non-finite clauses, which indicates that Russian speakers have difficulty in acquiring long-distance binding of *ziji* in finite clauses but not in non-finite clauses. This can be explained by L1 influence on the L2 grammar, because in Russian, long-distance binding is not allowed in finite clauses, but possible in non-finite clauses. In contrast, English-speaking learners showed quite high rates in interpreting long-distance binding both in finite (25% - 58%) and non-finite clauses (58% - 71%), which suggests that not instantiated by their L1, English speakers are able to acquire long-distance binding of *ziji* both in finite and non-finite clauses. This provides evidence for possible parameter resetting in L2 acquisition. Regarding subject-orientation of *ziji* (reviewed in Chapter 2.1.1), results showed that there was no significant difference between Russian speakers and native Chinese speakers, which gives evidence that both Russian and Chinese speakers' syntactic knowledge can correctly resist pragmatic influence given that long-distance binding entails subject-orientation in Russian as well as in Chinese. However, English speakers incorrectly chose local antecedent at high rates (50% - 62%) when the embedded NP was favored by pragmatic information, which can be explained by L1 transfer given that both matrix-subject and embedded-subject antecedents are possible for the reflexive in English. Overall, Dugarova (2007, 2008) argued for L1 transfer and UG-constrained L2 parameter resetting in L2 Russian and English learners' acquisition of *ziji*.

In summary, studies on L2 acquisition of the Chinese simple reflexive *ziji* have also yielded inconclusive evidence for L1 effects and UG-constrained L2 parameter resetting. The majority of results have indicated that English-speaking learners of Chinese locally bind *ziji* in the beginning stage, but they are able to acquire long-distance binding of *ziji* as their proficiency increases. In addition, this is more apparent in pragmatically biased sentences favoring long-distance binding, but not in pragmatically neutral sentences. Here also seems to be some controversy around whether native Chinese speakers have clearer preferences as well.

3.2.3 Methodological issues

Most previous studies used a multiple-choice task or a picture-identification task to test L2 learners' knowledge of reflexive binding. These methodologies can only show that L2 learners or native speakers have a preference for one interpretation over the other, particularly in the case of potentially ambiguous sentences (White et al., 1997, p. 145). White et al. (1997) examined methodological issues in assessing L2 learners' knowledge of reflexive binding by comparing two truth-value judgment tasks, one using stories and the other using pictures. In both tasks, contexts were provided for different interpretations of potentially ambiguous sentences. In the story task, each story was followed by a one-sentence comment, and L2 learners had to indicate whether the subsequent comment was true or false according to the context given in the story. In the picture task, L2 learners saw a picture with a sentence underneath it, and had to indicate whether the sentence matches what was going on in the picture or not. Results showed that L2 learners' performance varied considerably between the story-based and the picture-based truth-value judgment task. Specifically, the story task appears to be much more successful than the picture task in eliciting recognition of the possibility of embedded-subject antecedents in English. In contrast, the picture task resembled earlier results from the multiple-choice task. White et al. (1997) proposed that the story task provides a more accurate picture of L2 learners' linguistic competence, due to the following two reasons: (i) pictures do not in fact provide a suitable discourse context for a long-distance subject other than a local subject as the

antecedent of the reflexive (White et al. 1997, p. 162); (ii) in the picture task, reading the sentence before looking at the picture may make L2 learners assume an interpretation in advance, while the following picture does not necessarily match that interpretation. However, in the story task, L2 learners are more or less obliged to first read the story providing the context (White et al. 1997, p. 163). Accordingly, White et al. (1997) concluded that differences in task demands may affect L2 performance, and also, a certain task could lead to an underestimation of L2 learners' competence.

As a matter of fact, what speakers know about one language (i.e. language competence) is distinct from what speakers do based on that knowledge of the language in concrete situation (i.e. language performance). Also, linguistic rules that speakers have internalized as their mental grammar are not open to direct inspection. So, it is reasonable to uncover speakers' competence on the basis of speakers' observable performance during language comprehension and production. However, it is difficult to tell to what extent speakers' performance data, such as judgments or choices from off-line tasks (i.e. multiple-choice task, picture-identification task, truth-value judgment task), truly reflect their subconscious and underlying knowledge of language, irrespective of task factors (Hawkins, 2001). For example, native English speakers apply the syntactic-binding rule immediately during processing (e.g. Nicol and Swinney 1989; Sturt 2003), while L2 learners may not have a similar way of processing but still show native-like performance in off-line tasks. In addition, working memory may also play an effect in L2 learners' processing. For instance, L2 learners may choose the correct antecedent because focusing on the local antecedent is the more working-memory-friendly option rather than as a result of having successfully reset the relevant binding parameters (e.g. Cunnings and Felser, 2013). In addition, it is also possible that L2 learners whose antecedent choices are non-native-like due to interference of processing difficulties (e.g. Roberts, Gullberg and Indefrey, 2008; Felser, Sato and Bertenshaw, 2009).

In a word, although providing useful measures on L2 learners' ultimate interpretations, off-line tasks cannot identify areas of differences and difficulties in L2 processing. Therefore, it is necessary to use on-line experimental techniques (i.e. self-paced reading, eye-tracking, etc.) to further investigate the internalized linguistic rules L2 learners have, to provide a window on the mental processes underlying L2 learners' interpretation, and to better understand how different types of linguistic information (i.e. syntax, semantics and discourse/pragmatics) affect native and non-native speakers' real-time language processing (Felser and Cunnings 2012).

3.3 Studies on L2 processing of reflexives

Compared to the mixed picture in the L1 literature on real-time processing of reflexives, reviewed in Chapter 2.2, results from recent two representative studies of Felser, Sato and Bertenshaw (2009) and Felser and Cunnings (2012) on L2 real-time processing of English reflexives indicate that L2 learners rely more strongly than native speakers on semantic and discourse information, and comparatively less on syntactic information.

Felser, Sato, and Bertenshaw (2009) used eye-tracking to investigate whether Japanese-speaking learners of English and native English speakers would consider a discourse-salience inaccessible antecedent in real-time processing of English reflexives in sentences such as (32), (33), (34), and (35) (Felser, Sato, and Bertenshaw, 2009, p. 494). The rationale in the study is that manipulating gender congruence between the reflexive and the inaccessible (i.e. syntactically inappropriate) antecedent would affect real-time processing of the reflexive only if the inaccessible antecedent is indeed considered to be a possible antecedent by comprehenders. The binding-as-initial-filter hypothesis, reviewed in Chapter 2.2.1, predicts that the inaccessible antecedent should not be included in the initial antecedent candidate set, whereas multiple-constraint and cue-based models, reviewed in Chapter 2.2.2, would allow for the inaccessible antecedent to be considered, at least initially. The analysis of the reading-time data found

that in c-command conditions, Japanese-speaking learners of English, but not native English speakers, were indeed distracted by the gender-matching inaccessible antecedent. The L2 group showed longer first-pass reading times for the reflexive region when the inaccessible antecedent matched the reflexive in gender in (32) compared with when it did not in (33). No such gender-match effect was found for non-c-command conditions in (34) and (35). However, Japanese-speaking learners' consideration of the inaccessible antecedent was observed only during their initial reading of the reflexive but not in later eye-movement measures or at later sentence regions. Also, the results from a complementary offline antecedent choice task showed that they had no difficulty in identifying the correct accessible antecedent in principle. Therefore, Felser, Sato, and Bertenshaw (2009) interpreted their result as an index for a cue-based competition between the accessible antecedent and the inaccessible antecedent, when both of them matched the gender cue of the reflexive during L2 processing.

(32) inaccessible match, c-command:
John$_i$ noticed that Richard$_j$ had cut himself$_{*i/j}$ with a very sharp knife.
(33) inaccessible mismatch, c-command:
Jane$_i$ noticed that Richard$_j$ had cut himself$_{*i/j}$ with a very sharp knife.
(34) inaccessible match, no c-command:
It was clear to John$_i$ that Richard$_j$ had cut himself$_{*i/j}$ with a very sharp knife.
(35) inaccessible match, no c-command:
It was clear to Jane$_i$ that Richard$_j$ had cut himself$_{*i/j}$ with a very sharp knife.

As the Japanese reflexive anaphor *zibun* allows long-distance binding, one issue that the study could not fully resolve is the question of whether Japanese-speaking learners initially transfer the long-distance binding property of *zibun* to English reflexives, or whether the preference for salient (i.e. matrix subject) antecedents is a more general feature of L2 processing. Since only the inaccessible antecedent's gender was manipulated in the study, another issue that the study could not resolve is when native and non-native speakers start to home in on the accessible antecedent (Felser, 2016, p. 235). A subsequent study conducted by Felser and Cunnings (2012) further investigated these two unresolved issues.

Also using eye-tracking, Felser and Cunnings (2012) investigated real-time processing of English reflexives by proficient German-speaking learners of English and native English speakers in sentences like (36), (37), (38) and (39) (Felser and Cunnings, 2012, p. 579). German reflexives, like English reflexives, require syntactic binding by a local antecedent, German-speaking learners' initial preference for an inaccessible antecedent can thus hardly be explained by negative L1 transfer. Hence, by eliminating L1 influence as a potential factor, Felser and Cunnings (2012) could tell more precisely about which information guides L2 learners' initial antecedent preference. The results found that German-speaking learners initially considered only the inaccessible antecedent, as reflected by longer first fixation durations and first-pass reading times at the reflexive for the inaccessible mismatch conditions (37), (39) compared with the inaccessible match conditions (36), (38). Thus, German-speaking learners incorrectly tried to link the reflexive to the matrix subject during early processing stages. However, they did not show any evidence of considering the accessible antecedent until reading the post-critical region consisting of two words following the reflexive. In contrast, native English speakers showed the effect of the gender-mismatching accessible antecedent during their initial reading of the reflexive, but no evidence of considering the inaccessible antecedent at any processing stage.

(36) <u>accessible match, inaccessible match</u>:

James$_i$ has worked at the army hospital for years. He$_i$ noticed that the soldier$_j$ had wounded himself$^{*i/j}$ while on duty in the Far East.

(37) <u>accessible match, inaccessible mismatch</u>:

Helen$_i$ has worked at the army hospital for years. She$_i$ noticed that the soldier$_j$ had wounded himself$^{*i/j}$ while on duty in the Far East.

(38) <u>accessible mismatch, inaccessible match</u>:

Helen$_i$ has worked at the army hospital for years. She$_i$ noticed that the soldier$_j$ had wounded herself$^{*i/*j}$ while on duty in the Far East.

(39) <u>accessible mismatch, inaccessible mismatch</u>:

James$_i$ has worked at the army hospital for years. He$_i$ noticed that the soldier$_j$ had wounded herself$^{*i/*j}$ while on duty in the Far East.

Because in sentences such as (36)-(39), both the accessible and the inaccessible antecedent *she/he* c-commands the reflexive, it could not tell whether German-

speaking learners initially attempted long-distance binding or tried to resolve the reflexive via discourse-based co-reference assignment. To further examine this issue, a follow-up eye-movement experiment was carried out using sentences like (40) (Felser and Cunnings, 2012, p. 591) in which the inaccessible antecedent no longer c-commands the reflexive. The results showed that German-speaking learners tried to link the reflexive to the most discourse-salient referent (*James/Helen*) when first encountering the reflexive, which indicates co-reference assignment rather than binding. (Note that the inaccessible antecedent was highly discourse-prominent in both experiments as a result of being mentioned twice.)

(40) {James/Helen} has worked at the army hospital for years. The soldier that {he/she} treated on the ward wounded {himself/herself} while on duty in the Far East.

Taken together, native English speakers applied the syntactic-binding constraint immediately and considered only the accessible antecedent at initial stages of processing, while L2 learners from different language backgrounds showed evidence of being distracted by the inaccessible antecedent during initial stages of processing. These findings were taken to indicate that L2 learners may not be able to apply the syntactic-binding constraint faithfully during initial processing, but instead rely on discourse constraints. Therefore, Felser and Cunnings (2012) argued that the application of syntactic constraints on English reflexives may generally be delayed in L2 processing compared with L1 processing.

In sum, comparing native speakers' and L2 learners' real-time processing of English reflexives not only can potentially better understand the specific mechanism in antecedent retrieval, but also can tell different processing pathways. Some studies have already investigated L2 acquisition of *ziji*, however, to my knowledge, few studies have been conducted to investigate real-time processing of *ziji* by L2 learners of Chinese.

3.4 Summary

Given the above, this current work further aims to investigate L2 acquisition of the long-distance binding of *ziji* from the perspective of Yang's (2002) Variational Learning Theory, and to examine the role of non-structural (i.e. verb-semantic and discourse-context) information in L2/non-native Chinese speakers' interpretation of *ziji*, and also to provide new experimental evidence for the cue-based retrieval mechanism during L2/non-native Chinese speakers' real-time processing of *ziji*. Most importantly, this current work attempts to reveal in what respects the interpretation and real-time processing of *ziji* by L2/non-native Chinese speakers is different from that by native Chinese speakers.

Chapter 4 A corpus study to the long-distance binding of *ziji*

As reviewed in Chapter 2.1.2, there are three types of Chinese transitive verbs affect *ziji* to have local or long-distance binding. Specifically, VT1 (i.e. the self-oriented/introverted verb) allowing *ziji* to have local binding only, and VT2 (i.e. the other-oriented/extroverted verb) allowing *ziji* to have long-distance binding only, thus, the binding of *ziji* with VT1 and VT2 depends on the verb-semantic orientation only. VT3 (i.e. the ambiguous/context-dependent verb) allowing *ziji* to have both local and long-distance binding, hence, the prominence in the discourse context, reviewed in Chapter 2.1.3, plays the crucial role in the binding of *ziji* with VT3. According to Yang's (2002) Variational Learning Theory, discussed in Chapter 3.1, the variability in language input affects language acquisition and development. Therefore, the corpus study presented in this chapter is conducted to provide empirical data for the variability of these three verb types influencing the binding of *ziji* in the input of Chinese. Research questions, hypotheses and predictions are presented at the beginning of this chapter, followed by detailed research methods and results. In addition, regarding local and long-distance binding of *ziji*, it is not actually clear which the interpretative preference is for *ziji* in the literature. Hence, based on the corpus data, an exploratory mixed-effects modelling is built to predict the likelihood of the long-distance interpretation of *ziji*. Discussion is given at the end of this chapter.

4.1 Research questions, hypotheses and predictions

The main research questions addressed in this corpus study are as follows.

(1) What is the variability of the three verb types in the input of Chinese?

(2) When used with *ziji*, what is the variability of the three verb types in the input of Chinese?

Accordingly, the corresponding hypotheses are made as follows.

(1) The three verb types have different distributions in the input of Chinese.

(2) When used with *ziji*, the three verb types also have different distributions in the input of Chinese.

VT1 (i.e. the self-oriented/introverted verb) expresses a reflexive action, thus, the agent and the patient of VT1 must be the same person. VT2 (i.e. the other-oriented/extroverted verb) expresses a non-reflexive action on somebody else rather than on the agent, thus, the agent and the patient of VT2 must be different persons. VT3 (i.e. the ambiguous/ context-dependent verb) expresses actions either on the agent or on somebody else, so the agent and the patient of VT3 can be either the same person or a different person. Hence, the first prediction is made as below.

(1) Compared with VT1 and VT2, VT3 has the highest frequency in the input of Chinese. In addition, the frequency of VT1 does not vary much from the frequency of VT2 in the input of Chinese.

The Chinese simple reflexive *ziji* allow both local and long-distance interpretation. Besides, VT1 (i.e. the self-oriented/introverted verb) allows *ziji* to have a local interpretation only, VT2 (i.e. the other-oriented/extroverted verb) allows *ziji* to have a long-distance interpretation only, and VT3 (i.e. the ambiguous/context-dependent verb) allows *ziji* to have both local and long-distance interpretation. Hence, the second prediction is made as below.

(2) When used with *ziji*, VT3 is used more frequently than VT1 and VT2. In addition, VT1 is used as frequently as VT2.

4.2 Research methods

Li and Zhou (2010, reviewed in Chapter 2.1.2 and 2.2.3) investigated the effect of verb-semantics in real-time processing of *ziji* in a common sentence structure *[NP1 VP1 [NP2 VP2 ziji]]*. In the study, native Chinese speakers were asked to read each sentence and to judge the referent of *ziji*. Based on their judgements, 95 verbs as the embedded verb VP2 were classified into the three verb types,

specifically, 20 introverted/self-oriented verbs (VT1), 32 extroverted/other-oriented verbs (VT2), and 43 ambiguous/context-dependent verbs (VT3).

Hence, those 95 verbs were examined in the largest corpus of modern Mandarin Chinese built by the Centre for Chinese Linguistics at Peking University. The modern Mandarin Chinese corpus is made up of 307, 317, 060 words taken from 40 different written and oral texts, such as news reports, fictions, academic science papers, and etc.

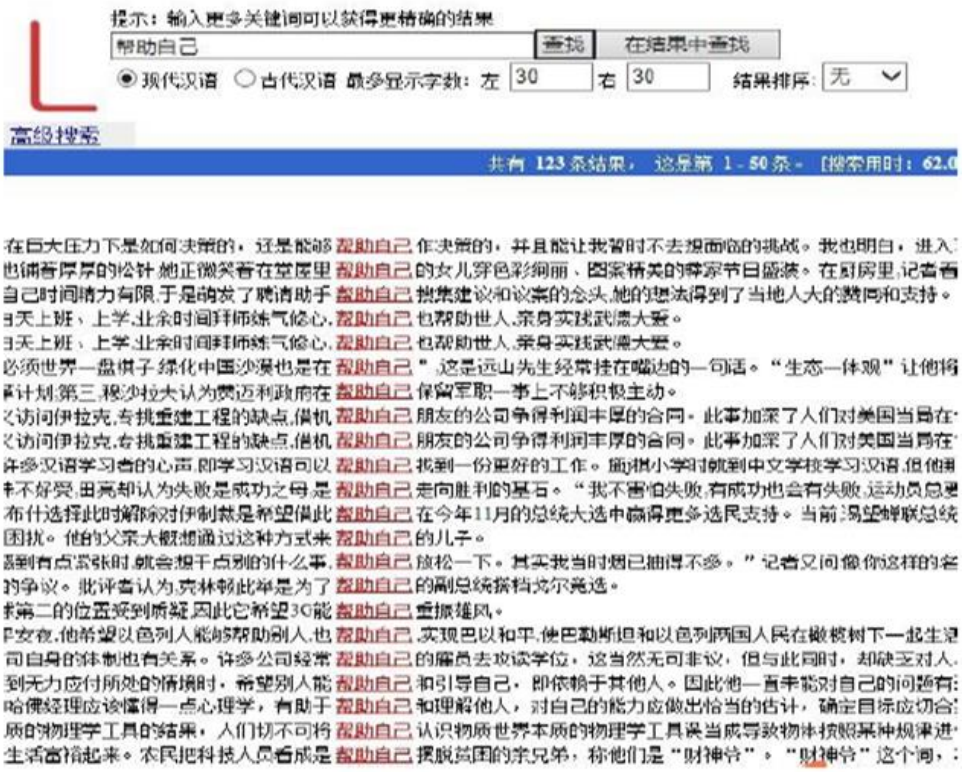
Firstly, each of the 95 verbs were extracted from the corpus. For instance, as shown in the following Figure 4.1, the verb *bangzhu* (i.e. *help* in English) was extracted from the corpus.

Figure 4.1 Extracting the verb

Secondly, when used with *ziji*, those 95 verbs in the structure *[verb ziji]* were extracted from the corpus. Here, in the structure, *ziji* is immediately following the verb, with no intervening materials between the verb and *ziji*. For instance,

as shown in the following Figure 4.2, the verb *bangzhu* (i.e. *help* in English) in the structure *[bangzhu ziji]* was extracted from the corpus.

Figure 4.2 Extracting the structure *[verb ziji]*



4.3 Data analysis and results

4.3.1 Token frequency of the verb

Specific token frequency of the 95 verbs is presented in the following Table 4.1. As the data did not have a normal distribution, a non-parametric Kruskal-Wallis test (its corresponding parametric test is one-way ANOVA test) was conducted. The result showed that token frequency of the three verb types in the corpus was significantly different ($p = 0.006$). The mean rank (MR) showed that VT3 had the highest frequency (MR = 55.92), VT1 had the lowest frequency (MR = 31.88), while VT2 had the intermediate frequency (MR = 47.44). Thus, the result suggests that the three verb types have different distributions in the corpus, that is, VT3 has higher frequency than VT1 which has lower frequency than VT2. Hence, the first prediction that VT3 has the highest frequency is supported,

however, the prediction that the distribution of VT1 does not vary much from the distribution of VT2 is not supported.

Table 4.1 Token frequency of the 95 verbs

VT1 (the introverted/ self-oriented verb) (20 verbs)		**VT2 (the extroverted/ other-oriented verb) (32 verbs)**		**VT3 (the ambiguous/ context-dependent verb) (43 verbs)**	
Verb	**Frequency**	**Verb**	**Frequency**	**Verb**	**Frequency**
检讨 self-criticize	1468	思念 think of	1873	照料 look after	1884
坦白 confess	1986	挽留 hold/keep	565	描写 describe	6589
反思 rethink of	2056	骚扰 annoy	933	鼓励 encourage	16656
反省 introspect	1763	采访 interview	20409	重视 pay attention to	38522
保重 take care of	768	想念 miss	1365	磨练 temper	783
伪装 disguise	939	协助 help	7634	惩罚 punish	3538
卖弄 show off	502	冒充 pretend to be	908	忽视 ignore	7234
放纵 indulge	599	联络 contact	5476	数落 rebuke	236
掩饰 conceal	2182	排挤 squeeze out	574	批评 criticize	2314
表白 profess/self-express	790	赔偿 pay for	6734	折腾 toss about	16793
显摆 show off	42	算计 calculate	555	抱怨 complain	1340
封闭 close	4800	接近 approach	11146	埋怨 blame	3330
把握 grasp/seize	11527	联系 contact	30980	推荐 recommend	1585
珍重 value highly /treasure	362	追求 pursue/go after	17462	介绍 introduce	5384
吹嘘 boast	582	误会 misunderstand	1827	限制 restrict	50813
放松 relax	4134	妒忌 envy at	472	宣传 advertise/ propagandize	13702

浮夸 exaggerate	656	干涉 intervene	4539	难为 embarrass	29554
遮掩 hide/ conceal	864	代替 replace	5976	肯定 affirm	1468
奉献 dedicate	9023	欢迎 welcome	26141	折磨 torture	22396
展现 show	5242	邀请 invite	16751	挑战 challenge	3842
		扣留 arrest	789	监督 supervise	13126
		使唤 order (sb.) about	525	伤害 hurt	27843
		拥护 advocate	3737	拯救 rescue	5548
		遇到 come across/ encounter	15793	吓唬 frighten/ scare	2683
		引诱 induce	1171	轻视 look down on /despise	761
		靠近 get close to	4411	打扮 dress up	1440
		等候 wait for (sb.)	3539	讨厌 hate	2950
		收留 stay/ take (sb.) in	571	尊重 respect	3787
		误解 misunderstand	2821	虐待 abuse	2304
		羡慕 admire	2686	耽误 delay/hold up	1882
		打扰 disturb	1212	处罚 punish/ penalize	7463
		帮助 help	38941	挖苦 sarcasm	661
				检查 inspect	27951
				考验 test	5786
				挽救 save/rescue	1942
				称赞 praise	5451

				抛弃 abandon	3165
				原谅 forgive	3339
				培养 train/foster/ cultivate	22237
				关心 care for/ concern	22681
				放弃 give up	11461
				为难 embarrass/ feel awkward	2872
				装扮 dress up /make up	735

4.3.2 Token frequency of the structure *[verb ziji]*

When used with *ziji*, specific token frequency of the 95 verbs in the structure *[verb ziji]* is presented in the following Table 4.2. Also, the data did not have a normal distribution, so, the non-parametric Kruskal-Wallis test was conducted again. The result showed that when used with *ziji* in the structure *[verb ziji]*, there was a significant difference between VT1 and VT2 ($p < 0.001$), and also a significant difference between VT3 and VT2 ($p < 0.001$). However, there was no significant difference between VT1 and VT3 ($p = 0.883$). The MR showed that when used with *ziji* in the structure *[verb ziji]*, VT2 (i.e. the extroverted/other-oriented verb) has the lowest frequency (MR = 27.42), while VT1 (i.e. the introverted/self-oriented verb) has a frequency (MR = 58.70) similar to the frequency of VT3 (i.e. the ambiguous/context-dependent verb) (MR = 58.34). Thus, the result suggests that when used with *ziji* in the structure *[verb ziji]*, the three verb types also have different distributions in the corpus, that is, VT2 is used less frequently than VT1 and VT3, and VT1 is used as frequently as VT3. Hence, the result does not support the prediction that when used with *ziji*, VT3 is used more frequently than VT1 and VT2, and VT1 is used as frequently as VT2.

Table 4.2 Token frequency of the 95 verbs in the structure *[verb ziji]*

VT1 (the introverted/ self-oriented verb) (20 verbs)		**VT2 (the extroverted/ other-oriented verb) (32 verbs)**		**VT3 (the ambiguous/ context-dependent verb) (43 verbs)**	
Verb	**Frequency**	**Verb**	**Frequency**	**Verb**	**Frequency**
检讨 self-criticize	90	思念 think of	17	照料 look after	45
坦白 confess	11	挽留 hold/keep	0	描写 describe	16
反思 rethink of	44	骚扰 annoy	0	鼓励 encourage	76
反省 introspect	114	采访 interview	3	重视 pay attention to	98
保重 take care of	35	想念 miss	20	磨练 temper	53
伪装 disguise	14	协助 help	5	惩罚 punish	31
卖弄 show off	18	冒充 pretend to be	5	忽视 ignore	17
放纵 indulge	38	联络 contact	0	数落 rebuke	2
掩饰 conceal	268	排挤 squeeze out	1	批评 criticize	55
表白 profess/self -express	102	赔偿 pay for	3	折腾 toss about	7
显摆 show off	2	算计 calculate	2	抱怨 complain	75
封闭 close	18	接近 approach	15	埋怨 blame	65
把握 grasp/seize	111	联系 contact	50	推荐 recommend	13
珍重 value highly /treasure	20	追求 pursue/ go after	113	介绍 introduce	177
吹嘘 boast	63	误会 misunderstand	3	限制 restrict	29
放松 relax	72	妒忌 envy at	0	宣传 advertise/ propagandize	160
浮夸 exaggerate	0	干涉 intervene	2	难为 embarrass	11
遮掩 hide/ conceal	22	代替 replace	37	肯定 affirm	92

奉献 dedicate	97	欢迎 welcome	8	折磨 torture	97
展现 show	60	邀请 invite	12	挑战 challenge	15
		扣留 arrest	0	监督 supervise	8
		使唤 order (sb.) about	0	伤害 hurt	69
		拥护 advocate	5	拯救 rescue	60
		遇到 come across/ encounter	18	吓唬 frighten/ scare	18
		引诱 induce	2	轻视 look down on/despise	15
		靠近 get close to	18	打扮 dress up	64
		等候 wait for (sb.)	6	讨厌 hate	35
		收留 stay/take (sb.) in	2	尊重 respect	139
		误解 misunderstand	2	虐待 abuse	17
		羡慕 admire	6	耽误 delay/hold up	7
		打扰 disturb	4	处罚 punish/ penalize	1
		帮助 help	123	挖苦 sarcasm	5
				检查 inspect	128
				考验 test	23
				挽救 save/rescue	35
				称赞 praise	21
				抛弃 abandon	51
				原谅 forgive	135

				培养 train/foster/ cultivate	211
				关心 care for/ concern	185
				放弃 give up	305
				为难 embarrass/ feel awkward	3
				装扮 dress up /make up	21

4.3.3 An exploratory mixed-effects modelling

Although *ziji* allow both local and long-distance interpretation, it is not actually clear which the interpretative preference is for *ziji* in the literature. Therefore, an exploratory mixed-effects modelling predicting the likelihood of the long-distance interpretation of *ziji* was conducted.

346 sentences of *ziji* using the 95 verbs in the common sentence structure *[NP1 VP1 [NP2 VP2 ziji]]* were extracted for the following analysis, see Appendix I for a full list. There were 139 sentences with VT1, 101 sentences with VT2, and 106 sentences with VT3. Thirty native Chinese speakers were asked to read each sentence and to interpret *ziji*, and there were no different responses among their interpretation of *ziji* in each sentence. Hence, based on native Chinese speakers' interpretation, the referent of *ziji* in the 346 sentences were defined, either local or long-distance. Due to this binary, a logistic mixed-effects modelling using the R package 'lme4' (version 1.1-13) in R (version 3.4.1) was built to test what factors predict the long-distance interpretation of *ziji* in the common sentence structure *[NP1 VP1 [NP2 VP2 ziji]]*. In the analysis, while allowing model convergence, any variable was retained only if it improved the mixed-effects

model fit significantly by yielding a significant reduction in AIC[1] and a significant R-squared value for the model[2].

The factors/predictors tested in the mixed-effects modelling are presented in the following Table 4.3. The fixed effects are as follows: (a) how many times referents (i.e. the matrix subject *NP1* and the embedded subject *NP2*) mentioned in the preceding sentences is tested as a predictor of the salience of referents in the discourse context (i.e. discourse prominence, reviewed in Chapter 2.1.3) affecting *ziji* to refer to one referent than the other; (b) the referent of *ziji* is always a person, however, sometimes, the referent of *ziji* can be not a person. As a grammatical and semantic principle expressed in language, based on how sentient or alive the referent of a noun is, animacy of the matrix subject *NP1* and the embedded subject *NP2* is tested as a predictor; (c) semantic role is the underlying relationship that a participant has with the verb in a clause, such as agent, patient, and other (source, perceiver), thus, semantic role of the matrix subject *NP1* and the embedded subject *NP2* is tested as a predictor; (d) in terms of the verb-semantic orientation, the agent and the patient of the verb must be the same person or different persons, which results in the three verb types affecting the interpretation of *ziji*, as reviewed in Chapter 2.1.2 and 4.1. Hence, the verb type of the embedded verb *VP2* is tested as a predictor; (e) a causative verb expresses a meaning of cause, or an action by the agent, thus, whether the matrix verb *VP1* is causative or not is tested as a predictor; (f) not each of the 346 sentences extracted from the corpus ends with *ziji*, and there are other materials after *ziji* in some sentences. Hence, the syntactic relationship between *ziji* and other materials is also tested as a predictor. In addition, because the corpus includes texts and direct speech, the sentence type displaying uncontrolled characteristics is used as a random-effect predictor causing random variation in the data.

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[1] The Akaike Information Criterion (AIC) is a value that estimates model fit against its inclusion of superfluous parameters. The smaller the AIC, the better the model.

[2] The R-squared of a model expresses how much variance is captured by the model.

Table 4.3 Description of predictors/variables in the corpus data

Data Size	**346 obs. of 7 variables**
Predictors:	
Discourse prominence: the salience of referents in the discourse context	coded as '0': unmentioned, '1': mentioned once, '2': mentioned twice and/or more
Animacy of referents	coded as 'animate' vs. 'inanimate'
Semantic role of referents	coded as 'agent', 'patient' and 'other'
The causative of the matrix verb	coded as 'causative' vs. 'non-causative'
The verb type of the embedded verb	coded as 'VT1': the introverted/self-oriented verb, 'VT2': the extroverted/other-oriented verb, 'VT3': the ambiguous/context-dependent verb
The syntactic relationship between *ziji* and other materials in the sentence	coded as 'object': the sentence ending with *ziji* as the object of the embedded verb, 'possession': the sentence not ending with *ziji*, and *ziji* is embedded inside the object of the embedded verb, and with a meaning of possession (i.e. 's), 'embedded': the sentence not ending with *ziji*, and *ziji* is embedded inside the object of the embedded verb, but not with a meaning of possession
Sentence Type	coded as 'Text' vs. 'Direct Speech'

The results of the optimal model[3] predicting the long-distance interpretation of *ziji* are summarized in the following Table 4.4. Compared with VT1 (i.e. the introverted/self-oriented verb) as the embedded verb, it is more likely for *ziji* to have the long-distance interpretation when the embedded verb is VT2 (i.e. the extroverted/other-oriented verb, coefficient = 55.793, p = 0.01032). When the embedded verb is VT3 (i.e. the ambiguous/context-dependent verb), it has a trend for *ziji* to have the long-distance interpretation (coefficient = 32.043, p = 0.06746). Also, compared with the non-causative matrix verb, when the matrix verb is causative, it is more likely for *ziji* to have the long-distance interpretation (coefficient = 6.489, p = 0.01379). In addition, compared with the agent matrix

[3] The formular is 'Ziji.Binding ~ (1|Sentence.Type) + VP2.Type + VP1.Causative + NP1.Semantic + NP2.Mention + Ziji.Relationship'.

subject *NP1*, it is less likely for *ziji* to have the long-distance interpretation when the matrix subject *NP1* is not agent (coefficient = -13.016, p = 0.00967). Moreover, compared with *ziji* as a direct object of the embedded verb, it is less likely for *ziji* to have the long-distance interpretation when *ziji* expresses the meaning of possession (coefficient = -11.701, p = 0.00304), whereas it is more likely for *ziji* to have the long-distance interpretation when *ziji* does not express the meaning of possession (coefficient = 14.358, p = 0.01134). Furthermore, it is more likely for *ziji* to have the long-distance interpretation when the embedded subject *NP2* is not salient in the discourse context than when the embedded subject *NP2* is salient (i.e. NP2.mentioned once (coefficient = -18.219, p = 0.00608), and NP2.mentioned twice or more (coefficient = -8.418, p = 0.00938)). There was no significant effect of the matrix subject *NP1* mentioned in the discourse context (p = 0.094).

Table 4.4 Coefficients of fixed effects in a logistic mixed-effects model predicting the long-distance binding of *ziji*

	Estimate	**Std.Error**	**z value**	**Pr(>|z|)**
(Intercept)	-19.249	16.604	-1.159	0.24633
Embedded Verb: VT2	55.793	21.753	2.565	0.01032 *
Embedded Verb: VT3	32.043	17.524	1.829	0.06746 *
Matrix Verb: Causative	6.489	2.635	2.463	0.01379 *
NP1. Semantic Role: other	-13.016	5.030	-2.587	0.00967 **
Ziji: possession	-11.701	3.948	-2.964	0.00304 **
Ziji: embedded	14.358	5.671	2.532	0.01134 *
NP2. Mention: once	-18.219	6.641	-2.744	0.00608 **
NP2. Mention: twice or more	-8.418	3.240	-2.598	0.00938 **

(reference levels: *VT1* as the embedded verb; the non-causative matrix verb; the matrix subject *NP1* is agent; *ziji* is the direct object of the embedded verb; the embedded subject *NP2* is not mentioned in the preceding sentences.)

4.4 Discussion

The results shows that the three verb types have different distributions in the corpus, that is, the ambiguous verb (VT3) has the highest frequency, while the self-oriented/introverted verb (VT1) has the lowest frequency. The frequency of the other-oriented/extroverted verb (VT2) is in-between. However, when used with *ziji* in the structure *[verb ziji]*, the distribution pattern of the three verb types changes, that is, the other-oriented/extroverted verb (VT2) is used less frequently than the self-oriented/introverted verb (VT1) and the ambiguous verb (VT3), and the self-oriented/introverted verb (VT1) is used as frequently as the ambiguous verb (VT3). Hence, the variability of the three verb types in the corpus indicates the relative scarcity of VT2 with *ziji* and the prevalence of VT1 and VT3 with *ziji* in the input of Chinese.

According to Yang's (2002) Variational Learning Theory discussed in Chapter 3.1, variability in language input may lead learners to swing back and forth between grammars because actual language input is hardly uniform with respect to a single idealized grammar. In other words, the input that learners receive may not transparently and categorically reflect the grammar of the language that learners acquire. In particular, the more unambiguous the input is, the faster the learner will converge on a native-like grammar. Conversely, the more ambiguous the input is, the longer the learner will take to converge in the target grammar (Yang, 2002, p. 20). Hence, on the one hand, in the input of Chinese, only VT1 provide unambiguous evidence for a local binding of *ziji*, and only VT2 provide unambiguous evidence for a long-distance binding of *ziji*, thus, it is easier for learners to acquire local binding of *ziji* with VT1, and long-distance binding of *ziji* with VT2. However, given the relative scarcity of VT2 with *ziji* and the prevalence of VT1 with *ziji* in the input of Chinese, it still takes longer time for learners to converge on the target long-distance binding of *ziji* with VT2 than to converge on the target local binding of *ziji* with VT1. On the other hand, VT3 provide ambiguous evidence for local and long-distance binding of *ziji*, given the prevalence of VT3 with *ziji* in the input of Chinese, learners may swing back and forth between local and long-distance binding of *ziji* with VT3. Hence, the

variations of the three verb types according to the corpus data reinforce the prediction that the verb-semantic orientation might not be perceived as very robust, and the acquisition of the long-distance binding of *ziji* might be protracted.

In addition, the exploratory mixed-effects modelling also suggests that the likelihood of the long-distance interpretation of *ziji* is affected by several factors, that is, discourse prominence, agency, semantic role, verb-semantic orientation and syntactic structure. Although not being as the only factor, the verb-semantic orientation (i.e. the three verb type) still plays a determinant role in the long-distance interpretation of *ziji*. Hence, the findings support the theory of verb-semantic orientation reviewed in Chapter 2.1.2, and the theory of discourse prominence reviewed in Chapter 2.1.3.

In all, this corpus study contributes to the existing literature on the long-distance binding of *ziji* by examining the variability of the three verb types affecting the binding of *ziji* in the input of Chinese, and by exploring what factors predicting the long-distance interpretation of *ziji* using a statistical modelling.

The next chapter will report a self-paced reading study investigating effects of verb-semantic and discourse-context information in the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese.

Chapter 5 A Cue-based approach to the long-distance interpretation of *ziji*

This chapter presents a self-paced reading study investigating how verb-semantic and discourse-context information are used as retrieval cues in the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese. Research questions, hypotheses, research design and predictions are presented first, followed by detailed research methodology including participants, experiment materials, tasks and procedures. Data analysis and visualization, and results are given afterwards, followed by discussion.

5.1 Research questions and hypotheses

The specific research questions addressed in this self-paced reading study are as follows:

(1) Do English-speaking learners of Chinese allow a long-distance interpretation of *ziji*, which is ruled out by their L1?

(2) Are English-speaking learners of Chinese sensitive to the verb-semantic cue as well as the discourse-context cue during real-time processing of *ziji*, like native Chinese speakers?

(3) Do English-speaking learners of Chinese and native Chinese speakers weigh the verb-semantic cue and the discourse-context cue in the same way during real-time processing of *ziji*?

(4) Does working memory capacity in both English-speaking learners of Chinese and native Chinese speakers affect their real-time processing of *ziji*?

(5) Does (L2) Chinese proficiency in English-speaking learners of Chinese affect their interpretation and real-time processing of *ziji*?

According to Schwartz and Sprouse's (1996) Full Transfer/Full Access model and Yang's (2002) Variational Learning Theory in second language acquisition, discussed in Chapter 3.1, L2 learners would be able to converge on the target grammar. In addition, when the L2 input provides reliable evidence, L2 learners'

convergence on the target grammar would be easier and faster. Hence, the first hypothesis is made as below.

(1) English-speaking learners of Chinese will allow a long-distance interpretation of *ziji* although it is ruled out by their native English (L1). However, in the input of Chinese (L2), only VT1 provides unambiguous evidence for a local interpretation of *ziji*, VT3 provides ambiguous evidence for both local and long-distance interpretation of *ziji*, while only VT2 provides unambiguous evidence for a long-distance interpretation of *ziji*, so the convergence on the target long-distance interpretation of *ziji* with VT2 will be difficult and slow for English-speaking learners of Chinese.

The interactive-parallel-constraint model (e.g. Badecker and Straub, 2002), discussed in Chapter 2.2.2, suggests that all relevant linguistic information/constraints are used during real-time processing of reflexives. Moreover, the cue-based retrieval mechanism (e.g. McElree 2000, 2006; Van Dyke and Lewis, 2003; Lewis and Vasishth, 2005; Lewis, Vasishth and Van Dyke, 2006; Van Dyke and McElree 2006) suggests that those linguistic information coming from lexical items and/or local structures are used as cues for retrieving antecedents during real-time processing of reflexives. Thus, native Chinese speakers and English-speaking learners of Chinese will use both verb-semantic and discourse-context information during real-time processing of *ziji.* Hence, the second hypothesis is made as below.

(2) English-speaking learners of Chinese will be sensitive to both verb-semantic and discourse-context cues, like native Chinese speakers, during real-time processing of *ziji*.

As discussed in Chapter 2.1.2, VT1 (the introverted/self-oriented verb) and VT2 (the extroverted/other-oriented verb) impose verb-semantic restrictions on the interpretation of *ziji*, that is, VT1 only allows a local interpretation of *ziji*, while VT2 only allows a long-distance interpretation of *ziji*. Hence, native Chinese speakers are mainly influenced by verb-semantic information to interpret *ziji* with VT1 and VT2 during real-time processing (e.g. Li and Zhou, 2010). Also, as discussed in Chapter 2.1.3, VT3 (the ambiguous/context-dependent verb) does not impose a verb-semantic restriction, and allows both local and long-distance

interpretation of *ziji*, thus, a discourse context is required to interpret *ziji* with VT3. Hence, native Chinese speakers interpret *ziji* with VT3 according to discourse-context information during real-time processing (e.g. Li and Kaiser, 2009). By comparison, as discussed in Chapter 3.3, L2 learners have a greater reliance on discourse-based information than native speakers (e.g. Felser, Sato and Bertenshaw, 2009; Felser and Cunnings, 2012). In addition, Clahsen and Felser's (2006a, 2006b, 2006c) Shallow Structure Hypothesis also suggests L2 learners' sensitivity to semantics. Hence, the following third hypothesis is made as below.

(3) English-speaking learners of Chinese and native Chinese speakers will weigh the verb-semantic cue and the discourse-context cue differently during real-time processing of *ziji*. Specifically, although English-speaking learners of Chinese are sensitive to the verb-semantic cue, they will give priority to the discourse-context cue with VT1, VT2 and VT3. However, native Chinese speakers will give priority to the verb-semantic cue with VT1 and VT2, but the discourse-context cue with VT3.

It has been found that working memory capacity storing and processing information temporally plays a significant role in a vast array of L2 acquisition areas (for reviews, see Juffs and Harrington, 2011; Williams, 2011; Sagarra, 2012; Linck et al., 2014; Wen et al., 2015). By taking reading span as a measure of working memory capacity, Nieuwland and Van Berkum (2006) found that individuals with higher reading span are better at being sensitive to the alternative interpretations borne by the pronoun. However, Van Dyke, Johns and Kukona (2014) suggested that it is the content and quality of memory representations, rather than the quantity of information that can be actively maintained in working memory (i.e. working memory capacity), that affects language processing. Hence, the fourth hypothesis is made as below.

(4) High or low working memory capacity in English-speaking learners of Chinese and native Chinese speakers will not affect their real-time processing of *ziji*.

With L2 (Chinese) proficiency increasing, L2 learners may have increased exposure to the input of Chinese with variability in the interpretation of *ziji* (local

or/and long-distance), but not necessarily. Hence, the fifth hypothesis is made as below.

(5) English-speaking learners of Chinese at high (L2) Chinese proficiency levels will allow more long-distance interpretation of *ziji*, and also with faster processing.

5.2 Research design and predictions

According to verb-semantic (reviewed in Chapter 2.1.2) and discourse-context (reviewed in Chapter 2.1.3) information affecting the interpretation of *ziji*, a three (Verb Type) by two (Context) design is defined, which results in six conditions. Specifically, the factor of 'Verb Type' is VT1 (i.e. the introverted/self-oriented verb) only allowing a local interpretation of *ziji*, VT2 (i.e. the extroverted/other-oriented verb) only allowing a long-distance interpretation of *ziji*, and VT3 (i.e. the ambiguous/context-dependent verb) allowing both local and long-distance interpretation of *ziji*. The manipulation of 'Context' is operated on the preceding discourse-context, which determines a plausible interpretation for either the local antecedent or the long-distance antecedent as the referent of *ziji*. Hence, on the one hand, in the case of VT1 and VT2, the 'Verb Type' and 'Context' manipulation results in 'Matching' vs. 'Conflicting' condition. In particular, when the preceding context favours a local interpretation of *ziji*, there will have a 'Matching' condition with VT1 that requires a local interpretation, but a 'Conflicting' condition with VT2 that requires a long-distance interpretation. Also, when the preceding context favours a long-distance interpretation of *ziji*, there will have a 'Matching' condition with VT2 that requires a long-distance interpretation, but a 'Conflicting' condition with VT1 that requires a local interpretation. On the other hand, in the case of VT3, the preceding discourse-context favouring a local interpretation of *ziji* will lead to the 'Local Context' condition, and the preceding discourse-context favouring a long-distance interpretation of *ziji* will lead to the 'Long-distance Context' condition.

Based on the research design, and in relation to the above research questions and hypotheses, predictions relating to the expected patterns of antecedent

choices and reading times are summarized respectively as follows.

5.2.1 Predictions relating to antecedent choices

(1) With VT3 requiring a discourse context to interpret *ziji*, both English-speaking learners of Chinese and native Chinese speakers are expected to choose the antecedent for *ziji* depending on the discourse-context. Specifically, the local antecedent will be chosen when the discourse-context favours a local interpretation, and the long-distance antecedent will be chosen when the discourse-context favours a long-distance interpretation. However, compared with native Chinese speakers, English-speaking learners of Chinese are expected to choose the long-distance antecedent less for *ziji*, because only the local binding is allowed in their native English (L1).

(2) VT1 and VT2 impose verb-semantic restrictions on the interpretation of *ziji*, thus, choosing an antecedent for *ziji* will depend on whether the verb-semantic information matches the discourse-context information or not.

On the one hand, in the 'Matching' condition (i.e. a local/long-distance interpretation both required by the verb and favoured by the discourse-context), (a) native Chinese speakers are expected to choose the local antecedent only for *ziji* with VT1, and to choose the long-distance antecedent only for *ziji* with VT2; (b) English-speaking learners of Chinese will choose the local antecedent only for *ziji* with VT1 because it matches the local binding in their native English (L1); (c) compared with native Chinese speakers, English-speaking learners of Chinese will choose less long-distance antecedents for *ziji* with VT2 because it does not match the local binding in their native English (L1).

On the other hand, in the 'Conflicting' condition (i.e. a local interpretation required by the verb but a long-distance interpretation favoured by the discourse-context, or vice versa), (a) because native Chinese speakers give priority to the verb-semantic information, they are expected to choose the local antecedent only for *ziji* with VT1, and the long-distance antecedent only for *ziji* with VT2; (b) because English-speaking learners of Chinese rely more on discourse-context information, they are expected to choose the antecedent favoured by discourse-context information, that is, a local

antecedent for *ziji* with VT2, and a long-distance antecedent for *ziji* with VT1.

(3) Both English-speaking learners' and native Chinese speakers' antecedent choices of *ziji* are not expected to be affected by high or low working memory capacity.

(4) English-speaking learners of Chinese at high (L2) Chinese proficiency levels are expected to choose more long-distance antecedent for *ziji* with VT2.

5.2.2 Predictions relating to reading times

(1) According to the interactive-parallel-constraint model (Badecker and Straub, 2002), and the cue-based retrieval mechanism (e.g. McElree 2000, 2006; Van Dyke and Lewis, 2003; Lewis and Vasishth, 2005; Lewis, Vasishth and Van Dyke, 2006; Van Dyke and McElree, 2006), all linguistic information/constraints converging positively on a single antecedent candidate will result in faster processing because of the facilitatory effect of 'multiple cues'. Compared with VT3 utilizing the discourse-context cue only, the processing of *ziji* will be faster with VT1 and VT2 in the 'Matching' condition as the verb-semantic cue and the discourse-context cue converge positively on the same antecedent. Hence, compared with VT3, both native Chinese speakers' and English-speaking learners' reading times at or following *ziji* are expected to be faster with VT1 and VT2 in the 'Matching' condition.

(2) Based on the cue-based retrieval mechanism (e.g. McElree 2000, 2006; Van Dyke and Lewis, 2003; Lewis and Vasishth, 2005; Lewis, Vasishth and Van Dyke, 2006; Van Dyke and McElree, 2006), cue-based retrieval interference is assumed to arise due to cue-overload at the moment of retrieval. Cue-overload refers to a scenario when the cues used for retrieval do not point to a unique target, but rather match multiple items, which is assumed to result in mis-retrieval and the inhibitory interference between distractors and the target (Jäger et al., 2015, p. 2). Then, the inhibitory interference effect causes competition among antecedent candidates, which further leads to slower processing. Thus, compared with in the 'Matching' condition as the verb-semantic cue and the discourse-context cue point to the same target antecedent, the processing of *ziji* will be slower with VT1 and VT2 in the

'Conflicting' condition as the verb-semantic cue and the discourse-context cue point to different antecedent candidates.

Hence, (a) both native Chinese speakers' and English-speaking learners' reading times at or following *ziji* are expected to be slower with VT1 and VT2 in the 'Conflicting' condition than in the 'Mismatching' condition; (b) both native Chinese speakers' and English-speaking learners' reading times at or following *ziji* are expected to be slower with VT1 and VT2 in the 'Conflicting' condition than with VT3.

(3) Only the local binding is allowed in English-speaking learners' L1. Also, as discussed in Chapter 2.2.3, native Chinese speakers have a preference for the local interpretation of *ziji*, and it takes more time, and higher processing costs to have a long-distance interpretation (e.g. Gao, Liu and Huang, 2005; Liu, 2009, Li and Zhou, 2010). Hence, both native Chinese speakers' and English-speaking learners' reading times at or following *ziji* are expected to be faster when choosing a local antecedent than choosing a long-distance antecedent.

(4) Both English-speaking learners' and native Chinese speakers' reading times at or following *ziji* are not expected to be faster with high working memory capacity, or to be slower with low working memory capacity.

(5) At high (L2) Chinese proficiency levels, English-speaking learners' reading times at or following *ziji* are expected to be faster.

5.3 Research methods

5.3.1 Participants

29 English-speaking learners of Chinese (15 female, 14 male), who were either third- or fourth-year undergraduates studying Chinese at the Department of East Asian Studies, University of Leeds, participated in the current study as the experimental group. Also, 25 native Chinese speakers (18 female, 7 male), who were either undergraduate or postgraduate students at various departments, University of Leeds, participated in the current study as the control group.

All the 54 participants were right-handed according to Briggs and Nebes' (1975) handedness inventory (see Appendix II), had normal or corrected-to-normal

vision, and no speech or language difficulties. Ethical approval was granted by the Ethics Committee, School of Psychology, University of Leeds. Informed written consent forms were also obtained from all the participants.

Individual differences, such as factors relating to cognitive functions and language proficiency, also affect language comprehension and processing (Van Dyke, Johns and Kukona, 2014). Hence, before participating in the self-paced reading experiment, participants underwent a battery of tasks controlling for cognitive attention networks, working memory capacity, and language learning background and proficiency as follows.

5.3.1.1 Attention network test

All the participants did the ANT test (see Fan et al., 2002 for details) that evaluates attention consisted of three networks: alerting, orienting, and executive control of attention (Posner and Petersen, 1990). Alerting is defined as achieving and maintaining an alert state. Orienting is the selection of information from sensory input. Executive attention control is defined as resolving conflict among responses (Fan et al., 2002, p. 340). Efficiency of the three networks is assessed by measuring response times influenced by alerting cues, spatial cues and flanker conditions (Fan et al., 2002, p. 341).

The following Figure 5.1 presents conditions, stimuli and an example of the ANT test. Specifically, participants were shown an arrow on the screen pointing either to the left or to the right, for example, → or ←. On some trials, the arrow was flanked by two arrows to the left and two arrows to the right, for example, →→→→→ or →→←→→. Hence, participants were asked to respond to the direction of the CENTRAL arrow by pressing the left mouse button for the left direction or the right mouse button for the right direction. Also, participants were asked to make their responses as quickly and accurately as possible. Participants' reaction times and accuracy were recorded automatically. In addition, there was a cross ("+") on the center of the screen and the arrows appeared either above or below the cross. Participants were asked to try to fixate on the cross throughout the experiment. On some trials, there was asterisk cues

indicating when or where the arrow would occur. When the cue was at the center or both above and below fixation, it indicated that the arrow would appear shortly. When the cue was only above or below fixation, it indicated both that the trial would occur shortly and where it would occur. Participants were also asked to try to maintain fixation at all times. However, they might attend when and where indicated by the cues.

Figure 5.1 Conditions, stimuli and an example of the ANT test

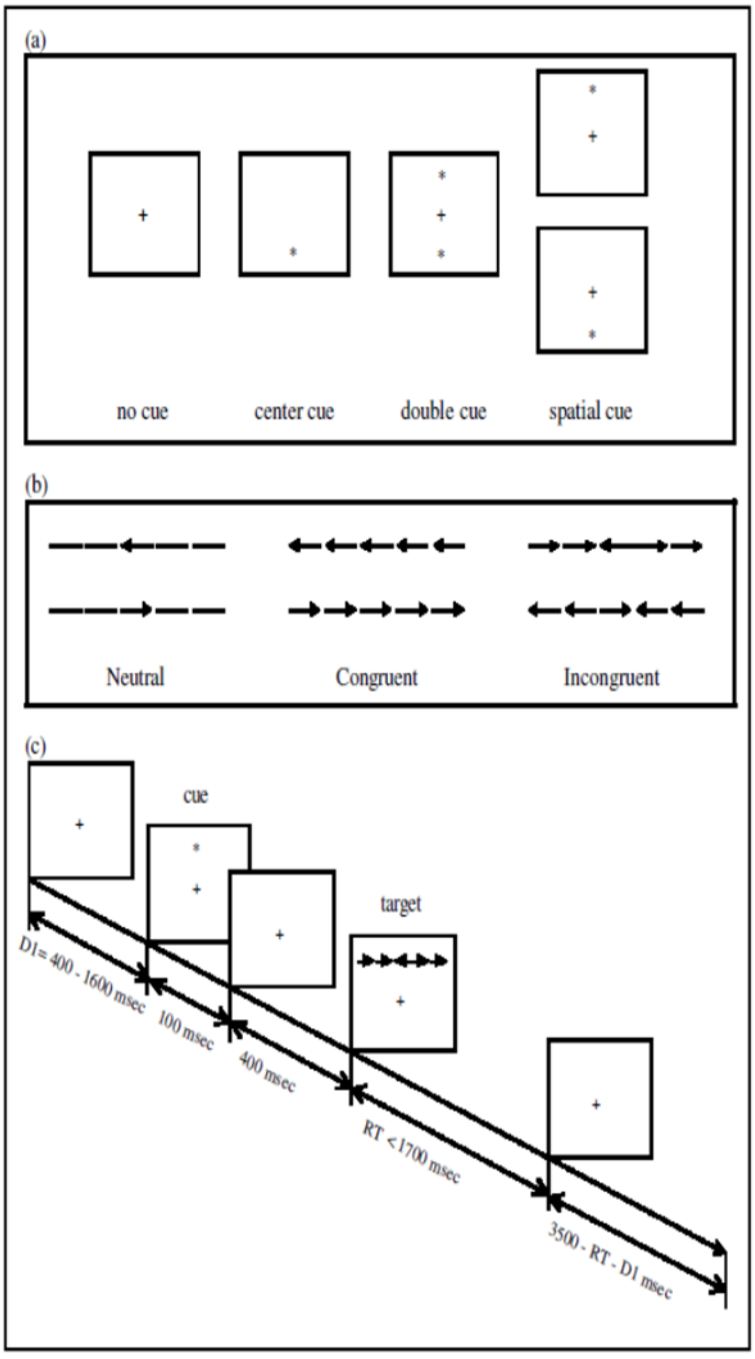


Figure 1. Experimental procedure. (a) The four cue conditions; (b) The six stimuli used in the present experiment; and (c) An example of the procedure.

(Fan et al., 2002, p. 341)

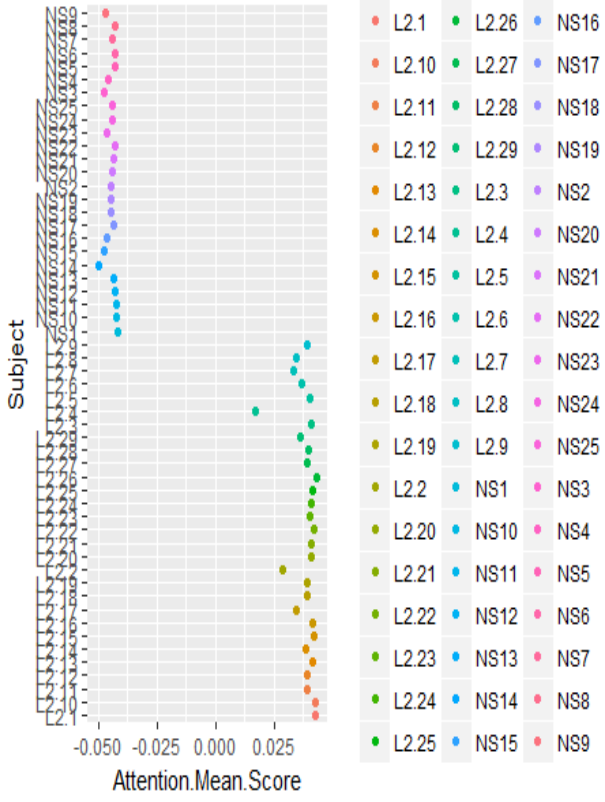
The whole ANT contained four blocks, one 2-minute practice block of 24 trials, and three 5-minute experiment blocks of 96 trials. There was a short break after each block. Participants received feedback on the computer about their accuracy and speed for practice trials, but not for experimental trials. In all, the whole ANT took about twenty minutes. All the trials were presented in a random order via E-prime 1.0 software, and all the participants were tested individually in the Linguistics Lab, at the Department of Linguistics and Phonetics, University of Leeds. In all, the whole ANT took about 17 minutes.

The Cox Proportional Hazard modelling is commonly used in the context of survival analysis to model 'time-to-event' data (Armitage, Berry and Matthews, 2008; Collett, 2015). Imagine that a 'good' participant takes X amount of time to answer correctly on a particular trial. Thus, a 'bad' participant is expected to take either longer to answer correctly, or the same amount of time (or shorter) to answer incorrectly. It is most unlikely that the 'bad' participant would be able to take shorter than the 'good' participant to answer correctly in that trial. Hence, the Cox PH modelling enables us to capture this by including the time to an incorrect answer as a censored observation. Even though without knowing how long it would actually take, censored observations are interpreted as the minimum amount of time it would take to produce a correct answer in that trial. Hence, all the answers (i.e. both the time taken to answer correctly, and the time taken to answer incorrectly) are included in the Cox PH modelling. Observations between items within the same participant are expected to be correlated as they are taken in sequence. Thus, items are considered as random effects in the Cox PH modelling in order to take the correlation between items into account. In addition, as the unit of observations, participants are also independent observations because they are randomly selected from a wider population in order to control potential confounders (De Cat, Gusnanto and Serratrice, 2017). In a word, while being able to handle multiple predictors/variables, the Cox PH modelling allows the modelling of all data points without transformation or outlier removal, and captures both accuracy and reaction time within the same analysis.

In the current ANT test, correct responses took on average 373ms longer than

incorrect responses: correct responses: mean = 626ms (SD = 191ms); incorrect responses: mean = 253ms (SD = 309ms), which fits perfectly with the assumptions of the Cox PH modelling. Instead of including participants as a predictor in the model, according to participants' native language, the participant-related variable 'Group' was used, that is, NS (native Chinese speakers) and L2 (English-speaking learners of Chinese). Taking 'time-to-a-correct-response' as the dependent variable, the Cox PH modelling on the results of ANT revealed an interaction effect between 'Flanker Conditions' and 'Group' only. Specifically, native Chinese speakers' reaction times to correct responses were significantly faster with the congruent flanker ($p < 0.001$). Conversely, English-speaking learners' reaction times to correct responses were significantly faster with the incongruent flanker ($p < 0.001$). This unexpected result across group leads to a confound in the following data analysis. In addition, English-speaking learners markedly faster at responding correctly, which is also unexpected with participants' results of the Digit Memory Test as follows. The distribution of participant's average modelled scores in the ANT is presented in the following Figure 5.2.

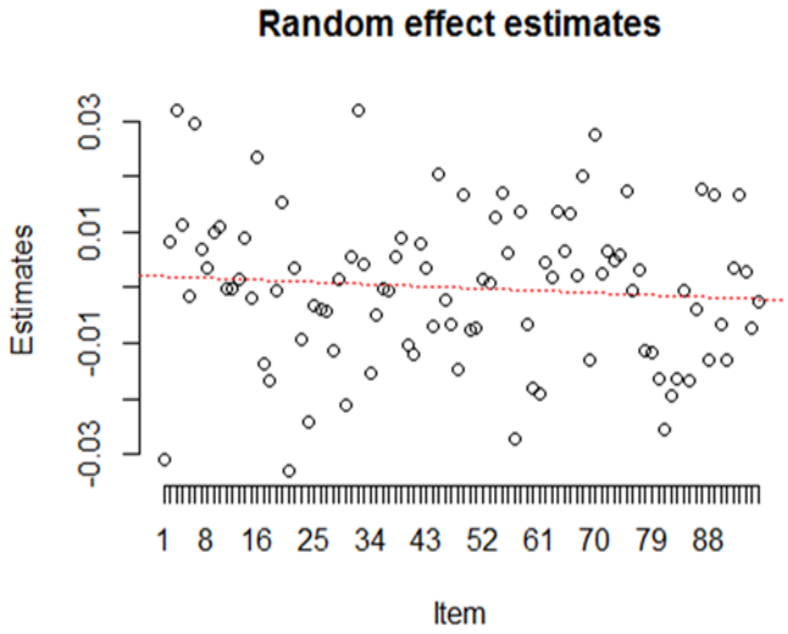
Figure 5.2 Distribution of participants' average modelled scores of the ANT test



(NS: native Chinese speakers; L2: English-speaking learners of Chinese)

Moreover, participants tended to slow down slightly as the ANT progressed, as shown in the following Figure 5.3. However, the estimates did not have a downward linear trend (p = 0.3834).

Figure 5.3 Random effects estimates for Item 1 to Item 96 in the ANT test



5.3.1.2 Digit memory test

All the participants completed the Digit Memory test (Turner and Ridsdale 2004, see Appendix III) evaluating working memory capacity. There were two parts: Digits Forwards (DF) and Digits Backwards (DB), taking about 10 minutes in all. There were eight items from A (two digits) to H (nine digits) in DF, and seven items from A (two digits) to G (eight digits) in DB, and each item consisted of two consecutive digit sequences. The experimenter presented digits verbally in English. In DF, participants were asked to repeat digit sequences of increasing difficulty until two consecutive sequences were failed; DB required reverse repetition of digit sequences. According to Turner and Ridsdale (2004), each individual's raw score was the total number of digit sequences correctly repeated in both DF and DB, which could be converted to an estimated standard score (see Table 1 in Appendix III) and also, a percentile equivalent score (see Table 2 in Appendix III). Detailed information of English-speaking learners' and native Chinese speakers' standard scores of the Digit Memory test are presented

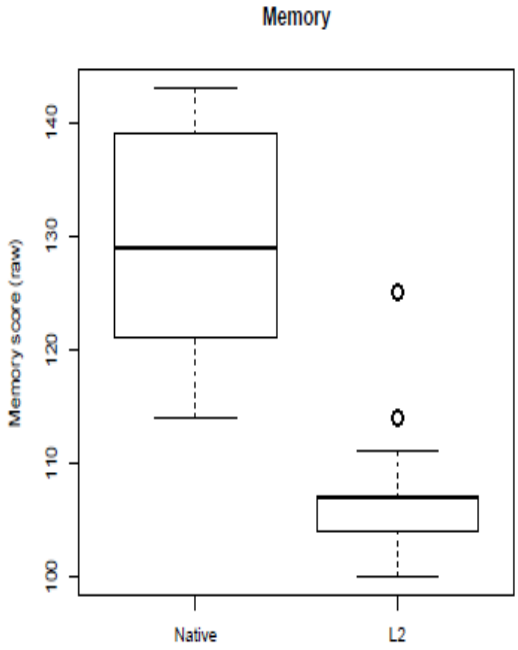
in the following Table 5.1.

Table 5.1 Detailed information of English-speaking learners' and native Chinese speakers' results of the Digit Memory Test

	Min	Max	Mean	SD
English-speaking learners' standard score	100	125	106	5.6
Native Chinese speakers' standard score	114	143	130	10.3

Native Chinese speakers' results had many variations, while there were notable outliers in English-speaking learners' results, as illustrated in the following Figure 5.4.

Figure 5.4 Distribution of participants' results of the Digit Memory Test

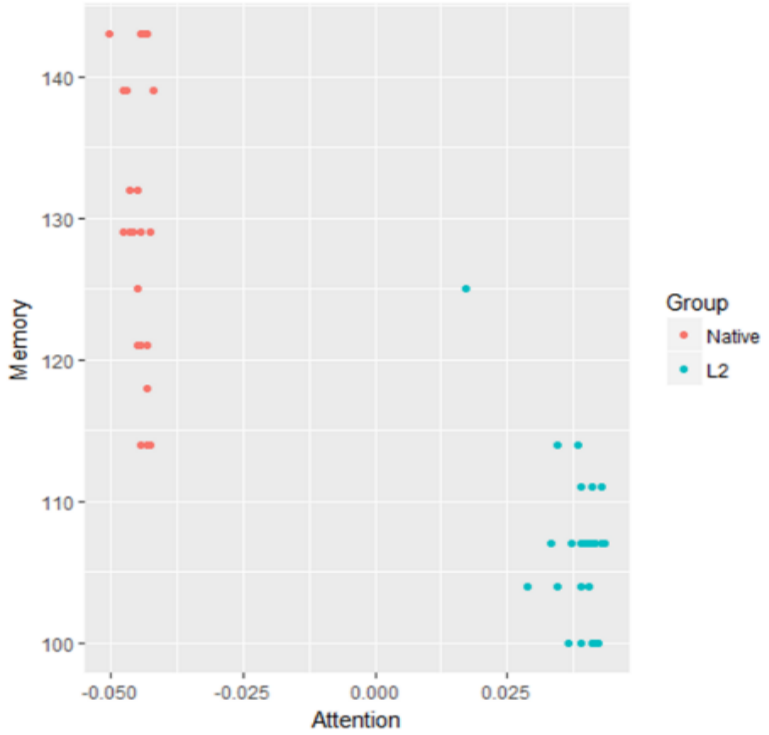


(Native: native Chinese speakers; L2: English-speaking learners of Chinese)

As shown in the following Figure 5.5, a correlation analysis showed that there was a significantly weak negative correlation in English-speaking learners' results of the ANT test and the Digits Memory Test (cor = -0.3014911, $p < 0.0001$). This negative correlation was also true for native Chinese speakers, which was significantly moderate (cor = -0.5478075, $p < 0.0001$). In all, native Chinese speakers performed better in the Digits Memory Test, but worse in the ANT test; while oppositely, English-speaking learners performed better in the ANT test, but worse in the Digits Memory Test. Because attention and working memory

are two dimensions evaluating the cognitive executive function, it is expected that there is a positive correlation between attention and working memory (i.e. better attention, better working memory). Hence, this discrepancy in native Chinese speakers' and English-speaking learners' results of the ANT test and the Digits Memory Test leads to a confound in the following data analysis. Therefore, participants' results of the ANT test and the Digits Memory Test were used as two predictors/variables representing attention and working memory separately in the following data analysis.

Figure 5.5 Correlation in participants' results of the ANT test and the Digit Memory Test



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

5.3.1.3 Language learning background and proficiency

English-speaking learners of Chinese completed a questionnaire evaluating their Chinese learning background (see Appendix IV). For instance, when they started to learn Chinese, how long they have been learning Chinese, how many hours they spend on learning Chinese characters, vocabulary, and grammar, listening, speaking, reading, and writing in Chinese on average each week, and how long they had been in China. Also, they completed a Chinese proficiency test (see Appendix V) based on the international HSK (i.e., Guoji Hanyu Shuiping Kaoshi)

examination in Level IV and V including (i) ten questions on vocabulary, (ii) eight questions on grammar, and (iii) two reading comprehension questions. The individual's proficiency score was the total number of questions answered correctly, which was converted to a percentage score. In addition, they also self-evaluated their Chinese competence by completing a Likert-scale self-evaluation questionnaire (see Appendix VI) of eight questions. In particular, they rated each question in one of the following five options: extremely well(excellent), very well(very good), well(good), not very well(fair), not at all(poor), and the five options labelled from 5 scores to 1 score. The individual's self-evaluation score was the score(s) of each question added in total, which was converted to a percentage score. In all, it took about 10 minutes for English-speaking learners to finish the Chinese proficiency test and the two questionnaires.

Detailed information of English-speaking learners' language learning background, proficiency and self-evaluated competency of Chinese is presented in the following Table 5.2.

Table 5.2 Detailed information of English-speaking learners' language learning background, proficiency and self-evaluated competency of Chinese

(L2) English-speaking learners of Chinese	Min	Max	Mean	SD
Age (in years)	20	27	22	1.5
Age of first exposure to Chinese (in years)	11	24	18	2.2
Time of learning Chinese (in years)	1.5	9	4	1.9
Learning Chinese characters/vocabulary/grammar per week (in hours)	1	20	5	4.3
Listening to/Watching Chinese programs per week (in hours)	0	14	2	2.6
Speaking in Chinese per week (in hours)	0	10	3	2.3
Reading in Chinese per week (in hours)	0	12	4	2.7
Writing in Chinese per week (in hours)	0	5	2	1.3
Time of living in China (in months)	0	18	10	4.4
Chinese proficiency Test Score (100%)	60	100	82.5	10.7
Self-Evaluation Score (100%)	45	87.5	65.4	11.7

Their scores of the Chinese proficiency test are illustrated in the following Figure 5.6. A correlation analysis revealed that there was a significant positive correlation ($r = 0.676$, $p < 0.0001$) in English-speaking learners' scores of the Chinese proficiency test and the self-evaluated competency of Chinese, as shown in the following Figure 5.7. Hence, English-speaking learners' scores of the Chinese proficiency test was taken as a variable/predictor of English-speaking learners' Chinese proficiency in the following data analysis.

Figure 5.6 Distribution of English-speaking learners' scores of the Chinese proficiency test

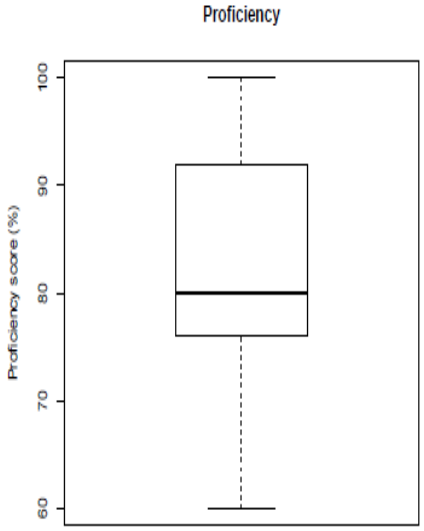
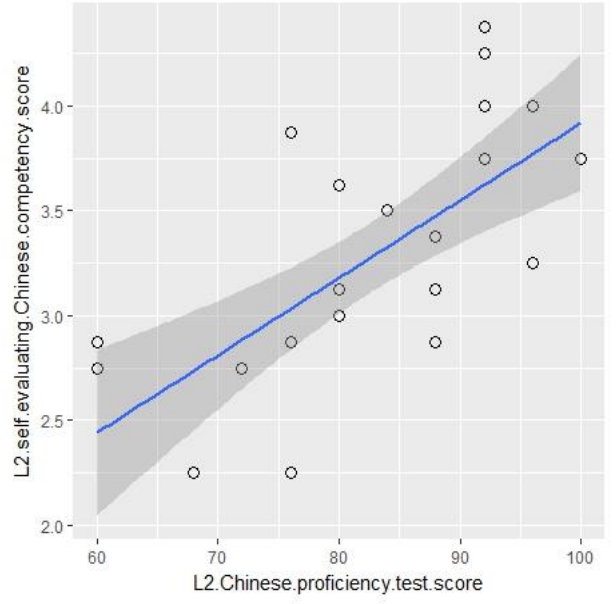


Figure 5.7 Correlation in English-speaking learners' scores of the Chinese proficiency test and self-evaluated competency of Chinese



Native Chinese speakers completed a questionnaire evaluating their English learning background and proficiency (see Appendix VII), which took about 5 minutes. For instance, when they started to learn English, how long they have been learning English, how long they had been staying in English-speaking countries including the UK, and the best/highest total score of IELTS or TOEFL they got. Detailed information of native Chinese speakers' language learning background and proficiency of English is presented in the following Table 5.3.

Table 5.3 Detailed information of native Chinese speakers' language learning background and proficiency of English

Native Chinese speakers	Min	Max	Mean	SD
Age (in years)	22	29	25	1.9
Age of first exposure to English (in years)	6	13	10	2.1
Time of learning English (in years)	11	20	16	2.0
Time of living in English-speaking countries including UK (in months)	12	60	32	16.2
IELTS Total Score (out of 9)	6.5	8	7	0.42

Comparing these two groups of participants' language learning background and proficiency, English-speaking learners' Chinese was at intermediate level, while native Chinese speakers' English was at advanced level. In addition, T-tests showed that (i) English-speaking learners of Chinese had significantly lower Chinese proficiency than native Chinese speakers ($p < 0.001$) as expected by assuming that native Chinese speakers got full marks in the Chinese proficiency test; (ii) native Chinese speakers had significantly better working memory than English-speaking learners of Chinese (possibly explained by the fact that native Chinese speakers were advanced bilinguals). However, compared with English-speaking learners of Chinese, native Chinese speakers performed better in the Digits Memory Test, but worse in the ANT test. This discrepancy in native Chinese speakers' and English-speaking learners' performance on the ANT test and the Digits Memory Test needs to be further investigated. Furthermore, a correlation analysis showed that there was no correlation in English-speaking learners' scores of the Chinese proficiency test and the Digits Memory Test ($r = 0.185$, $p = 0.3354$), and also no correlation in native Chinese speakers' scores of English proficiency and the Digits Memory Test ($r = -0.038$, $p = 0.8586$).

In sum, there were many confounds in participant-related predictors/variables (i.e. attention, language proficiency, and working memory). Hence, these three participant-related predictors/variables (i.e. attention, language proficiency, and working memory) would be tested within each group in the following data analysis. Specifically, attention, Chinese proficiency, and working memory would be tested within L2 group of English-speaking learners of Chinese, while attention and working memory would be tested within NS group of native Chinese speakers.

5.3.2 Experiment materials

Six experiment conditions were defined according to a three (Verb Type) by two (Context) design, as explained in Chapter 5.2. Specifically, the 'Verb Type' factor affected the embedded verb, that is, VT1 (i.e. the introverted/self-oriented verb) only allows a local interpretation of *ziji*, VT2 (i.e. the extroverted/other-oriented verb) only allows a long-distance interpretation of *ziji*, and VT3 (i.e. the ambiguous/context-dependent verb) allows both local and long-distance interpretation of *ziji*. The manipulation of 'Context' is operated on the preceding discourse-context, which determines a plausible interpretation for either the local antecedent or the long-distance antecedent as the referent of *ziji*. Hence, on the one hand, in the case of VT1 and VT2, the 'Verb Type' and 'Context' manipulation results in 'Matching' vs. 'Conflicting' condition. In particular, when the preceding discourse-context favours a local interpretation of *ziji*, there is a 'Matching' condition with VT1 that requires a local interpretation, like (41), but a 'Conflicting' condition with VT2 that requires a long-distance interpretation, like (43). Also, when the preceding discourse-context favours a long-distance interpretation of *ziji*, there is a 'Matching' condition with VT2 that requires a long-distance interpretation, like (42), but a 'Conflicting' condition with VT1 that requires a local interpretation, like (44). On the other hand, in the case of VT3, the preceding discourse-context favouring a local interpretation of *ziji* leads to a 'Local Context' condition, like (45), and the preceding discourse-context favouring a long-distance interpretation of *ziji* leads to a 'Long-distance Context' condition, like (46).

Each condition had 15 experiment items, that is, 30 experiment items with VT1, 30 experiment items with VT2, and 30 experiment items with VT3. Thus, there were 90 experiment items in total.

Each item contained a context sentence and a test sentence in pair, followed by a two-choice forced comprehension question. The context sentence was always one-sentence long. The two proper names *Zhangsan* and *Lisi* were counterbalanced in the context sentence, that is, sometimes *Zhangsan* was the agent, while sometimes *Lisi* was the agent. In the test sentence, the matrix subject was always the same proper name *Zhangsan*, and the embedded subject was always the same proper name *Lisi*. Each proper name was used equally in all conditions as the antecedent for *ziji*, aiming to discourage reliance on the proper name as a response strategy. The matrix verb was always the same causative verb *rang* taking a clausal complement, while the embedded verb was one verb in terms of the above three verb types, taking *ziji* as its object. In self-paced reading studies, there is a tendency for processing effects to 'carry over' from one word/segment to the next (Mackey and Gass 2011, p. 121), and the effects may not be detectable until one, two or even three words after the critical word, known as spill-over effects. Here, there were three words following *ziji* as the spill-over regions.

In addition, in some cases, in order to make the test sentence plausible, it was necessary to negate the embedded clause by adding one negative word to the sentence, see the following (47) as an example. In all, there were 34 negation items out of the 90 experimental items, specifically, 10 negation items with VT1 as the embedded verb in the test sentence, 12 negation items with VT2 as the embedded verb in the test sentence, and 12 negation items with VT3 as the embedded verb in the test sentence.

Moreover, there were 90 filler items with the Chinese pronoun *ta* as the object of the embedded verb in the test sentence, as shown in the following sentence (48). Also, there were 44 negation items out of the 90 filler items in total, see the

following (49) as an example. See Appendix VIII for a full list of the 90 experimental items and the 90 filler items.

(41) VT1 in the 'Matching' condition:

Context Sentence:

Lisi dui Zhangsan yinman zhenxiang.

Lisi to Zhangsan conceal fact

Lisi conceals a fact to Zhangsan.

Test Sentence:

Zhangsan rang Lisi tanbai ziji, dajia dou tongyi.

Zhangsan ask Lisi confess self, everyone (all) agree

Zhangsan asks Lisi to confess himself, everyone agrees.

Comprehension Question:

Shui yinggai tanbai shishi?

who should confess truth

Who should confess the truth?

A. Zhangsan

B. Lisi

(42) VT1 in the 'Conflicting' condition:

Context Sentence:

Zhangsan dui Lisi shuohuang.

Zhangsan to Lisi tell a lie

Zhangsan tells a lie to Lisi.

Test Sentence:

Zhangsan rang Lisi tanbai ziji, dajia dou tongyi.

Zhangsan ask Lisi confess self, everyone all agree

Zhangsan asks Lisi to confess himself, everyone agrees.

Comprehension Question:

Shui yinggai tanbai shishi?

who should confess truth

Who should confess the truth?

A. Zhangsan

B. Lisi

(43) VT2 in the 'Matching' condition:

Context Sentence:

Zhangsan mei you shijian canjia huiyi, ganghao Lisi you shijian.

Zhangsan not have time attend meeting, while Lisi have time

Zhangsan does not have time to attend a meeting, while Lisi has time.

Test Sentence:

Zhangsan rang Lisi daiti ziji, dajia dou tongyi.

Zhangsan ask Lisi replace self, everyone all agree

Zhangsan asks Lisi to replace him, everyone agrees.

Comprehension Question:

Shui xuyao bei daiti?

who need be replace

Who needs to be replaced?

A. Zhangsan

B. Lisi

(44) VT2 in the 'Conflicting' condition:

Context Sentence:

Zhangsan tingshuo Lisi buneng canjia bisai.

Zhangsan hear Lisi cannot join competition

Zhangsan hears that Lisi cannot join the competition.

Test Sentence:

Zhangsan rang Lisi daiti ziji, dajia dou tongyi.

Zhangsan ask Lisi replace self, everyone all agree

Zhangsan asks Lisi to replace him, everyone agrees.

Comprehension Question:

Shui xuyao bei daiti?

who need be replace

Who needs to be replaced?

A. Zhangsan

B. Lisi

(45) VT3 in the 'Local Context' condition:

Context Sentence:

Zhangsan faxian Lisi bu zixin.

Zhangsan find Lisi not confident

Zhangsan finds that Lisi is not confident.

Test Sentence:

Zhangsan rang Lisi xiangxin ziji, yiqie hui shunlide.

Zhangsan ask Lisi trust self, everything be fine

Zhangsan asks Lisi to trust himself, everything will be fine.

Comprehension Question:

Shui xuyao bei xiangxin?

who need be trust

Who needs to be trusted?

A. Zhangsan

B. Lisi

(46) VT3 in the 'Long-distance Context' condition:

Context Sentence:

Lisi danxin Zhangsan shoushang.

Lisi worry Zhangsan hurt

Lisi worries about that Zhangsan will be hurt.

Test Sentence:

Zhangsan rang Lisi xiangxin ziji, yiqie hui shunlide.

Zhangsan ask Lisi trust self, everything be fine

Zhangsan asks Lisi to trust him, everything will be fine.

Comprehension Question:

Shui xuyao bei xiangxin?

who need be trust

Who needs to be trusted?

A. Zhangsan

B. Lisi

(47) An experimental item with a negation test sentence:

Context Sentence:

Lisi wangji gei Zhangsan mai liwu.

Lisi forget to Zhangsan buy gift

Lisi forgets to buy a gift for Zhangsan.

(Negation) Test Sentence:

Zhangsan rang Lisi buyao zeguai ziji, dajia dou tongyi.

Zhangsan ask Lisi not blame self, everyone all agree

Zhangsan asks Lisi not to blame him, everyone agrees.

Comprehension Question:

buyao zeguai shui?

not blame who

Who need not be blamed?

A. Zhangsan

B. Lisi

(48) A filler item with a non-negation test sentence:

Context Sentence:

Zhangsan mei you shijian canjia bisai, ganghao Lisi you shijian.

Zhangsan not have time join competition, while Lisi have time

Zhangsan does not have time to join the competition, while Lisi has time.

Test Sentence:

Zhangsan rang Lisi daiti ta, duiyuanmen dou tongyi.

Zhangsan ask Lisi replace him, members all agree

Zhangsan asks Lisi to replace him, members all agree.

Comprehension Question:

Shui xuyao bei daiti?

who need be replace

Who need to be replaced?

A. Zhangsan

B. Lisi

(49) A filler item with a negation test sentence:

Context Sentence:

Zhangsan's friend bi Lisi geng youxiu.

Zhangsan's friend than Lisi more excellent

Zhangsan's friend is more excellent than Lisi.

(Negation) Test Sentence:

Zhangsan rang Lisi buyao xianmu ta, dajia yiqi nuli.

Zhangsan ask Lisi not admire him, everyone together make efforts

Zhangsan asks Lisi not to admire him, everyone makes efforts together.

Comprehension Question:

buyao xianmu shui?

not admire who

Who need not be admired?

A. Zhangsan

B. Zhangsan's friend

5.3.3 Task and procedures

The experiment consisted of a self-paced reading task. Participants read two-sentence sequences consisting of a context sentence (one-sentence long) and a bi-clausal test sentence, and then, participants had to identify the referent for *ziji*. Specifically, participants read the context sentence in the first screen. Then, participants pressed the SPACE bar to read the test sentence segment by segment in a self-paced non-cumulative moving window paradigm in the second screen. Then, after reading the last segment of the test sentence, participants pressed the SPACE bar again to read the context sentence and the test sentence together in the third screen. (In order to make sure that participants could remember and understand everything, the context sentence and the test sentence appeared together again.) Lastly, by pressing the SPACE bar again, participants answered a comprehension question with two choices in the final screen (i.e. 'A. Zhangsan' or 'B. Lisi' always appearing at the same position on the screen) by left or right clicking the MOUSE (i.e. 'A' always left, 'B' always right) using their dominant right hand. Participants' answers and reading times were recorded by the computer automatically.

Participants were tested individually on a laptop computer using E-prime 1.0 software, in the Linguistics Lab at Department of Linguistics and Phonetics, University of Leeds. After reading instructions, participants did three trials for practice, and then, proceeded to the 90 experimental trials and the 90 filler items.

The whole self-paced reading task took about 1.5 hours for native Chinese speakers, and about 2 hours for English-speaking learners. Hence, in order to avoid fatigue, the whole self-paced reading task was separated into two sessions with a break in-between, that is, each single session took 45 minutes for native Chinese speakers, and 1 hour for English-speaking learners of Chinese.

5.4 Data analysis and results

In order to capture effects of all the predictors/variables in the data, using the R package 'lme4' (version 1.1-13) in R (version 3.4.1), mixed-effects modelling was conducted in a semi-exploratory fashion guided by both research questions, and preliminary data visualization, aiming to identify what needs to take into account in the structure of fixed and random effects, and also to get a sense of the effects that the optimal model would capture.

Reading times below 150ms and above 4000ms were discarded from the data. Because the variability between local and long-distance interpretation of *ziji* which is not only with VT3, but also to an extent with VT1 and VT2 (revealed by the corpus study in Chapter 4), participants' antecedent choices (local vs. long-distance) were analysed by a logistic mixed-effects regression modelling, due to its binary. Participants' reading times were analysed by a linear mixed-effects regression modelling.

In general, because participants and experimental items display uncontrolled characteristics, they are used as random effects causing random variation in the data. However, due to those confounds explained in Chapter 5.3.1, participant-

related predictors/variables (i.e. attention, language proficiency, and working memory) were tested as fixed effects within each group. Specifically, attention, Chinese proficiency, and working memory were tested within L2 group of English-speaking learners of Chinese, while attention and working memory were tested within NS group of native Chinese speakers.

In addition, in the analysis, any variable or interaction showing a visible effect in data visualization was considered first, and then, retained only if it improved the mixed-effects model fit significantly by yielding a significant reduction in AIC and a significant R-squared value for the model (while allowing model convergence). The optimal models are reported, and the statistics for non-significant factors are given in the text. Then, the optimal models are plotted to visualise effects of the predictors.

A full list of predictors/variables adopted in the analysis is presented in the following Table 5.4.

Table 5.4 Description of predictors/variables in the experimental data

Data Size	**40164 obs. of 17 variables**
Participant-related variables:	
(1) Subject	NS1 to NS25 for native Chinese speakers, L2.1 to L2.29 for English-speaking learners of Chinese
(2) Group	NS for native Chinese speakers, L2 for English-speaking learners of Chinese
(3) Attention	the mean score of the ANT test
(4) Proficiency (of Chinese)	the total score of the Chinese proficiency test
(5) Memory	the raw standard score of the Digit Memory test
Here, 'Subject' was used as a random effect, while 'Group', 'Attention', 'Proficiency' and 'Memory' were used as fixed effects.	
Experiment-manipulated Variables:	
(6) Context	coded as 'Local vs. 'Long-distance'

(the preceding discourse-context sentence prefers local or long-distance interpretation of *'ziji'*)	
(7) Verb.Type (the type of the embedded verb in the test sentence)	coded as 'VT1', 'VT2' and 'VT3'
(8) Condition (a dummy-coded variable capturing the interaction between 'Verb Type' and 'Context')	coded as 'Verb Type*Context'
(9) Conflict (for VT1 and VT2 only)	coded as 'Cues.match' (i.e. VT1 in the 'Local Context' and VT2 in the 'Long-distance Context') vs. 'Cues.mismatch' (i.e. VT1 in the 'Long-distance Context' and VT2 in the 'Local Context')
Here, all the experiment-manipulated variables were used as fixed effects.	
Task-specific Variables:	
(10) Session	The two sessions of the experiment: 1 vs. 2
(11) Item	The 90 experimental items: 1 to 90
Here, 'Session' was used as a fixed effect, while 'Item' was used as a random effect.	
Dependent/Response-related Variables:	
• **Antecedent Choices**	
(12) Antecedent (participants' antecedent choices)	coded as 'Local' vs. 'Long-distance'
(13) Chosen.cue (for VT1 and VT2 only, participants' antecedent choices made according to which cue)	coded as 'Context' vs. 'Verb Type'
• **Reading times**	
(14) Region (each segment of the test sentence)	(1) Matrix Subject, (2) Matrix Verb, (3) Embedded Subject, (4) NOT(negation), (5) Embedded Verb, (6) *'ziji'*, (7) Spillover1, (8) Spillover2,

	(9) Spillover3
(15) Reading.baseline	this measures a general baseline of participants' reading times
(16) RT	this measures the reading times of each segment of the test sentence
(17) RTtrans	the box-cox transformation of RT (in order to get rid of differences in means)
Here, in the data of reading times, 'Reading.baseline' was used as a random effect, while 'Region' was used as a fixed effect.	

5.4.1 Antecedent choices: data visualization and modelling

5.4.1.1 Data visualization

Native Chinese speakers' and English-speaking learners' antecedent choices had many variations in the 90 experimental items, as illustrated in the following Figure 5.8. Hence, the variable 'Item' was used as a random effect in the modelling.

Each participants' antecedent choices (Local vs. Long-distance) also had many variations, as shown in the following Figure 5.9. Hence, the variable 'Subject' was used as a random effect in the modelling.

The effects of 'Verb Type' and 'Context' in native Chinese speakers' and English-speaking learners' antecedent choices are illustrated in the following Figure 5.10. Hence, the two variables 'Verb Type' and 'Context' were used as fixed effects in the modelling.

Due to confounds in the participant-related variables explained in Chapter 5.3.1, 'Memory' were used as fixed main effects in modelling native Chinese speakers' antecedent choices, while 'Proficiency', and 'Memory' were used as fixed main effects in modelling English-speaking learners' antecedent choices (while allowing model convergence).

Figure 5.8 Variation of participants' antecedent choices in the 90 experimental items

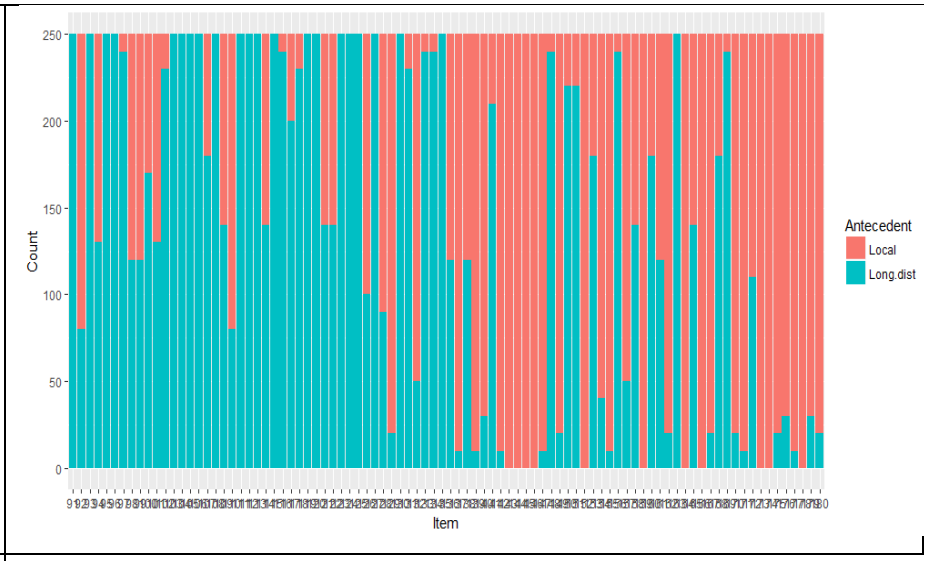
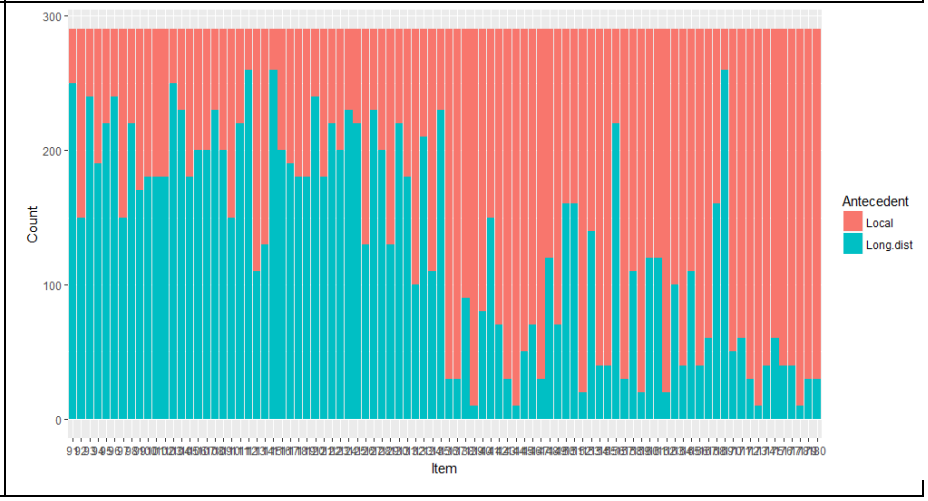
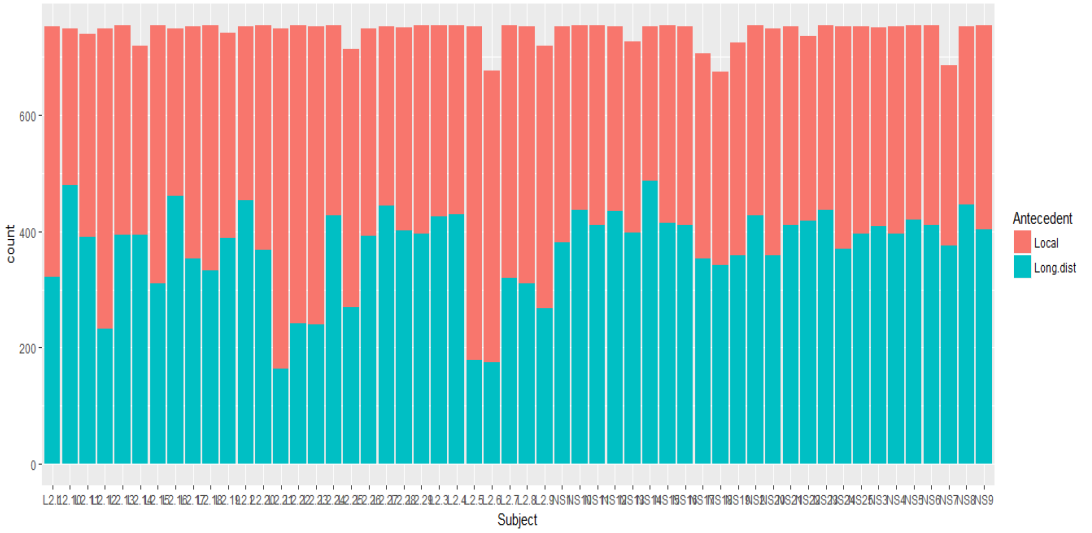
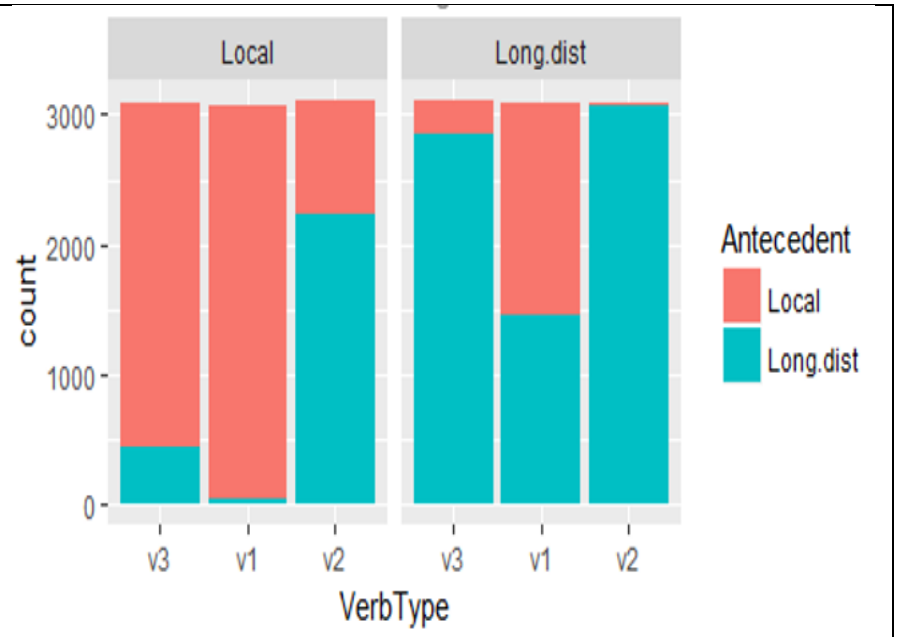
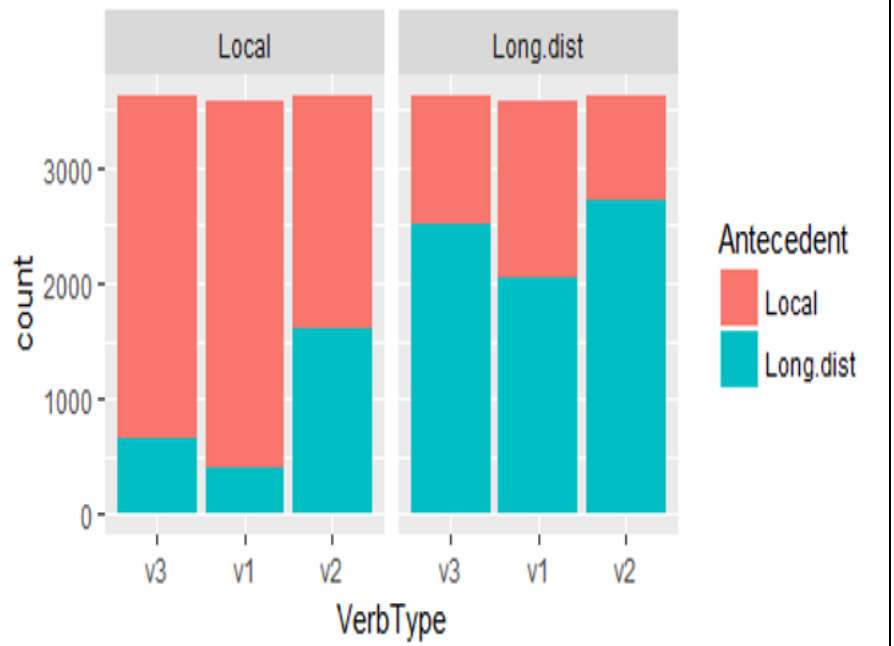
Native Chinese speakers	
English-Speaking learners of Chinese	

Figure 5.9 Variation of each participant's antecedent choices



(NS: native Chinese speakers, NS1 to NS25; L2: English-speaking learners of Chinese, from L2.1 to L2.29)

Figure 5.10 Effects of 'Verb Type' and 'Context' in participants' antecedent choices

Native Chinese speakers	
English-speaking learners of Chinese	

5.4.1.2 Native Chinese speakers' results

The results of the optimal logistic mixed-effects model[4] predicting the likelihood of choosing a long-distance antecedent of *ziji* by native Chinese speakers are summarized in the following Table 5.5. The random effects for 'Item' and 'Subject' had a variance of 4.5398 (Std.Dev: 2.1307) and 0.1735 (Std.Dev:

[4] The formula is 'Antecedent Choice ~ (1|Item) + (1|Subject) + Verb Type + Context'.

0.4166) respectively. There was no significant main fixed effect of 'Memory' (p = 0.5936). There were significant main fixed effects of 'Verb Type' and 'Context'. Specifically, when the discourse-context favoured a local antecedent (i.e. 'Local Context'), compared with VT3 as the reference level in the intercept, native Chinese speakers chose more local antecedents with VT1 (Z = -6.530, p < 0.001), and more long-distance antecedent with VT2 (Z = 5.787, p < 0.001). Also, when the discourse-context favoured a long-distance antecedent (i.e. 'Long-distance Context'), more long-distance antecedents were chosen with VT3 (Z = 11.486, p < 0.001).

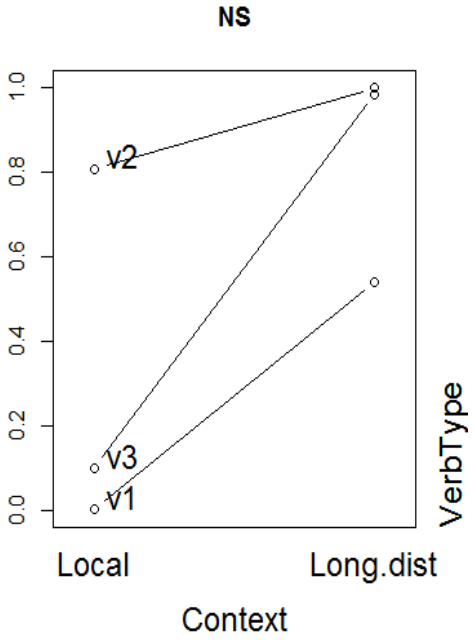
Table 5.5 Coefficients of fixed effects in a logistic mixed-effects model predicting the likelihood of choosing a long-distance antecedent of *ziji* by native Chinese speakers

	Estimate	**Std.Error**	**z value**	**Pr(>|z|)**
(Intercept)	-2.2022	0.4864	-4.527	5.97e-06 ***
VT1	-4.0628	0.6222	-6.530	6.59e-11 ***
VT2	3.6373	0.6285	5.787	7.14e-09 ***
Long-distance Context	6.4273	0.5596	11.486	< 2e-16 ***

(reference levels: VT3 and 'Local Context')

The fixed effects of this model are plotted in the following Figure 5.11. The figure demonstrates that in native Chinese speakers' antecedent choices of *ziji*, compared with VT3, VT1 strongly favours a local antecedent, and VT2 strongly favours a long-distance antecedent. Although there was no significant interaction effect between 'Verb Type' and 'Context', 'Context' still has an effect on VT1 and VT2, otherwise, there should be a horizontal line in both cases. Also, the long-distance antecedent is preferred. In addition, the preference of choosing the local antecedent with VT1 seems more easily to be overridden.

Figure 5.11 Likelihood of choosing a long-distance antecedent for *ziji* in native Chinese speakers (NS), depending on 'Verb Type' and 'Context'



5.4.1.3 English-speaking learners' results

The results of the optimal logistic mixed-effects model[5] predicting the likelihood of choosing a long-distance antecedent of *ziji* by English-speaking learners are summarized in the following Table 5.6. The random effects for 'Item' and 'Subject' had a variance of 0.6015 (Std.Dev:0.7755) and 0.5266 (Std.Dev: 0.7257) respectively. The model could not be converged by taking 'Memory' as a main fixed effect, thus, 'Memory' was excluded here. There were significant main fixed effects of 'Verb Type' and 'Context', and also a significant interaction effect between 'Verb Type' and 'Context'. Specifically, when the discourse-context favoured a local antecedent (i.e. 'Local Context'), compared with VT3 as the reference level in the intercept, there was a trend for English-speaking learners to choose more local antecedent with VT1 ($Z = -1.840$, $p = 0.06579$). Also, they chose more long-distance antecedents with VT2 ($Z = 5.336$, $p < 0.001$), especially when the discourse-context favoured a long-distance antecedent (i.e. 'Long-distance Context') ($Z = 2.953$, $p = 0.00314$). Moreover, they chose more long-

5 The formula is 'Antecedent Choice ~ (1|Item) + (1|Subject) + Verb Type * Context + Verb Type * Proficiency'.

distance antecedents with VT3 when the discourse-context favoured a long-distance antecedent (i.e. 'Long-distance Context') (Z = 9.810, p < 0.001). There were also significant main fixed effects of 'Verb Type' and 'Proficiency', and also a significant interaction effect between 'Verb Type' and 'Proficiency'. Specifically, as proficiency increasing, more long-distance antecedents were chosen with VT3 (Z = 2.246, p = 0.02470), and less long-distance antecedents were chosen with VT1 (Z = -13.820, p < 0.001). However, the likelihood of choosing a long-distance antecedent with VT2 was not affected (Z = -1.061, p = 0.28871).

Table 5.6 Coefficients of fixed effects in a logistic mixed-effects model predicting the likelihood of choosing a long-distance antecedent of *ziji* by English-speaking learners

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	-1.8529	0.2461	-7.530	5.07e-14 ***
VT1	-0.5386	0.2928	-1.840	0.06579 .
VT2	1.5440	0.2894	5.336	9.51e-08 ***
Long-distance Context	2.8407	0.2896	9.810	< 2e-16 ***
Proficiency	2.9643	1.3197	2.246	0.02470 *
VT1: Long-distance Context	-0.1184	0.4106	-0.288	0.77313
VT2: Long-distance Context	-1.2062	0.4084	2.953	0.00314 **
VT1: Proficiency	-5.1941	0.3758	-13.820	<2e-16 ***
VT2 : Proficiency	-0.3878	0.3656	-1.061	0.28871

(reference levels: VT3 and 'Local Context')

The following Figure 5.12 shows that the significant interaction effect between 'Verb Type' and 'Context' in English-speaking learners' antecedent choices of *ziji*. In addition, the following Figure 5.13 shows that in English-speaking learners' antecedent choices of *ziji*, 'Proficiency' has a significant interaction effect with VT1 and VT3, but no significant interaction effect with VT2.

Figure 5.12 Likelihood of choosing a long-distance antecedent for *ziji* in English-speaking learners (L2), depending on 'Verb Type' and 'Context'

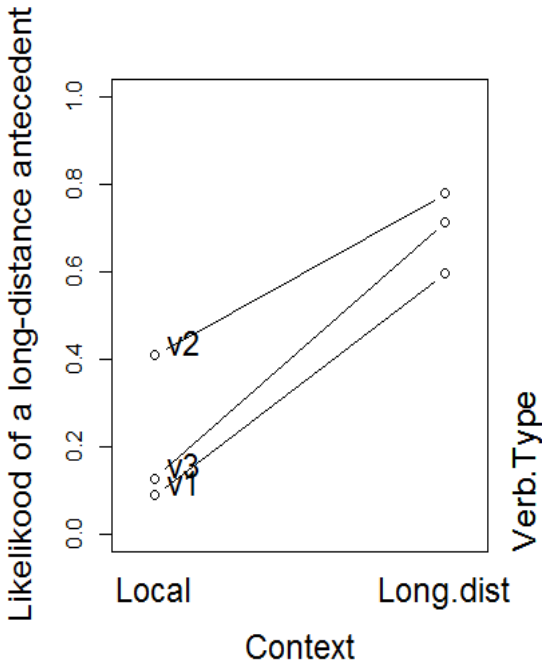
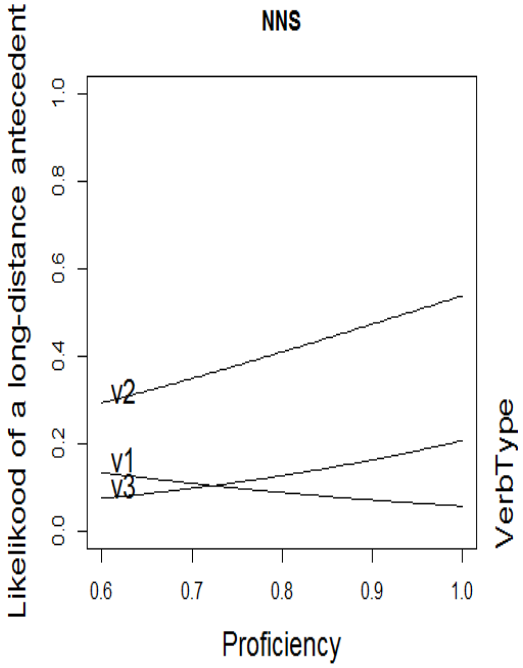


Figure 5.13 Likelihood of choosing a long-distance antecedent for *ziji* in English-speaking learners (L2), depending on 'Verb Type' and 'Proficiency'



5.4.1.4 Two groups' results

The results of the optimal logistic mixed-effects model[6] predicting the likelihood of choosing a long-distance antecedent of *ziji* by the two groups are summarized in the following Table 5.7. The random effects for 'Item' and 'Subject' had a variance of 0.6659 (Std.Dev: 0.8160) and 0.3566 (Std.Dev: 0.5971) respectively. There were significant main fixed effects of 'Verb Type', 'Context', and 'Group', and also significant interaction effects among 'Verb Type', 'Context' and 'Group'. Specifically, when the discourse-context favoured a local antecedent (i.e. 'Local Context'), compared with VT3 as the reference level in the intercept, English-speaking learners chose less long-distance antecedents with VT1 ($Z = -10.535$, $p < 0.001$) and more long-distance antecedents with VT2 ($Z = 17.538$, $p < 0.001$) than native Chinese speakers. Also, when the discourse-context favoured a long-distance antecedent (i.e. 'Long-distance Context'), English-speaking learners chose more long-distance antecedents with VT3 ($Z = 17.451$, $p < 0.001$) and with VT2 ($Z = 1.996$, $p = 0.0459$) than native Chinese speakers.

6 The formula is 'Antecedent Choice ~ (1|Item) + (1|Subject) + Verb type * Context * Group'.

Table 5.7 Coefficients of fixed effects in a logistic mixed-effects model predicting the likelihood of choosing a long-distance antecedent of *ziji* by the two groups

	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	-2.11034	0.24824	-8.501	<2e-16 ***
VT1	-2.33800	0.33675	-6.943	3.84e-12 ***
VT2	3.27043	0.30549	10.706	<2e-16 ***
Long-distance Context	4.77910	0.31012	15.410	< 2e-16 ***
L2 Group	0.23766	0.17949	1.324	0.1855
VT1: Long-distance Context	-0.45346	0.45463	-0.997	0.3186
VT2: Long-distance Context	-0.77963	0.47479	-1.642	0.1006
VT1: L2 Group	1.83727	0.17439	-10.535	<2e-16 ***
VT2 : L2 Group	-1.68449	0.09605	17.538	<2e-16 ***
Long-distance Context : L2 Group	-1.90809	0.10934	17.451	<2e-16 ***
VT1: Long-distance Context : L2 Group	0.29584	0.19835	1.491	0.1358
VT2 : Long-distance Context : L2 Group	-0.47468	0.23777	1.996	0.0459 *

(reference levels: Native Chinese speakers, VT3, and 'Local Context')

5.4.1.5 Which cue is used to make antecedent choices?

In order to investigate which cue is relied on more than the other one to interpret *ziji*, and whether the reliance is different between native Chinese speakers and English-speaking learners, which cue used to choose the antecedent for *ziji* was examined. As VT3 only using the discourse-context cue only, results of antecedent choices with VT1 and VT2 in the 'Conflicting' condition (i.e. a local interpretation required by the verb but a long-distance interpretation favoured by the discourse-context, or vice versa) were included in the analysis.

The following Table 5.8 summarizes the results of the optimal logistic mixed-effects model [7] predicting the likelihood of using the 'Verb Type' cue to choose an antecedent for *ziji* by the two groups. The random effects for 'Item' and 'Subject' had a variance of 0.8966 (Std.Dev: 0.9469) and 1.2335 (Std.Dev: 1.1106) respectively. There were significant main fixed effects of 'Verb Type' and 'Group', and also a significant interaction effect between 'Verb Type' and 'Group'. Specifically, compared with VT1 as the reference level in the intercept, native Chinese speakers relied on the 'Verb Type' cue more with VT2 (Z = 3.530, p = 0.000415). Compared with native Chinese speakers, English-speaking learners relied less on the 'Verb Type' cue both with VT1 (Z = -1.984, p = 0.047272) and with VT2 (Z = -13.703, p < 0.001). The level of 'Proficiency' (p = 0.254) investigated here did not have a significant main fixed effect on English-speaking learners' reliance on the 'Verb Type' cue.

Table 5.8 Coefficients of fixed effects in a logistic mixed-effects model predicting the likelihood of using the 'Verb Type' cue to choose an antecedent for *ziji* by the two groups

	Estimate	**Std.Error**	**z value**	**Pr(>|z|)**
(Intercept)	0.25203	0.33348	0.756	0.449783
VT2	1.24178	0.35173	3.530	0.000415 ***
L2 Group	-0.61284	0.30891	-1.984	0.047272 *
VT2 : L2 Group	-1.16933	0.08533	-13.703	< 2e-16 ***

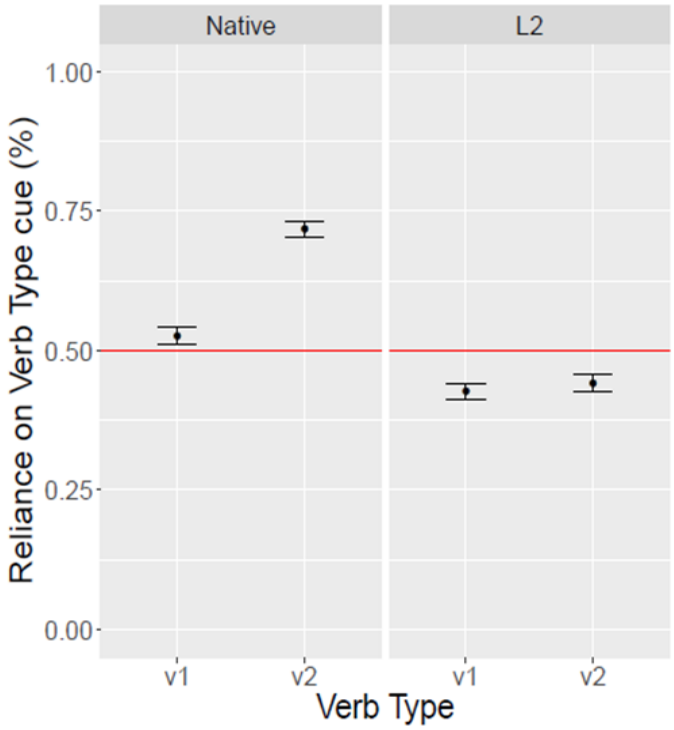
(reference levels: native Chinese speakers and VT1)

The following Figure 5.14 shows the two groups' reliance on the 'Verb Type' cue to choose an antecedent for *ziji* with VT1 and VT2 in the 'Conflicting' condition. The 'means+confidence' intervals above the red line means more reliance on the 'Verb Type' cue, while The 'means+confidence' intervals below the red line means less reliance on the 'Verb Type' cue. Specifically, in native Chinese speakers' antecedent choices of *ziji*, there were 53% with VT1 and 72% with VT2 made relying on the 'Verb Type' cue. However, in English-speaking learners' antecedent choices of *ziji*, there were 43% with VT1 and 44% with VT2 made

[7] The formula is 'Cue Choice ~ (1|Item) + (1|Subject) + Verb type * Group'.

relying on the 'Verb Type' cue, which seems like a chance level. In sum, (a) English-speaking learners of Chinese relied less on the verb-semantic cue than native Chinese speakers; (b) native Chinese speakers relied on the verb-semantic cue more with VT2 than with VT1.

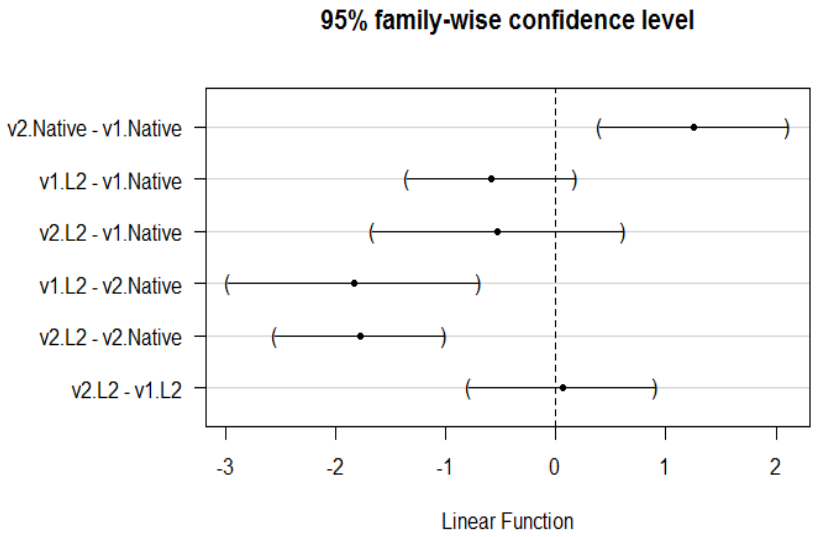
Figure 5.14 Two groups' reliance on the 'Verb Type' cue to choose an antecedent for *ziji* with VT1 and VT2 in the 'Conflicting' condition



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

A follow-up multiple comparison analysis is plotted in the following Figure 5.15, (in the figure, for the first term in the comparison on the y axis, 'Intervals > 0' indicates a stronger reliance on the cue of 'Verb Type', 'Intervals < 0' indicates a stronger reliance on the cue of 'Context', and 'Intervals crossing 0' indicates non-significant comparisons (i.e. no preference for either cue)). Native Chinese speakers had a significant stronger reliance on the verb-semantic cue to choose an antecedent for *ziji* with VT2 than with VT1, as shown in the first comparison. In addition, there was no significant difference in the reliance on either cue to choose an antecedent for *ziji* with VT1 and with VT2 by English-speaking learners of Chinese, as shown in the last comparison.

Figure 5.15 Tukey HSD contrasts (with Bonferroni correction) comparing native Chinese speakers' and English-speaking learners' reliance on the 'Verb Type' cue (against the 'Context' cue)



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

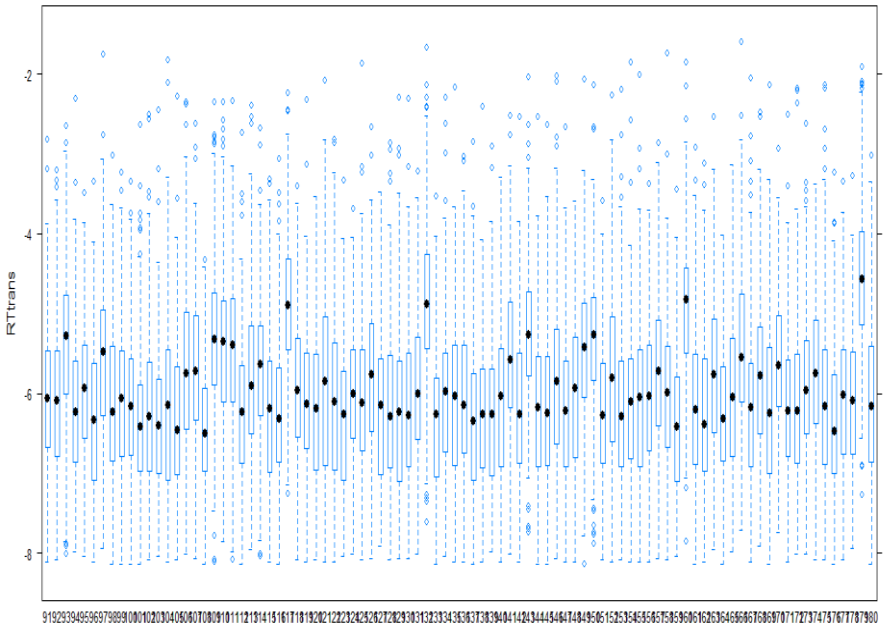
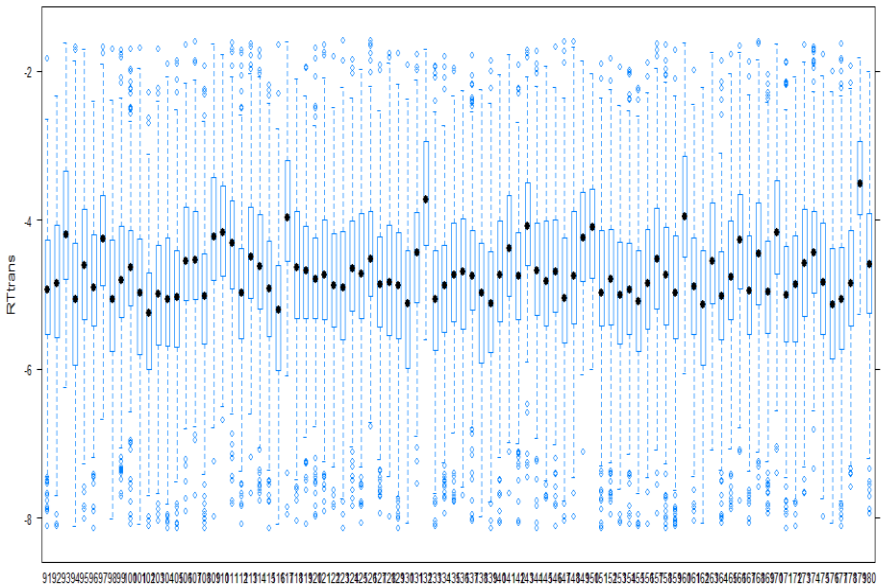
In summary, English-speaking learners of Chinese allow a long-distance interpretation of *ziji*, even it is ruled out by their (L1) English. Also, as Chinese proficiency increasing, they allow more local interpretation of *ziji* with VT1, and more long-distance interpretation of *ziji* with VT3. However, the Chinese proficiency level investigated here does not have a significant effect on the long-distance interpretation of *ziji* with VT2. In addition, native Chinese speakers and English-speaking learners of Chinese are sensitive to both the verb-semantic cue and the discourse-context cue to interpret *ziji*, but they weigh the two cues differently. Specifically, native Chinese speakers give priority to the verb-semantic cue to interpret *ziji*, although the discourse-context cue can overrule the verb-semantic cue. English-speaking learners of Chinese rely more on the discourse-context (less on the verb-semantic cue) to interpret *ziji*. Moreover, working memory capacity investigated here does not influence the interpretation of *ziji* by both native Chinese speakers and English-speaking learners of Chinese.

5.4.2 Reading times: data visualization and modelling

5.4.2.1 Data visualization

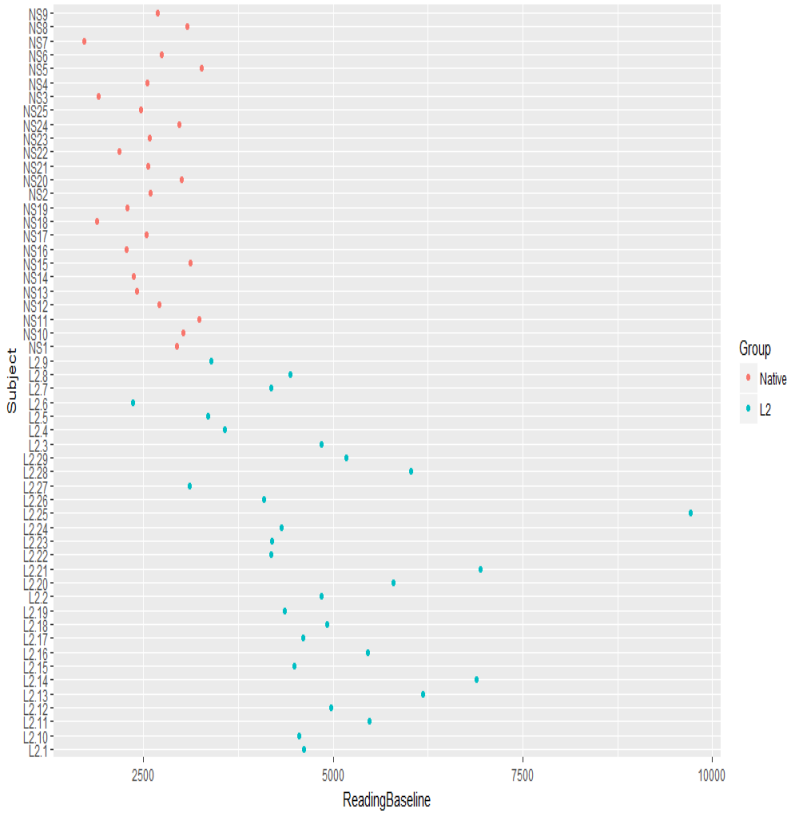
Native Chinese speakers' and English-speaking learners' reading times had many variations in the 90 experimental items, as illustrated in the following Figure 5.16. Hence, the variable 'Item' was also used as a random effect in the modelling.

Figure 5.16 Variation of participants' reading times in the 90 experimental items

Native Chinese speakers	
English-speaking learners of Chinese	

The variations of native Chinese speakers' and English-speaking learners' general baseline of reading times (i.e. 'Reading.baseline') are illustrated in the following Figure 5.17. Each participant had a different reading baseline. Hence, the variable 'Reading.baseline' was used as a random effect in the following modelling.

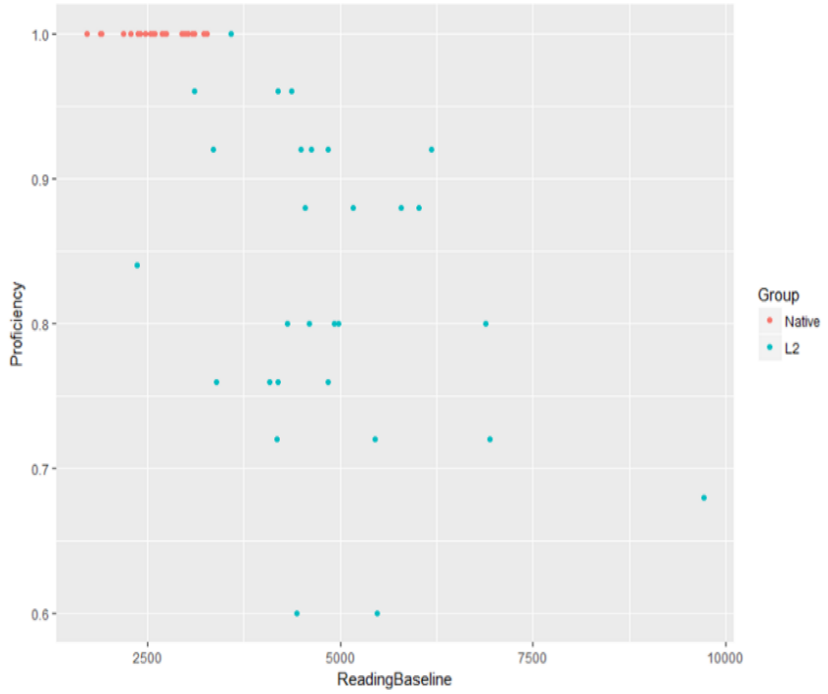
Figure 5.17 Variation of participants' reading times in the 90 experimental items



(Native: native Chinese speakers, from NS1 to NS25; L2: English-speaking learners of Chinese, from L2.1 to L2.29)

The correlation between participants' 'Reading.baseline' and 'Proficiency' was not very strong, as shown in the following Figure 5.18. However, a correlation analysis showed that this moderate correlation between 'Reading.baseline' and 'Proficiency' is significant in the group of English-speaking learners of Chinese (cor = -0.3364426, $p < 0.001$). Hence, the variable 'Proficiency' was used as a fixed effect in the modelling of English-speaking learners' reading times.

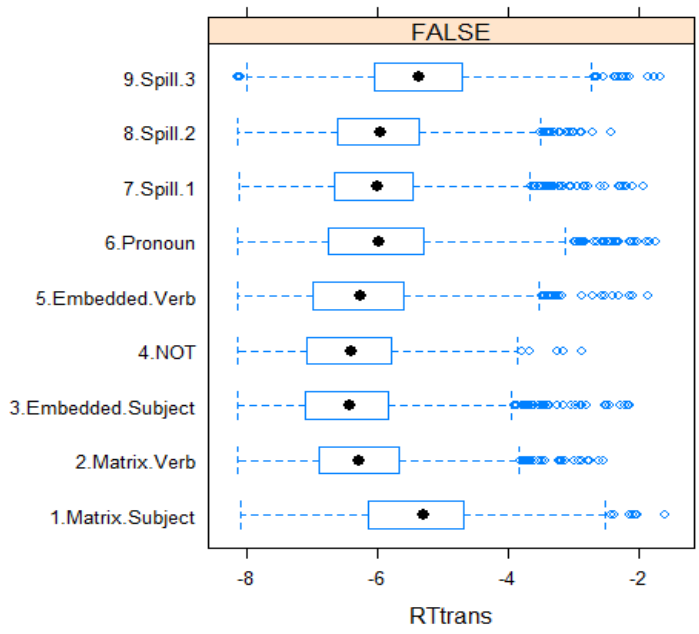
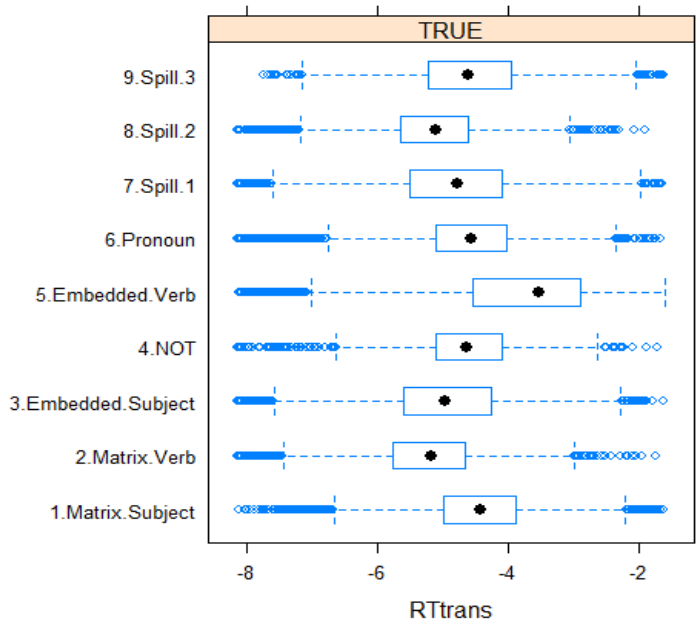
Figure 5.18 Correlation between participants' 'Reading Baseline' and 'Proficiency'



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

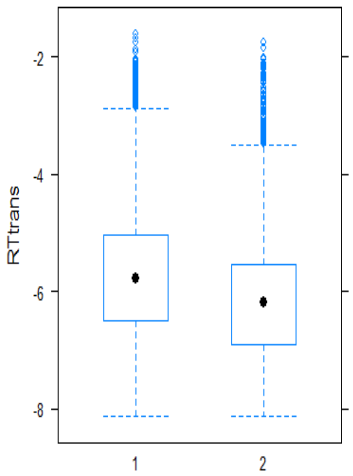
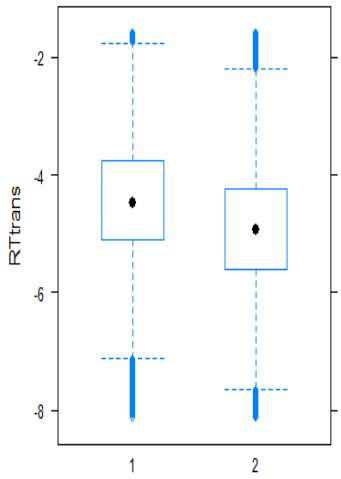
The correlation between participants' attention (i.e. the ANT scores modelled in Chapter 5.3.1.1) and reading times at each region of the test sentence is illustrated in the following Figure 5.19. The correlation between English-speaking learners' attention and reading times was strongest at the region of 'Embedded.Verb', and also a bit stronger at the region of 'Spillover3'. However, the correlation between native Chinese speakers' attention and reading times was not strong at each region. Hence, the variable 'Attention' was tested as a fixed effect within each group, while improving the model fit, and also allowing model convergence.

Figure 5.19 Correlation between participants' attention and reading times at each region of the test sentence

Native Chinese speakers	
English-speaking learners of Chinese	

The effect of session in participants' reading times is illustrated in the following Figure 5.20. Session 2 was always faster than Session 1. Hence, the variable 'Session' was used as a fixed effect in the modelling.

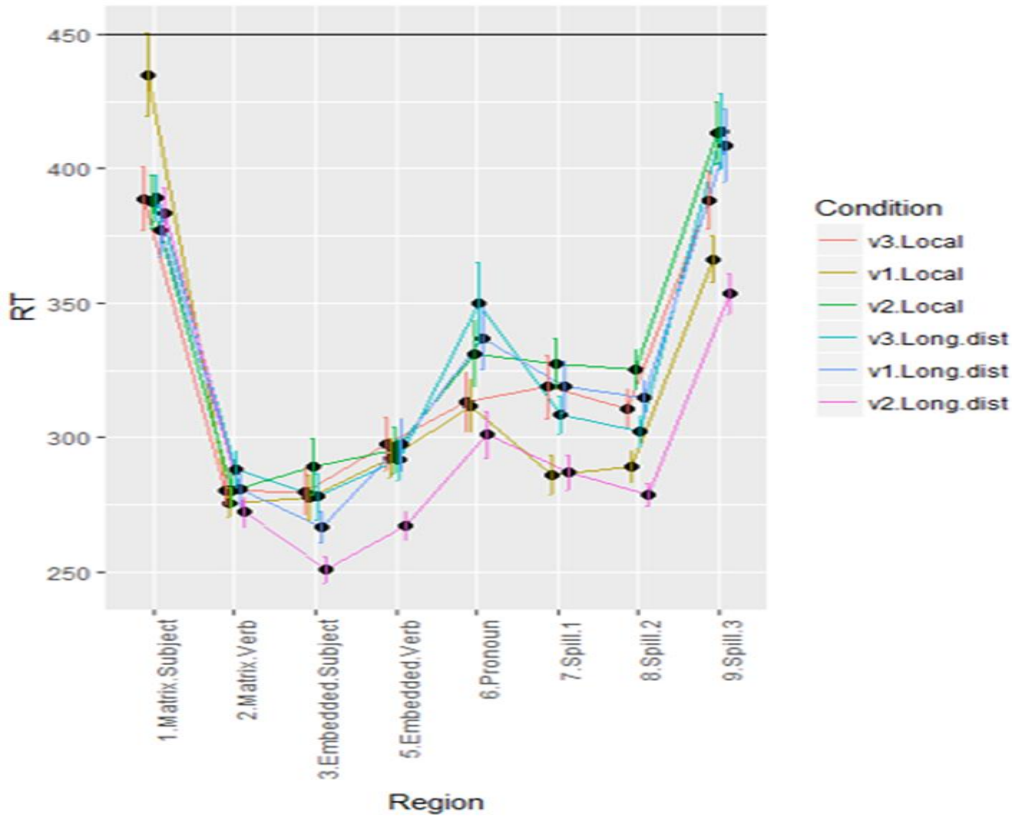
Figure 5.20 Effect of session in participants' reading times

Native Chinese speakers	
English-speaking learners of Chinese	

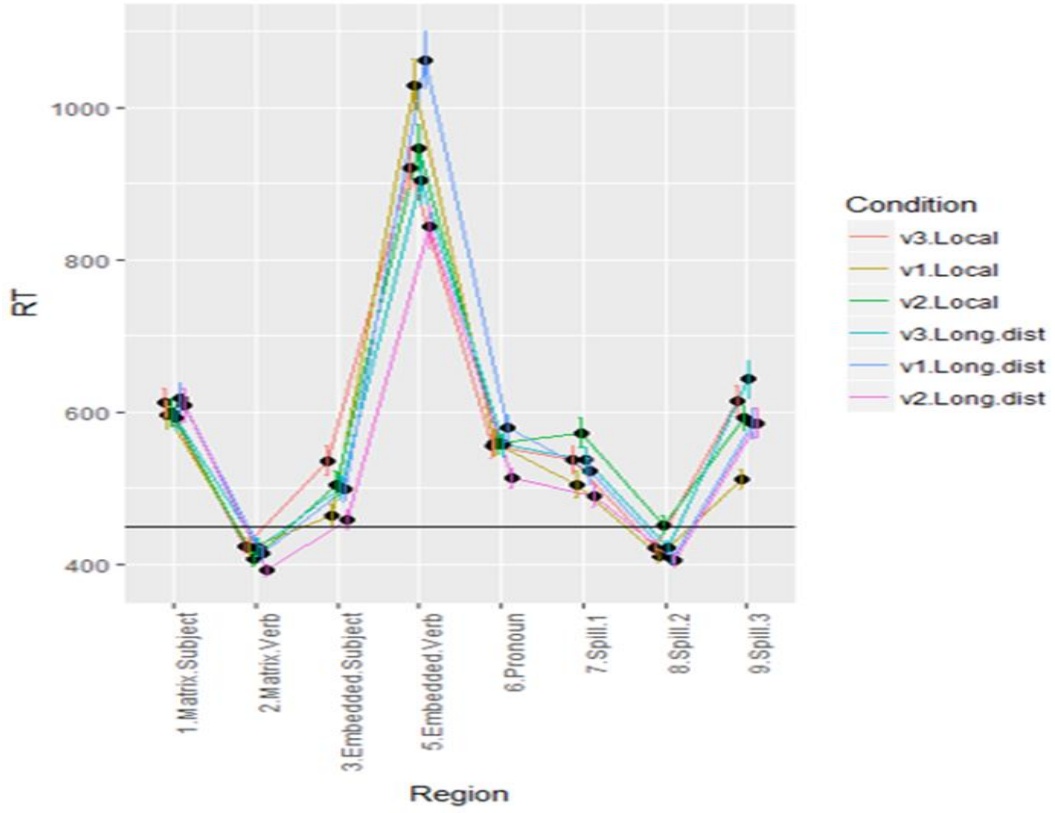
The interaction of 'Condition' (i.e. 'Verb Type*Context') affecting participants' reading times at each region of the test sentence is illustrated in the following Figure 5.21. There was an effect of VT1 in 'Local Context' (i.e. V1.Local) at the region of 'Matrix.Subject' in native Chinese speakers' reading times, which was likely just a spillover effect from the context sentence influencing reading times of the first segment of the test sentence. Although it would be not likely to influence reading times at the region of the reflexive *ziji* and onwards, this effect of the 'Matrix.Subject' with VT1 in 'Local Context' (i.e. Matrix.Subject.Effect) was used as a random effect in the modelling of native Chinese speakers' reading times.

Figure 5.21 Interaction of 'Condition' ('Verb Type*Context') affecting participants' reading times at each region of the test sentence

· Native Chinese speakers



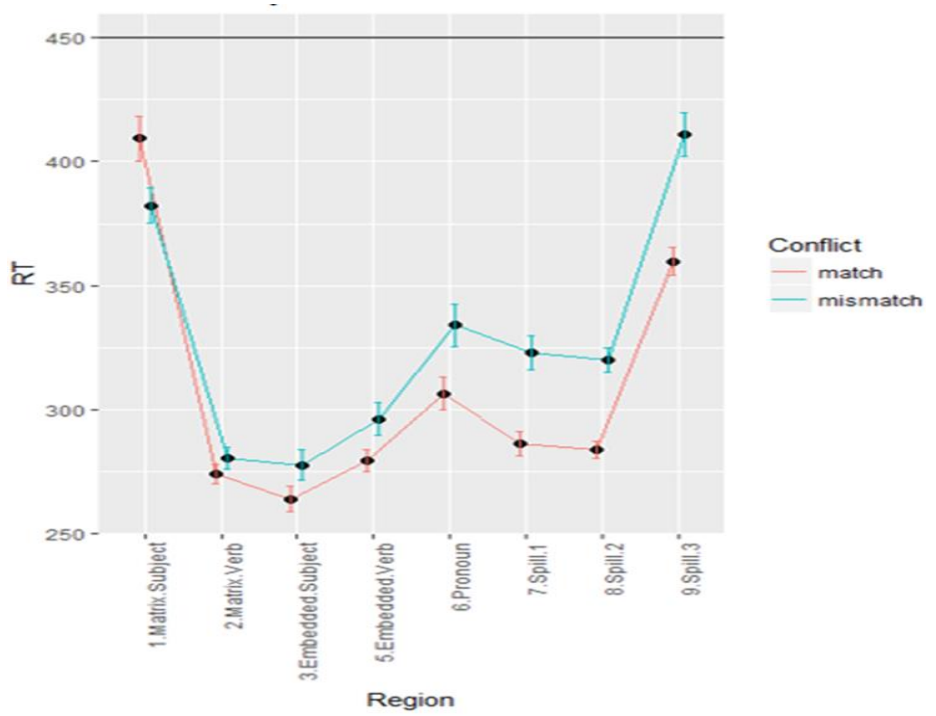
· English-speaking learners of Chinese



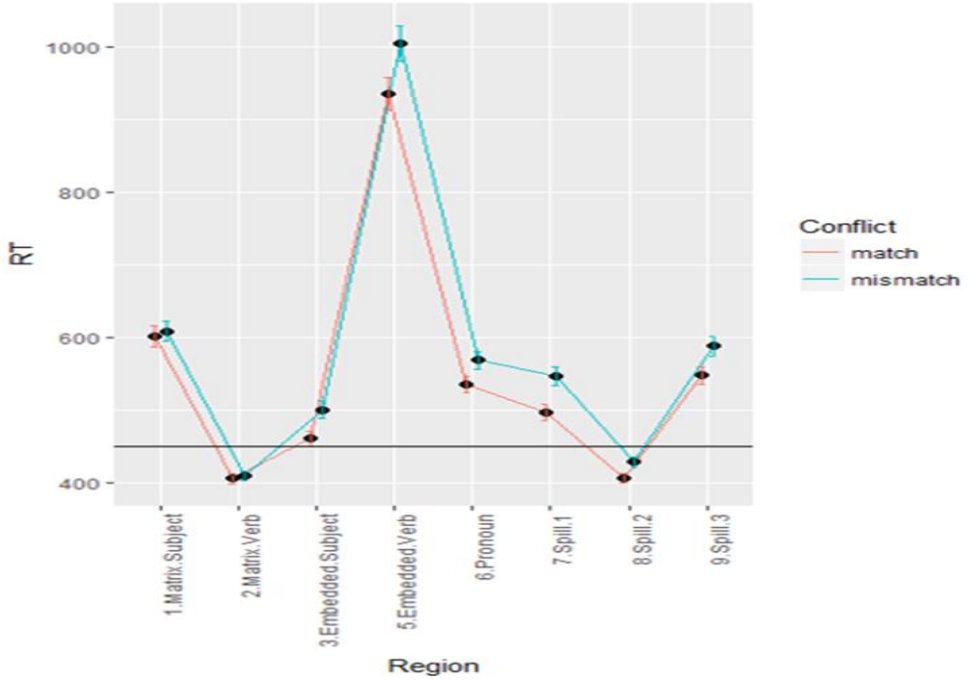
In addition, excluding participants' reading times with VT3, the effect of 'Conflict' (i.e. Cues.match vs. Cues.mismatch) between the two cues in participants' reading times with VT1 and VT2 at each region of the test sentence is illustrated in the following Figure 5.22.

Figure 5.22 Effect of 'Conflict' (Cues.match vs. Cues.mismatch) in participants' reading times at each region of the test sentence

- Native Chinese speakers



- English-speaking learners of Chinese



Hence, the following modelling will have to ascertain whether the observed differences in data visualization are significant or not: (i) 'Condition' by 'Region', (ii) 'Conflict' by 'Region'. In all, compared with native Chinese speakers, English-speaking learner' reading times were much slower. Also, native Chinese speakers' reading times were longer at the reflexive *ziji* and onwards, while English-speaking learners' reading times were longest at the embedded verb.

5.4.2.2 Native Chinese speakers' reading times by condition

The results of the optimal linear mixed-effects model[8] predicting the interaction of 'Condition' (i.e. 'Verb Type*Context') affecting native Chinese speakers' reading times at each region of the test sentence are summarized in the following Table 5.9. The random effects for 'Item', 'Reading.baseline', and 'Matrix.Subject.Effect' had a variance of 0.0952 (Std.Dev: 0.3085), 0.2187 (Std.Dev: 0.4677) and 0.6287 (Std.Dev: 0.7929) respectively. There were no significant main fixed effects of 'Memory' (t = -0.647), and of 'Attention' (t = 1.739). During native Chinese speakers' processing, VT1 was faster to process (coefficient = -0.286435, t = -2.393), but this was counteracted by interactions of 'Region' and 'Context'. VT2 did not have a significant main fixed effect (t = 0.252), but this was reinforced by interactions of 'Region' and 'Context'. Also, the 'Long-distance Context' (i.e. the discourse-context favouring a long-distance antecedent) did not have a significant main fixed effect (t = 0.401), which was strengthen by interactions of 'Region' and 'Verb Type'. However, most of the effects did not appear very strong.

[8] The formula is 'NS.RTtrans ~ (1 | Item) + (1 | Subject) + Region * Verb Type * Context + Session'

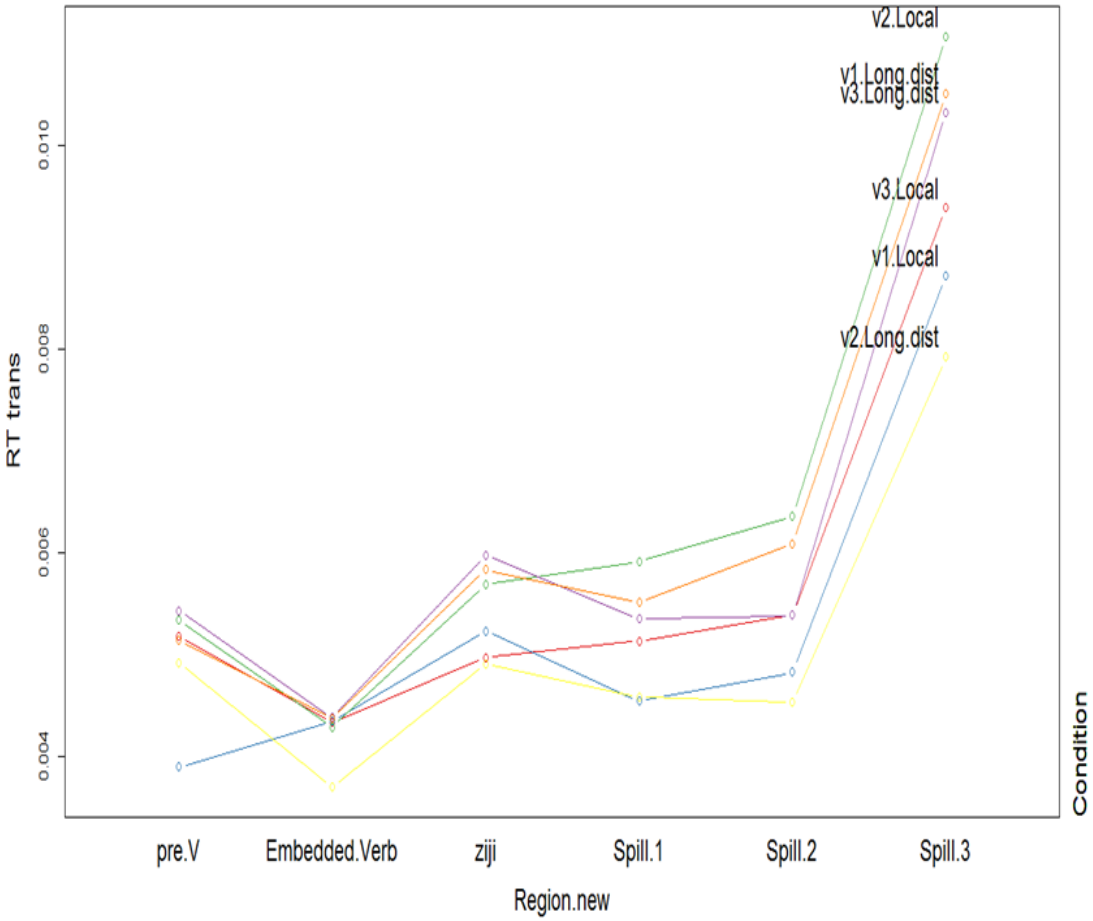
Table 5.9 Coefficients of fixed effects in a linear mixed-effects model predicting native Chinese speakers' reading times by 'Region', depending on 'Verb Type' and 'Context'

	Estimate	Std.Error	t value
(Intercept)	-4.844683	0.583338	-8.305
Embedded.Verb	-0.179969	0.050749	-3.546
ziji	-0.042103	0.050696	-0.830
Spillover1	-0.009813	0.050853	-0.193
Spillover2	0.039375	0.050697	0.777
Spillover3	0.598069	0.050440	11.857
VT1	-0.286435	0.119705	-2.393
VT2	0.029744	0.118240	0.252
Long-distance context	0.047377	0.118238	0.401
Session	-0.412577	0.066417	-6.212
Embedded.Verb:VT1	0.288330	0.074330	3.879
ziji:VT1	0.337382	0.074002	4.559
Spillover1:VT1	0.164207	0.074005	2.219
Spillover2:VT1	0.175105	0.073934	2.368
Spillover3:VT1	0.212473	0.073687	2.883
Embedded.Verb:VT2	-0.040850	0.071933	-0.568
ziji:VT2	0.106112	0.071711	1.480
Spillover1:VT2	0.112329	0.071785	1.565
Spillover2:VT2	0.135573	0.071567	1.894
Spillover3:VT2	0.136794	0.071313	1.918
Embedded.Verb:Long-distance Context	-0.036874	0.071817	-0.513
ziji:Long-distance Context	0.138328	0.071670	1.930
Spillover1:Long-distance Context	-0.005206	0.071709	-0.073
Spillover2:Long-distance Context	-0.048286	0.071634	-0.674
Spillover3:Long-distance Context	0.048982	0.071380	0.686
VT1:Long-distance Context	0.230332	0.168185	1.370
VT2:Long-distance Context	-0.128741	0.167279	-0.770
Embedded.Verb:VT1:Long-distance Context	-0.233590	0.103288	-2.262
ziji:VT1:Long-distance Context	-0.306185	0.102951	-2.974
Spillover1:VT1:Long-distance Context	-0.078582	0.102904	-0.764
Spillover2:VT1:Long-distance Context	0.003393	0.102826	0.033
Spillover3:VT1:Long-distance Context	-0.138575	0.102574	-1.351
Embedded.Verb:VT2:Long-distance Context	-0.028610	0.101733	-0.281
ziji:VT2:Long-distance Context	-0.205008	0.101421	-2.021
Spillover1:VT2:Long-distance Context	-0.169548	0.101344	-1.673
Spillover2:VT2:Long-distance Context	-0.210378	0.101215	-2.079
Spillover3:VT2:Long-distance Context	-0.304831	0.100959	-3.019

(reference levels: VT3 and 'Local Context')

The results of fixed effects of the model is plotted in the following Figure 5.23. As shown in the figure, most of native Chinese speakers' processing happened at the region of 'Spillover3'. Hence, native Chinese speakers' reading times at the region of 'Spillover3' were further modelled by a linear mixed-effects model.

Figure 5.23 Fixed effects in the linear mixed-effects model predicting native Chinese speakers' reading times at each region of the test sentence



V2.Long.dist: VT2 in the Long-distance Context

V1.Local: VT1 in the Local Context

V3.Local: VT3 in the Local Context

V3.Long.dist: VT3 in the Long-distance Context

V1.Long.dist: VT1 in the Long-distance Context

V2.Local: VT2 in the Local Context

(pre.V: regions of 'Matrix.Subject', 'Matrix.Verb', and 'Embedded.Subject';
Spill.1: Spillover1; Spill.2 : Spillover2; Spill.3: Spillover3)

The results of the optimal linear mixed-effects model[9] predicting the interaction of 'Condition' (i.e. 'Verb Type*Context') affecting native Chinese speakers' reading times at the region of 'Spillover3' are summarized in the following Table 5.10. The random effects for 'Item' and 'Reading.baseline' had a variance of

[9] The formula is 'NS.Spillover3.RTtrans ~ (1 | Item) + (1 | Reading.baseline) + Verb Type * Context + Session'.

0.09174 (Std.Dev: 0.3029) and 0.33133 (Std.Dev: 0.5756) respectively. There were no significant main fixed effects of 'Memory' (t = -0.647) and of 'Attention' (t = 1.739). During native Chinese speakers' processing at the region of 'Spillover3', compared with VT3 in 'Local Context' (i.e. the discourse-context favouring a local antecedent), there were no significant differences in native Chinese speakers' reading times with VT1 (t = -0.665) and with VT2 (t = 1.329). Also, there were no significant differences in native Chinese speakers' reading times in 'Long-distance Context' (i.e. the discourse-context favouring a long-distance antecedent) with VT3 (t = 0.759) and with VT1 (t = 0.522). However, native Chinese speakers' reading times were significantly faster with VT2 in 'Long-distance Context' (coefficient = -0.18021, t = -2.499).

Table 5.10 Coefficients of fixed effects in a linear mixed-effects model predicting native Chinese speakers' reading times at the region of 'Spillover3' by 'Condition'

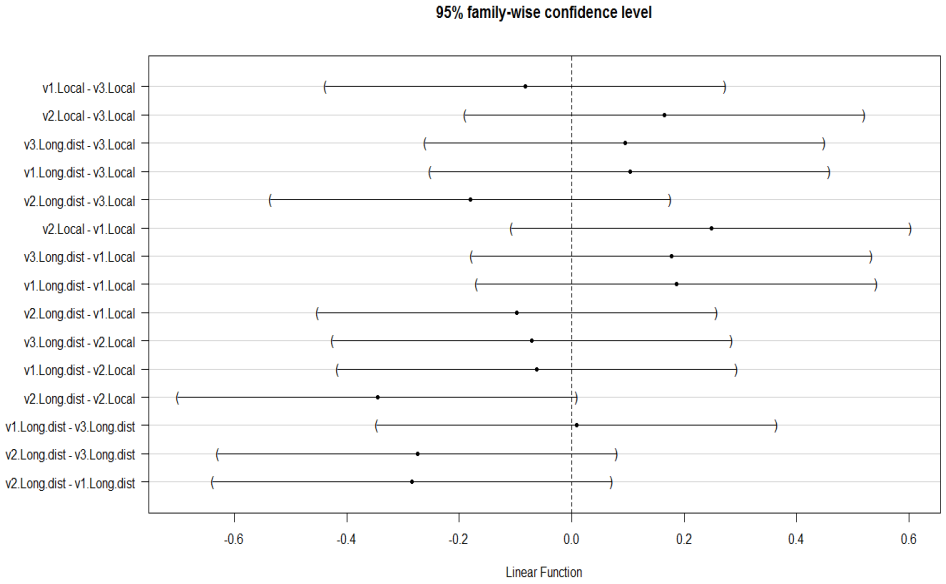
	Estimate	**Std. Error**	**t value**
(Intercept)	-4.99026	0.17928	-27.834
VT1	-0.08286	0.12455	-0.665
VT2	0.16529	0.12440	1.329
Long-distance Context	0.09446	0.12444	0.759
Session2	- 0.28655	0.07201	-3.979
VT1: Long-distance Context	0.09187	0.17600	0.522
VT2 : Long-distance Context	-0.43996	0.17605	-2.499

(reference levels: VT3 and 'Local Context')

A follow-up multiple comparisons analysis is plotted in the following Figure 5.24, (in the figure, for the first term in the comparison on the y axis, 'Intervals > 0' indicates slower reading times, 'Intervals < 0' indicates faster reading times, and 'Intervals crossing 0' indicates non-significant comparisons). As shown in the figure, none of the pairwise comparisons reach significance, even the most extreme one ('VT2.Long-distance context' vs. 'VT2.Local context'), which suggests that the significant effects observed in the model summary are not very

robust. However, the following analysis by 'Conflict' (i.e. Cues.match vs. Cues.mismatch) in Chapter 5.4.2.5 might be able to shed a clearer light on the apparent patterns in this figure.

Figure 5.24 Tukey HSD contrasts (with Bonferroni correction) comparing native Chinese speakers' reading times at the region of 'Spillover3' in each condition



5.4.2.3 English-speaking learners' reading times by condition

The results of the optimal linear mixed-effects model[10] predicting the interaction of 'Condition' (i.e. 'Verb Type*Context') affecting English-speaking learners' reading times at each region of the test sentence are summarized in the following Table 5.11. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.07556 (Std.Dev: 0.2749) and 0.33494 (Std.Dev: 0.5787) respectively. There were no significant main fixed effects of 'Memory' (t = -0.753), of 'Attention' (t = 0.728), and of 'Proficiency' (t = -0.254). During English-speaking learners' processing, there were no significant main fixed effects of VT1 (t = -0.508), VT2 (t = -0.585), and 'Long-distance Context' (t = -0. 482), which could be strengthen

[10] The formula is 'L2.RTtrans ~ (1 | Item) + (1 | Reading.baseline) + Region * Verb Type * Context + Session'.

by the interaction of 'Region'. However, most of the effects did not appear very strong.

Table 5.11 Coefficients of fixed effects in a linear mixed-effects model predicting English-speaking learners' reading times by 'Region', depending on 'Verb Type' and 'Context'

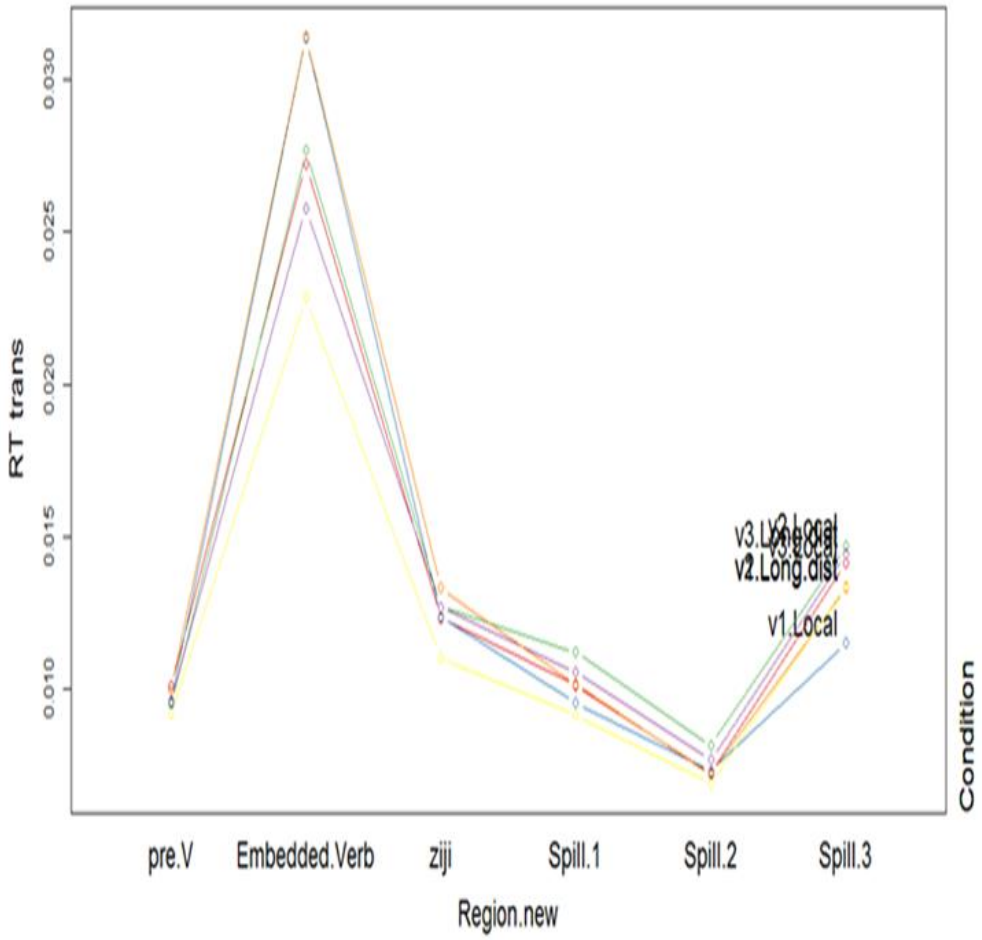
	Estimate	Std. Error	t value
(Intercept)	-4.050155	0.157519	-25.712
Embedded.Verb	1.011952	0.050609	19.995
ziji	0.204825	0.050162	4.083
Spillover1	0.003237	0.050206	0.064
Spillover2	-0.339230	0.050162	-6.763
Spillover3	0.340966	0.050250	6.785
VT1	-0.054091	0.106521	-0.508
VT2	-0.062289	0.106463	-0.585
Long-distance Context	-0.051306	0.106454	-0.482
Session	-0.537992	0.059429	-9.053
Embedded.Verb:VT1	0.199708	0.071884	2.778
ziji:VT1	0.055443	0.071020	0.781
Spillover1:VT1	-0.004873	0.071019	-0.069
Spillover2:VT1	0.066867	0.070988	0.942
Spillover3:VT1	-0.154081	0.070989	-2.170
Embedded.Verb:VT2	0.079196	0.071613	1.106
ziji:VT2	0.090294	0.070920	1.273
Spillover1:VT2	0.165457	0.071106	2.327
Spillover2:VT2	0.184397	0.070919	2.600
Spillover3:VT2	0.103979	0.071043	1.464
Embedded.Verb:Long-distance Context	-0.004064	0.071697	-0.057
ziji:Long-distance Context	0.078798	0.071062	1.109
Spillover1:Long-distance Context	0.093088	0.070968	1.312
Spillover2:Long-distance Context	0.112709	0.070906	1.590
Spillover3:Long-distance Context	0.073282	0.070999	1.032
VT1:Long-distance Context	0.094549	0.150544	0.628
VT2:Long-distance Context	0.018499	0.150611	0.123
Embedded.Verb:VT1:Long-distance Context	-0.037177	0.101641	-0.366
ziji:VT1:Long-distance Context	-0.046917	0.100533	-0.467
Spillover1:VT1:Long-distance Context	-0.074680	0.100356	-0.744
Spillover2:VT1:Long-distance Context	-0.170891	0.100356	-1.703
Spillover3:VT1:Long-distance Context	0.033439	0.100335	0.333
Embedded.Verb:VT2:Long-distance Context	-0.159251	0.101385	-1.571
ziji:VT2:Long-distance Context	-0.188551	0.100423	-1.878
Spillover1:VT2:Long-distance Context	-0.267168	0.100489	-2.659
Spillover2:VT2:Long-distance Context	-0.245818	0.100247	-2.452
Spillover3:VT2:Long-distance Context	-0.135802	0.100357	-1.353

(reference levels: VT3 and 'Local Context')

The results of fixed effects of the model is plotted in the following Figure 5.25. As shown in the figure, most of English-speaking learners' processing happened at

the region of 'Embedded.Verb'. Also, not only with a matter of magnitude, there was also a qualitative interaction between 'Condition' and the region of 'Spillover3'. In addition, it looks like VT1 in 'Local Context' (i.e. the discourse-context favouring a local antecedent) gradually become the fastest during processing. Hence, English-speaking learners' reading times at the region of 'Embedded.Verb' and at the region of 'Spillover3' were further modelled by a linear mixed-effects model separately.

Figure 5.25 Fixed effects in the linear mixed-effects model predicting English-speaking learners' reading times at each region of the test sentence



V2.Long.dist: VT2 in the Long-distance Context

V1.Local: VT1 in the Local Context

V3.Local: VT3 in the Local Context

V3.Long.dist: VT3 in the Long-distance Context

V1.Long.dist: VT1 in the Long-distance Context

V2.Local: VT2 in the Local Context

(pre.V: regions of 'Matrix.Subject', 'Matrix.Verb', and 'Embedded.Subject';
Spill.1: Spillover1; Spill.2 : Spillover2; Spill.3: Spillover3)

The results of the optimal linear mixed-effects model[11] predicting the interaction of 'Condition' (i.e. 'Verb Type*Context') affecting English-speaking learners' reading times at the region of 'Embedded.Verb' are summarized in the following Table 5.12. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.06089 (Std.Dev: 0.2468) and 0.91523 (Std.Dev: 0.9567) respectively. There were no significant main fixed effects of 'Memory' (t = -0.753), of 'Attention' (t = 0.728), and of 'Proficiency' (t = -0.254). There were also no significant main effects of 'Verb Type' and 'Context', and also no significant interaction effect of 'Condition' (i.e. 'Verb Type*Context'). Hence, although there was a qualitative difference in English-speaking learners' processing at the region of 'Embedded.Verb', English-speaking learners' reading times had no significant difference in each condition.

Table 5.12 Coefficients of fixed effects in a linear mixed-effects model predicting English-speaking learners' reading times at the region of 'Embedded.Verb' by 'Condition'

	Estimate	**Std. Error**	**t value**
(Intercept)	-2.872496	0.216167	-13.288
VT1	0.157026	0.111590	1.407
VT2	0.009691	0.111295	0.087
Long-distance Context	-0.056351	0.111368	-0.506
Session2	- 0.640913	0.064505	-9.936
VT1: Long-distance Context	0.055626	0.157678	0.353
VT2 : Long-distance Context	-0.139016	0.157542	-0.882

(reference levels: VT3 and 'Local Context')

The results of the optimal linear mixed-effects model[12] predicting the interaction of 'Condition' (i.e. 'Verb Type*Context') affecting English-speaking learners'

11 The formula is 'L2.Embedded.Verb.RTtrans ~ (1 | Item) + (1 | Reading.baseline) + Verb Type * Context + Session'.

12 The formula is 'L2.Spillover3.RTtrans ~ (1 | Item) + (1 | Reading.baseline) + Verb Type * Context + Session'.

reading times at the region of 'Spillover3' are summarized in the following Table 5.13. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.1371 (Std.Dev: 0.3703) and 0.1684 (Std.Dev: 0.4104) respectively. There were no significant main fixed effects of 'Memory' (t = -0.753), of 'Attention' (t = 0.728), and of 'Proficiency' (t = -0.254). There were also no significant main effects of 'Verb Type' and 'Context', and also no significant interaction effect of 'Condition' (i.e. 'Verb Type*Context'). Hence, although there was a qualitative difference in English-speaking learners' processing at the region of 'Spillover3', English-speaking learners' reading times had no significant difference in each condition.

Table 5.13 Coefficients of fixed effects in a linear mixed-effects model predicting English-speaking learners' reading times at the region of 'Spillover3' by 'Condition'

	Estimate	**Std. Error**	**t value**
(Intercept)	-3.72094	0.17902	-20.785
VT1	-0.20690	0.14675	-1.410
VT2	0.04148	0.14666	0.283
Long-distance Context	0.01948	0.14664	0.133
Session2	- 0.53026	0.08484	-6.250
VT1: Long-distance Context	0.12932	0.20736	0.624
VT2 : Long-distance Context	-0.11591	0.20743	-0.559

(reference levels: VT3 and 'Local Context')

5.4.2.4 Two Groups' reading times by condition

Based on the previous models, it was not necessary to do a three-way interaction of 'Group*Verb Type*Context'. Here, the following modelling will have to ascertain significant differences between native Chinese speakers' processing and English-speaking learners' processing: (i) Region by Group, (ii) Verb Type by Group, (iii) Context by Group.

The results of the optimal linear mixed-effects model[13] predicting differences in the two groups' reading times by 'Region' are summarized in the following Table 5.14. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.07935 (Std.Dev: 0.2817) and 0.28076 (Std.Dev: 0.5299) respectively. In general, English-speaking learners were significantly slower (coefficient = 1.10279, t = 7.59) than native Chinese speakers. Specifically, English-speaking learners were slower at the region of 'Embedded.Verb' (coefficient = 1.10279 – 0.22264 + 1.29187 = 2.17202, t = 43.42), and at the region of *ziji* (coefficient = 1.10279 + 0.02676 + 0.22674 = , t = 7.67), and also at the three spillover regions ('Spillover1': coefficient = 1.10279 -0.02489 + 0.07122 = 1.14912, t = 2.41; 'Spillover2': coefficient = 1.10279 + 0.02148 –0.28998 = 0.83429, t = -9.83; 'Spillover3': coefficient = 1.10279 + 0.60193 –0.25841 = 1.44631, t = -8.77). The results of fixed effects of the model is plotted in the following Figure 5.26.

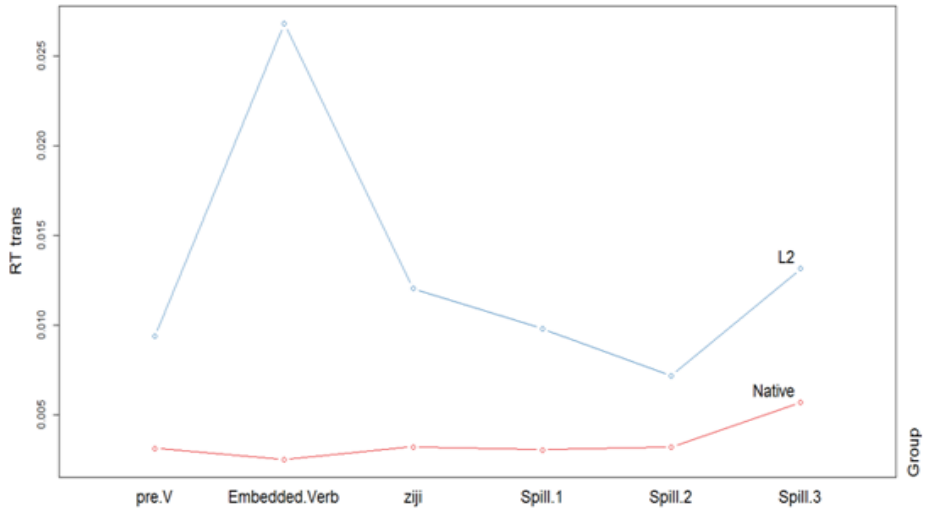
Table 5.14 Coefficients of fixed effects in a linear mixed-effects model predicting differences in the two groups' reading times by 'Region'

	Estimate	Std.Error	t value
(Intercept)	-5.28029	0.14264	-37.02
L2 Group	1.10279	0.14536	7.59
Embedded.Verb	-0.22264	0.02176	-10.23
ziji	0.02676	0.02168	1.23
Spillover1	-0.02489	0.02166	-1.15
Spillover2	0.02148	0.02164	0.99
Spillover3	0.60193	0.02159	27.88
Session	-0.48334	0.06007	-8.05
L2 Group:Embedded.Verb	1.29187	0.02975	43.42
L2 Group:ziji	0.22674	0.02954	7.67
L2 Group:Spillover1	0.07122	0.02952	2.41
L2 Group:Spillover2	-0.28998	0.02949	-9.83
L2 Group:Spillover3	-0.25841	0.02946	-8.77

(reference level: native Chinese speakers)

[13] The formula is 'RTtrans ~ (1 | Item) + (1 | Reading.baseline) + Group * Region + Session'.

Figure 5.26 Differences in the two groups' reading times at each region of the test sentence



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

The results of the optimal model[14] predicting differences in the two groups' reading times by 'Verb Type' are summarized in the following Table 5.15. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.08078 (Std.Dev: 0.2842) and 0.27965 (Std.Dev: 0.5288) respectively. Compared with native Chinese speakers, English-speaking learners were significantly slower with VT3 (coefficient = 1.235042, t = 8.50). However, there was no significant difference in English-speaking learners' reading times with VT1 (t = -0.64) and with VT2 (t = -0.24). The results of fixed effects of the model is plotted in the following Figure 5.27.

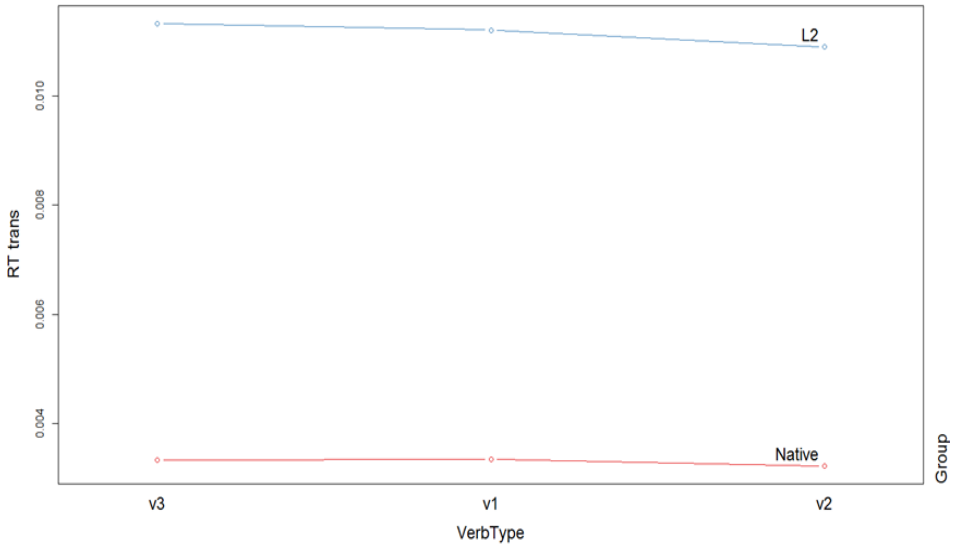
[14] The formula is 'RTtrans ~ (1 | Item) + (1 | Reading.baseline) + Group * Verb Type + Session'.

Table 5.15 Coefficients of fixed effects in a linear mixed-effects model predicting differences in the two groups' reading times by 'Verb Type'

	Estimate	Std.Error	t value
(Intercept)	-5.221984	0.148225	-35.23
L2 Group	1.235042	0.145279	8.50
VT1	0.004352	0.075492	0.06
VT2	-0.033249	0.075413	-0.44
Session	-0.481467	0.060769	-7.92
L2 Group:VT1	-0.015071	0.023514	-0.64
L2 Group:VT2	-0.005527	0.023518	-0.24

(reference levels: native Chinese speakers and VT3)

Figure 5.27 Differences in the two groups' reading times by 'Verb Type'



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

The results of the optimal model[15] predicting differences in the two groups' reading times by 'Context' are summarized in the following Table 5.16. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.07996 (Std.Dev: 0.2828) and 0.27965 (Std.Dev: 0.5288) respectively. Compared with native Chinese speakers, English-speaking learners were significantly slower in 'Local Context' (i.e. the discourse-context favouring a local antecedent) (coefficient = 1.228733, t = 8.48). However, there was no significant difference in English-speaking learners' reading times in 'Long-distance Context' (i.e. the

15 The formula is 'RTtrans ~ (1 | Item) + (1 | Reading.baseline) + Group * Context + Session'.

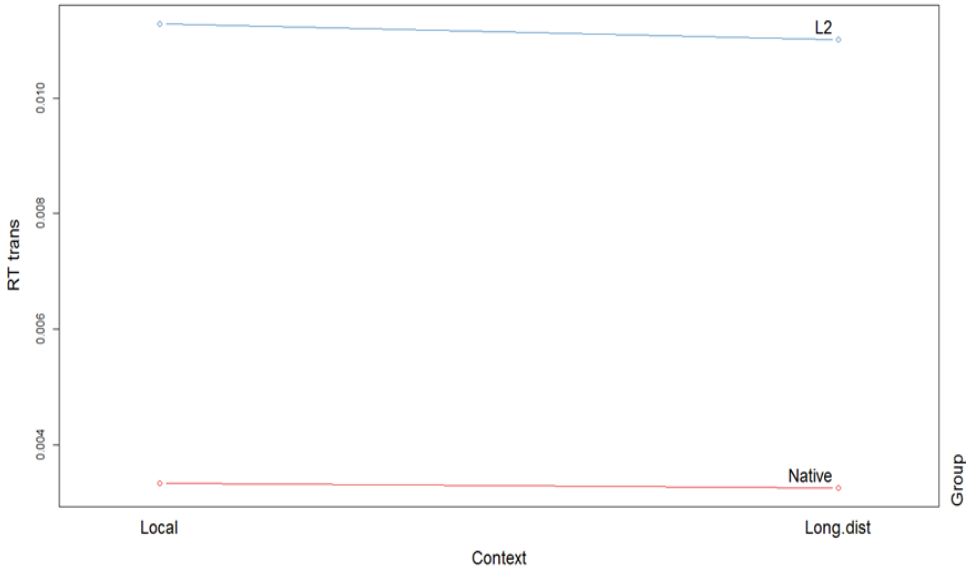
discourse-context favouring a long-distance antecedent) (t = -0.06). The results of fixed effects of the model is plotted in the following Figure 5.28.

Table 5.16 Coefficients of fixed effects in a linear mixed-effects model predicting differences in the two groups' reading times by 'Context'

	Estimate	Std.Error	t value
(Intercept)	-5.220565	0.145418	-35.90
L2 Group	1.228733	0.144961	8.48
Long-distance Context	-0.023180	0.061268	-0.38
Session	-0.481106	0.060392	-7.97
L2 Group: Long-distance Context	-0.001115	0.019201	-0.06

(reference levels: native Chinese speakers and 'Local Context')

Figure 5.28 Differences in the two groups' reading times by 'Context'



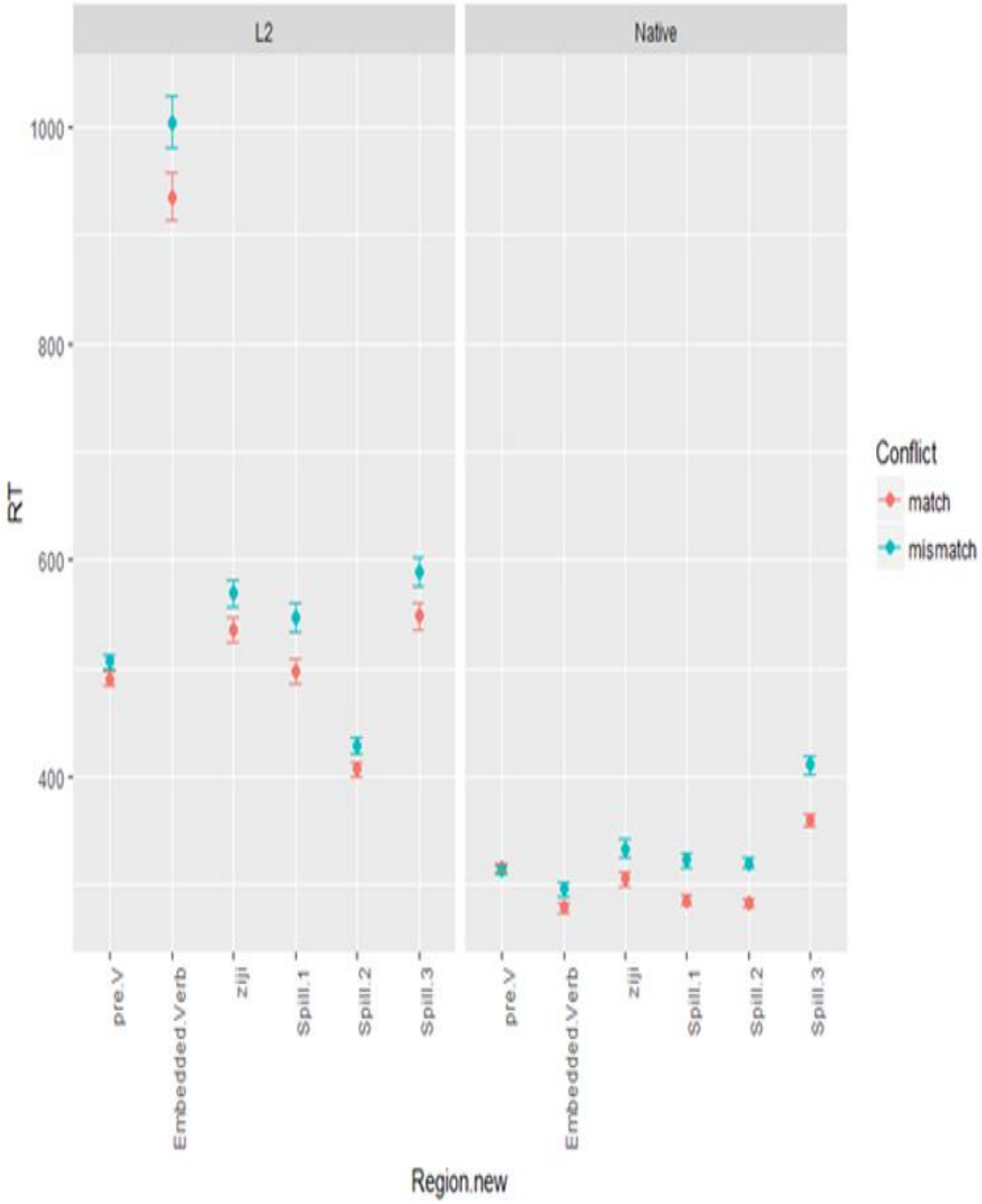
(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

5.4.2.5 Two Groups' reading times by conflict

By excluding participants' reading times with VT3, the effect of 'Conflict' (i.e. Cues.match vs. Cues.mismatch) between the two cues in the two groups' reading times with VT1 and VT2 at each region of the test sentence are plotted in the following Figure 5.29. As shown in the figure, both of the two groups' reading times with VT1 and VT2 were obviously faster in 'Cues.match' than in 'Cues.mismatch' at the 'Embedded.Verb' and onwards. Hence, in order to investigate whether English-speaking learners of Chinese were more susceptible to the interference of 'Conflict' between the two cues than native Chinese speakers, the following modelling will compare the size of the difference

between 'Cues.match' and 'Cues.mismatch' in the two groups' reading times with VT1 and VT2 at the region of 'Embedde.Verb', at the region of *ziji* and at each spillover region.

Figure 5.29 Two groups' reading times with VT1 and VT2 at each region of the test sentence by 'Conflict' (Cues.match vs. Cues.mismatch)



(Cues.match: local/long-distance interpretation both required by the verb and favoured by the context; Cues.mismatch: local interpretation required by the verb but long-distance interpretation favoured by the context, or vice versa; Native: native Chinese speakers; L2:English-speaking learners of Chinese)

The results of the optimal model[16] predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of 'Embedded.Verb' by 'Conflict' are summarized in the following Table 5.17. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.0826 (Std.Dev: 0.2874) and 0.6668 (Std.Dev: 0.8166) respectively. There was no significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch' (t = 0.846). Compared with native Chinese speakers, English-speaking learners were significantly slower in 'Cues.match' (coefficient = 2.42977, t = 10.680). However, the difference in 'Cues.mismatch' between English-speaking learners' reading times and native Chinese speakers' reading times did not appear very strong (t = 0.455), which is actually significant shown in the following multiple comparisons.

Table 5.17 Coefficients of fixed effects in a linear mixed-effects model predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of 'Embedded.Verb' by 'Conflict'

	Estimate	Std. Error	t value
(Intercept)	-5.49584	0.21430	-25.646
L2 Group	2.42977	0.22750	10.680
Cues.mismatch	0.07439	0.08790	0.846
Session	-0.52628	0.08096	-6.501
L2 Group:Cues.mismatch	0.02929	0.06440	0.455

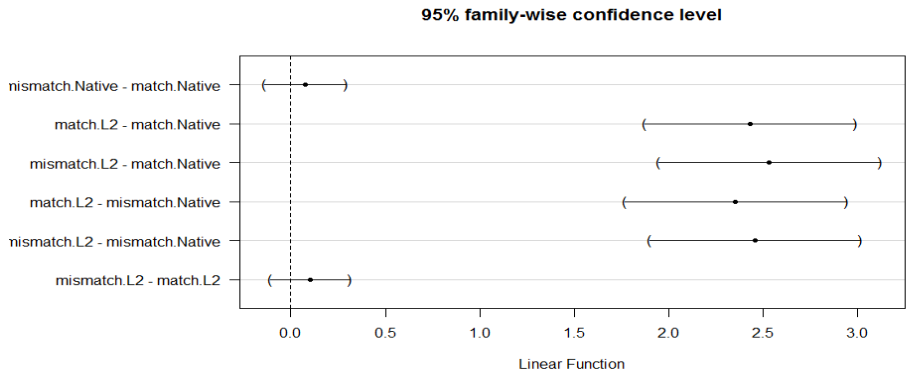
(reference levels: native Chinese speakers and 'Cues.match')

A follow-up multiple comparisons analysis is plotted in the following Figure 5.30 (in the figure, for the first term in the comparison on the y axis, 'Intervals > 0' indicates slower reading times, 'Intervals < 0' indicates faster reading times, and 'Intervals crossing 0' indicates non-significant comparisons). There was no significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the first comparison. Also, there was no significant difference in English-speaking learners' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the last comparison.

16 The formula is 'RTtrans.Embedded.Verb ~ (1 | Item) + (1 | Reading.baseline) + Group * Conflict + Session'.

However, English-speaking learners of Chinese were significantly slower than native Chinese speakers not only in 'Cues.match', as shown in the second comparison, but also in 'Cues.mismatch', as shown in the comparison next to the last.

Figure 5.30 Tukey HSD contrasts (with Bonferroni correction) comparing the size of difference in the two groups' reading times with VT1 and VT2 at the region of 'Embedded.Verb' between 'Cues.match' and 'Cues.mismatch'



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

The results of the optimal model[17] predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of *ziji* by 'Conflict' are summarized in the following Table 5.18. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.07339 (Std.Dev: 0.2709) and 0.41669 (Std.Dev: 0.6455) respectively. There was no significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch' (t = 1.572). Compared with native Chinese speakers, English-speaking learners were significantly slower in 'Cues.match' (coefficient = 1.33249, t = 7.367). However, the difference in 'Cues.mismatch' between English-speaking learners' reading times and native Chinese speakers' reading times did not appear very strong (t = -0.286), which is actually significant shown in the following multiple comparisons.

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[17] The formula is 'RTtrans.Ziji ~ (1 | Item) + (1 | Reading.baseline) + Group * Conflict + Session'.

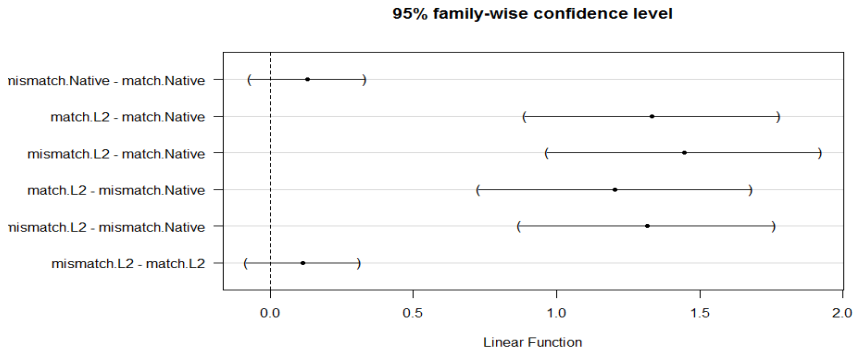
Table 5.18 Coefficients of fixed effects in a linear mixed-effects model predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of *ziji* by 'Conflict'

	Estimate	Std. Error	t value
(Intercept)	-5.35200	0.18306	-29.237
L2 Group	1.33249	0.18088	7.367
Cues.mismatch	0.12874	0.08188	1.572
Session	-0.46338	0.07575	-6.117
L2 Group:Cues.mismatch	-0.01658	0.05790	-0.286

(reference levels: native Chinese speakers and 'Cues.match')

A follow-up multiple comparisons analysis is plotted in the following Figure 5.31 (in the figure, for the first term in the comparison on the y axis, 'Intervals > 0' indicates slower reading times, 'Intervals < 0' indicates faster reading times, and 'Intervals crossing 0' indicates non-significant comparisons). There was no significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the first comparison. Also, there was no significant difference in English-speaking learners' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the last comparison. However, English-speaking learners of Chinese were significantly slower than native Chinese speakers not only in 'Cues.match', as shown in the second comparison, but also in 'Cues.mismatch', as shown in the comparison next to the last.

Figure 5.31 Tukey HSD contrasts (with Bonferroni correction) comparing the size of difference in the two groups' reading times with VT1 and VT2 at the region of *ziji* between 'Cues.match' and 'Cues.mismatch'



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

The results of the optimal model[18] predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover1' by 'Conflict' are summarized in the following Table 5.19. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.07953 (Std.Dev: 0.2820) and 0.43063 (Std.Dev: 0.6562) respectively. There was a significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch' (coefficient = 0.21828, t = 2.602). Compared with native Chinese speakers, English-speaking learners were significantly slower in 'Cues.match' (coefficient = 1.21106, t = 6.599). However, the difference in 'Cues.mismatch' between English-speaking learners' reading times and native Chinese speakers' reading times did not appear very strong (t = -1.489), which is actually significant shown in the following multiple comparisons.

Table 5.19 Coefficients of fixed effects in a linear mixed-effects model predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover1' by 'Conflict'

	Estimate	Std. Error	t value
(Intercept)	-5.32919	0.18740	-28.438
L2 Group	1.21106	0.18353	6.599
Cues.mismatch	0.21828	0.08389	2.602
Session	-0.54642	0.07821	-6.987
L2 Group:Cues.mismatch	-0.08449	0.05673	-1.489

(reference levels: native Chinese speakers and 'Cues.match')

A follow-up multiple comparisons analysis is plotted in the following Figure 5.32 (in the figure, for the first term in the comparison on the y axis, 'Intervals > 0' indicates slower reading times, 'Intervals < 0' indicates faster reading times, and 'Intervals crossing 0' indicates non-significant comparisons). There was a trend for a significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the first comparison. However, there was no significant difference in English-speaking learners' reading times

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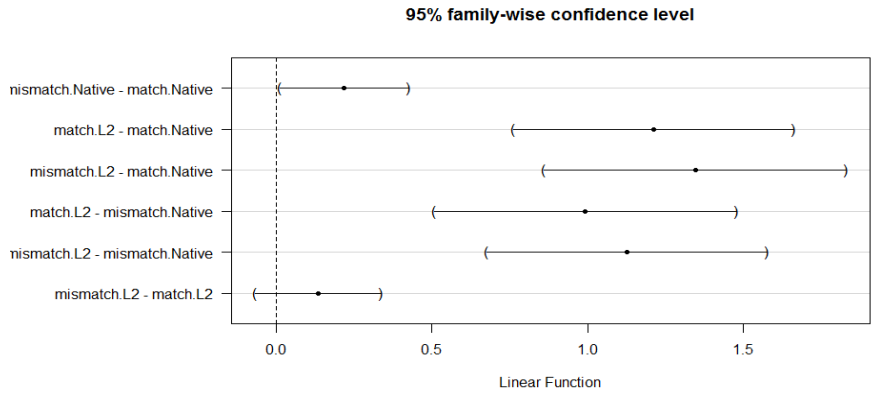
[18] The formula is 'RTtrans.Spillover1 ~ (1 | Item) + (1 | Reading.baseline) + Group * Conflict + Session'.

between 'Cues.match' and 'Cues.mismatch', as shown in the last comparison. In addition, English-speaking learners of Chinese were significantly slower than native Chinese speakers not only in 'Cues.match', as shown in the second comparison, but also in 'Cues.mismatch', as shown in the comparison next to the last.

Figure 5.32 Tukey HSD contrasts (with Bonferroni correction) comparing the size of difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover1' between 'Cues.match' and 'Cues.mismatch'



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

The results of the optimal model[19] predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover2' by 'Conflict' are summarized in the following Table 5.20. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.05034 (Std.Dev: 0.2244) and 0.24552 (Std.Dev: 0.4955) respectively. There was a significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch' (coefficient = 0.28627, t = 4.13). Compared with native Chinese speakers, English-speaking learners were significantly slower not only in 'Cues.match' (coefficient = 0.91306, t = 6.52), but also in 'Cues.mismatch' (coefficient = 0.20723, t = -4.01).

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19 The formula is 'RTtrans.Spillover2 ~ (1 | Item) + (1 | Reading.baseline) + Group * Conflict + Session'.

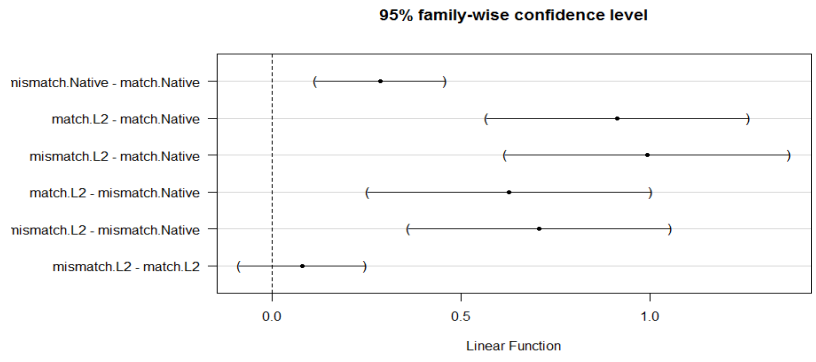
Table 5.20 Coefficients of fixed effects in a linear mixed-effects model predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover2' by 'Conflict'

	Estimate	Std. Error	t value
(Intercept)	-5.53875	0.14725	-37.61
L2 Group	0.91306	0.14009	6.52
Cues.mismatch	0.28627	0.06924	4.13
Session	-0.39236	0.06347	-6.18
L2 Group:Cues.mismatch	0.20723	0.05166	-4.01

(reference levels: native Chinese speakers and 'Cues.match')

A follow-up multiple comparisons analysis is plotted in the following Figure 5.33 (in the figure, for the first term in the comparison on the y axis, 'Intervals > 0' indicates slower reading times, 'Intervals < 0' indicates faster reading times, and 'Intervals crossing 0' indicates non-significant comparisons). There was a significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the first comparison. However, there was no significant difference in English-speaking learners' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the last comparison. In addition, English-speaking learners of Chinese were significantly slower than native Chinese speakers not only in 'Cues.match', as shown in the second comparison, but also in 'Cues.mismatch', as shown in the comparison next to the last.

Figure 5.33 Tukey HSD contrasts (with Bonferroni correction) comparing the size of difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover2' between 'Cues.match' and 'Cues.mismatch'



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

The results of the optimal model[20] predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover3' by 'Conflict' are summarized in the following Table 5.21. The random effects for 'Item' and 'Reading.baseline' had a variance of 0.08667 (Std.Dev: 0.2944) and 0.24773 (Std.Dev: 0.4977) respectively. There was a significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch' (coefficient = 0.26289, t = 3.034). Compared with native Chinese speakers, English-speaking learners were significantly slower not only in 'Cues.match' (coefficient = 0.89627, t = 6.328), but also in 'Cues.mismatch' (coefficient = 0.13568, t = -2.394).

Table 5.21 Coefficients of fixed effects in a linear mixed-effects model predicting the size of the difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover3' by 'Conflict'

	Estimate	Std. Error	t value
(Intercept)	-4.97021	0.17074	-29.109
L2 Group	0.89627	0.14163	6.328
Cues.mismatch	0.26289	0.08666	3.034
Session	-0.38550	0.08119	-4.748
L2 Group:Cues.mismatch	0.13568	0.05668	-2.394

(reference levels: native Chinese speakers and 'Cues.match')

A follow-up multiple comparisons analysis is plotted in the following Figure 5.34 (in the figure, for the first term in the comparison on the y axis, 'Intervals > 0' indicates slower reading times, 'Intervals < 0' indicates faster reading times, and 'Intervals crossing 0' indicates non-significant comparisons). There was a significant difference in native Chinese speakers' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the first comparison. However, there was no significant difference in English-speaking learners' reading times between 'Cues.match' and 'Cues.mismatch', as shown in the last comparison. In addition, English-speaking learners of Chinese were significantly slower than native Chinese speakers not only in 'Cues.match', as shown in the second

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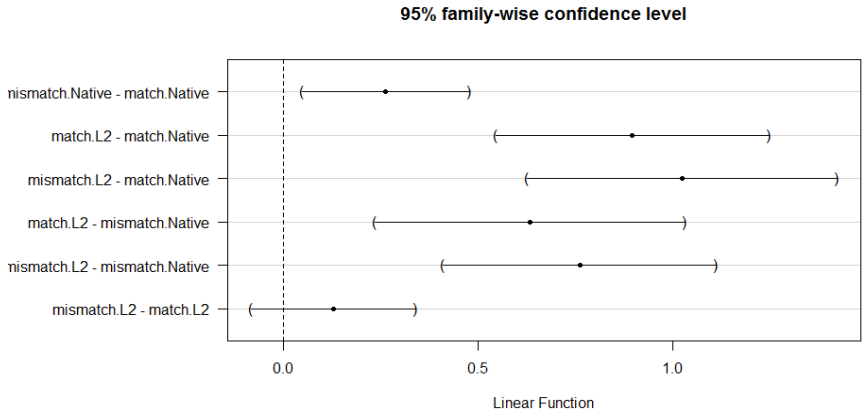
20 The formula is 'RTtrans.Spillover3 ~ (1 | Item) + (1 | Reading.baseline) + Group * Conflict + Session'.

comparison, but also in 'Cues.mismatch', as shown in the comparison next to the last.

Figure 5.34 Tukey HSD contrasts (with Bonferroni correction) comparing the size of difference in the two groups' reading times with VT1 and VT2 at the region of 'Spillover3' between 'Cues.match' and 'Cues.mismatch'



(Native: native Chinese speakers, L2: English-speaking learners of Chinese)

In summary, the interference of 'Conflict' (i.e. Cues.match vs. Cues.mismatch) between the two cues influences native Chinese speakers' processing at the three spillover regions. Specifically, native Chinese speakers' reading times with VT1 and VT2 have a trend to be significantly slower at the region of 'Spillover1' in 'Cues.mismatch' than in 'Cues.match'. Then, native Chinese speakers' reading times with VT1 and VT2 are significantly slower at the region of 'Spillover2' and 'Spillover3' in 'Cues.mismatch' than in 'Cues.match'. In contrast, the interference of 'Conflict' (i.e. Cues.match vs. Cues.mismatch) between the two cues results in that English-speaking learners' processing is significantly slower than native Chinese speakers' processing, starting at the region of 'Embedded.Verb' and lasting to the region of *ziji* and onwards. In particular, in 'Cues.match', English-speaking learners' reading times with VT1 and VT2 are significantly slower than native Chinese speakers' reading times with VT1 and VT2 at the region of 'Embedded.Verb', *ziji* and onwards. Also, in 'Cues.mismatch', English-speaking learners' reading times with VT1 and VT2 are significantly slower than native Chinese speakers' reading times with VT1 and VT2 at the region of 'Embedded.Verb', *ziji* and onwards. Hence, compared with native Chinese

speakers, English-speaking learners of Chinese are more susceptible to the interference during processing. However, English-speaking learners' processing in 'Cues.match' is not significantly different from in 'Cues.mismtach' at any regions.

5.5 Discussion

The self-paced reading study investigates how verb-semantic and discourse-context information are used as retrieval cues in the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese, which also takes cognitive factors (i.e. attention, working memory) and (L2) Chinese proficiency into consideration.

On the one hand, the offline data of antecedent choices tells us how verb-semantic and discourse-context information as retrieval cues affect the interpretation of *ziji* by native Chinese speakers and English-speaking learners of Chinese, and the role of (L2) Chinese proficiency and working memory as follows. Native Chinese speakers use the discourse-context cue to interpret *ziji* with VT3, which fits with the theory of discourse prominence affecting the interpretation of *ziji*, reviewed in Chapter 2.1.3. In addition, native Chinese speakers rely on the verb-semantic cue to interpret *ziji* with VT1 and VT2. However, this strong preference of the local interpretation with VT1 and the long-distance interpretation with VT2 is also influenced by the discourse-context cue, which indicates that native Chinese speakers' intuition of *ziji* with VT1 and VT2 is not as clear-cut as the theory of verb-semantic orientation affecting the interpretation of *ziji* with VT1 and VT2, reviewed in Chapter 2.1.2. English-speaking learners of Chinese allow a long-distance interpretation of *ziji* with VT2, although their L1 English rules out the long-distance interpretation. Also, as (L2) Chinese proficiency increasing, English-speaking learners of Chinese allow less long-distance interpretation of *ziji* with VT1. However, English-speaking learners' long-distance interpretation of *ziji* with VT2 is not affected by (L2) Chinese proficiency investigated here. Hence, it is more difficult for English-

speaking learners of Chinese to converge on the target long-distance interpretation of *ziji* with VT2 than to converge on the target local interpretation of *ziji* with VT1. Moreover, compared with native Chinese speakers, English-speaking learners of Chinese rely less on the verb-semantic cue to interpret *ziji* with VT1 and VT2. When the discourse-context favours a long-distance interpretation of *ziji*, more long-distance interpretation with VT2 and with VT3 are allowed by English-speaking learners of Chinese. These results are in line with that L2/non-native speakers rely more on the discourse-level information during sentence processing and comprehension, reviewed in Chapter 3.3. Thus, both English-speaking learners of Chinese and native Chinese speakers are sensitive to both cues, however, English-speaking learners of Chinese weigh the two cues differently from native Chinese speakers. Specifically, English-speaking learners of Chinese take precedent to the discourse-context cue, while native Chinese speakers give priority to the verb-semantic cue. Furthermore, working memory investigated here does not affect the interpretation of *ziji* by native Chinese speakers and English-speaking learners of Chinese.

On the other hand, the online data of reading times tells us how verb-semantic and discourse-context information used as retrieval cues affect real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese, and effects of attention, working memory and (L2) Chinese proficiency as follows. English-speaking learners' processing are much slower than native Chinese speakers' processing in general. During sentence processing, native Chinese speakers take longer time to process the reflexive *ziji* and onwards, whereas English-speaking learners of Chinese take much longer time to process the embedded verb affecting the interpretation of *ziji*. This is probably because the effect of the verb-semantic cue is visible at that point. However, the reflexive *ziji* has not been encountered at that point. Hence, this could be a kind of 'anticipation' effect. What's more, when there is a conflict between the two cues (i.e. a local interpretation required by the verb but a long-distance interpretation favoured by the discourse-context, or vice versa), English-speaking learners of Chinese are more susceptible to the conflict than native Chinese speakers. This result fits with that L2/non-native speakers are more susceptible to retrieval

interference during processing (Cunnings, 2017). However, the impact of attention, working memory and (L2) Chinese proficiency has not been observed as a remarkable one.

In all, as a cue-based approach, this self-paced reading study investigates verb-semantic and discourse-context information used as retrieval cues in the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese:

- English-speaking learners of Chinese can allow a long-distance interpretation of *ziji* with VT2, although their L1 English rules out the long-distance interpretation. Also, as (L2) Chinese proficiency increasing, they allow less long-distance interpretation of *ziji* with VT1.
- The discourse-context cue can over-rule the verb-semantic cue in native Chinese speakers' interpretation of *ziji*, while English-speaking learners of Chinese rely more on the discourse-context cue (i.e. less on the verb-semantic cue) to interpret *ziji*.
- Native Chinese speakers take longer time to process *ziji* and onwards, while English-speaking learners of Chinese process more when encountering the verb before *ziji*.
- English-speaking learners of Chinese are more susceptible than native Chinese speakers to the interference when there is a conflict between the two cues.

Chapter 6 General discussion

The following part will give a discussion on the corpus study and the self-paced reading study, relating to both linguistic accounts of the long-distance interpretation of *ziji* in Chinese, and theories of language processing and acquisition.

Syntactic accounts (in Chapter 2.1.1) could not fully explain the long-distance interpretation of *ziji*, hence, linguistic accounts from semantic (in Chapter 2.1.2) and pragmatic/discourse (in Chapter 2.1.3) approach have been devoted to explain the long-distance interpretation of *ziji*. Also, the interpretation of reflexive binding in languages such as Chinese, Korean and Japanese is largely treated as a semantic and/or pragmatic phenomenon rather than a syntactic phenomenon (e.g., Zribi-Hertz, 1989; Reinhart and Reuland, 1991; Pollard and Sag, 1992; Huang, 1994, 2000; Pollard and Xue, 2001). Accordingly, verb-semantic orientation reviewed in Chapter 2.1.2 and discourse prominence reviewed in Chapter 2.1.3 have been proposed to explain the long-distance interpretation of *ziji*. Specifically, Chinese features three verb types in relation to the interpretation of *ziji*, that is, the introverted/self-oriented verb (VT1) only allows a local interpretation of *ziji*, and the extroverted/other-oriented verb (VT2) only allows a long-distance interpretation of *ziji*, while the ambiguous/context-dependent verb (VT3) allows both interpretations of *ziji* depending on the discourse-context. Hence, the corpus study (in Chapter 4) examines the distribution of the three verb types in the input of Chinese, showing that the relative scarcity of VT2 with *ziji* and the prevalence of VT1 and VT3 with *ziji*, which is expected to result in the protracted acquisition of the long-distance interpretation of *ziji* with VT2 according to Yang's (2002) Variational Learning Theory. The corpus study also statistically models those linguistic factors/accounts proposed by semantic and pragmatic/discourse approach predicting the long-distance interpretation of *ziji*, showing that although verb-semantic orientation plays a determinant role in the interpretation of *ziji*, other factors such as discourse prominence also affect the interpretation of *ziji*.

From the perspective of language processing, the self-paced reading study (in Chapter 5) investigates how verb-semantic and discourse-context information used as retrieval cues affect the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese within the cue-based memory retrieval model of language processing (e.g., McElree 2000, 2006; Van Dyke and Lewis, 2003; Lewis and Vasishth, 2005; Lewis, Vasishth and Van Dyke, 2006; Van Dyke and McElree, 2006). During real-time processing, native Chinese speakers mainly use the verb-semantic cue to interpret *ziji* with VT1 and VT2, and mainly rely on the discourse-context cue to interpret *ziji* with VT3. However, the discourse-context cue can over-rule the verb-semantic cue, suggesting that native Chinese speakers' interpretation of *ziji* is not as clear-cut as theoretical linguistic accounts of the interpretation of *ziji* (i.e. the verb-semantic information deals with VT1 and VT2 only, whereas the discourse-context information deals with VT3 only), which is in line with that both verb-semantic orientation and discourse prominence affect the interpretation of *ziji*, found by the statistical modelling in the corpus study. In addition, native Chinese speakers take priority to the verb-semantic cue with VT1 and VT2 than the discourse-context cue, supporting the view that all relevant cues are combined together but not in an equally-weighted fashion to interpret reflexive dependencies during language processing (e.g. Van Dyke and McElree, 2011; Dillon et al., 2013). In contrast, English-speaking learners of Chinese give precedence to the discourse-context cue to interpret *ziji*, which is in line with recent works indicating L2/non-native speakers rely more on 'top-down' (discourse-based) cues than 'bottom-up' (lexical/structural) cues (e.g. Felser, Sato, and Bertenshaw, 2009; Pan and Felser, 2011; Cunnings and Felser, 2012; Felser and Cunnings, 2012; Pan et al., 2015; Felser, 2016). Also, an over-reliance on discourse-based cues is one symptom of L2/non-native speakers' under-weighting syntactic cues compared with native speakers (Cunnings, 2017, p.3). Hence, although native Chinese speakers and English-speaking learners of Chinese are sensitive to both cues, they weigh the two cues differently, which also fits with the view that retrieval cues influence language processing depending on their relative strengths, and retrieval cues are weighed differently by different population (native vs. L2/non-native speakers) (Kaiser et al., 2009). However, how these two cues are implemented in the interpretation of *ziji* is not

entirely clear. In cue-based parsing, cues can be drawn from either the lexical properties of words (e.g. English reflexive *himself* is lexically marked as singular, masculine, and animate) or the local syntactic context (e.g. the syntactic-binding in English). The discourse-context cue is marked as [+/- topic] depending on whether the discourse-context biases one antecedent or the other one, whereas the verb-semantic cue is derived from the lexical properties of verbs, but is not overtly marked on the verb. Also, the reflexive *ziji* is not marked with any cues. Hence, it might be that *[the verb ziji]* creates a joint cue, that is, *[the self-oriented/introverted verb ziji]* as a cue for the local interpretation of *ziji*, while *[the other-oriented/extroverted verb ziji]* as a cue for the long-distance interpretation of *ziji*, which is treated more as a grammatically cue solving the problem of mapping meanings (Bates and Macwhinney, 1989). What's more, due to the conflict between the two cues, reading time slowdowns are observed in both groups' processing. Also, compared with native Chinese speakers, it is significantly slower for English-speaking learners of Chinese to process (in Chapter 5.4.2.5). Hence, this could be taken as a evidence for that L2/non-native speakers are more susceptible to retrieval interference by exhibiting larger inhibitory interference (Cunnings, 2016). Furthermore, when there is no conflict between the two cues, due to no competition/interference and a multiple-cue matching accessible antecedent, there is a clear facilitation in both groups' processing, observed by reading time speed-up. However, the facilitatory effect observed here is qualitatively different from the facilitatory interference due to the presence of a cue-matching inaccessible distractor (Jäger, Engelmann and Vasishth, 2015). Nevertheless, compared with VT3 only requiring the discourse-context cue, no statistically significant faster processing is observed in both groups with VT1 and VT2 when there is no conflict between the two cues.

From the perspective of language acquisition, the self-paced reading study also investigates L2 acquisition of the long-distance binding of *ziji* by English-speaking learners of Chinese. English-speaking learners of Chinese are able to acquire the long-distance binding of *ziji*, even if the long-distance binding is ruled out in their L1 (English), which follows Schwartz and Sprouse's (1996) 'Full Transfer/Full Access' model. As the default parameter of local binding in their

(L1) English, it is reasonable to assume that the local binding is adopted as the initial parameter setting by English-speaking learners of Chinese to parse/process the L2 (Chinese) input. If the parse is successful, there is no need to reset the parameter setting of the local binding, such as the local binding of *ziji* with VT1 and VT3. If the parse is unsuccessful, then, the initial parameter setting of the local binding is required to be reset, such as the long-distance binding of *ziji* with VT2 and VT3. In addition, with (L2) Chinese proficiency increasing, English-speaking learners of Chinese do not allow more long-distance interpretation of *ziji* with VT2, but allow less long-distance interpretation of *ziji* with VT1. Hence, it is more difficult for English-speaking learners of Chinese to converge on the target long-distance interpretation of *ziji* with VT2 than to converge on the target local interpretation of *ziji* with VT1, which is in line with Yang's (2002) Variational Learning Theory. The more reliable the input, the faster the convergence on the target grammar. Only VT1 provides unambiguous input of the local binding matching the L1 setting. Only VT2 provides unambiguous input of the long-distance binding. VT3 provides ambiguous input of both local and long-distance binding. However, the variations of the three verb types found by the corpus study show that the relative scarcity of VT2 with *ziji* and the prevalence of VT1 and VT3 with *ziji* in the input of Chinese. Hence, the acquisition of the long-distance binding of *ziji* with VT2 by English-speaking learners of Chinese is in a gradual way.

Chapter 7 Concluding remarks

7.1 Major findings and implications

The corpus study shows that the three verb types have different distributions in the input of Chinese, that is, VT3 has higher frequency than VT1 which has lower frequency than VT2. However, the distribution pattern of the three verb types changes when they are used with *ziji*, that is, VT2 is used less frequently than VT1 and VT3, and VT1 is used as frequently as VT3. Only VT2 provides unambiguous evidence for the long-distance interpretation of *ziji*, hence, the variations of the three verb types in the input of Chinese results in a protracted acquisition of the long-distance interpretation of *ziji* in terms of Yang's (2002) Variational Learning theory (in Chapter 3.1). In addition, the role of verb-semantic orientation (in Chapter 2.1.2) and discourse prominence (in Chapter 2.1.3) affecting the interpretation of *ziji* is also supported by a mixed-effects modelling based on the corpus data.

The findings of the self-paced reading study investigating how verb-semantic and discourse-context information used as retrieval cues guide the interpretation and real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese are as follows. English-speaking learners of Chinese are able to acquire the long-distance interpretation of *ziji*, even if the long-distance interpretation is ruled out in their L1 (English). With (L2) Chinese proficiency increasing, English-speaking learners of Chinese allow less long-distance interpretation with VT1, but do not allow more long-distance interpretation with VT2. Hence, the acquisition of the long-distance interpretation of *ziji* by English-speaking learners of Chinese supports a probabilistic approach to L2 parameter (re)setting (Yang, 2002). In addition, native Chinese speakers and English-speaking learners of Chinese are sensitive to both cues, but they do not weigh the two cues in an equal way. Native Chinese speakers rely more on the verb-semantic cue to interpret *ziji*, however, the discourse-context cue can over-rule the verb-semantic cue. Thus, native Chinese speakers' interpretation of *ziji* fits with the finding of the corpus study that

although verb-semantic orientation is the determinant factor in the interpretation of *ziji*, discourse prominence also affects the interpretation of *ziji* (in Chapter 4.3.3). Also, native Chinese speakers' interpretation of *ziji* is not as clear-cut as the theory of verb-semantic orientation affecting the interpretation of *ziji* (in Chapter 2.1.2). In contrast, English-speaking learners of Chinese rely less on the verb-semantic cue to interpret *ziji*. With (L2) Chinese proficiency increasing, English-speaking learners of Chinese become more reliance on the verb-semantic cue, however, their reliance on the discourse-context cue is not decreased. Hence, English-speaking learners' interpretation of *ziji* fits with that L2/non-native speakers rely more on the discourse-level information during language processing and comprehension (e.g. Felser, Sato and Bertenshaw, 2009; Felser and Cunnings, 2012; see Chapter 3.3). Moreover, English-speaking learners of Chinese are generally slower than native Chinese speakers during real-time processing. English-speaking learners of Chinese process more when they encounter the verb before *ziji*, while native Chinese speakers take longer time to process *ziji* and onwards. Furthermore, English-speaking learners of Chinese are more susceptible to the conflict between the two cues than native Chinese speakers, which supports that L2/non-native speakers are more susceptible to the retrieval interference than native speakers (Cunnings, 2017). Hence, real-time processing of *ziji* by native Chinese speakers and English-speaking learners of Chinese supports a cue-based approach to language processing and comprehension (e.g. McElree 2000, 2006; Van Dyke and Lewis, 2003; Lewis and Vasishth, 2005; Lewis, Vasishth and Van Dyke, 2006; Van Dyke and McElree, 2006; see Chapter 2.2.2).

In summary, the current work not only gives empirical corpus evidence for linguistic accounts of the long-distance binding/interpretation of *ziji* in Chinese, but also provides new experiment evidence for language acquisition and cue-based language processing of the long-distance binding/interpretation of *ziji*. Also, it is worth noting that the current work is the first one comparing different populations' (i.e. native vs. L2/non-native speakers) cue weightings in real-time processing of *ziji*.

7.2 Limitations and future work

The current study has limitations on the research method. In particular, the current self-paced reading task can tell real-time processing by showing reading time speed-up and/or slowdown, but cannot tell which cue is used immediately in the earliest stage of processing, and which cue has its effect later as 'filters'. Hence, in the future work, the eye-tracking technique should be applied. As a time-course sensitive experimental technique, the eye-tracking technique has been shown to be suitable for studying native and non-native sentence processing (Roberts, Gullerg and Indefrey 2008). The logic of linking eye movements to antecedent retrieval of reflexives is based on the fact that attentional shifts to potential antecedents in the visual field are typically accompanied by a saccadic eye movement. How comprehenders' patterns of eye fixations unfold over time during processing could be revealed by monitoring eye movements. Early and later processing stages are potentially distinguished by recording different eye movement measures at different regions in a sentence. Specifically, 'early' eye movement measures such as first fixation durations and first-pass reading times are thought to provide information about early processing stages, such as initial parsing decisions, whereas 'later' eye movement measures such as second-pass reading times are sensitive to later processing stages, such as subsequent reanalysis (Staub and Rayner 2007). In this way, a fine-grained and continuous picture of comprehenders' time course of both initial and subsequent processing of stimulus is provided, which is helpful to provide the nature of multiple retrieval cues during language processing and comprehension (Felser and Cunnings 2012). Therefore, the further study will explore native and L2/non-native speakers' processing of the Chinese simple reflexive *ziji* using the eye-tracking technique, with an aim to reveal the time course of verb-semantic and discourse-context cues in guiding antecedent retrieval of *ziji* during real-time processing. Some research questions could be addressed: (i) which cue is used immediately in the initial antecedent retrieval when *ziji* is first encountered, (ii) which cue has its effect later, as a 'filter' on the final interpretation of *ziji*, (iii) whether the time course of L2/non-native speakers' processing is different from native speakers' processing, (iv)

whether L2/non-native speakers' processing exhibits larger retrieval interference.

In addition, there are some limitations on participant-related data. First, the current study has a small scale of participants. Second, L2 group of English-speaking learners of Chinese in the current study are intermediate Chinese learners. In order to examine Yang's (2002) Variational Learning Theory, another group will be required, that is, advanced Chinese learners. Third, compared with English allowing local binding only, L2/non-native Chinese speakers whose native language (L1) allowing both local and long-distance binding (e.g. Japanese) will be also required in the future work. Hence, the interaction of L1 grammar and L2 input in L2 acquisition could be further investigated. Fourth, various variables of language experience examined in the current study should be used as fixed effects in the mixed-effects modelling predicting their effects on the interpretation and real-time processing of *ziji*. Fifth, in terms of the corpus data, frequency of each verb should also be used as a fixed effect in the mixed-effects modelling predicting how different verbs affect the interpretation and real-time processing of *ziji*.

Moreover, Chinese also has a complex reflexive *taziji*, which has gender feature, and is locally bound like English reflexives, so future work could also examine *taziji* to compare whether and how the processing pattern of this complex reflexive differs from that of the simple long-distance reflexive *ziji*.

Furthermore, experimental materials in the current study are all texts, thus, pictures could be used in the future work.

In summary, improvement can be made to give a more comprehensive picture of L2 acquisition and processing of the Chinese simple reflexive *ziji*. In spite of limitations, the current investigation provides a good starting point to explore L2 acquisition of *ziji* from a probabilistic approach, and the interpretation and

real-time processing of *ziji* within the cue-based memory retrieval model of language processing. The evidences found in this study suggest that different types of linguistic information, such as verb-semantic and discourse-context, can exert their influence and interact with each other, giving rise to different patterns in native and L2/non-native speakers' language processing and comprehension of *ziji*.

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Appendix I The corpus materials

The 346 sentences of *'ziji'* using the 95 verbs in the common sentence structure *'[NP1 VP1 [NP2 VP2 ziji]]'* extracted from the largest corpus of modern Mandarin Chinese were translated in English as follows.

(1) Views of female members asked male members to self-criticize the sexism of their thoughts.

(2) It asks me to self-criticize my actions.

(3) Most countries accused by America all over the world ask America to self-criticize itself.

(4) He asks the Communist Party to self-criticize its policies.

(5) The idea asks us to self-criticize our academic standpoint.

(6) It asks people to rethink of their thoughts or actions.

(7) The entrance of the western culture asks Chinese people to rethink of their cultural tradition.

(8) Reality asks the young man to rethink of his actions.

(9) The bad environment asks local people to rethink of their life style.

(10) This accident asks European countries to rethink of their energy policies.

(11) The feeling asks us to rethink of our busy life.

(12) He urged American government to introspect its Middle-East policies.

(13) He appealed Eastern Europe people to introspect themselves.

(14) This jade always reminded the emperor to introspect his behaviours.

(15) We ask Taiwanese leaders to introspect their themselves.

(16) A series of education work asks Qin Xiaolin to introspect his actions.

(17) Modern psychological analysis theory teaches people to introspect themselves.

(18) The son said to his mother: you need to take care of yourself.

(19) Yu Shan said: you also need to take care of yourself.

(20) He comforted his wife: you take care of yourself.

(21) I enjoined you: take care of yourself.

(22) Her lover asked her to take care of herself.

(23) He adjured the president to take care of himself.

(24) Yang Xinfo asks Song Qingling to take care of herself.

(25) A patient gave a box of American ginseng: doctor Huan, you need to take care of yourself.

(26) They wrote a letter: you should take care of yourself.

(27) Chen Wenjie is touching him: take care of yourself.

(28) The queen answered: King, I ask you to take care of yourself.

(29) The survival pressure asks the fake moth to disguise its ability.

(30) The instinct does not ask her to disguise herself.

(31) He warned: people should not indulge themselves.

(32) His arrival asked Feng Xuefeng not to conceal his moving.

(33) Father said: Ye Sang, you need not conceal yourself in front of me.

(34) It encourages people to grasp their life.

(35) Internet asks you to grasp your health.

(36) We ask you to grasp yourself.

(37) Humility asks people to treasure their right and freedom.

(38) Getting in touch with those stimulating entertainment asks children to give up their efforts.

(39) He asks characters to show their nature.

(40) The pressure asks the industry to show its energy.

(41) Questions and answers ask competitors to expound their understanding on preventing and curing AIDS.

(42) Holding a hearing asks different groups to expound their views.

(43) The opportunity asks us to expound our standpoints.

(44) I ask Czech people to restrain themselves.

(45) It asks them to promote their images.

(46) The opportunity promotes China to perfect its price mechanism.

(47) The reasoning asks the other side to lose its target.

(48) Wang said to Lala: you do not feel sorry for yourself.

(49) We encourage her not to feel sorry for herself.

(50) Song said: you do not feel sorry for yourself.

(51) Indonesian government forbids Chinese people to develop their culture.

(52) The traditional culture of Tibetan does not encourage women to develop their business.

(53) He encourages you to develop your speciality.

(54) Many educational workers ask people and teenagers to arm themselves.

(55) Liu said: You do not constrain your feelings.

(56) He asks team members to square their positions.

(57) He asks them to square their positions.

(58) Zhang said: I ask them to square their positions.

(59) Chinese communists enlighten them to reform their undeveloped national characters.

(60) He asks young players to enrich themselves.

(61) We ask students to enrich themselves.

(62) Someone persuade her to enrich herself.

(63) These projects ask technicians to fully display their abilities.

(64) The period of time asks many people to display their talents.

(65) The drama asks him to display his unique skills.

(66) The great social transformation asks everyone to exhibit his social value.

(67) It asks us to re-examine ourselves.

(68) The history asks them to re-examine their souls.

(69) The seminar asks employees to present their teaching skills.

(70) Education labours ask her to analyse her actions.

(71) American and other western countries force Chinese people to change their path.

(72) Gao Xiaolan warns youths to change their bad habits.

(73) The movement asks Korean people to change their orignal Korean name.

(74) He encourages Chinese university students to change their lives.

(75) My colleague persuades me to change my life.

(76) Those rich families ask children to exercise themselves.

(77) He encourages the young reporter to exercise himself.

(78) He warns them to fully exercise themselves.

(79) Hu Jintao asks leading cadres to exercise their vision of the world.

(80) He asks everyone to exercise his eyesight.

(81) The team leader asks them to exercise themselves.

(82) Li asks her to exercise herself.

(83) It asks them to exercise their debate skills.

(84) Parents ask children to exert their vocational skills.

(85) The company encourages people to exert their abilities during practical activities.

(86) The county government asks businessmen to exert their skills.

(87) He asks coaches to exert their knowledge and ability.

(88) The new situation asks senior technicians to exert their particular function.

(89) He asks technicians to exert their abilities.

(90) Jiang Zemin encourages those representatives to exert their wisdom.

(91) Wushu competition asks athletes to exert their strong points.

(92) The system encourages them to exert their wisdom and creativity.

(93) The crisis awareness asks Isarel to exert its wisdom.

(94) The warm atmosphere asks the football team to exert its level.

(95) He encourages art and sport expertise to exert their talents.

(96) He warns the whole team to fully exert their skills.

(97) Lin Biao asks his subordinates to exert their wisdom.

(98) He asks you to exert your talent.

(99) He asks his representatives to exert themselves.

(100) You ask those talented people to exert their positivity.

(101) The flexible space asks you to exert your design talent.

(102) I ask students to exert their imagination.

(103) I lead other people to exert their goodness.

(104) The power asks the party to exert their all functions.

(105) He encourages those businessmen to improve themselves.

(106) He encourages us to improve our political and cultural qualities.

(107) Listening to those famous music asks people to improve their aesthetic knowledge.

(108) Setting up the judicial system asks the judicial staff to improve their legal level.

(109) Helping women with housework asks women to improve their quality.

(110) It asks many teachers to improve their professional skills.

(111) He asks young officials to improve themselves.

(112) He encourages teenagers to improve their general quality.

(113) Zhang Wentian asks embassy personnel to improve themselves.

(114) He asks artists to improve their ability of getting a clear understanding of life.

(115) The mission asks leaders to improve their knowledge and administration.

(116) The company asks staff to improve themselves.

(117) We encourage young scientisits to improve their reputation.

(118) The chess movement asks players to improve their skills.

(119) It helps audience to improve their aesthetic knowledge.

(120) The mission asks the party to improve its leadership.

(121) Party schools help leaders to improve their quality.

(122) Our school encourages teachers to improve their teaching quality.

(123) Yangzhou University encourages teachers to improve their quality.

(124) Jiang Zemin asks members to improve their political quality.

(125) Those anti-China forces make Chinese people improve their political vigilance.

(126) The union asks them to improve themselves.

(127) It asks cooks to improve their cultural quality and skills.

(128) It asks goalkeepers to improve their skills.

(129) It asks athletes to improve their skills.

(130) The competition asks businessmen to improve their professional skills.

(131) Experience exchanging asks Chinese industries to improve themselves.

(132) It asks leaders to improve their general quality.

(133) She suggests Chinese women to improve their cultural quality.

(134) The win encourages them to improve their skills.

(135) He asks commanders to improve their military and politcal quality.

(136) Socialism asks people to improve their living levels.

(137) I help them to improve themselves.

(138) Those facts reminds us to improve our quality.

(139) This way asks people to improve their living quality.

(140) Wang Qingwei mobilized his father to assist his work.

(141) Mr. Gu invited Mr. Tong to assist him with the task in Beijing.

(142) Merlin asks Lieutenant General Robin to assist him with the inquiry.

(143) Zude arranges his staff to pretend to be his lover.

(144) Zheng Tu asked them to pay him three thousand yuan.

(145) She found that he accessed to her.

(146) Xiao Ai did not ask him to access to her.

(147) Japanese fighter planes did not wait for American fighter planes to access to their bombers.

(148) He wants to prohibit people to access to his arrogance.

(149) Some people only ask others to contact them.

(150) He encouraged single middle-aged people to seek their happy life.

(151) Those stories encouraged Xiao Qingyu to seek her personal values.

(152) I do not want parents to interfere my affairs.

(153) China definitely does not admit any other countries to interfere its internal affairs.

(154) He recommended Song to replace him as the Prime Minister.

(155) Cao Cao asked Cui Yan to replace him to receive the ambassador of the Huns.

(156) He recommended Xiao Min to replace him as the head of the higher education institution.

(157) A woman introduced another woman to replace her.

(158) He finds a handsome youth to replace him.

(159) When he already found a responsible man to replace him, such was the case.

(160) He trains a fresh man to replace him.

(161) Shamgar asks Cossa to replace him to explore the cellar.

(162) He asks Champmathieu to replace him to being tortured.

(163) He asks his old classmate to invite him to pay a visit.

(164) Trainers encourage members to invite their favourite players.

(165) He does not allow anybody to approach him.

(166) Yang Guo pulled her to approach him.

(167) You cannot ask the power to approach you.

(168) Everyone does not allow others to approach his castle.

(169) The girl pulled him to approach her.

(170) The young driver holds her approaching him.

(171) The husband begged his wife to take him in.

(172) She does not want him to disturb her happiness at that moment.

(173) Peter hates someone to disturb him.

(174) She employed assistants to help her to collect suggestions and proposals.

(175) Korean asked American to help them to develop products.

(176) Zhang Fulong asked him to help him to improve pronunciation.

(177) Yang asked Wang to help him with force transformation.

(178) Xu Liang asked them to help him.

(179) She asked Cosby to help her to get away from difficulties.

(180) Businessmen and rural households employed consultants and technicians to help them with project selection, information analysis and problem solution.

(181) Shi Naian left Luo Guanzhong to help him to arrange manuscripts.

(182) He asks her to help him with nuts business.

(183) You ask Uncle Ma to help you to educate Da Hu.

(184) He expected them to help him to manage these properties.

(185) Miller asked Kepler to help him to consolidate the kingship.

(186) Robert asked Claire to help him.

(187) He uses his man to help him to manage these properties.

(188) Anyone cannot force others to help him.

(189) Manufacturers employ lawyers or social activities to help them to develop business.

(190) Beijing invites technicians from America and Australia to help it to promotes its new image.

(191) Foreign female chess players invite male chess players to help them to promote their skills.

(192) Mrs Li invites Sha to help her to deal with the clothes workshop.

(193) Zhao Yidi asks Zhang Xueliang to help him to find the solution.

(194) Tom does not ask him to recognize him.

(195) Xue Dinge asks her to accompany him.

(196) Drivers ask it to accompany them.

(197) The rich man asks a Japanese prostitute to accompany him to go for a walk.

(198) The concubine asks an actress to accompany her husband.

(199) She asks him to comfort her.

(200) It allows customers to trace their information online.

(201) Fishes ask girls to touch them.

(202) She is waiting for him to answer her questions.

(203) Nobles lobby others to affirm their heirship.

(204) They do not ask Ukraine to repay their debts.

(205) He asks Murakiviski to object to his old friends.

(206) He also asks friends to object to him.

(207) The female spider asks young spiders to leave away from her.

(208) Some parents do not want children to leave away from them.

(209) Father does not want his daughter to leave away from him.

(210) Chen forces his assistants to leave away from him.

(211) He does not want her to leave away from him.

(212) Grandpa does not want his grandson to leave away from him.

(213) Zhu never asks them to leave away from him.

(214) He does not ask her to leave away from him.

(215) Yin Lihua asks Liu Yan to leave away from her.

(216) Yehehua does not drive out them to leave away from him.

(217) Lager does not want his daughter to leave away from him.

(218) He asks them to leave away from him.

(219) He does not ask her to leave away from him for a long time.

(220) They ask residents not to leave away from their home.

(221) He induces her to leave away from his room.

(222) Mei does not want Gu to see her table manner.

(223) He does not want criminals to see his sad look.

(224) He does not want his wife to see his face.

(225) Yan Nanfei does not want him to see his expression.

(226) Harry does not want her to see him in the reading room.

(227) She does not want him to see her tears.

(228) San does not want Weis mother to see him.

(229) She asks Jin Tao to see her.

(230) He does not want Yang Huilan to see him crying.

(231) Usona does not want foreigners to see her granddaughter.

(232) She does not want him to see her feelings.

(233) Ticca does not want him to see her smile.

(234) She does not want him to see her face.

(235) He wants her to like him.

(236) Yang cannot force the teenager to obey his advice.

(237) Chinese parents ask children to obey their desires.

(238) Mrs Macbethy asks Mr Macbethy to obey his desire.

(239) She asks Susans family to accept her.

(240) She asks Susans family to confirm her.

(241) Some people ask relatives and friends to praise them by writing letters.

(242) The King advises Emol to convince his relatives to repect the will.

(243) He asked adults to look after him.

(244) They do not want children to look after them.

(245) Farmers asked housekeepers to look after their children.

(246) Zhu asked him to look after her sister Zi.

(247) It encourages people to abandon their past.

(248) He asks people to praise his actions.

(249) Holmes asked Watson not to praise him.

(250) He asked the organization to test him.

(251) The old aunt accused her son of abusing her.

(252) People prayed to God for rescuing them.

(253) Government gave the last chance to the head of Football Association to rescue himself.

(254) Family members asked her not to hurt their relatives.

(255) The minister prevented her hurting herself.

(256) Wuhan Civil Affairs Bureau asks citizens to supervise their work.

(257) Some famous companies ask customers to supervise them.

(258) The good service month of Bai Yun Airport asks travellers to supervise them.

(259) The mechanism trained members to challenge their skills of thinking against other people.

(260) Outdoor expend training asks staff to challenge themselves.

(261) I do not like you to torture yourself.

(262) Xiao Pang said to Tony: Do not embarrass yourself.

(263) Many companies asked Song Yongheng to recommend their looms.

(264) Ding Peng does not allow him to blame him.

(265) He welcomed people to criticize him.

(266) Government admitted opposition parties to criticize its policies.

(267) Sukarno asks them to ignore their problems.

(268) They urged the conference to pay attention to their proposals.

(269) Industry and commerce forced government to pay attention to them.

(270) Chinese want other people to pay attention to their performance.

(271) We asked other people to pay attention to our values.

(272) People like others to encourage their wisdom and temperament.

(273) Hospital informed patients to check them whether they were infected with AIDS.

(274) Feminist should not allow other people to check it.

(275) The political party asked leaders to check their behaviors.

(276) Provincial Party Secretary Yue Qifeng asked leaders and citizens to check their thoughts.

(277) Wuhan shopping malls asked factories to check their productions.

(278) System Innovation promotes America to check its prejudice of old practices.

(279) The meeting asked Fan Denggao and Yuan Tiancheng to check their strong capitalism.

(280) Engels asked platypus to forgive his arrogance and ignorance.

(281) Children asked parents to forgive their impiety.

(282) The fact should not ask us to forgive our weakness.

(283) Son asked his mother to forgive him.

(284) Xiao Juan asked him to forgive her.

(285) He only asked parents to forgive his impiety.

(286) She asked him to forgive her mistake.

(287) His honor does not allow him to forgive his relatives.

(288) Some comrades always ask people to respect their unrealistic creations.

(289) He asks RPR to respect him.

(290) Political freedom teaches lower classes to respect themselves.

(291) The casting asked us to introduce ourselves.

(292) They asked scientists to introduce their work.

(293) Yu invited him to introduce him to visit the bank.

(294) Children do not want parents to care about them.

(295) Zhou Enlai asks Mao Zedong to care about himself.

(296) No one in the world can ask Palestinian to give up their rights.

(297) America has no right to ask Palestinian to give up their territory.

(298) Government will not ask them to give up their candidacy.

(299) Colonialism forced Asian people to give up their culture.

(300) The capitalist countries asked China to give up its independence and sovereignty.

(301) Different explanations asked critics to give up their opinions.

(302) They forced Turehot to give up their Buddhism.

(303) He persuaded Churchill to give up his decision.

(304) Mother teach us not to give up our favorite things.

(305) The old Earl asked Nicolay to give up his plan.

(306) The prestige of the old boss asked this man to give up his plan.

(307) Sofia forced Susan to give up her plan.

(308) I persuaded him to give up his harsh decision.

(309) Half the people suggest the Consumer Federation to publish itself.

(310) China wants the world to understand him.

(311) USA asks Palestine to choose its political system.

(312) He encourages me to choose my life.

(313) Leaders ask us to consider our health.

(314) The decision asks EU to consider its decision.

(315) He urges other countries to consider their actions.

(316) She asks him to cherish her.

(317) Those angry fans ask players to cherish their shirts.

(318) We ask them to face their true nature.

(319) Headmaster does not allow her to face her favorite students.

(320) I suggest her to take notice of her health.

(321) I persuade you to take notice of your troubles.

(322) Doctor suggests him to take notice of his health.
(323) Robinson reminds Milleroviqi to take notice of his defence time.
(324) Professor Miller reminds me to take notice of my educational background.
(325) I also persuade you to take notice of your health.
(326) You persuade him to take notice of his impact among students.
(327) The court asks prosecution to take notice of his words.
(328) He asked Jim to take notice of his words.
(329) Our friends always remind us to take notice of our weaknesses.
(330) Jiajia asks him to take notice of her.
(331) He asks union officials to realize their responsibility.
(332) You persuade him not to ruin himself.
(333) Researchers ask volunteers to describe their mood.
(334) Zhang does not want Cheng to look down upon him.
(335) Mao Zedong asked the whole army to train themselves.
(336) It reminds us to observe our wishes.
(337) He asks them to laugh at him.
(338) I persuade him to value himself.
(339) She asks me to treasure myself.
(340) He asks the deputy secretary to remember his responsibility.
(341) She asks Emma to remember her true identity.
(342) She asks the female landlord to remember her status.
(343) He does not want us to forget our home country.
(344) Parents should encourage children to find their friends.
(345) Parents ask children to find their ambitions.
(346) Jiamusi women organization helps the orphans to find their parents.

Appendix II The handedness inventory

(modified from Annett, 1967; Source: Briggs and Nebes, 1975)

Are either of your parents left handed? If yes, which? _____

Indicate hand preferences	**Always left (-2)**	**Usually left (-1)**	**No preference (0)**	**Usually right (1)**	**Always right (2)**
1. To write a letter legibly					
2. To throw a ball to hit a target					
3. To play a game requiring the use of a racquet					
4. At the top of the broom to sweep dust from the floor					
5. At the top of a shovel to move sand					
6. To hold a match whilst striking it					
7. To hold scissors to cut paper					
8. To hold thread to guide through the eye of a needle.					
9. To deal playing cards					
10. To hammer a nail into wood					
11. To hold a toothbrush while cleaning teeth					
12. To screw the lid of a jar					
Column total:					
Total score (range – 24 to +24)					
Designation:	- Right handed (+9 and above) - Mixed handed (-8 - +8) - Left handed (-9 and below)				

How many siblings of each sex do you have? Male _____ Female ____

How many of each sex are left handed? Male _____ Female _____

Which eye do you use when only using one? e.g., telescope, keyhole. ___

Have you ever suffered any severe head trauma?_____

Appendix III The digit memory test

THE DIGIT MEMORY TEST

An assessment procedure for specialist teachers to investigate verbal memory difficulties in children's learning. Both parts are administered.

Digits forwards

Start Item A

Finish Failure on both trials of a pair.

Directions "Listen carefully as I say some numbers. When I finish, you say them."

Delivery Digits should be given at the rate of one per second. Administer both trials of each item. Recite digits in an even monotone without any variation in pitch of voice.

Scoring The individual's score is the total number of items correctly repeated forwards.

WORKED EXAMPLE

Item	First Trial	√ or X	Second Trial	√ or X
A	43	√	16	√
B	792	√	847	√
C	5941	X	7253	√
D	93872	X	75396	X

In this example, the total correct is 5.

Digits Backwards

Directions Administer as above but say, "Repeat these numbers after me but this time I want you to say them backwards." Give two practice trials of two digits first – any two numbers. If the child gets them wrong - correct her or him. If the child repeats the digits *forwards*, give a reminder that they should be reversed.

Score As for digits forwards.

Final score Total number managed (ticks) backwards and forwards *added together*. Consult Table 1 for standard score. This can also be expressed as a percentile equivalent: consult Table 2.

Comparison Most people can remember two more digits forwards than they can backwards. If the gap is larger than three, or smaller than one, this may be worthy of note.

DIGITS FORWARDS

Item	First trial	√ or X	Second trial	√ or X	Total
A	43		16		
B	792		847		
C	5941		7253		
D	93872		75396		
E	152649		216748		
F	3745261		4925316		
G	82973546		69174253		
H	246937185		371625948		
				Forwards score:	

DIGITS BACKWARDS

Item	Trial one	√ or X	Trial two	√ or X	Total
A	83		29		
B	475		615		
C	2619		3852		
D	28736		59413		
E	624719		276391		
F	4183627		1586937		
G	52624197		94617385		
				Backwards score:	

FINAL SCORE:

Total forwards and backwards:	
Standard score:	
Percentile equivalent:	

Martin Turner
Jacky Ridsdale
revised 6th October 2004

TABLE 1

Table 1: Estimated standard scores for digit memory performances from six years to adult

Age	6	7	8	9	10	11	12	13	14	15	16	Adult
Raw score 4	74	57	60	56	54	55	50	48	52	52	51	50
5	79	63	65	61	59	59	55	53	56	56	55	54
6	85	69	70	66	64	64	59	57	60	60	59	57
7	90	75	75	71	69	68	64	61	64	64	63	61
8	96	81	80	76	74	73	68	66	68	68	66	64
9	101	87	85	81	79	77	73	70	72	72	70	68
10	106	93	90	86	85	82	77	74	76	75	74	71
11	112	99	95	91	90	86	81	78	80	79	78	75
12	117	105	100	96	95	91	86	83	84	83	82	79
13	123	111	105	101	100	95	90	87	88	87	86	82
14	128	117	110	106	105	100	95	91	92	91	89	86
15	134	123	115	111	110	105	99	96	96	95	93	89
16	139	129	120	116	115	109	104	100	100	98	97	93
17	144	135	125	121	121	114	108	104	104	102	101	96
18	150	141	130	126	126	118	112	109	108	106	105	100
19	155	147	135	131	131	123	117	113	112	110	108	104
20	161	153	140	136	136	127	121	117	116	114	112	107
21			145	141	141	132	126	122	120	118	116	111
22			150	146	146	136	130	126	124	121	120	114
23			155	151	152	141	134	130	128	125	124	118
24			159	156	157	145	139	134	132	129	127	121
25						150	143	139	136	133	131	125
26						154	148	143	140	137	135	129
27						159	152	147	144	141	139	132
28						163	157	152	148	144	143	136
29								156	152	148	147	139
30								160	156	152	150	143
31									160	156	154	146
32									164	160	158	150
33												154
34												157
35												161
36												164

TABLE 2

Standard score	%ile equiv	Standard score	%ile equiv	Standard score	%ile equiv	Standard score	%ile equiv
54	0.1	77	6	100	50	123	94
55	0.1	78	7	101	53	124	95
56	0.2	79	8	102	55	125	95
57	0.2	80	9	103	58	126	96
58	0.3	81	10	104	61	127	96
59	0.3	82	12	105	63	128	97
60	0.4	83	13	106	66	129	97
61	0.5	84	14	107	68	130	98
62	0.6	85	16	108	70	131	98
63	0.7	86	18	109	73	132	98
64	0.8	87	19	110	75	133	99
65	1	88	21	111	77	134	99
66	1	89	23	112	79	135	99
67	1	90	25	113	81	136	99.2
68	2	91	27	114	82	137	99.3
69	2	92	30	115	84	138	99.4
70	2	93	32	116	86	139	99.5
71	3	94	34	117	87	140	99.6
72	3	95	37	118	88	141	99.7
73	4	96	39	119	90	142	99.7
74	4	97	42	120	91	143	99.8
75	5	98	45	121	92	144	99.8
76	5	99	47	122	93	145	99.9

Appendix IV The Chinese learning background questionnaire

Name _____ Nationality _____ Mother Tongue _____ Age ____ Gender ____

Did you speak a language other than English when you were a child?

☐ No ☐ Yes, language spoken: _____, at age _____

Years of Chinese learning _____ at which age start to learn Chinese _____

Where have you been learning Chinese? (Please tick one or all that apply to your situation) ☐ UK ☐ China ☐ other countries

Have you ever had or do you have a native Chinese-speaking teacher or tutor?

☐ Yes ☐ No

How have you been learning Chinese? (Please tick one or all that apply to your situation)

☐ lessons in a class ☐ self-studying ☐ private tuition ☐ naturalistic setting

How many hours do you spend in average on the following activities each week?

1) Learning Chinese character, vocabulary, grammar, etc. ___ hours a week

2) Listening to or Watching Chinese dramas or programmes, etc. ___ hours a week

3) Speaking in Chinese ___ hours a week

4) Reading in Chinese ___ hours a week

5) Writing in Chinese ___ hours a week

Do you have native Chinese-speaking language partners or friends?

☐Yes ☐No

Have you ever been in China (e.g. travelling, studying, and working)?

☐ Yes, spent ____ years or ____ months in China in total ☐ No

Appendix V The Chinese proficiency test

一． 请从以下词语中选择正确的词语填空。

1. 见面 2. 爱好 3. 一直 4. 提高 5. 声音 6. 回答 7. 当然 8. 结束 9. 节日 10. 总是 11. 应该

例如： 她说话的（ 5 ）多好听啊！

(1) 我相信在她的帮助下，你的汉语水平一定会（ ）的。

(2) 谁能（ ）黑板上的这个问题？

(3) （ ）到会议结束，大家也没想出办法来。

(4) 表演几点（ ）？我去接你。

(5) 祝您（ ）快乐，这是我们送您的礼物，希望您喜欢。

(6) 人们（ ）在生病以后，才认识到健康有多么重要。

(7) A：你有什么（ ）？

B：我喜欢体育。

(8) A：我们在哪儿（ ）？

B：国家体育馆北门吧，那儿离你家和我家都近。

(9) A：下周我要去旅游，能借你的照相机用一下吗？

B：（ ）可以，你打算去哪儿？

(10) A：银行那边打电话让我去面试，你说我去不去啊？

B：我觉得这个机会不错，你（ ）试试。

二． 请将下列词语按正常的顺序排列成一句话。

例如: 1. 小船 2. 河上 3. 一条 4. 有 2 4 3 1 (河上有一条小船)。

(11) 1. 锻炼 2. 健身房 3. 去 4. 他 5. 偶尔 6. 会

(12) 1. 一定 2. 道歉的时候 3. 态度诚恳 4. 要

(13) 1. 节日 2. 是 3. 春节 4. 一个 5. 传统的

(14) 1. 北京 2. 给 3. 深刻的印象 4. 他 5. 留下了

(15) 1. 彩虹 2. 雨后 3. 常常能 4. 看到

(16) 1. 他 2. 日程 3. 把 4. 已经 5. 安排好了

(17) 1. 总共 2. 消费 3. 您 4. 198 块钱

(18) 1. 意义 2. 他的 3. 有 4. 很特殊的 5. 这段经历

三． 阅读短文，选出正确的词语填空。

(1) 在沙滩排球场上，半躺在沙滩椅中，头顶着蓝天，脚下踩着软软的细沙，吹着海风，享受那份惬意。阳光下，球场两边各有两名 (19) 着太阳眼镜、晒得一身古铜色 (20) 的运动员在网前争夺。满身的沙子，还有满身的汗水，在蓝天白云的衬托下，阳光的照射下，动感而 (21) 活力。

(19) A 穿 B 带 C 挂 D 戴

(20) A 皮肤 B 身体 C 头发 D 胳膊

(21) A 形成 B 包括 C 充满 D 实现

(2) 从前有一位老人叫愚公，他家门前有两座山，又高又大， (22) ，全家人出门都很不方便。一天，愚公把家里人叫到一起，说：“有山挡着，出门太困难了，我们把它搬走，好不好？”全家人都很 (23) ，只有他的妻子没有信心。她说：“你已经快 90 了，怎么能搬山呢？而且山上的石头，要搬到哪里去呢？”愚公说：“可以扔到海里。”村里人看到愚公这么大年纪还在搬山，都很感动，也来帮助他们。有个叫智叟的老头儿看到了， (24) 愚公太傻。愚公却说：“我死了还有儿子，儿子还有孙子，我们的人越来越多，山上的石头却越来越少，我们一定能 (25) ！”

(22) A 挡住了路 B 十分矛盾 C 因为无法推辞 D 犹豫了很长时间

(23) A 允许 B 注意 C 反对 D 赞成

(24) A 相信 B 考虑 C 笑话 D 确认

(25) A 发展 B 努力 C 到达 D 成功

Appendix VI The self-evaluation questionnaire on Chinese competence

Please rate the following eight statements by ticking the one qualifier that applies to your competence in Chinese (Extremely well = Excellent, Very well = Very good, Well = Good, Not very well = Fair, Not at all = Poor):

(1) I can understand the gist of lectures and conversations.

☐ Extremely well ☐ Very well ☐ Well ☐ Not very well ☐ Not at all

(2) I can understand the detail of lectures and conversations.

☐ Extremely well ☐ Very well ☐ Well ☐ Not very well ☐ Not at all

(3) I can understand a speaker's attitude or opinion about what he or she is saying.

☐ Extremely well ☐ Very well ☐ Well ☐ Not very well ☐ Not at all

(4) I can read texts, reports, newspapers and articles on unfamiliar topics.

☐ Extremely well ☐ Very well ☐ Well ☐ Not very well ☐ Not at all

(5) I can read texts, reports, newspapers and articles about daily or familiar topics.

☐ Extremely well ☐ Very well ☐ Well ☐ Not very well ☐ Not at all

(6) I can write an essay, a report or an article on an assigned topic.

☐ Extremely well ☐ Very well ☐ Well ☐ Not very well ☐ Not at all

(7) I can write clear, detailed text on a wide range of subjects related to my interests.

☐ Extremely well ☐ Very well ☐ Well ☐ Not very well ☐ Not at all

(8) I can write simple connected sentences, passing on information or providing justifications, describing events, experiences and impressions.

☐ Extremely well ☐ Very well ☐ Well ☐ Not very well ☐ Not at all

Appendix VII The English learning background questionnaire

Name _____ Nationality _____ Mother Tongue _____ Age ____ Gender ____

Did you speak a language other than Chinese when you were a child?

☐ No ☐ Yes, language spoken: _____, at age _____

Years of English learning _____ at which age start to learn English ____

Where have you been learning English? (Please tick one or all that apply to your situation) ☐ UK ☐ China ☐ other countries

Have you ever had or do you have a native English-speaking teacher or tutor?

☐ Yes ☐ No

How have you been learning English? (Please tick one or all that apply to your situation)

☐ lessons in a class ☐ self-studying ☐ private tuition ☐ naturalistic setting

Do you have native English-speaking language partners or friends?

☐ Yes ☐ No

Have you ever been in English-speaking countries including UK (e.g. travelling, studying, and working)?

☐ Yes, spent ____ years ____ months in total ☐ No

Did you take an IELTS or TOEFL test?

☐ Yes, (☐ IELTS ☐ TOEFL) ☐ No

How many times have you taken the IELTS or TOEFL test? ____

The best/highest total score is _____

Appendix VIII The experiment materials

- 30 experiment items with VT1 as the embedded verb in the test sentence

The Test Sentence	The Context Sentence favours a local interpretation of *'ziji'* (i.e. the 'Matching' condition)	The Context Sentence favours a long-distance interpretation of *'ziji'* (i.e. the 'Conflicting' condition)
张三让李四**检讨**自己，大家都同意。 Zhangsan asks Lisi to self-criticize ziji, everyone agrees.	张三发现李四没有完成作业。 Zhangsan finds that Lisi does not finish homework on time.	李四发现张三经常迟到。 Lisi finds that Zhangsan is always late for school.
张三让李四**坦白**自己，大家都同意。 Zhangsan asks Lisi to confess ziji, everyone agrees.	李四对张三隐瞒真相。 Lisi conceals a fact to Zhangsan.	张三对李四说谎。 Zhangsan tells a lie to Lisi.
张三让李四**反思**自己，大家都同意。 Zhangsan asks Lisi to rethink of ziji, everyone agrees.	张三觉得李四做事不认真。 Zhangsan thinks that Lisi does not work carefully.	李四发现张三经常犯同样的错误。 Lisi finds that Zhangsan always makes the same mistake.
张三让李四**反省**自己，大家都同意。 Zhangsan asks Lisi to introspect ziji, everyone agrees.	张三发现李四在考试中作弊。 Zhangsan finds that Lisi cheats in the exam.	李四发现张三偷了公司的钱。 Lisi finds that Zhangsan steals the properties of the company.
张三让李四**保重**自己，大家都这样认为。 Zhangsan asks Lisi to take care of ziji, everyone thinks so.	张三知道李四生病住院了。 Zhangsan knows that Lisi is ill at hospital.	张三没有李四身体好。 Zhangsan is not as healthy as Lisi.
张三让李四**展现**自己，大家都很期待。 Zhangsan asks Lisi to show ziji, everyone looks forward to.	李四唱歌比张三好听。 Lisi sings better than Zhangsan.	李四知道张三会弹钢琴。 Lisi knows that Zhangsan can play the piano.
张三让李四**放松**自己，大家都同意。 Zhangsan asks Lisi to relax ziji, everyone agrees.	李四在张三面前非常紧张。 Lisi is very nervous when he sees Zhangsan.	李四知道张三一直忙于工作。 Lisi knows that Zhangsan has been busy for a long time.

张三让李四**克制**自己，大家都这样认为。 Zhangsan asks Lisi to restrain ziji, everyone thinks so.	张三知道李四非常容易激动。 Zhangsan knows that Lisi is very easy to get excited.	张三对李四非常生气。 Zhangsan is very angry at Lisi.
张三让李四**充实**自己，大家都支持。 Zhangsan asks Lisi to replenish ziji, everyone supports.	张三发现李四没有任何爱好。 Zhangsan finds that Lisi does not have any hobbies.	李四发现张三生活无趣。 Lisi finds that Zhangsan lives a boring life.
张三让李四**丰富**自己，大家都支持。 Zhangsan asks Lisi to enrich ziji, everyone supports.	李四比张三懂得少。 Lisi knows less than Zhangsan.	张三比李四的社会经验少。 Zhangsan has less social experiences than Lisi.
张三让李四不要**封闭**自己，大家都这样认为。 Zhangsan asks Lisi not to close ziji, everyone thinks so.	李四不愿意与张三交流。 Lisi does not like to communicate with Zhangsan.	李四发现张三一直一个人呆在房间。 Lisi finds that Zhangsan is in the room alone for a long time.
张三让李四不要**隐藏**自己，大家都这样觉得。 Zhangsan asks Lisi not to hide ziji, everyone thinks so.	李四从来不对张三表达内心的感受。 Lisi never expresses his feelings to Zhangsan.	李四非常防范张三。 Lisi is over-protective of Zhangsan.
张三让李四不要**掩饰**自己，大家都这样认为。 Zhangsan asks Lisi not to conceal ziji, everyone thinks so.	李四在张三面前编造了许多谎言。 Lisi has maken up lots of lies in front of Zhangsan.	张三从来没有对李四说实话。 Zhangsan has never expressed his actual thoughts to Lisi.
张三让李四不要**压抑**自己，大家都同意。 Zhangsan asks Lisi not to repress ziji, everyone agrees.	李四在张三面前忍住不哭。 Lisi resists crying in front of Lisi.	李四知道张三最近压力很大。 Lisi knows that Zhangsan is stressed out.
张三让李四不要**迷失**自己，大家都支持。 Zhangsan asks Lisi not to lose ziji, everyone supports.	张三发现生活让李四放弃了梦想。 Zhangsan finds that life forces Lisi to give up his dream.	张三经受不住李四的甜言蜜语。 Zhangsan cannot resist Lisi's sweet words.

· 30 experiment items with VT2 as the embedded verb in the test sentence

The Test Sentence	The Context Sentence favours a local interpretation of *'ziji'* (i.e. the 'Conflicting' condition)	The Context Sentence favours a long-distance interpretation of *'ziji'* (i.e. the 'Matching' condition)
张三让李四**帮助**自己，大家都很高兴。 Zhangsan asks Lisi to help ziji, everyone is happy.	张三听说李四有困难。 Zhangsan hears that Lisi is in difficulty with his study.	李四比张三有更丰富的比赛经验。 Lisi has more experiences of competitions than Zhangsan.
张三让李四**代替**自己，大家都同意。 Zhangsan asks Lisi to replace ziji, everyone agrees.	张三听说李四不能参加比赛。 Zhangsan hears that Lisi cannot join the competition.	张三没有时间参加会议，刚好李四有时间。 Zhangsan does not have time to attend a meeting, while Lisi has time.
张三让李四**收留**自己，没有人反对。 Zhangsan asks Lisi to take in ziji, nobody oppose.	张三听说李四无家可归。 Zhangsan hears that Lisi is homeless.	李四住别墅，而张三却没钱租房子。 Lisi has a cottage, while Zhangsan does not have money to rent a flat.
张三让李四**联系**自己，大家都很期待。 Zhangsan asks Lisi to contact ziji, everyone looks forward to.	李四找不到张三。 Lisi cannot find Zhangsan.	张三知道李四想出国留学。 Zhangsan knows that Lisi plans to study abroad.
张三让李四**陪伴**自己，大家都很开心。 Zhangsan asks Lisi to accompany ziji, everyone is happy.	张三听说李四不想独自去看电影。 Zhangsan hears that Lisi does not want to watch movie alone.	张三不开心，所以找李四喝酒聊天。 Zhangsan is unhappy, so he invites Lisi to have a drink together.
张三让李四**赔偿**自己，大家都同意这样做。 Zhangsan asks Lisi to pay for ziji, everyone agrees.	张三忘记替李四领取奖金。 Zhangsan forgets to collect the prize for Lisi.	李四弄坏了张三的电脑。 Lisi breaks Zhangsan's computer.
张三让李四**邀请**自己，大家都很开心。 Zhangsan asks Lisi to invite ziji, everyone is happy.	李四获奖了，所以张三想办一个舞会。 Lisi wins the prize, so Zhangsan wants to host a celebration party.	张三想去李四的新家看看。 Zhangsan wants to visit Lisi's new house.
张三让李四**采访**自己，大家都很期待。 Zhangsan asks Lisi to interview ziji, everyone looks forward to.	张三十分好奇李四环游世界的经历。 Zhangsan is very curious about Lisi's experience of travelling round the world.	李四非常喜欢张三的作品。 Lisi admires Zhangsan's work very much.

张三让李四**回答**自己，大家都在等待。 Zhangsan asks Lisi to answer ziji, everyone is waiting.	李四对张三的决定有很多疑问。 Lisi has lots of doubts about Zhangsan's decision.	张三对李四的研究提出了许多问题。 Zhangsan has many questions about Lisi's research.
张三让李四不要**冒充**自己，没有人会相信的。 Zhangsan asks Lisi not to pretend to be ziji, nobody believe.	张三经常打扮成李四的样子。 Zhangsan always dresses up like Lisi.	李四谎称是作家张三。 Lisi lies in saying that he is Zhangsan, (in order to receive royalties).
张三让李四不要**牵连**自己，大家都会有麻烦。 Zhangsan asks Lisi not to involve ziji in, everyone will get into trouble.	张三说李四策划了这次事件。 Zhangsan claims that Lisi plans this accident.	李四请张三帮忙收留一个犯人。 Lisi tells Zhangsan to hide an escaped prisoner.
张三让李四不要**想念**自己，大家很伤心。 Zhangsan asks Lisi not to miss ziji, everyone is sad.	李四告诉张三很久不能见面。 Lisi tells Zhangsan that they will not see each other for a long time.	张三告诉李四要去很远的地方旅行。 Zhangsan tells Lisi that he will travel very far away.
张三让李四不要**嫉妒**自己，大家都要努力。 Zhangsan asks Lisi not to be jealous of ziji, everyone makes effort.	李四比张三受到更多的帮助。 Lisi receives more help than Zhangsan.	张三比李四优秀。 Zhangsan is more excellent than Lisi.
张三让李四不要**挽留**自己，大家还会见面的。 Zhangsan asks Lisi not to retain ziji, everyone will meet again.	李四决定离开张三。 Lisi decides to leave Zhangsan.	李四觉得张三不应该辞职。 Lisi thinks that Zhangsan should not resign from his position.
张三让李四不要**干涉**自己，大家互相尊重隐私。 Zhangsan asks Lisi not to intervene ziji, everyone should respect privacy.	张三不准李四认识新朋友。 Zhangsan does not allow Lisi to make new friends.	李四经常查看张三的约会记录。 Lisi often checks Zhangsan's appointments.

· 30 experiment items with VT3 as the embedded verb in the test sentence

The Test Sentence	The Context Sentence favours a local interpretation of *'ziji'* (i.e. the 'Local Context' condition)	The Context Sentence favours a long-distance interpretation of *'ziji'* (i.e. the 'Long-distance Context' condition)
张三让李四**尊重**自己，大家都这样认为。 Zhangsan asks Lisi to respect ziji, everyone thinks so.	张三看到李四在公共场合不自重。 Zhangsan sees that Lisi does not conduct himself with dignity in public.	李四在采访中不尊重张三。 Lisi does not respect Zhangsan during the interview.
张三让李四**相信**自己，一切会顺利的。 Zhangsan asks Lisi to trust ziji, everything will be fine.	张三发现李四不自信。 Zhangsan finds that Lisi is not confident.	李四担心张三受伤。 Lisi worries about that Zhangsan will be hurt.
张三让李四**挑战**自己，大家都要尽力。 Zhangsan asks Lisi to challenge ziji, everyone tries best.	张三听说李四打算放弃比赛。 Zhangsan hears that Lisi plans to give up the competition.	张三听说没有人比李四跑得快。 Zhangsan hears that nobody runs faster than Lisi.
张三让李四**原谅**自己，毕竟不是故意的。 Zhangsan asks Lisi to forgive ziji, because it does not mean to happen.	李四弄丢了张三的钱包。 Lisi loses Zhangsan's wallet.	张三对李四说谎。 Zhangsan tells a lie to Lisi.
张三让李四**打扮**自己，大家都很期待。 Zhangsan asks Lisi to dress ziji up, everyone looks forward to.	李四想参加张三的化妆舞会。 Lisi wants to join the fancy ball held by Zhangsan.	在化妆上，张三需要李四的帮忙。 Zhangsan needs Lisi's help on the make-up.
张三让李四**证明**自己，大家都同意这样做。 Zhangsan asks Lisi to prove ziji, everyone agrees.	李四被冤枉偷了张三的钱包。 Lisi is accused of stealing Zhangsan's wallet.	张三请李四做目击证人。 Zhangsan asks Lisi to be the witness.
张三让李四**批评**自己，大家很惊讶。 Zhangsan asks Lisi to criticize ziji, everyone is shocked.	张三发现李四考试作弊。 Zhangsan finds that Lisi cheats in the exam.	张三请李四指出缺点。 Zhangsan asks Lisi to give him advice on his weakness.
张三让李四**介绍**自己，大家很好奇。 Zhangsan asks Lisi to	李四是张三的新同事。 Lisi is a new colleague of Zhangsan.	张三是李四请来的客人。 Zhangsan is the guest invited by Lisi.

introduce ziji, everyone is very curious.		
张三让李四**鼓励**自己，大家很激动。 Zhangsan asks Lisi to encourage ziji, everyone is moved.	李四不敢挑战张三的记录。 Lisi is afraid to challenge Zhangsan's record.	张三想得到李四更多的支持。 Zhangsan wants to have more support from Lisi.
张三让李四不要**忽视**自己，大家都这样认为。 Zhangsan asks Lisi not to ignore ziji, everyone thinks so.	张三发现李四总是先考虑别人。 Zhangsan finds that Lisi always considers others before his own.	李四觉得张三不应该得到支持。 Lisi thinks that Zhangsan does not deserve to be supported.
张三让李四不要**埋怨**自己，大家都同意。 Zhangsan asks Lisi not to blame ziji, everyone agrees.	李四忘记给张三预订航班。 Lisi forgets to book a flight for Zhangsan.	张三弄丢了李四的钱包。 Zhangsan loses Lisi's wallet.
张三让李四不要**折磨**自己，这样做对大家不好。 Zhangsan asks Lisi not to torture ziji, it is bad for everyone.	张三发现李四连续三天不吃不喝。 Zhangsan finds that Lisi has no food and drinks for three days.	李四要张三罚站三小时。 Lisi tells Zhangsan to stand for three hours as punishment.
张三让李四不要**伤害**自己，大家都同意。 Zhangsan asks Lisi not to hurt ziji, everyone agrees.	张三看到李四用刀割手腕。 Zhangsan sees that Lisi is cutting his wrist.	李四编造谎言污蔑张三。 Lisi makes up lies to insult Zhangsan.
张三让李四不要**责怪**自己，大家都同意。 Zhangsan asks Lisi not to blame ziji, everyone agrees.	李四忘记给张三买礼物。 Lisi forgets to buy a gift for Zhangsan.	李四发现张三打破了花瓶。 Lisi finds that it is Zhangsan who breaks the vase.
张三让李四不要**放弃**自己，大家都要坚持下去。 Zhangsan asks Lisi not to give up ziji, everyone should keep going.	李四把不想治病的想法告诉了张三。 Lisi tells Zhangsan that he does not want to receive medical treatment anymore.	李四很失望张三这次没能升职。 Lisi is very disappointed that Zhangsan does not get the job promotion this time.

· 90 filler items with the Chinese pronoun *ta*

The Test Sentence	The Context Sentence favours a long-distance interpretation of *'ta'* (i.e. the 'Long-distance Context' condition)	The Context Sentence favours a third-person interpretation of *'ta'* (i.e. the 'Third-person Context' condition)
张三让李四尊重他，大家友好地相处。 Zhangsan asks Lisi to respect ta, everyone gets on well with each other.	李四总是看不起张三。 Lisi always looks down on Zhangsan.	李四不尊敬张三的哥哥。 Lisi does not estmeed Zhangsan's older brother.
张三让李四相信他，大家不要有怀疑。 Zhangsan asks Lisi to trust ta, everyone should not have any doubts.	张三说一定会还给李四钱。 Zhangsan promises to pay Lisi back.	李四不信任张三的朋友。 Lisi does not believe in Zhangsan's friend.
张三让李四严格要求他，大家共同进步。 Zhangsan asks Lisi to be strict with ta, everyone makes progress together.	李四从来没有批评过张三。 Lisi has never criticized Zhangsan.	李四发现张三的朋友非常懒惰。 Lisi finds that Zhangsan's friend is very lazy.
张三让李四介绍他，大家可以互相认识。 Zhangsan asks Lisi to introduce ta, everyone can know each other.	李四把张三的情况向所有人说了一遍。 Lisi tolds Zhangsan's personal information to everyone.	张三突然忘记了李四朋友的名字。 Zhangsan suddenly forgets the name of Lisi's friend.
张三让李四保护他，大家一起躲避坏人。 Zhangsan asks Lisi to protect ta, everyone can avoid bad guys together.	张三发现李四会武术。 Zhangsan finds that Lisi is expect at Chinese Kongfu.	李四发现张三的朋友有危险。 Lisi finds that Zhangsan's friend is in danger.
张三让李四照顾他，大家好好生活。 Zhangsan asks Lisi to look after ta, everyone has a good life.	李四得知张三生病住院了。 Lisi knows that Zhangsan is ill in hospital.	张三决定出国，把弟弟交给了李四。 Zhangsan plans to go abroad and leave the young brother to Lisi.
张三让李四养活他，大家一起生活。 Zhangsan asks Lisi to feed ta, everyone lives together.	张三找不到工作，找李四帮助。 Zhangsan cannot find a job and asks Lisi for help.	张三无法维持生活，把弟弟交给了李四。 Zhangsan cannot keep living and leave the young brother to Lisi.

张三让李四原谅他，大家还是朋友。 Zhangsan asks Lisi to forgive ta, everyone are still friends.	张三偷卖了李四的作品。 Zhangsan steals Lisi's work and sell it.	张三的朋友喝醉了，骂了李四。 Zhangsan's friend gets drunk and scolds Lisi.
张三让李四邀请他，大家一起聚聚。 Zhangsan asks Lisi to invite ta, everyone can play together.	张三很想参观李四的新家。 Zhangsan wants to visit Lisi's new house.	张三很久没有见过李四的弟弟了。 Zhangsan has not seen Lisi's brother for a long time.
张三让李四帮助他，大家可以互相学习。 Zhangsan asks Lisi to help ta with promotion, everyone can learn from each other.	李四比张三有更多的工作经验。 Lisi has more working experiences than Zhangsan.	李四负责教导张三的弟弟。 Lisi is responsible for teaching Zhangsan's brother.
张三让李四收留他，大家一起生活。 Zhangsan asks Lisi to take ta in, everyone can live together.	张三无依无靠，只有李四一个朋友。 Zhangsan is helpless, and has only one friend Lisi.	李四听说张三的朋友无家可归。 Lisi hears that Zhangsan's friend is homeless.
张三让李四不要忘记他，大家开心地生活。 Zhangsan asks Lisi not to forget ta, everyone has a happy life.	张三打算离开李四，独自出国。 Zhangsan plans to leave Lisi, and go abroad alone.	李四爱上了张三的朋友，却不能在一起。 Lisi falls in love with Zhangsan's friend, but they cannot be together.
张三让李四不要轻视他，大家一起完成项目。 Zhangsan asks Lisi not to despise ta, everyone finishes the project together.	张三不仅比李四年轻，而且缺少工作经验。 Zhangsan is younger than Lisi, and lacks in working experiences.	李四觉得张三的朋友什么都不会。 Lisi thinks that Zhangsan's friend cannot do anything.
张三让李四不要怨恨他，大家忘掉不愉快的事。 Zhangsan asks Lisi not to hate ta, everyone forgets unhappy issues.	张三没有投票给李四。 Zhangsan does not vote for Lisi.	张三的朋友没能救活李四的哥哥。 Zhangsan's friend is not able to save Lisi's brother.
张三让李四不要为难他，大家专心工作。 Zhangsan asks Lisi not to embarrass ta, everyone focuses on working.	李四经常对张三提出不合理的要求。 Lisi always puts unreasonable demands on Zhangsan.	李四故意把最困难的事交给了张三的朋友。 Lisi intentionally tells Zhangsan's friend to do the most difficult task.

张三让李四不要欺骗他，大家都会不高兴。 Zhangsan asks Lisi not to deceive ta, everyone will be unhappy.	李四不承认抄袭张三的设计。 Lisi does not admit that he copies Zhangsan's design.	李四对张三的朋友隐瞒了一些事情。 Lisi hides something to Zhangsan's friend.
张三让李四不要谈论他，大家互相尊重隐私。 Zhangsan asks Lisi not to discuss ta, everyone respect each other's privacy.	李四发现张三的父母离婚了。 Lisi finds that Zhangsan's parents get divorced.	李四很好奇张三的朋友。 Lisi is very interested in Zhangsan's friend.
张三让李四不要打他，大家要讲道理。 Zhangsan asks Lisi not to beat ta, everyone should talk reasonable.	张三弄丢了李四的手机。 Zhangsan loses Lisi's mobile phone.	张三的朋友弄坏了李四的电脑。 Zhangsan's friend breaks Lisi's computer.
张三让李四不要讨厌他，大家能成为朋友。 Zhangsan asks Lisi not to hate ta, everyone can be friends.	李四觉得张三是个自私的人。 Lisi thinks that Zhangsan is selfish.	张三的朋友把李四的房间弄乱了。 Zhangsan's friend messes up Lisi's room.
张三让李四不要靠近他，大家保持距离。 Zhangsan asks Lisi not to get close to ta, everyone keeps distance.	张三不想把感冒传染给李四。 Zhangsan does not want to infect Lisi with his cold.	张三的朋友对李四不怀好意。 Zhangsan's friend smiles at Lisi with an evil smile.
张三让李四不要使唤他，大家都这样认为。 Zhangsan asks Lisi not to order about ta to do everything, everyone agrees.	李四总是要张三做各种家务活。 Lisi always tells Zhangsan to do all the cleaning.	张三的朋友是来李四家做客的。 Zhangsan's friend comes to Lisi's house as a guest.
张三让李四不要羡慕他，大家都要努力。 Zhangsan asks Lisi not to admire ta, everyone makes effort.	李四来自农村，张三来自大城市。 Lisi comes from countryside, while Zhangsan comes from a big city.	张三的朋友比李四受到更多女生的喜欢。 Zhangsan's friend receives more love from girls than Lisi.
张三让李四推荐他，老师们都同意。 Zhangsan asks Lisi to recommend ta, teachers all agree.	张三知道大家都信任李四。 Zhangsan knows that everyone trusts Lisi.	李四非常欣赏张三的朋友。 Lisi admires Zhangsan's friend very much.

张三让李四挑战他，大家都很紧张。 Zhangsan asks Lisi to challenge ta, everyone is very nervous.	张三不相信李四可以获得第一名。 Zhangsan cannot believe that Lisi wins the 1st prize.	李四想打败张三的朋友。 Lisi wants to win Zhangsan's friend.
张三让李四代替他，队员们都同意。 Zhangsan asks Lisi to replace ta, members all agree.	张三没有时间参加比赛，刚好李四有时间。 Zhangsan does not have time to join the competition, while Lisi does.	张三让李四代替他，队员们都同意。 Zhangsan asks Lisi to replace ta, and all the members agree on it.
张三让李四联系他，大家都很期待。 Zhangsan asks Lisi to contact ta, everyone looks forward to.	李四有事情找张三商量。 Lisi has something to discuss with Zhangsan.	张三让李四联系他，大家都很期待。 Zhangsan asks Lisi to contact ta, and everyone expects it.
张三让李四陪伴他，父母都同意。 Zhangsan asks Lisi to accompany ta, parents agree.	张三想与李四一起度过这个假期。 Zhangsan wants to spend the holiday with Lisi.	张三让李四陪伴他，父母都同意。 Zhangsan asks Lisi to accompany ta, and their parents agree on it.
张三让李四欢迎他，大家都很高兴。 Zhangsan asks Lisi to welcome ta, everyone is very happy.	张三被邀请参加李四的生日会。 Zhangsan is invited to Lisi's birthday party.	张三让李四欢迎他，大家都很高兴。 Zhangsan asks Lisi to welcome ta, and everyone is happy.
张三让李四赔偿他，大家都同意。 Zhangsan asks Lisi to pay for ta, everyone agrees.	李四弄坏了张三的电脑。 Lisi breaks Zhangsan's computer.	李四打碎了张三朋友的花瓶。 Lisi breaks a vase of Zhangsan's friend.
张三让李四采访他，观众们都很期待。 Zhangsan asks Lisi to interview ta, the audience looks forward to.	张三非常欣赏李四的工作态度。 Zhangsan admires Lisi's working attitude very much.	李四非常好奇张三朋友的经历。 Lisi is very curious about life of Zhangsan's friend.
张三让李四谢谢他，同学们都笑了。 Zhangsan asks Lisi to thank ta, students all smile.	张三帮助李四完成了作业。 Zhangsan helps Lisi to finish the project.	张三的朋友把捡到的钱包还给了李四。 Zhangsan's friend return the wallet to Lisi.
张三让李四重视他，队员们都同意。 Zhangsan asks Lisi to pay attention to ta, members all agree.	李四从来不考虑张三的感受。 Lisi never considers Zhangsan's feelings.	李四从来不把重要的任务交给张三的弟弟。 Lisi never leaves important tasks to Zhangsan's little brother.

张三让李四回答他，同学们都在等待。 Zhangsan asks Lisi to answer ta, students all are waiting.	张三对李四提出了许多问题。 Zhangsan has lots of questions for Lisi.	张三的朋友怀疑李四偷了钱。 Zhangsan's friend doubts that Lisi steals the money.
张三让李四鼓励他，朋友们都很期待。 Zhangsan asks Lisi to encourage ta, friends all look forward to.	张三没有信心能打败李四。 Zhangsan has no confidence in winning Lisi.	张三的朋友需要李四的支持。 Zhangsan's friend needs Lisi's support.
张三让李四不要批评他，同学们不同意。 Zhangsan asks Lisi not to criticize ta, students do not agree.	张三抄了李四的作业。 Zhangsan copies Lisi's homework.	张三的朋友偷拿了李四的笔记本。 Zhangsan's friend steals Lisi's notebook.
张三让李四不要指责他，大家都很惊讶。 Zhangsan asks Lisi not to blame ta, everyone is very surprised.	李四发现张三在考试中作弊。 Lisi finds that Zhangsan cheats in the exam.	因为张三朋友的失误，李四输掉了比赛。 Lisi loses the game because Zhangsan's friend makes a mistake.
张三让李四不要干涉他， 朋友们都同意。 Zhangsan asks Lisi not to intervene ta, friends all agree.	李四不让张三交新朋友。 Lisi does not allow Zhangsan to make new friends.	李四不让张三的朋友玩电脑。 Lisi does not allow Zhangsan's friend to play computer.
张三让李四鼓励他，朋友们都很期待。 Zhangsan asks Lisi to encourage ta, friends all look forward to.	张三没有信心能打败李四。 Zhangsan has no confidence in winning Lisi.	张三的朋友需要李四的支持。 Zhangsan's friend needs Lisi's support.
张三让李四不要强迫他，大家有不同的意见。 Zhangsan asks Lisi not to force ta, everyone has different opinions.	李四经常让张三做不喜欢的事情。 Lisi always tells Zhangsan to do something that he does not like.	张三的朋友不愿意帮助李四。 Zhangsan's friend does not want to help Lisi.
张三让李四不要怀疑他， 大家合作愉快。 Zhangsan asks Lisi not to doubt ta, everyone works together successfully.	李四不相信张三的能力。 Lisi does not believe in Zhangsan's ability.	李四觉得张三的朋友会把秘密说出去。 Lisi thinks that Zhangsan's friend will speak the secret out.

张三让李四不要伤害他，大家都不开心。 Zhangsan asks Lisi not to hurt ta, everyone is unhappy.	李四说张三的坏话。 Lisi says bad words about Zhangsan.	李四经常不让张三的弟弟吃饭。 Lisi always does let Zhangsan's little brother eat.
张三让李四不要打扰他，大家认真工作。 Zhangsan asks Lisi not to disturb ta, everyone works seriously.	李四说话声音太大，吵到了张三。 Lisi speaks so loud that he noises Zhangsan.	李四经常在工作时间打电话给张三的朋友。 Lisi always calls Zhangsan's friend during working hours.
张三让李四不要冒充他，朋友们会弄不清楚。 Zhangsan asks Lisi not to pretend to be ta, friends all are confused.	李四经常打扮成张三的样子。 Lisi always dresses up like Zhangsan.	李四谎称是张三的弟弟。 Lisi claims that he is Zhangsan's brother.
张三让李四不要想念他，大家很伤心。 Zhangsan asks Lisi not to miss ta, everyone is sad.	张三告诉李四很长时间都不能见面。 Zhangsan tells Lisi that they cannot meet each other for a long time.	张三的朋友打算离开李四。 Zhangsan's friend wants to leave Lisi for some time.
张三让李四不要误会他，大家成为好朋友。 Zhangsan asks Lisi not to misunderstand ta, they become good friends.	张三不小心说出了李四的秘密。 Zhangsan unintentionally speaks a secret of Lisi out.	张三的朋友不是故意指出李四的缺点。 Zhangsan's friend does not points out Lisi's weaknesses intentionally,
张三让李四不要嫉妒他，大家一起努力。 Zhangsan asks Lisi not to be jealous of ta, everyone makes effort together.	与李四相比，老师们更满意张三。 Teachers are satisfied with Zhangsan more than Lisi.	张三的朋友比李四能干。 Zhangsan's friend is more competent than Lisi.