Crosslinguistic structural priming of passives in sentence comprehension: Evidence from Chinese proficient EFL learners



Yingshang Gong, MSc Candidate
Department of Education and Kellogg College
University of Oxford

Supervisor: Dr. Faidra Faitaki

Word Count: 18,148

Thesis submitted in partial fulfilment of the requirements for the Degree of
Master of Science in Applied Linguistics and Second Language Acquisition

August 2023

Acknowledgements

The completion of this thesis would not have been possible without the help of numerous individuals and organisations. First, I would like to extend sincere gratitude to my thesis supervisor, Dr. Faidra Faitaki, for her meticulous guidance and invaluable insights throughout this research journey. I genuinely appreciate her patience and kindness, in project supervision, coursework teaching, and in everyday life. Her detailed comments have always given me fresh inspirations, and her constant encouragement has boosted my self-confidence. I am also grateful to Kellogg College for the research grant, which allowed me to focus on this project without additional financial burden.

My deep gratitude also goes to my undergraduate supervisor, who has provided me with considerable support for academic writing. It is her enthusiasm for research that has motivated me to pursue this master's degree in the UK.

In addition, I would like to thank all the ALSLA teachers at the University of Oxford, as well as the teachers in the Department of Foreign Languages and Literature at my undergraduate university. Their courses and assistance have been of significant help to me.

Meanwhile, I am much obliged to my fellow classmates, my new friends in Oxford, and my old friends in Shanghai. Thank you all for your encouragement during the past ten months.

Finally, I am indebted to my parents for their unwavering love and support.

Table of Contents

ACKNOWLEDGEMENTS **2**

ABSTRACT **7**

LIST OF TABLES **8**

LIST OF FIGURES **9**

1. INTRODUCTION **10**

2. LITERATURE REVIEW **13**

2.1. Understanding crosslinguistic structural priming **13**

2.1.1. Explaining structural priming 13

2.1.2. Theoretical underpinnings of crosslinguistic structural priming 14

2.1.2.1. The residual activation account 14

2.1.2.2. The implicit learning account 17

2.1.2.3. Comparing residual activation and implicit learning accounts 18

2.2. Investigating crosslinguistic structural priming **19**

2.2.1. The passive construction 19

2.2.1.1. Word order 20

2.2.1.2. Frequency 21

2.2.2. Structural priming in sentence comprehension 22

2.2.2.1. The processing of garden-path sentences 22

2.2.2.2. Experiment paradigms 25

2.2.3. Potential factors of crosslinguistic structural priming 27

2.2.3.1. L2 proficiency 28

2.2.3.2. Language direction 28

2.2.3.3. Frequency 29

2.2.3.4. Word order 29

2.2.3.5. Lexical repetition 31

2.3. Research motivation and significance 31

2.4. Research questions and predictions 32

3. METHODOLOGY 34

3.1. Experiment design 34

3.2. Participants 38

3.2.1. Participant recruitment 38

3.2.2. English proficiency level 39

3.2.3. Demographic information and language background 41

3.3. Materials 43

3.4. Procedures 45

3.5. Preparations for data analysis 46

4. RESULTS 47

4.1. Chinese to English (L1-L2) priming 47

4.1.1. Responses to comprehension questions 47

4.1.2. Reading times for sentences 48

4.1.2.1. Reading times for fillers and primes 48

4.1.2.2. Reading times for targets 49

4.1.2.3. Potential factors explaining the observed differences 51

4.2. English to Chinese (L2-L1) priming 54

4.2.1. Responses to comprehension questions 54

4.2.2. Reading times for sentences 55

4.2.2.1. Reading times for fillers and primes 55

4.2.2.2. Reading times for targets 56

5. DISCUSSION 59

5.1. L1-L2 priming in sentence comprehension 59

5.2. L2-L1 priming in sentence comprehension 62

5.3. Language direction effects in crosslinguistic structural priming 64

5.4. Pedagogical implications 66

5.5. Limitations and future directions 67

6. CONCLUSION 70

REFERENCES 72

APPENDICES 87

Appendix A. Power analysis 87

Appendix B. Recruitment flyer 88

Appendix C. Post-test questionnaire 89

Appendix D. Experiment materials 91

Appendix E. CUREC approval for the study 101

Appendix F. Participant information sheet and consent form 103

Appendix G. Outliers in reading times for fillers and primes 105

Appendix H. Outliers in reading times for targets per L1-L2 experiment group 107

Appendix I. Descriptives of RTs for targets per L1-L2 experiment group, F-test results for equal variances, and independent samples t-test results comparing the groups' RTs per sentence region, by sentences and on average. 124

Appendix J. Regression results concerning the effects of experiment group and mean RT for fillers on mean RTs for target regions (1), (2), and (4) for L1-L2 experiment groups.. 128

Appendix K. Outliers in reading times for targets per L2-L1 experiment group 131

Appendix L. Descriptives of RTs for targets per L2-L1 experiment group, F-test results for equal variances, and independent samples t-test results comparing the groups' RTs per sentence region, by sentences and on average. 148

Abstract

Crosslinguistic structural priming occurs when prior experience with a linguistic structure in one language facilitates the production and/or comprehension of similar structures in another language. This psycholinguistic phenomenon has been intensely investigated in bilinguals, but most research centres on the processes involved in language production. As such, crosslinguistic structural priming in language comprehension remains largely understudied, and there are considerable theoretical uncertainties over the mechanisms of bilingual structural representation and sentence processing during priming. Moreover, it is unclear how crosslinguistic priming interacts with language directions (L1 to L2 and L2 to L1). To address these gaps, this research project aims to examine and compare crosslinguistic structural priming effects across both language directions in Chinese EFL learners' sentence comprehension, focusing on the passive constructions that pose learning challenges for Chinese-English bilinguals.

Utilising a non-cumulative self-paced reading experimental paradigm, this study investigated whether reading passive relative clauses (RCs) in one language (L1/L2) would accelerate the subsequent processing of garden-path target sentences in the other language (L2/L1). The garden-path targets were temporarily ambiguous between past-tense active structures (initial interpretation) and reduced passive RCs (correct interpretation). Participants were adult Mandarin Chinese speakers with upper-intermediate to advanced English proficiency, who were randomly assigned into four experimental groups: L1-L2 prime group, L1-L2 no-prime group, L2-L1 prime group, and L2-L1 no-prime group. Participants' reading time for target sentences were compared between prime and no-prime groups, and across language directions.

The results indicated crosslinguistic structural priming from L1 to L2, and there were effects of whole language activation (activation of the entire target language during priming). L2 to L1 priming was not observed. The L1-L2 priming provided evidence for the residual activation account of structural priming, and/or an implicit learning account. The absence of L2-L1 priming might be attributed to the weak priming magnitude and the potential priming from L2 actives to L1 passive RCs. The different priming magnitude between the two directions corroborated the inverse frequency effect as suggested by the implicit learning account. Overall, the findings supported a shared-syntax mechanism of structural representation in proficient bilinguals, as well as a two-stage account of syntactic processing in sentence comprehension.

List of Tables

Table 1. Sentence types for each trial in the four experiment conditions. 35
Table 2. Example sentences for each sentence type. 36
Table 3. Relationship between L2 English proficiency levels and LexTALE scores. 40
Table 4. Descriptives of LexTALE scores of the selected participants. 41
Table 5. Participants' profile. 42
Table 6. Participants' English language background. 43
Table 7. Descriptives of mean RT for fillers per L1-L2 experiment group, with independent samples t-test results comparing the groups. 49
Table 8. Descriptives of mean RT for primes per L1-L2 experiment group, with independent samples t-test results comparing the groups. 49
Table 9. Descriptives of mean RTs per target region for L1-L2 experiment groups, F-test results for equal variances, and independent samples t-test results comparing the groups. 50
Table 10. Correlations between mean RT for each of the five target regions, mean RT for fillers, and LexTALE scores for participants in L1-L2 experiment groups. 52
Table 11. Nonparametric correlations between correct rate of comprehension question responses and LexTALE score, mean RT for fillers, and mean RT for each of the five target regions for participants in L1-L2 experiment groups. 52
Table 12. Regression ANOVA table on the effects of experiment group and mean RT for fillers on mean RT for target region (3) for L1-L2 experiment groups. 53
Table 13. Regression ANOVA table on the effects of experiment group, LexTALE score, and mean RT for fillers on mean RT for target region (5) for L1-L2 experiment groups. 54
Table 14. Descriptives of mean RT for fillers per L2-L1 experiment group, with independent samples t-test results comparing the groups. 56
Table 15. Descriptives of mean RT for primes per L2-L1 experiment group, with independent samples t-test results comparing the groups. 56
Table 16. Descriptives of mean RTs per target region for L2-L1 experiment groups, F-test results for equal variances, and independent samples t-test results comparing the groups. 57

List of Figures

Figure 1. The multilingual processing model. 16
Figure 2. The garden-path model of syntactic parsing..... 24
Figure 3. An illustration of non-cumulative self-paced sentence reading. 27
Figure 4. Regions of English and Chinese target sentences. 44
Figure 5. Mean correct rate of comprehension question responses for L1-L2 experiment groups. 48
Figure 6. Clustered bar of mean RTs for targets by sentence region per L1-L2 experiment group. 51
Figure 7. Mean correct rate of comprehension question responses for L2-L1 experiment groups. 55
Figure 8. Clustered bar of mean RTs for targets by sentence region per L2-L1 experiment group. 58

1. Introduction

Structural priming is a psycholinguistic phenomenon in which prior exposure to a syntactic structure facilitates the subsequent production and/or comprehension of similar structures (Bock, 1986; Pickering & Ferreira, 2008). Structural priming leads language speakers to unconsciously reproduce the structures they have encountered in previous discourse, despite their freedom to opt for alternative structures (e.g., Bock & Loebell, 1990; Bock et al., 1992; Pickering & Branigan, 1998; Scheepers & Crocker, 2004; Tannen, 1987; Weiner & Labov, 1983). For instance, if language users have heard a sentence like *The man brought his wife some flowers*, they tend to describe a transfer event in subsequent utterances using the same structure, such as *The professor sent me an email*, instead of using the alternative structure as in *The professor sent an email to me*. Structural priming happens not only within a single language, but also between languages; structures of one language can prime similar structures of another language, irrespective of their meaning. The cross-language occurrence of structural priming is commonly referred to as 'crosslinguistic structural priming', and has been a topic of interest in bilingual processing and second language (L2) development.

Crosslinguistic structural priming is subject to various theoretical interpretations. These include 'residual activation' of shared abstract structures between languages (Hartsuiker et al., 2004; Schoonbaert et al., 2007), 'implicit learning' of structural relationships (Loebell & Bock, 2003; Shin, 2008), or a combination of the two (Chen et al., 2023). Therefore, priming is not only a language phenomenon that is worthy of investigation per se, but can also serve as an experimental tool to probe into mental representations of bilingual structures (Hartsuiker et al., 2004; Messenger, 2022), as well as mechanisms of L2 learning and processing (Chang et al., 2006; Trofimovich & McDonough, 2011). Over the past two decades, crosslinguistic structural priming has been intensely investigated across different language pairs and syntactic structures (e.g., passives, datives, transitives, genetives) (see Chen et al., 2023; Kotzochampou & Chondrogianni, 2022). However, compared to the substantial evidence of crosslinguistic structural priming during language production (Bernolet et al., 2007; Cai et al., 2011; Chen et al., 2013; Desmet & Declercq, 2006; Hsin et al., 2013; Huang et al., 2019; Shin & Christianson, 2009), priming effects in language comprehension are largely understudied. It is still unclear whether the levels of structural representation and language processing mechanisms for sentence production could apply equally to sentence comprehension during structural priming (Phillips, 2018; Tooley & Traxler, 2010).

For Chinese learners of English as a Foreign Language (hereafter EFL), passive constructions deserve particular attention. The Chinese passive construction is relatively infrequent and differs in word order from English passives, which renders it difficult for Chinese speakers to acquire and process the English passive construction (Chang & Wang, 2013, 2016). Studies on crosslinguistic priming of Chinese and English passives could provide insights into how these structures are stored and represented in the mind of Chinese EFL learners. Previous research has suggested that Chinese and English passives are shared in the bilingual mind in spite of word order differences, and could be primed crosslinguistically during both sentence production and comprehension (Chen et al., 2013; Hsieh, 2017). Hsieh (2017), the only prior study on Chinese-English crosslinguistic priming of passives during sentence comprehension, has confirmed the existence of L1 to L2 priming. Yet, little is known about L2 to L1 priming of these structures in the sentence comprehension domain.

To further explore crosslinguistic structural priming of Chinese/English passives in sentence comprehension, the present research attempts to replicate Hsieh (2017)'s findings, and to extend her study by investigating priming effects in both language directions (L1 to L2 and L2 to L1). Language direction is of interest because structural priming probably occurs with different magnitude in different directions (Bernolet et al., 2013; Schoonbaert et al., 2007). Specifically, structural priming in this study is operationalised through 'garden-path' sentences with a reduced relative clause (RC), such as *The company boss interviewed by the reporter answered a few questions*. These sentences are characterized by temporary structural ambiguities that initially mislead language users to adopt a certain interpretation (i.e., past-tense active structure) before they ultimately arrive at the correct interpretation (i.e., reduced passive RC) (see Bever, 1970; Trueswell & Tanenhaus, 1991). If priming of passives occurs crosslinguistically during sentence comprehension, prior reading of passives in the prime language would promote the (correct) passive interpretation of these garden-path sentences in the target language, and language users would presumably spend less time processing the garden-path sentences (Pickering & Ferreira, 2008; Traxler & Tooley, 2008). Regarding the participants of the priming experiment, the present study focuses on Chinese EFL learners with upper-intermediate to advanced L2 proficiency. This decision was motivated by the observation that priming effects are more likely observed in proficient bilinguals than in beginner/intermediate L2 learners (Hartsuiker & Bernolet, 2017).

This chapter has captured the background and aims of the research. The remaining chapters of the thesis are structured as follows. Chapter 2 reviews key issues in the theoretical underpinnings

and empirical investigations of crosslinguistic structural priming, and then explains the research significance, questions and predictions. Chapter 3 outlines the research method, including descriptions of the experiment design, participants, materials, procedures, and preparations for data analysis. Chapter 4 presents the results of the experiment. Chapter 5 discusses the results in relation to previous literature and theoretical accounts, and offers suggestions for language pedagogy and future research. Finally, Chapter 6 summarises the findings and implications of the research.

2. Literature Review

This chapter begins with an overview of crosslinguistic structural priming and its theoretical foundations. It then reviews key considerations in investigating crosslinguistic structural priming, including the type of structure (passives), ways to operationalise priming within sentence comprehension, and factors that might moderate priming effects. Afterwards, research motivation and significance are explained, followed by research questions and predictions.

2.1. Understanding crosslinguistic structural priming

2.1.1. Explaining structural priming

To understand crosslinguistic structural priming, it is necessary to first delineate the scope of structural priming. Structural priming should be differentiated from syntactic priming. While the latter term refers to any facilitative effect of the syntactic context (including lexical facilitation) on language processing (e.g., Deutsch & Bentin, 1994; Wright & Garrett, 1984), the former term is confined to the priming of abstract linguistic structures (Pickering & Ferreira, 2008). Since this research project does not touch on lexical effects in priming, the term 'structural priming' will be adopted throughout.

Structural priming was first discovered as a naturally-occurring phenomenon: the tendency to repeat structures unconsciously in everyday conversations (e.g., Kempen, 1977; Tannen, 1987; Weiner & Labov, 1983). Later, controlled experiments were conducted. In a groundbreaking study on monolingual structural priming, Bock (1986) designed a picture-describing task in which participants switched between repeating prime sentences and describing pictures. The findings suggested that those who repeated active (cf. passive) primes were more likely to produce active sentences in picture descriptions, and vice versa. The same effects were observed for sentences with prepositional-object datives (e.g., *He gave a book to his brother*) or double-object datives (e.g., *He gave his brother a book*). The results indicated that structural priming could occur independently of discourse content or communicative intentions. Since then, numerous studies have examined structural priming for different constructions and languages, in adults, children, bilinguals, aphasics or amnesiacs (see Pickering & Ferreira, 2008).

Investigations on crosslinguistic structural priming emerged with the seminal study by Loebell and Bock (2003), which was the first to demonstrate that structural priming could occur crosslinguistically. The authors analysed the language production of 48 adult German-English

fluent bilinguals, using an experiment adapted from Bock (1986). The difference was that the sentences that participants repeated and produced were in different languages. They found that repeating prepositional-object structures in one language primed the subsequent use of prepositional-object structures in the other, and the same was the case for double-object structures. The succeeding decades have witnessed an upsurge of experiments on crosslinguistic structural priming, covering a range of linguistic constructions and language pairs (e.g., Bernolet et al., 2007; Cai et al., 2011; Chen et al., 2013; Chen et al., 2023; Desmet & Declercq, 2006; Hartsuiker et al., 2004; Hsieh, 2017; Hsin et al., 2013; Huang et al., 2019; Kotzochampou & Chondrogianni, 2022; Shin & Christianson, 2009). Most of these studies, however, focus on language production (but cf. Chen et al., 2023; Hsieh, 2017). The investigation of crosslinguistic structural priming during sentence comprehension has been relatively limited, probably because priming effects in comprehension are quite elusive and could only be measured by sensitive methods (e.g., eye-tracking) (Pickering & Ferreira, 2008).

2.1.2. Theoretical underpinnings of crosslinguistic structural priming

The occurrence of crosslinguistic structural priming is subject to two different theoretical interpretations. These theoretical accounts are explained below.

2.1.2.1. The residual activation account

Structural priming can be viewed as the residual activation of shared structures between languages. Residual activation is defined as the transient activation of recently-processed structures. This process has been observed in monolingual structural priming experiments (e.g, Branigan et al., 1999; Pickering & Branigan, 1998) and verified by simulation models of language processing (e.g., Dell, 1986). In crosslinguistic structural priming, the residual activation account is in line with the idea that abstract structures are shared between languages – otherwise known as the 'shared syntax' hypothesis (Hartsuiker et al., 2004). Before elaborating on how crosslinguistic structural priming would provide evidence for shared syntax, it is essential to illustrate de Bot (2004)'s multilingual processing model[1], which explains language processing procedures in the bilingual mind.

As represented in Figure 1, this model presumes the presence of three information stores:

[1] Although referred to as the "multilingual" processing model, it applies to bilingual processing as well. A further note is that this model is geared towards bi/multilingual production, but the underlying mechanism of bi/multilingual structural representation also works for language comprehension (see de Bot, 2004).

lexical concepts, syntactic procedures, and form elements (syllables/sounds/gestures). Each of these stores contains overlapping language-specific subsets, reflecting the shared components (combinatorial nodes) between the languages acquired by a bi/multilingual. Accessing information within each store is a non-selective process, during which subsets of different languages compete for activation. Information from the overlap tends to coactivate subsets of relevant languages, which allows sharing linguistic representations across languages. Additionally, an external language node controls the entire processing. When information from a particular language is activated, it is relayed to the language node, which then activates all relevant information stores of that language. This process is termed as 'whole-language activation' in the present study[2]. Bi/multilingual processing starts when one's communicative intention to use a certain language informs lexical concepts, as well as the language node. The following syntactic procedures are influenced by both lexical concepts and the language node. Likewise, form elements are shaped by information from previous stages and the language node as well.

[2] This is the term that I use to capture the language activation process initiated by the external language node. Although de Bot (2004) did not use the term, his model implicates such a process.

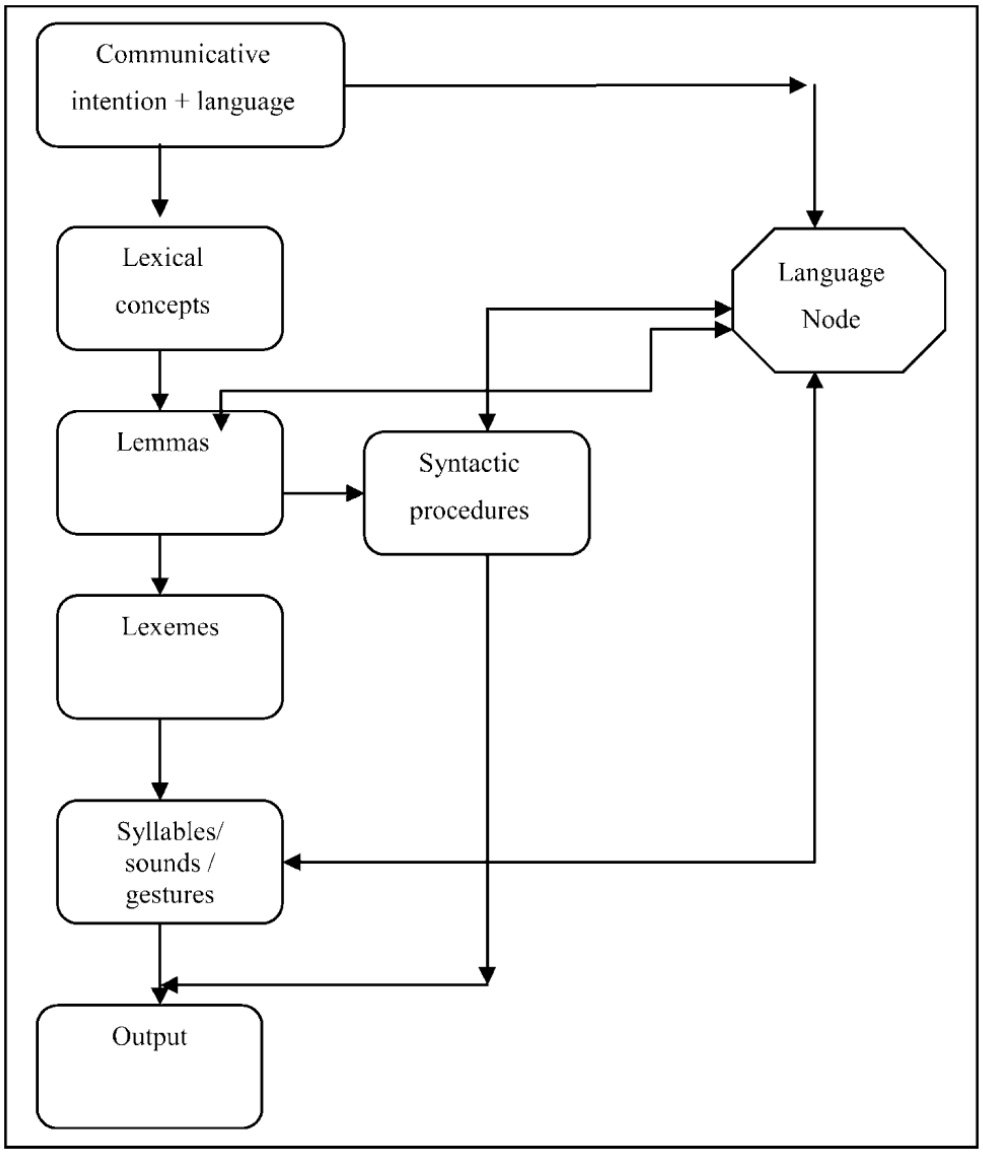


Figure 1. The multilingual processing model.

Source: de Bot (2004, p. 29)

During bi/multilingual syntactic processing, abstract structures which are shared between languages would trigger the combinatorial nodes that coactivate the subsets of these languages, meanwhile informing the language node. This can happen between languages with a large linguistic distance (cf. de Bot, 1992), such as Chinese and English. For example, if the mental representation of the passive construction is shared between Chinese and English, processing a Chinese passive structure would activate the English passive structure in the mind of Chinese-

English bilinguals. When the information is relayed to the language node system, not only Chinese but also English would be activated as a whole language, which might exert further influence on processing the lexical, syntactic, and form-related elements of that language. Therefore, processing a Chinese passive structure would facilitate the processing of English passives, and even the English language as a whole, giving rise to crosslinguistic structural priming.

Noteworthily, de Bot (2004)'s multilingual processing model is premised on the *speculation* of shared syntax, as it was formulated in the absence of relevant empirical evidence[3]. Among the ensuing proliferation of studies on crosslinguistic structural priming, Hartsuiker et al. (2004) was the first to attribute the observed priming effects to shared syntax. It was a theory-driven study that tested the shared syntax account using a dialogue task (see Branigan et al., 2000). Participants were 24 adult Spanish-English bilinguals with moderate to high L2 proficiency. They heard prime sentences in their L1 (Spanish) and then described pictures in their L2 (English). Results showed that hearing passive sentences in Spanish primed their production in English. Hartsuiker et al (2004) proposed that shared syntactic structures were linked to relevant languages by combinatorial nodes. They also predicted that crosslinguistic syntactic priming would be enhanced by the presence of a shared lexicon between languages, which is subject to discussion (see Section 2.2.3.5). More experimental evidence is needed to confirm the shared syntax hypothesis.

As for whole-language activation, it is uncertain whether it indeed exists in crosslinguistic structural priming. Cai et al. (2011), for example, found that within-language structural priming was stronger than between-language priming in language production. They interpreted the result in relation to the external language node, arguing that it might only boost within-language priming by activating the entire language, but not between-language priming. Thus, it would be meaningful to explore whether whole-language activation occurs in crosslinguistic priming.

2.1.2.2. The implicit learning account

The other account of structural priming is implicit learning, a fundamental mechanism of human cognition that also underlies language learning (Ellis, 1993; Michas & Berry, 1994; Perruchet, 2008; Williams & Rebuschat, 2012). Implicit learning presupposes that knowledge acquisition takes place automatically (unintentionally) without awareness of the learning process (Ellis, 1994;

[3] De Bot (2004) claimed that "there seems to be no research on cross-linguistic syntactic priming" (p.26). The first study on crosslinguistic structural priming was published by Loebell and Bock in 2003, which might not have been accessible when de Bot (2004) completed his article.

Paradis, 2004; Schmidt, 1990; Stadler & Frensch, 1998), and that the knowledge acquired is inaccessible to explicit memory and cannot be consciously verbalised by learners (Dienes & Berry, 1997; Seger, 1994; Seger, 1998). The implicit learning account would, then, suggest that structural priming occurs due to unintentional procedural learning of language structures, during which psycholinguistic processing operations are implicitly fine-tuned by one's prior language experience (Bock & Griffin, 2000; Chang et al., 2000; Trofimovich & McDonough, 2011).

To specify, this process might be similar to statistical learning (or connectionism), which views learning as a bottom-up process of tracking reoccurring, consistent relationships between features in the input, and extracting appropriate patterns from the probabilistic information (Elman, 1996; Gómez, 2007; Saffran, 2003; Wonnacott, 2013). For example, to process a passive sentence, the language user should learn to map a meaning relationship (i.e., the agent-patient relationship) onto the form elements of the passive structure. Such meaning-form mappings would be strengthened by repeated and consistent occurrences of passives in the language input, thereby making it more likely to understand/produce the same meaning relationship through the passive form. The strengthened mapping is manifested as structural priming (e.g., Chang, 2002; Chang et al., 2006).

More specifically, the implicit learning account explains structural priming with regard to error-based learning (see Chang et al., 2006). 'Error' here refers to prediction error, the case where upcoming words in a sentence fail to fulfil the language user's predictions (or preferences). When prediction errors accumulate during sentence processing, the connection weights attached to the aforementioned meaning-form mappings would be changed, which leads to structural priming. Higher prediction errors would result in larger changes in connection weights, and accordingly, stronger priming effects. This is known as the 'inverse preference' (or 'inverse frequency') effect of structural priming: less frequent structures, which have less familiar distributional properties in the input and consequently have higher prediction errors, tend to yield greater priming effects (Ferreira & Bock, 2006).

2.1.2.3. Comparing residual activation and implicit learning accounts

Contrary to the transience of priming predicted by the residual activation account, the implicit learning account posits longer-term cumulative priming (Jaeger & Snider, 2008). Weight changes initiated by each sentence would persist until accurate predictions could be made. However, evidence on the durability of priming is mixed. While some studies have demonstrated long-lasting

priming (e.g., Bock & Griffin, 2000; Garraffa et al., 2018; Messenger, 2021; Pickering et al., 2013), others point to the rapid decay of priming over time, especially over intervening trials (e.g., Branigan et al., 1999; Levelt & Kelter, 1982; Wheeldon & Smith, 2003). There is also evidence of short-lived structural priming in corpus-based studies (e.g., Gries, 2005; Szmrecsanyi, 2005). Short-lived structural priming is often accompanied by lexical repetition between primes and targets, whereas long-lived structural priming could occur without lexical repetition (see Pickering & Ferreira, 2008). Such a difference might correspond with the different accounts of crosslinguistic structural priming: the residual activation account predicts transient priming and is possibly enhanced by lexical repetition through shared syntax; the implicit learning account predicts durable priming and is independent of lexical effects.

To sum up, there are uncertainties regarding both theoretical accounts of crosslinguistic structural priming, and empirical research has not yielded definite conclusions. Importantly, the two accounts are not entirely incompatible: the implicit learning account may also presume a shared syntax mechanism (see Chen et al., 2023). As research evidence to date has generally confirmed a shared representation of similar structures between languages in the bilingual mind (see Kotzochampou & Chondrogianni, 2022), crosslinguistic priming for a certain structure would likely reveal the shared representation of this structure between these languages, whether priming is a resultant of residual activation, implicit learning, or both.

2.2. Investigating crosslinguistic structural priming

2.2.1. The passive construction

Passive is a grammatical voice as opposed to active. In an active construction, the grammatical subject adopts the thematic role of an agent (one that initiates an action); in a passive construction, the subject denotes the patient (target recipient of an action) (Jackendoff, 1990). The passive construction is among the most-studied constructions in structural priming experiments. A passive construction could be classified as a notional passive or a syntactic passive. The former refers to a sentence unmarked by the passive form (voice), yet inexplicitly expressing a passive meaning, such as *The book sells well* (e.g., Jiao & Dou, 2002; Lian, 1993). The latter involves an explicit syntactic marker of passives (e.g., the preposition *by*, the participle *-ed*), and constitutes the standard definition of a passive construction (e.g., Dixon, 1994). Since structural priming research requires the explicitness of syntactic structures, the passive construction is normally equated with

the syntactic passive.

Researchers have investigated the priming of passives both within languages (e.g., Bock, 1986; 1989 for English; Chang et al., 2015 for German; Gámez & Shimpi, 2016 for Spanish; Vasilyeva & Waterfall, 2012 for Russian) and between languages (e.g., Chen et al., 2013 for Mandarin Chinese and English; Fleischer et al., 2012 for Polish and English; Hartsuiker et al., 2004 for Spanish and English; Kotzochampou & Chondrogianni, 2022 for Greek and English; Loebell & Bock, 2003 for German and English). For bilingual speakers of Mandarin Chinese and English, the passive construction is of particular concern because of two reasons: differences in word order and frequency.

2.2.1.1. Word order

When expressing agent-patient thematic relations, Chinese and English active sentences share the same word order of SVO (subject-verb-object) (e.g., Wu, 2006), as in sentences (1) and (2). Chinese and English passives (sentences (3) and (4)), however, differ in word order (see Chen et al., 2013). In an English passive sentence, the patient (e.g., *mouse*) is followed by the verb, and then the *by*-phrase that contains the agent (e.g., *cat*) at the end of the sentence. In a Chinese passive sentence, the patient is followed by the passive marker *bei*, and then the agent, which precedes the verb. The order of verb and agent is different in Chinese and English.

(1) The cat chased the mouse. (English active)

(2) 猫咪 追赶 了 老鼠。(Chinese active)
Māomī zhuīgǎn le lǎoshǔ.
Cat chase PST mouse.[4]
"The cat chased the mouse"

(3) The mouse was chased by the cat. (English passive)

(4) 老鼠 被 猫咪 追赶 了。(Chinese passive)
Lǎoshǔ *bèi* māomī zhuīgǎn le.
Mouse PASS cat chase PST.
"The mouse was chased by the cat."

[4] In this thesis, Chinese sentences are glossed following the Leipzig Glossing Rules (Comrie et al., 2008/2015). The standard abbreviations used include: PST (past), PASS (passive), REL (relative), and AUX (auxiliary).

The situation is more complex when the passive construction appears in a relative clause (RC). An English sentence with passive RC (sentence (5)) begins with the patient, followed by the passive RC and the main clause. In the RC structure (highlighted in bold), the relative marker (e.g., *that, which*) appears before the verb, which precedes *by* and the agent. In a Chinese passive RC (highlighted in bold in sentence (6)), the passive marker *bei* is at the beginning, followed successively by the agent, the verb, the RC marker *de*, and the patient. The order of agent and patient is completely opposite in Chinese and English passive RCs (see Hsieh, 2017).

(5) **The mouse that was chased by the cat** went away. (English passive RC)

(6) **被　猫咪　追赶　的　老鼠** 逃跑 了。(Chinese passive RC)

Bèi māomī zhuīgǎn *de* lǎoshǔ táopǎo le.

PASS cat chase REL mouse flee PST.

"The mouse that was chased by the cat went away."

It should be noted that the passive word order is the same in English passive simple sentences and English passive RCs, but different between Chinese passive simple sentences and Chinese passive RCs. In a Chinese passive RC, the patient (which appears at the beginning of Chinese passive simple sentences) is moved to the end of the RC, and serves as the subject of the main clause. Coincidentally, the passive word order is the same in English/Chinese active simple sentences and Chinese passive RCs, despite their difference in grammatical voice. These similarities and differences in word order might influence, or even determine, the effects of structural priming (see Section 2.2.3.4).

2.2.1.2. Frequency

In terms of frequency levels, the syntactic passive construction is used more frequently in English than in Chinese—a well-documented fact in contrastive studies of the two languages (e.g., Deng & Huang, 2014; Lian, 1993; Zeng, 1994). The difference should be viewed from a historical perspective. Classical/literary Chinese (the Chinese written language before the early 20th century) was almost devoid of syntactic passives[5]; the agent-patient relations were normally expressed

[5] There is controversy over the absence of syntactic passives in classical Chinese (see Xu, 2004, for a discussion). Among those who argue for the presence of such passives, it is agreed that passives in classical Chinese were infrequent, usually conveying negative connotations, thus being very different from passives in modern Chinese (see He, 2008).

through actives or notional passives (Lian, 1993; Xu, 2004; Zhu, 1987). Against the backdrop of unprecedented socio-political turbulence in the 1910s and 1920s, written vernacular Chinese (the basis of modern written Chinese) was promoted by the New Culture Movement that aimed at fighting the backwardness and ignorance of the Chinese spirit at that time (e.g., Button, 2009; DeFrancis, 1984; Larson, 2009). This was when Chinese intellectuals started appealing for the 'Europeanization' of Chinese grammar by assimilating the more rigorous, precise, and structured grammar of European languages (e.g., Fu, 1919; Hu, 1917; Lu, 1934/1981). 'European languages' mostly referred to English, owing to its pervasiveness as a contact language (e.g., Kachru, 1986, 1994). The English syntactic passive construction was thus introduced into Chinese as the *bei* construction, similar to the English *by* construction (see He, 2008; Wang, 1958/1980).

The overall frequency of Chinese syntactic passives has gradually increased since then (Hsu, 1994; Yu, 1987), but is still far lower than English syntactic passives. Xiao et al. (2006), a corpus-based study, analysed the frequency of passive constructions in the corpora of British English (British National Corpus) and Mandarin Chinese (CALLHOME Mandarin Chinese Transcripts), and found that English passives were roughly 10 times as frequent as Chinese ones in the corpora. Later corpus-based contrastive studies of Chinese and English have confirmed the pattern that passives appear more frequently in English than in Chinese (e.g., Xiao, 2015). Therefore, according to the inverse frequency effect (see Section 2.1.2.2), Chinese passives might induce greater priming effects as compared with English passives.

On account of these differences in word order and frequency, the English passive construction often causes learning difficulties for Chinese learners of English (Chang & Wang, 2013, 2016). It is therefore meaningful to explore how Chinese EFL learners process Chinese and English passive structures, using the technique of crosslinguistic structural priming.

2.2.2. Structural priming in sentence comprehension

Structural priming could reflect the online processing during sentence comprehension, but under what circumstances might structural priming occur within sentence comprehension? One particular circumstance is when processing temporary (local) structural ambiguities in garden-path sentences (Pickering & Ferreira, 2008; Traxler & Tooley, 2008).

2.2.2.1. The processing of garden-path sentences

A typical type of garden-path sentence is the sentence with a reduced relative clause (see Bever,

1970). For example, the passive RCs in sentence (5) (*The mouse that was chased by the cat went away*) and sentence (6) (*Bèi māomī zhuīgǎn de lǎoshǔ táopǎo le,* "The mouse that was chased by the cat went away") could be reduced by the removal of certain passive markers: *that* and *was* in sentence (5), and *bei* in sentence (6). The reduced passive RCs are seen in sentences (7) and (8).

(7) **The mouse chased by the cat** went away. (English reduced passive RC)

(8) 猫咪 追赶 的 老鼠 逃跑 了。(Chinese reduced passive RC)

Māomī zhuīgǎn *de* lǎoshǔ táopǎo le.

Cat chase REL mouse flee PST.

"The mouse that was chased by the cat went away."

Both sentences are temporarily ambiguous between an active and passive interpretation of the first few words of the sentences. The ambiguities lie in syntactic parsing, the mental process of organising words into hierarchical structures (Traxler, 2012). In sentence (7), the verb *chased* might be temporarily treated as a past-tense main verb of an active structure. But after encountering the *by*-phrase, language users would be clear that *chased* is a past participle in a reduced passive RC. That is, the sentence is disambiguated at the *by*-phrase region. In sentence (8), *māomī zhuīgǎn* ("cat chase") might be initially processed as an active structure, with *māomī* ("cat") being the subject of the main sentence. The sentence would then be disambiguated at the *de*-phrase region, which indicates that *māomī zhuīgǎn* is part of a reduced passive RC, with its patient *lǎoshǔ* ("mouse") being the subject of the main clause. The processing of these sentences is captured by the garden-path model (two-stage model) of syntactic parsing (Frazier, 1987), as depicted in Figure 2.

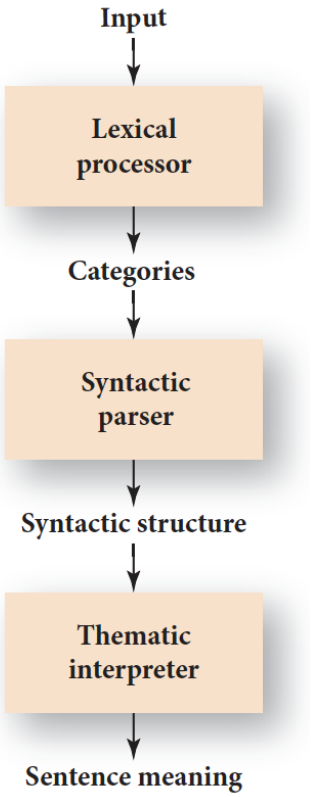


Figure 2. The garden-path model of syntactic parsing.

Source: (Traxler, 2012, p. 148)

This model regards syntactic parsing of garden-path sentences as a two-stage process. In the first stage, a lexical processor identifies and categorises words in the input. The sequence of word categories goes through the syntactic parser, formulating a syntactic structure. In the second stage, the thematic interpreter assigns thematic roles (e.g., agent/patient) to elements in the syntactic structure, and produces a sentence meaning. The second stage starts before the completion of the first stage: both the syntactic parser and thematic interpreter begin operating on a word-by-word basis, once information of categories is derived from the lexical processor. In addition, the model assumes principles of "minimal attachment" (formulating structures with the fewest elements) and "late closure" (adhering to the same structure until an alternative structure is necessary). Under these principles, the language user would first go down the garden path, build a structure with the fewest words possible, and arrive at a sentence meaning (i.e., preferred interpretation). Then, as incoming words from the disambiguating region necessitate an alternative syntactic structure, the correct structure would be built, with thematic roles reassigned (i.e., revised interpretation).

Such temporary structural ambiguities constitute the difficulty of parsing and understanding garden-path sentences (e.g., Altmann, 1998; Ferreira, 2003; Trueswell et al., 1993), especially for L2 learners (Yang & Shih, 2013). However, the difficulty could be reduced if language users have been primed with structures similar to those in the revised interpretation (e.g., Carey et al., 1970; Cuetos et al., 1996). For instance, since sentences (7) and (8) are temporarily ambiguous between an active main clause (preferred interpretation) and a reduced passive RC (revised interpretation), prior exposure to passive RCs (cf. active structures) may prime one's correct interpretation of the garden-path sentences as those involving passive RCs. Structural priming in sentence comprehension can be operationalised in this way.

2.2.2.2. Experiment paradigms

The previous section explained the role of garden-path sentences in exploring structural priming during sentence comprehension. But by what means can the priming effects be tested? Some of the experiment paradigms that have been used in the literature are discussed below.

One noteworthy paradigm is the visual-world eye-tracking paradigm (Arai et al., 2007; Chen et al., 2023; Scheepers & Crocker, 2004; Thothathiri & Snedeker, 2008). In a visual-world trial, participants are presented with a visual scene that contains multiple entities, and then given a relevant auditory verbal stimulus (e.g., a garden-path sentence) while simultaneously looking at the visual scene. They are informed that the auditory sentence matches the preceding picture. Participants' eye movements are tracked, which reflects their allocation of visual attention to different entities in the scene. The presupposition underlying this paradigm is that participants anticipate the grammatical and thematic role of a forthcoming linguistic reference to an entity, and accordingly, devote visual attention to their anticipated entity in the scene before hearing the actual entity (Altmann & Kamide, 1999). By measuring the duration and probability of gaze at different visual entities during particular time-windows when the auditory stimuli are ambiguous, researchers could analyse structural priming effects in processing temporary ambiguities within target sentences. Reliably longer and more frequent gazes at the correct entity would indicate the relative ease of resolving ambiguities. Despite its benefits, the visual-world paradigm has an inherent problem: participants' predictions about the upcoming linguistic reference are not only triggered by a verbal stimulus, but also by the visual context (Huettig et al., 2011; Kamide et al., 2003). As a result, it is difficult to determine whether the observed priming is due to the linguistic structures in the previous trials, or actually because of the unintended visual clues.

An alternative paradigm is non-cumulative self-paced sentence reading (Hsieh, 2017; Just et al., 1982; Traxler & Tooley, 2008). Participants read a sentence one word at a time, at their own pace. Different from traditional cumulative self-paced reading (in which previous words are not removed), this paradigm requires non-cumulative reading: only one word remains on the screen at any time point, forcing participants to continue reading without backtracking. Figure 3 illustrates the non-cumulative self-paced reading of the sentence *The girl who was invited by her friends attended the party*; participants move on to the next time point by pressing a button. According to Just et al. (1982), the initiators of this paradigm, non-cumulative reading would more accurately indicate the time spent on processing each word, for the latter paradigm prevents the risk that participants quickly elicit chunks of words before reading them together. Moreover, they found that the paradigm closely approximated eye fixation measures (e.g., Just & Carpenter, 1980) in recording the reading time (RT) of each segment. In turn, the RT of each segment positively correlated with its processing difficulty. Therefore, this paradigm could be considered a valid one in recording RTs and inferring the processing difficulty of sentence components (Traxler & Tooley, 2008; Witzel et al., 2012).

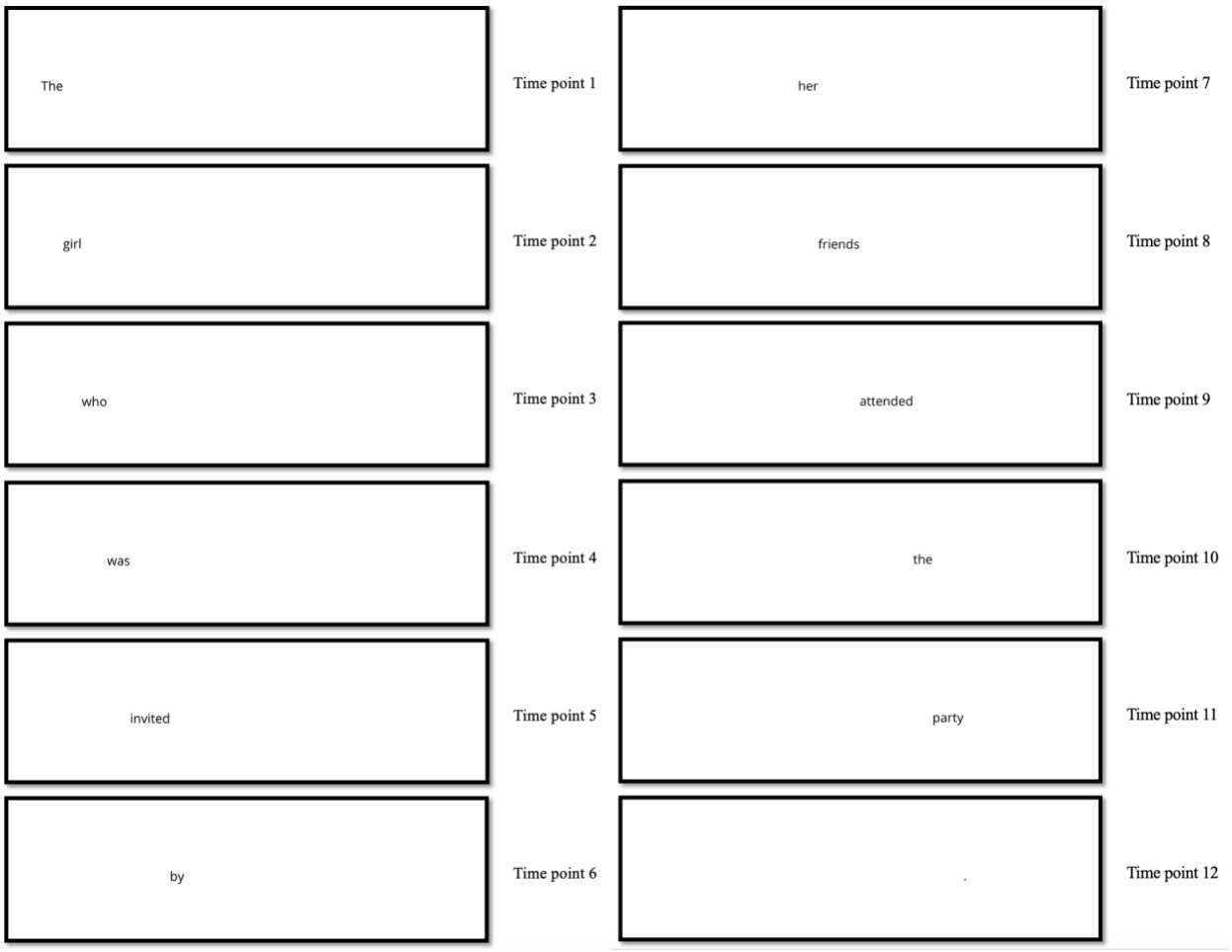


Figure 3. An illustration of non-cumulative self-paced sentence reading.

Other structural priming paradigms provide neurocognitive evidence for processing ambiguities, such as event-related potentials (ERPs) or functional magnetic resonance imaging (fMRI) (Ledoux et al., 2007; Noppeney & Price, 2004; Segaert et al., 2012). Despite being helpful in informing online language processing, these paradigms entail using extra experimental facilities, thereby increasing the cost of research.

2.2.3. Potential factors of crosslinguistic structural priming

(Crosslinguistic) structural priming is potentially influenced by a range of domain-general and language-specific factors. Domain-general factors, such as age and general cognitive abilities, are relevant to monolingual structural priming studies on child language development (see Messenger, 2021; Rowland, 2014). Specifically, conducting structural priming experiments on children

involves far more issues than experimenting with adults because of the tangled relationships between children's age, cognitive development, linguistic abilities, and other individual behavioural factors (Kidd, 2012). Given these complicated issues, it would be better to study crosslinguistic structural priming only in adults at the moment, so as to preclude the potential moderating effects of domain-general factors on priming. The language-specific factors that might affect priming in adults are discussed below.

2.2.3.1. L2 proficiency

Crosslinguistic structural priming is affected by one's relative proficiency in each language. Shin and colleagues (Shin, 2008, 2010; Shin & Christianson, 2009) conducted a series of experiments with unbalanced Korean-English bilinguals, and observed structural priming effects only in L1 to L2 priming. She attributed the findings to the participants' relatively lower proficiency in L2, suggesting that L2 to L1 priming might not occur in those with low L2 proficiency. Bernolet et al. (2013) studied L1 to L2 structural priming in Dutch-English unbalanced bilinguals with varying levels of L2 proficiency. They found an absence of priming in those with low L2 proficiency, and greater priming effects in those with higher L2 proficiency. The interaction effect between L2 proficiency and priming probably applies to both L1-L2 and L2-L1 directions (Pickering & Ferreira, 2008). Meanwhile, Bernolet et al. (2013) compared within-L2 priming and crosslinguistic priming in the same participants, and found that bilinguals with low proficiency could be primed within the L2 but not between languages.

What might account for the lack of crosslinguistic structural priming (L2-L1 and/or L1-L2) in bilinguals with lower L2 proficiency, while still observing within-L2 priming effects? One possible explanation is that only proficient bilinguals develop a shared syntax mechanism. According to Hartsuiker and Bernolet (2017)'s developmental account of shared syntax, the combinatorial nodes of structures between languages are not fully formed until L2 learners reach relatively high proficiency. Therefore, conducting crosslinguistic priming experiments on proficient bilinguals could enhance the likelihood of observing priming effects.

2.2.3.2. Language direction

Similar to L2 proficiency, language direction could also affect priming. Loebell and Bock (2003)'s seminal study on crosslinguistic structural priming detected slightly stronger priming effects in L1-L2 than L2-L1 for German-English fluent bilinguals. The authors explained that even for

proficient bilinguals, L1 would remain the dominant language that "carr[ies] more sway within the language processing system" (p. 800), hence producing enhanced activation of the shared structure. Likewise, experiments on bidirectional crosslinguistic structural priming consistently observed greater priming effects from L1 to L2 than in the other direction (Bernolet et al., 2013; Schoonbaert et al., 2007).

These effects might also be explained by de Bot (2004)'s multilingual processing model. Due to non-selective activation of multiple languages, processing a certain language requires inhibition of the other one(s), especially during language switching. Counterintuitively, though, L1 is more easily inhibited than L2: the L1 network is stronger and could be "deactivated as a whole more easily than the more loosely organised second and third languages" (p. 27). Accordingly, activating L2 would need less effort. Therefore, priming from L1 (prime language) to L2 (target language) would result in a higher activation level of the target language elements, whether it be the primed structure in target language or target language as a whole. It could thus be inferred that L1 to L2 priming might exhibit greater effects than L2 to L1 priming, both for the shared structure and for the entire target language (Hartsuiker et al., 2004).

2.2.3.3. Frequency

According to the inverse frequency effect of the implicit learning account (see Section 2.1.2.2), a structure with lower language-specific frequency would produce stronger priming. The inverse frequency effect has been consistently found in monolingual structural priming experiments (e.g., Bernolet & Hartsuiker, 2010; Fine & Jaeger, 2013; Jaeger & Snider, 2013; Scheepers, 2003). Many researchers also partly ascribe crosslinguistic structural priming effects to the usage frequency of the tested structure, calling on future researchers to consider frequency effects in priming experiments (e.g., Chen et al., 2013; Hwang & Shin, 2019; Kotzochampou & Chondrogianni, 2022; Shin & Christianson, 2009).

2.2.3.4. Word order

Another key issue in crosslinguistic priming research is word order: is word order equivalence of structures between languages a prerequisite for crosslinguistic priming? The question can be answered based on the two-stage or one-stage account of syntactic processing. In the two-stage account, syntactic processing involves a 'functional stage' for analysing hierarchical structure and assigning thematic roles, and a separate 'positional stage' for imposing word order on the

hierarchical structure (e.g., Bock & Levelt, 1994; Hartsuiker, 1999). Structures that share the same function between languages can be primed crosslinguistically even if their word order is not similar. In the one-stage account, functional and positional processing are integrated into one single stage, so that structures with distinct word order do not have shared representation between languages, and cannot be primed (e.g., Pickering et al., 2002; Ullman, 2001).

While earlier studies sided with the one-stage account, proposing that crosslinguistic priming might not occur if the tested structure had different word order in the two languages (Bernolet et al., 2007; Hartsuiker et al., 2004; Loebell & Bock, 2003), later experiments have yielded opposite findings and supported the two-stage account (Chen et al., 2013; Desmet & Declercq, 2006; Hsieh, 2017; Shin & Christianson, 2009). That is, crosslinguistic priming could occur in the absence of word order equivalence.

The word order difference of passives in Chinese and English has attracted researchers' attention. Chen et al. (2013) studied the role of word order similarity in Chinese-English and English-Chinese priming of the passive construction, and observed priming effects both from production to production and from comprehension to production despite word order differences. Hsieh (2017) explored structural priming of passives from Chinese (L1) to English (L2) in sentence comprehension. Employing a self-paced reading paradigm, the author investigated structural priming through the processing of garden-path reduced passive RCs, by asking whether prior reading of Chinese passive RCs would facilitate one's understanding of English reduced passive RCs. Participants were 54 adult Chinese EFL learners with intermediate English proficiency. Despite the word order discrepancy of passives in Chinese and English RCs, participants who had read passive RCs were found to process target sentences with less difficulty than those who had read active Chinese sentences. Their reduced difficulty was indicated by the shorter RTs that participants spent on the disambiguating region and the following region of garden-path sentences, but not on the other regions (which would suggest a whole-language activation effect). The finding proved that word order equivalence is unnecessary for Chinese-English crosslinguistic priming during sentence comprehension — one of the first pieces of evidence for the two-stage account of sentence processing in comprehension.

However, under the two-stage account, it is possible that structures with similar word order but different functions prime each other. For example, as mentioned in Section 2.2.1.1, although the passives differ in word order in English and Chinese RCs, the word order of English actives

and Chinese passive RCs are the same. Consequently, apart from the priming effect from English passive RCs to Chinese passive RCs (i.e., L2-L1 priming in this experiment), the English actives might also prime the Chinese passive RCs even though their grammatical functions differ.

2.2.3.5. Lexical repetition

A final issue concerns the role of lexical repetition: is structural (syntactic) priming enhanced through lexical repetition or independent of lexical choices? Lexical repetition refers to the repeated use of the same or a similar verb in prime and target sentences, which has been found to boost within- and between-language syntactic priming in sentence production (e.g., Cleland & Pickering, 2003; Pickering & Branigan, 1998; Salamoura & Williams, 2006), as well as comprehension (e.g., Arai et al., 2007; Tooley et al., 2019). Such lexical boost effects are congruent with the residual activation account of priming, for lexical repetition may reinforce the activation of the shared syntax between languages (Hartsuiker et al., 2004). By contrast, other studies have not detected lexical boost effects, aligning with the implicit learning account of priming. Hsieh (2017), for example, compared crosslinguistic structural priming with and without lexical repetition, and found equally-robust priming effects in the two priming conditions, suggesting that structural priming occurred independently of lexical choices.

Whether lexical repetition boosts structural (syntactic) priming effects or not, it is perhaps clear that crosslinguistic structural priming could occur without lexical repetition in production and comprehension for bilinguals (e.g., Hsieh, 2017; Loebell & Bock, 2003), but except Chen et al. (2023) (who observed lexically-independent priming only within languages instead of between languages).

2.3. Research motivation and significance

In summary, crosslinguistic structural priming involves considerable theoretical and empirical uncertainties. Regarding its theoretical underpinnings, crosslinguistic structural priming could be explained by either the residual activation account or the implicit learning account (or both). Moreover, priming appears to be affected by a series of language-specific factors, which are worthy of further experimental investigations, especially in the understudied domain of sentence comprehension.

Motivated by these issues, the present study examines crosslinguistic structural priming in sentence comprehension, and focuses on the passive construction that poses challenges for Chinese

EFL learners. Specifically, by employing a self-paced reading paradigm for processing garden-path reduced passive RCs, it aims to explore and compare structural priming effects in L1-L2 and L2-L1 directions for adult Chinese-English bilinguals with relatively-high L2 proficiency. It is hoped that this research will make the following contributions. Firstly, it will generate new insights into bidirectional crosslinguistic structural priming in sentence comprehension for adult bilinguals. Secondly, it will enhance our understanding of bilingual structural representation and sentence processing mechanisms. Thirdly, it could offer pedagogical implications for the learning and teaching of English passives among Chinese EFL learners.

2.4. Research questions and predictions

Given the issues stated above, the study aims to answer the following questions:

1) For Chinese upper-intermediate to advanced EFL learners, can L1 passive RCs prime the comprehension of L2 reduced passive RCs?
2) For Chinese upper-intermediate to advanced EFL learners, can L2 passive RCs prime the comprehension of L1 reduced passive RCs?
3) Comparing L1-L2 and L2-L1 priming, how does language direction affect crosslinguistic structural priming within sentence comprehension?

Regarding question 1), a partial replication of the L1-L2 priming effects in Hsieh (2017) is expected. Compared with those who have read L1 active sentences, participants with prior exposure to L1 passive RCs are expected to spend less time reading the disambiguating region of L2 reduced passive RCs. But since no evidence has supported the whole-language activation idea (suggesting that the entire target language gets activated during priming), no definite predictions are made on the RTs for the other regions of L2 target sentences. Likewise, for question 2), L2-L1 priming effects are predicted. The priming effects are expected to appear in the RTs for the disambiguating region of L1 reduced passive RCs, but it is unsure whether priming could be observed in other regions of L1 target sentences.

As for question 3), based on the aforementioned language direction effects on priming, L1-L2 priming effects are predicted to outweigh L2-L1 priming effects in sentence comprehension. In addition, the lower frequency of passives in Chinese than in English would probably lead to greater L1-L2 than L2-L1 priming, and enhance the discrepancy in priming size between the two

directions. Furthermore, while L2-L1 priming of passives is predicted, the observed priming effects in this experiment might be weakened by the possible priming from L2 actives to L1 passives because of word order similarities, further increasing the difference in priming magnitude across the language directions. In all, stronger priming effects are predicted in the L1-L2 direction.

3. Methodology

This chapter describes the methods used to address the research questions. It elaborates on the experimental design, the characteristics of the participants, the materials and the procedures involved in the experiment, as well as the preparations for data analysis.

3.1. Experiment design

The present study investigated the crosslinguistic structural priming of the passive construction through the processing of temporary ambiguities in garden-path sentences. To examine whether prior exposure to passive relative clauses (RCs) in one language would reduce processing difficulties with garden-path reduced passive RCs in another language, and how such priming effects interact with language directions, the study set up four experiment conditions: (A) Chinese-English prime, (B) Chinese-English no-prime, (C) English-Chinese prime, (D) English-Chinese no-prime. In each condition, every trial contained four sentences (two primes, one filler, and one target), followed by a comprehension question about the target. All targets included reduced passive past-tense RCs that might be temporarily misinterpreted as active past-tense sentences. All fillers and the primes in no-prime conditions were active past-tense sentences, while the primes in prime conditions were passive past-tense RCs. The two conditions for each language direction differed only in the primes. In the two Chinese-English conditions, the primes and fillers were in Chinese, with the targets and questions in English; in the English-Chinese conditions, only the targets and questions were in Chinese. The questions required participants to choose between two options based on the sentence they had just read, and none of the questions or options contained passive structures. The sentence types for all conditions are illustrated in Table 1. Examples for each sentence type are provided in Table 2. The structures and lengths of sentences are explained in Section 3.3.

Table 1. Sentence types for each trial in the four experiment conditions.

Condition group	*Sentence types for each trial*		
	Two primes	*One filler*	*One target + Comprehension question*
(A) Chinese-English prime	Chinese passive RC	Chinese active sentence	English reduced passive RC + English question
(B) Chinese-English no-prime	Chinese active sentence		
(C) English-Chinese prime	English passive RC	English active sentence	Chinese reduced passive RC + Chinese question
(D) English-Chinese no-prime	English active sentence		

Table 2. Example sentences for each sentence type.

Sentence type	*Example*										
English passive RC	The	refugee	who	was	spotted	by	the	guard	crossed	the	borders.
English active sentence	The	desperate	refugee	tried	his	best	to	cross	the	national	borders.
English reduced passive RC	The	great	travellers	guided	by	the	staff	went	into	the	cave.
English question	Did	the	travellers	enter	the	cave?	(Yes✓; No)				
Chinese passive RC	那个	被	守卫	发现	的	难民	跨越	了	边境。		
	Nàgè	bèi	shǒuwèi	fāxiàn	de	nànmín	kuàyuè	le	biānjìng.		
	The	PASS	guard	spot	REL	refugee	cross	PST	borders.		
	“The	refugee	who	was	spotted	by	the	guard	crossed	the	borders.”

Chinese active sentence	那个	绝望	的	难民	跨越	了	国家	的	边境。		
	Nàgè	juéwàng	de	nànmín	kuàyuè	le	guójiā	de	biānjìng.		
	The	desperate	AUX	refugee	cross	PST	national	AUX	borders.		
	“The	desperate	refugee	crossed	the	national	borders.”				
Chinese reduced passive RC	那个	向导	引领	的	旅客	进入	了	洞穴	深处。		
	Nàgè	xiàngdǎo	yǐnlǐng	de	lǚkè	jìnrù	le	dòngxué	shēnchù.		
	The	guide	lead	REL	travellers	enter	PST	cave	deep.		
	“The	travellers	led	by	the	guide	went	deep	into	the	cave.”
Chinese question	旅客	进入	洞穴	了	吗？	（是✓；否）					
	Lǚkè	jìnrù	dòngxué	le	ma?	(shì✓; fǒu)					
	Travellers	enter	cave	PST	AUX?	(Yes✓; No)					
	“Did	the	travellers	enter	the	cave?”	(Yes✓; No)				

As with previous experiments on structural priming in sentence comprehension (Hsieh, 2017; Thothathiri & Snedeker, 2008), two primes were presented instead of one in each trial so as to enhance the potential priming effects that might be weaker in sentence comprehension than production. Moreover, since priming effects would likely persist through multiple trials during comprehension if the implicit learning account is assumed (Pickering et al., 2013; Traxler & Tooley, 2008), a between-subject design was chosen to ensure that the observed priming effects in one condition did not interfere with those from other conditions.

Fillers and comprehension questions were included to "camouflage the priming manipulation" (Loebell & Bock, 2003, p. 799), i.e., to distract participants from observing the primed structures and consequently reducing their intentional processing of targets as those with passive constructions. Participants were not informed of the real purpose of the experiment in detail; they were only told to read sentences and answer questions that popped up. Apart from concealing the priming manipulation, the comprehension questions were used for checking attention and data validity (Buchanan & Scofield, 2018). The qualifying standard was set to 80% correct response — well beyond the chance level. Although in the initial design, all sentences were followed by questions to make sure that participants read every sentence carefully, the number of questions was reduced after piloting to avoid diminishing any priming effects (given the additional presence of active structures in the questions). Only the questions about the most critical items (targets) were retained to allow comparison of accuracy rates across condition groups.

All the declarative sentences (primes, fillers, and targets) were presented within the non-cumulative self-paced reading experiment paradigm (Just et al., 1982). Sentences appeared word by word in a moving window display: every new word appeared in the position as in a normal sentence while the previous word simultaneously disappeared. Participants read the sentences by pressing the space bar to reveal each successive word. Their reading time (RT) for each word was recorded. The comprehension questions were normally displayed as whole sentences.

3.2. Participants

3.2.1. Participant recruitment

Prior to participant recruitment, a power analysis was performed using G*Power (Faul et al., 2007). Based on the results of a similar study (Hsieh, 2017), the power analysis indicated that to achieve 80% power at the α=.05 level [(1-β)=.8] for main effects, a total of 272 participants (68 per group)

would be required (see Appendix A). Taking into account the feasible scope of a master's project, the total sample size was adjusted to 15-20 participants per condition (60-80 participants in total).

Altogether, 77 adult Chinese (Mandarin) speakers of English participated in the experiment, and were randomly assigned into one of the four condition groups. 31 participants were recruited through WeChat, a Chinese social media platform (see Appendix B for the recruitment flyer). 46 participants were recruited via Prolific, an online research platform that enables pre-screening of eligible participants. All participants learned English as a foreign language, and identified themselves as fluent English speakers with relatively-high English proficiency. They were rewarded with £1.65 (or ¥15) after completing the experiment.

3.2.2. English proficiency level

Prior to the experiment, participants took an English receptive vocabulary test, which was used as a predictor of their general English proficiency. A receptive vocabulary test was chosen for its efficiency and effectiveness in predicting EFL proficiency of intermediate/advanced learners (Miralpeix & Muñoz, 2018) over other types of language tests, such as a cloze test (e.g., Carson et al., 1990; Hwang & Shin, 2019; Lim & Christianson, 2013; Marsden et al., 2018; Shin, 2010), a translation test (e.g., Hyltenstam et al., 2009; Liang et al., 2022), or (subtests of) existing standardised tests (e.g., Deng et al., 2015; He, 2019; Hopp, 2015).

Specifically, the present study employed the Lexical Test for Advanced Learners of English (LexTALE) developed by Lemhöfer and Broersma (2012). The LexTALE is a standardised visual yes/no lexical decision test that takes only about three minutes to complete. According to its designers, the LexTALE has been proven to be valid in predicting English lexical knowledge and general English proficiency, and correlates well with other comprehensive proficiency tests. The test consists of 60 trials (40 words and 20 non-words), and participants are asked to decide whether each word is an existing English word. They should still respond 'yes' if they recognise the word form but do not understand its meaning. The test instructions and materials could be accessed openly at www.lextale.com.

The LexTALE score involves the percentage of right answers, "corrected for the unequal proportion of words and nonwords by averaging the percentages correct for these two item types" (Lemhöfer & Broersma, 2012, p. 329). The formula is: ((number of words correct/40*100) + (number of nonwords correct/20*100)) /2. Participants' scores were manually calculated, since the

platform on which the test was administered (see Section 3.4) did not support using the scoring formula. The scores were interpreted based on Lemhöfer and Broersma (2012, p. 341)'s estimates of L2 proficiency levels correspondent with LexTALE scores (see Table 3).

Table 3. Relationship between L2 English proficiency levels and LexTALE scores.

Common European Framework of Reference for Languages (CEFR) levels	*CEFR description*	*LexTALE score range*
C1 & C2	Upper & lower advanced/proficient user	80-100
B2	Upper intermediate	60-80
B1 and lower	Lower intermediate and lower	0-59

The LexTALE score was used as a further criterion for screening participants. Those who attained 60 (B2) or above were qualified for the study. For those scoring below 60, attention was paid to their self-reported English language qualifications or standardised test scores (see Section 3.2.3). If their reported English scores reached an equivalent of B2 or above, they were still included in the study. That is, participants were considered to have attained upper-intermediate English proficiency, if they reported having a minimum of 5.5 in the International English Language Testing System (IELTS), 72 in the internet-based Test of English as a Foreign Language (TOEFL), 493 in the College English Test (CET, band 4), 450 in CET (band 6), or having passed the Test for English Majors (TEM, band 4/8)[6] (Berkeley Summer Sessions, 2023; Educational Testing Service, 2021; Southern Cross University, 2020). The mean LexTALE score for all participants was 72.60 (SD=13.85). Among the 15 participants scoring lower than 60, only 4 were excluded for not having English qualifications of B2 equivalent or above. The scores of the selected 73 participants for each condition group are described in Table 4.

[6] CET and TEM tests are both standardised English tests monitored by the Chinese Ministry of Education.

Table 4. Descriptives of LexTALE scores of the selected participants.

		Condition group				*Total*
		(A)	(B)	(C)	(D)	
	80-100	5	9	4	11	29
	Score range (N) 60-80	10	7	12	4	33
	59 and below	2	5	1	3	11
	Total (N)	17	21	17	18	73
LexTALE scores	*Mean (M)*	73.46	72.08	72.28	76.94	73.65
	Standard Deviation (SD)	10.05	17.27	9.82	14.48	13.42
	Standard Error (SE) Mean	2.44	3.77	2.38	3.41	1.57
	Skewness	.237	-.633	.982	-.935	-.501
	Kurtosis	-.079	-.549	1.079	-.443	-.098
	Minimum (Min)	55	38.75	57.5	48.75	38.75
	Maximum (Max)	93.75	97.5	96.25	93.75	97.5

To investigate whether the four groups were matched for English proficiency, a one-way analysis of variance (ANOVA) on LexTALE scores was conducted. Since variances of the groups were not homogeneous ($F_{[3,69]}$=3.44, p=.021), the Brown–Forsythe F-statistics were generated to correct for the heterogeneity of variances (see Field, 2018). The Brown-Forsythe yielded a non-significant result ($F_{[3,61.317]}$=.536, p=.660), indicating that there were no significant differences in the mean LexTALE scores among the groups. Thus, the average English proficiency levels of participants in each group might be similar.

3.2.3. Demographic information and language background

After the experiment, participants filled in a questionnaire about their personal information and language background (see Appendix C). All questions contained an option of 'prefer not to say'. Basic personal information included age, gender, and education level. To protect the anonymity of participants (Dörnyei, 2007), age was measured as an ordinal variable with three categories. Table 5 displays the profile of participants in the study. A chi-square test of independence showed no significant gender differences among the groups [χ^2(3, 73)=4.702, p=.195]. Two independent-samples Kruskal-Wallis tests found no significant differences in the distribution of age

[$\chi^2(3)=2.601$, p=.457] and education level [$\chi^2(3)=3.864$, p=.277] across all groups. In other words, the groups were matched for age, gender, and education level.

Table 5. Participants' profile.

		Condition group				*Total (N)*	*Percent*
		(A)	(B)	(C)	(D)		
Age range (N)	18-30	13	13	11	14	51	69.9%
	31-50	4	4	5	4	17	23.3%
	50 and above	0	4	1	0	5	6.8%
Gender (N)	Male	9	7	4	4	24	32.9%
	Female	8	14	13	14	49	67.1%
Education level (N)	Secondary school	0	1	0	0	1	1.4%
	Undergraduate	4	10	7	6	27	37%
	Graduate	13	10	10	12	45	61.6%
Total		17	21	17	18	73	100%

As for language background, the information collected were the age of onset for learning English, percentage of English use, English language qualifications, and learning experiences of other languages (reported with self-perceived proficiency). All participants were sequential Chinese-English bilinguals raised only with their native language(s): Mandarin Chinese (and a certain Chinese regional dialect). Data on participants' English learning and use are presented in Table 6. Since group variances from the mean age of L2 onset were heterogeneous ($F_{[3,69]}=2.792$, p=.047), the Brown–Forsythe F was calculated in a one-way ANOVA, which showed no significant differences in the mean age of L2 onset across groups ($F_{[3,56.853]}=1.157$; p=.334). An independent-sample Kruskal-Wallis test found no significant group differences in the distribution of the percentage of English use [$\chi^2(3)=3.121$, p=.373]. That is, the groups were matched in terms of L2 onset age and percentage of English use.

Table 6. Participants' English language background.

		Condition group				*Total*	*Percent*
		(A)	(B)	(C)	(D)		
Age of onset	*M*	8.82	9.62	7.94	7.67	8.56	
	SD	4.57	3.74	2.25	3.57	3.64	
	Skewness	.725	.102	.045	.176	.480	
	Kurtosis	-.190	.239	-.849	-1.615	-.019	
Percentage of English use (N)	0-20%	2	1	0	2	5	6.8%
	20-40%	4	4	5	5	18	24.7%
	40-60%	3	4	7	3	17	23.3%
	60-80%	7	4	1	6	18	24.7%
	80-100%	1	8	4	2	15	20.5%
Total		17	21	17	18	73	100%

3.3. Materials

The experiment materials contained 20 comprehension questions and 120 declarative sentences of six types (see Table 1): 20 Chinese passive RCs, 30 Chinese active sentences (20 primes and 10 fillers), 20 English passive RCs, 30 English active sentences (20 primes and 10 fillers), 10 English reduced passive RCs (with 10 English questions), and 10 Chinese reduced passive RCs (with 10 Chinese questions). Additionally, 24 declarative sentences and four comprehension questions were prepared for practice sessions. Appendix D provides the full list of materials.

The self-paced-read declarative sentences were controlled for length. English sentences were 11 words long, and Chinese sentences were nine words long. As Chinese 'words' are calculated differently from Chinese characters, the counting of Chinese words was facilitated by the ICTCLAS System (Institute of Computing Technology, Chinese Lexical Analysis System) (Zhang et al., 2003). In the appendix, the Chinese word boundaries were marked by a space between characters, which does not appear in normal Chinese texts.

The sentence structures of primes and targets were carefully manipulated. Chinese passive RC primes were structured as: DET + head-final Chinese NP (*bei*+ NP_1 + V + *de* + NP_2) + past-tense

VP + 'VP+1'[7], such as *Nàgè bèi shǒuwèi fāxiàn de nànmín kuàyuè le biānjìng* ("The refugee who was spotted by the guard crossed the borders"). English passive RC primes were structured as: DET + head-initial English NP (NP_1 + REL + V + *by* + NP2) + past-tense VP + 'VP+1', such as *The refugee who was spotted by the guard crossed the borders*. Chinese and English active primes were structured as: DET + NP + past-tense VP + 'VP+1', such as *The desperate refugee tried his best to cross the national borders*. English garden-path passive RC targets were structured as: DET + NP_1 + V + *by* + NP_2 + past-tense VP + 'VP+1', such as *The great travellers guided by the staff went into the cave*. Chinese garden-path passive RC targets were structured as: DET + NP_1 + V + *de* + NP_2 + past-tense VP + 'VP+1', such as *Nàgè xiàngdǎo yǐnlǐng de lǚkè jìnrù le dòngxué shēnchù* ("The travellers led by the guide went deep into the cave").

The targets went through more fine-grained manipulation, so that the number of words for each sentence structure was controlled to enable comparing the RT of every sentence region, especially the region where the temporary ambiguity would be resolved. Following Hsieh (2017), targets were divided into five sentence regions: (1) DET + NP_1; (2) V; (3) *by*/*de* + NP_2; (4) past-tense VP; (5) 'VP+1'. As analysed in Figure 4, every 11-word English target had three, one, three, one, and three word(s) respectively for each region; every nine-word Chinese target had two, one, two, two, and two word(s) respectively for each region. The fillers were active past-tense sentences.

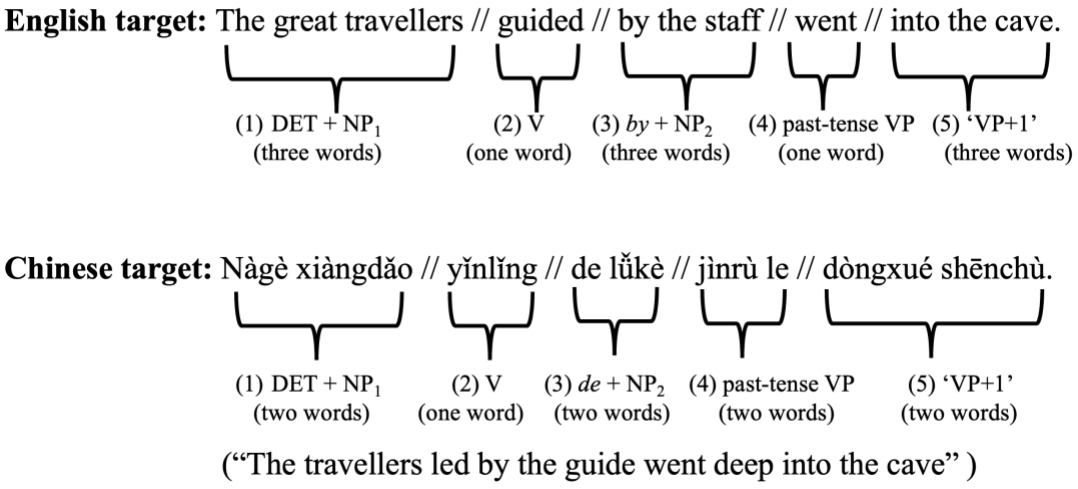


Figure 4. Regions of English and Chinese target sentences.

[7] 'DET' stands for 'determiner' (e.g., *the, a*). 'NP' denotes 'noun phrase'. 'V' represents 'verb', and 'VP' is 'verb phrase. 'VP+1' refers to any structure that could follow the VP in the sentence.

The comprehension questions that appeared automatically were short, simple questions devoid of passive structures. English questions had an average of 4.42 words (SD=1.24), and Chinese questions had 4.5 words on average (SD=.522). The two possible answers for each question both contained one/two word(s).

Some of the materials were adapted from Trueswell and Tanenhaus (1991) and Hsieh (2017), while others were compiled by the researcher. Every sentence formed an independent meaning. The targets contained no verbs that shared similar meanings with the verbs in primes or fillers, in order to eliminate any potential lexical boost effects on priming (see Section 2.2.3.5). To ensure the clarity and comprehensibility of sentences, the materials were piloted with four native Chinese adult EFL speakers (self-perceived proficiency: upper-intermediate to advanced). The pilots suggested several minor revisions to wording, and reported having no difficulty understanding the sentences.

3.4. Procedures

The experiment received ethical approval from the Central University Research Ethics Committee (CUREC) of the University of Oxford (see Appendix E). The entire experiment was built and administered on Gorilla, which recorded more precise RT across different browsers/operation systems than other experiment platforms (Anwyl-Irvine et al., 2020). RTs were recorded to millisecond accuracy. As participants needed to use a computer keyboard during the experiment, the allowed device types were restricted to computers. The experiment link was tested with different operation systems and browser types, which all proved compatible with the experiment.

Participants were presented with an information sheet and consent form in Chinese before the experiment (see Appendix F). The sheet provided brief explanations of the requirements and procedures of the experiment, assurances of voluntary participation and data protection, the contact information of the researcher and her supervisor, as well as highlighted reminders concerning some technique issues. Participants had to tick the consent box at the end of the sheet before proceeding to the next page.

The LexTALE test was first administered, followed by the main experiment and the post-test questionnaire. The whole process took approximately 10-15 minutes. All the instructions and the questionnaire were given in Chinese. The main experiment consisted of a practice session (two trials) and an experiment session (ten trials). Participants pressed the space bar to receive the next word in self-paced-read sentences, and clicked on the correct answer for comprehension questions.

Every sentence was displayed in one line. During the practice session, there were hints to "press the space bar" at the bottom of the screen, and participants were given feedback on their answers to the questions; the hints and feedback were not available in the experiment session. To prevent fatigue, there was a short break (one minute) after five trials in the experiment session.

After the experiment, participants recruited from Prolific got paid (£1.65) directly by the platform. Participants recruited via WeChat were told to leave their Alipay account in the questionnaire to receive payments (¥15).

3.5. Preparations for data analysis

Two steps were taken to prepare the data for analysis. Firstly, participants' responses to each comprehension question were scored as either 'correct' (1) or 'incorrect' (0). The percentage of correct responses by each participant was then calculated. Secondly, the RTs for self-paced-read sentences were further calculated. Since the data exported from Gorilla contained only RTs for every word, the SUM function in Excel was used to calculate the RTs for every whole sentence, and the RTs for every sentence region of the targets.

4. Results

In this chapter, the results of experiment are reported for both priming directions (L1-L2 and L2-L1). For both directions, responses to comprehension questions were first analysed to exclude inattentive participants, followed by investigations on the reading times (RTs) for sentences.

4.1. Chinese to English (L1-L2) priming

To investigate the effects of L1 to L2 structural priming in sentence comprehension, condition groups (A) (Chinese-English prime group) and (B) (Chinese-English no-prime group) were compared.

4.1.1. Responses to comprehension questions

Concerning the correct rate of comprehension questions, one participant from group (B) scored below 80%, which showed that he/she was not attentive enough to comprehend the target sentences accurately. The participant was excluded from the analysis. As displayed in Figure 5, participants in group (A) obtained an average correct rate of 94.71% (SD=12.307%), and the average correct rate for participants in group (B) was 93.00% (SD=11.286%). Since the variable was not normally distributed in either group (A) (Skewness=-2.203, Kurtosis=3.810) or (B) (Skewness=-1.884, Kurtosis=3.245), a Mann-Whitney U-test was carried out to check whether the two groups differed in the correct rate of responses. The test indicated no significant correct rate differences between the groups (U=139.500, p=.357).

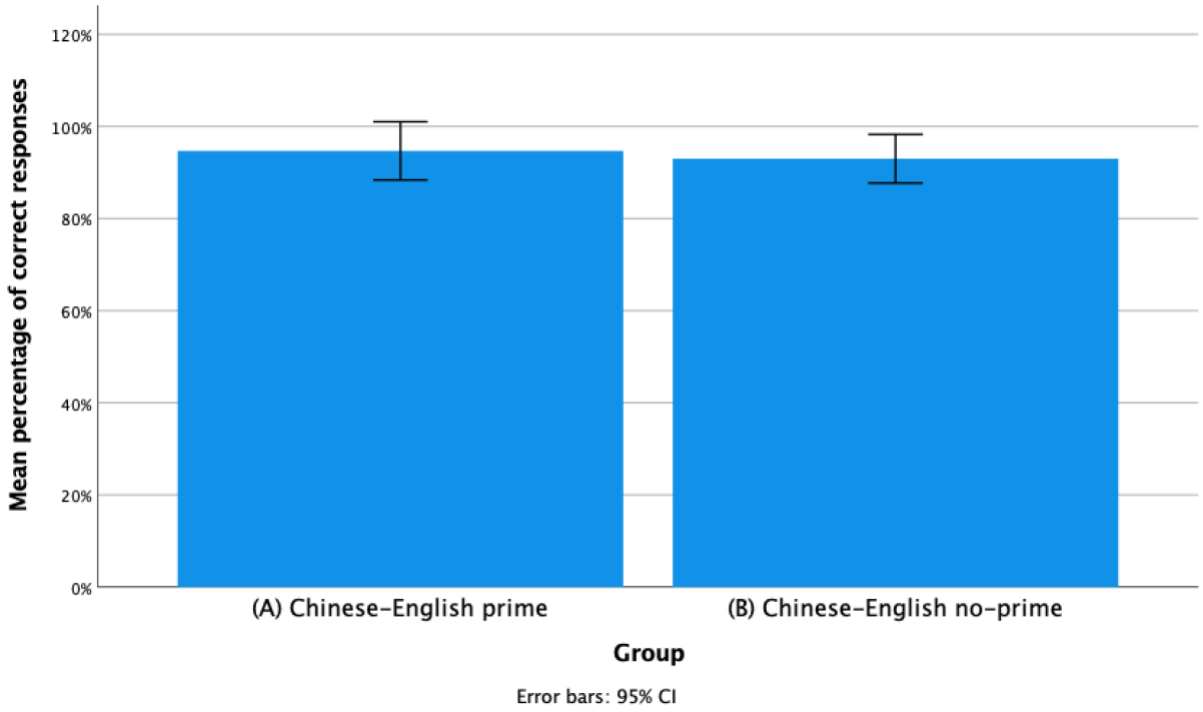


Figure 5. Mean correct rate of comprehension question responses for L1-L2 experiment groups.

4.1.2. Reading times for sentences

4.1.2.1. Reading times for fillers and primes

The two groups read the same fillers and targets, but not the same primes. To check whether the two groups had similar self-paced reading speed, the mean RTs for the 10 Chinese active fillers were compared between groups. An outlier (i.e., an extreme value lying outside ±2.58 SD) in the Chinese-English no-prime group was first identified via boxplots (see Appendix G). To prevent skewing the distribution with biased data, the outlier was "winsorised": replaced with the next highest/lowest value (not an outlier) in the group (Field, 2018).

With the outlier winsorised, the variable became normally distributed for both groups (see Table 7), and variances between the groups were equal (F=.156, p=.696). An independent samples t-test revealed no significant differences in the mean RT for fillers between the groups, as presented in Table 7. The mean-level difference was -174.24 (95% CI [-722.65, 374.18]).

Table 7. Descriptives of mean RT for fillers per L1-L2 experiment group, with independent samples t-test results comparing the groups.

	Group	*N*	*M (SE)*	*SD*	*Skewness*	*Kurtosis*	*t*	*df*	*Two-tailed p*
Mean RTs for fillers (*Milliseconds, ms*)	(A) Chinese-English prime	17	2725.79 (185.30)	764.03	.506	.022	-.645	35	.523
	(B) Chinese-English no-prime	20	2900.03 (192.84)	862.39	.892	-.001			
	Total	37	2819.97 (133.53)	812.22	.752	.038			

The 20 primes read by each group were different in structure but same in sentence length. A further comparison between the groups' mean RTs for primes was made, in case the groups differed in general reading speed. After an outlier (see Appendix G) was winsorised, the assumptions of normality and equal variances were met (F=.675, p=.417). As displayed in Table 8, an independent samples t-test showed no significant differences in the mean RT for primes between the groups. The mean-level difference was -357.28 (95% CI [-909.35, 194.80]).

Table 8. Descriptives of mean RT for primes per L1-L2 experiment group, with independent samples t-test results comparing the groups.

	Group	*N*	*M (SE)*	*SD*	*Skewness*	*Kurtosis*	*t*	*df*	*Two-tailed p*
Mean RTs for primes (*ms*)	(A) Chinese-English prime	17	2762.68 (172.41)	710.87	.059	-1.257	-1.314	35	.197
	(B) Chinese-English no-prime	20	3119.96 (203.26)	909.01	.533	-.744			
	Total	37	2955.80 (136.89)	832.64	.517	-.413			

4.1.2.2. Reading times for targets

To compare the RTs for target sentence regions, RTs were further calculated by the five sentence regions for each of the 10 English garden-path passive RC targets, forming a total of 50 variables

per condition group. First, 119 outliers in the 50 variables were identified and winsorised. The boxplots for locating outliers and the number of outliers in every variable are presented in Appendix G. Then, five additional variables were formed by calculating the mean RT of all targets per sentence region. The 55 variables with winsorised outliers were normally distributed for both groups.

To investigate whether the groups had statistically-significant differences in RT per sentence region by sentences, a number of independent samples t-tests were conducted. The null hypotheses (H_0s) were that the groups had equal RTs. According to the predictions, the alternative hypotheses (H_1s) for t-tests concerning the disambiguating region (region (3)) were that group (A) (Chinese-English prime group) had shorter RTs than group (B) (Chinese-English no-prime group), while the H_1s for the other t-tests were that the two groups had different RTs. The t-tests were run concurrently with Levene's F-tests for equal variances in SPSS. Table 9 displays the results of F-tests and t-tests regarding the mean RT of all targets per sentence region. The group differences in mean RT per region are visualised in Figure 6. For detailed test results about every target per region, see Appendix I.

Table 9. Descriptives of mean RTs per target region for L1-L2 experiment groups, F-test results for equal variances, and independent samples t-test results comparing the groups.

Note 1: According to the hypotheses, the p value was one-tailed for the t-test on sentence region (3), and two-tailed for the other t-tests.

Note 2: 'C' stands for 'Chinese', and 'E' stands for 'English'.

	Sentence region	*M (SE)*		*SD*		*Skewness*		*Kurtosis*		*F (sig.)*	*p*	*Cohen's d [95% CI]*
Group		(A) C-E prime	(B) C-E no-prime	(A) C-E prime	(B) C-E no-prime	(A) C-E prime	(B) C-E no-prime	(A) C-E prime	(B) C-E no-prime			
Mean RTs for targets (*ms*)	(1) DET + NP_1	1138.49 (67.81)	1377.72 (87.98)	279.58	393.47	-.093	.411	-.138	-.980	3.151 (.085)	.043	-.691 [-1.353, -.020]
	(2) V	477.34 (42.97)	646.28 (50.81)	177.16	227.24	.251	.319	-.123	-.827	1.656 (.207)	.018	-.821 [-1.490, -.141]
	(3) *by* + NP_2	1231.05 (68.09)	1436.24 (76.10)	280.76	340.34	-.282	.225	-.816	-.888	.417 (.523)	.028	-.652 [-1.312, .016]
	(4) past-tense VP	426.37 (26.29)	555.79 (40.64)	108.41	181.74	-.429	.452	-.279	-.497	3.705 (.062)	.015	-.848 [-1.518, -.166]
	(5) "VP+1"	1238.37 (60.50)	1580.12 (92.98)	249.46	415.82	.004	.350	.895	-.996	6.858 (.013)	.004	-.977 [-1.657, -.285]

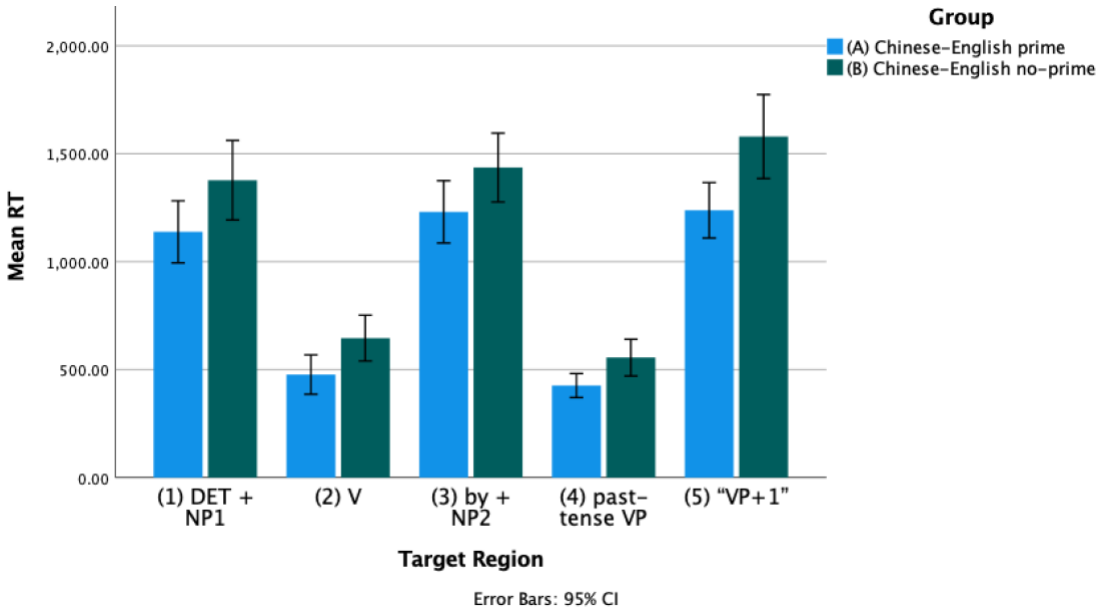


Figure 6. Clustered bar of mean RTs for targets by sentence region per L1-L2 experiment group.

As predicted, t-tests showed that participants in group (A) spent significantly shorter average time reading region (3) of the ten targets [t(35)=-.1.978, p=.028], with a medium effect size (Cohen's d=-.652)[8]. In terms of the average RT for each of the other target regions, t-tests revealed significant group differences, with a medium effect size for region (1) [t(35)=-2.095, p=.043, d=-.691], and large effect sizes for regions (2) [t(35)=-2.488, p=.018, d=-.821], (4) [t(35)=-2.570, p=.015, d=-.848], and (5) [t(31.739)=-3.081, p=.004, d=-.977].

4.1.2.3. Potential factors explaining the observed differences

To explore whether the observed group differences were associated with factors other than the experiment condition, tests of correlation were conducted to analyse the relationships between the 37 participants' average RT for targets by regions, self-paced reading speed (represented by average RT for fillers), correct rate of comprehension questions, and English proficiency level (indicated by LexTALE scores). As the variables except the correct rate were normally distributed, they underwent Pearson's bivariate correlation tests (see Table 10). The tests revealed significant positive correlations between the mean RT for fillers and mean RT for each of the five target regions. LexTALE score correlated negatively and significantly only with mean RT for target

[8] Cohen (1992) set the standards for effect sizes in social science research: *insignificant* (d<.20); *small effects* (.20≤d<.50); *medium effects* (.50≤d<.80); *large effects* (d≥.80).

region (5), but not with that of other regions.

Table 10. Correlations between mean RT for each of the five target regions, mean RT for fillers, and LexTALE scores for participants in L1-L2 experiment groups.

*Note: *: p<.05; **: p<.01; ***: p<.001.*

		LexTALE score	Mean RT for target region (1)	Mean RT for target region (2)	Mean RT for target region (3)	Mean RT for target region (4)	Mean RT for target region (5)
Pearson's r	Mean RT for fillers	.112	.788**	.572**	.725**	.563**	.572**
	LexTALE score		.068	-.277	-.153	-.268	-.328*

Nonparametric correlations between correct rate and the other variables were tested on Spearman's rank-order coefficient (see Table 11). No significant correlations were found.

Table 11. Nonparametric correlations between correct rate of comprehension question responses and LexTALE score, mean RT for fillers, and mean RT for each of the five target regions for participants in L1-L2 experiment groups.

		LexTALE score	Mean RT for fillers	Mean RT for target region (1)	Mean RT for target region (2)	Mean RT for target region (3)	Mean RT for target region (4)	Mean RT for target region (5)
Spearman's rho	Percentage of correct answers	.161	.053	.024	-.108	-.130	-.288	-.216

Thus, to investigate the role of the experiment group and mean RT for fillers in determining RTs for target regions (1) to (4), hierarchical multiple regression analyses were conducted, which incorporated two models. The predictor in the first model was mean RT for fillers; the second model included the experiment group, which was the focal variable. The experiment group was dummy coded (group (A)=0, group (B)=1). The regression results concerning region (3) are demonstrated in Table 12. Both models were a good fit. Model 1 accounted for 52.6% of the

variance [F(1,35)=38.797, p<.001], with mean RT for fillers significantly predicting mean RT for target region (3); model 2 explained an additional 5.8% of the variance [ΔF(1,34)=4.695, p=.037], with experiment group being a significant predictor of mean RT for region (3). In other words, when controlled for self-paced reading speed (i.e., mean RT for fillers), the experiment condition still significantly explained the group differences in mean RT for region (3). The results also applied to regions (1), (2), and (4) (see Appendix J).

Table 12. Regression ANOVA table on the effects of experiment group and mean RT for fillers on mean RT for target region (3) for L1-L2 experiment groups.

Model		*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
1	Regression	2023445.14	1	2023445.14	38.797	<.001
	Residual	1825407.01	35	52154.486		
	Total	3848852.15	36			
2	Regression	2244915.46	2	1122457.73	23.794	<.001
	Residual	1603936.69	34	47174.609		
	Total	3848852.15	36			

Next, a hierarchical multiple regression with three models was performed to explore the role that the experiment group, LexTALE score, and mean RT for fillers played in determining the RT for target region (5). The predictor in model 1 was mean RT for fillers; model 2 further included LexTALE score; model 3 additionally incorporated the experiment group (the focal variable). All three models fit the data well; mean RT for fillers, LexTALE score, and experiment group were all significant predictors of mean RT for region (5), as shown in Table 13. Specifically, model 1 accounted for 32.7% of the variance [F(1,35)=17.043, p<.001]; model 2 explained an additional 15.6% of the variance [ΔF(1,34)=10.258, p=.003]; model 3 further explained 15.0% of the variance [ΔF(1,33)=13.527, p<.001], showing that experiment condition significantly explained group differences when the effects of mean RT for fillers and LexTALE score were controlled.

Table 13. Regression ANOVA table on the effects of experiment group, LexTALE score, and mean RT for fillers on mean RT for target region (5) for L1-L2 experiment groups.

Model		*Sum of squares*	*df*	*Mean square*	*F*	*Sig.*
1	Regression	1753378.20	1	1753378.20	17.043	<.001
	Residual	3600686.37	35	102876.753		
	Total	5354064.56	36			
2	Regression	2587910.82	2	1293955.41	15.905	<.001
	Residual	2766153.74	34	81357.463		
	Total	5354064.56	36			
3	Regression	3392134.80	3	1130711.60	19.019	<.001
	Residual	1961929.76	33	59452.417		
	Total	5354064.56	36			

4.2. English to Chinese (L2-L1) priming

L2 to L1 structural priming effects in sentence comprehension were explored by comparing condition groups (C) (English-Chinese prime group) and (D) (English-Chinese no-prime group).

4.2.1. Responses to comprehension questions

All participants in these two groups had a minimum of 80% correct rate, and were therefore considered to have passed the attention checks. As shown in Figure 7, participants in group (C) scored 97.65% on average (SD=5.623%), and participants in group (D) scored an average of 97.22% (SD=4.609%). Due to the non-normal distribution of the variable in group (C) (Skewness=-2.473, Kurtosis=5.840), a Mann-Whitney U-test was conducted to compare the distribution of correct rates across the groups. The test gave rise to no significant group differences in the correct rate of responses (U=140.000, p=.684).

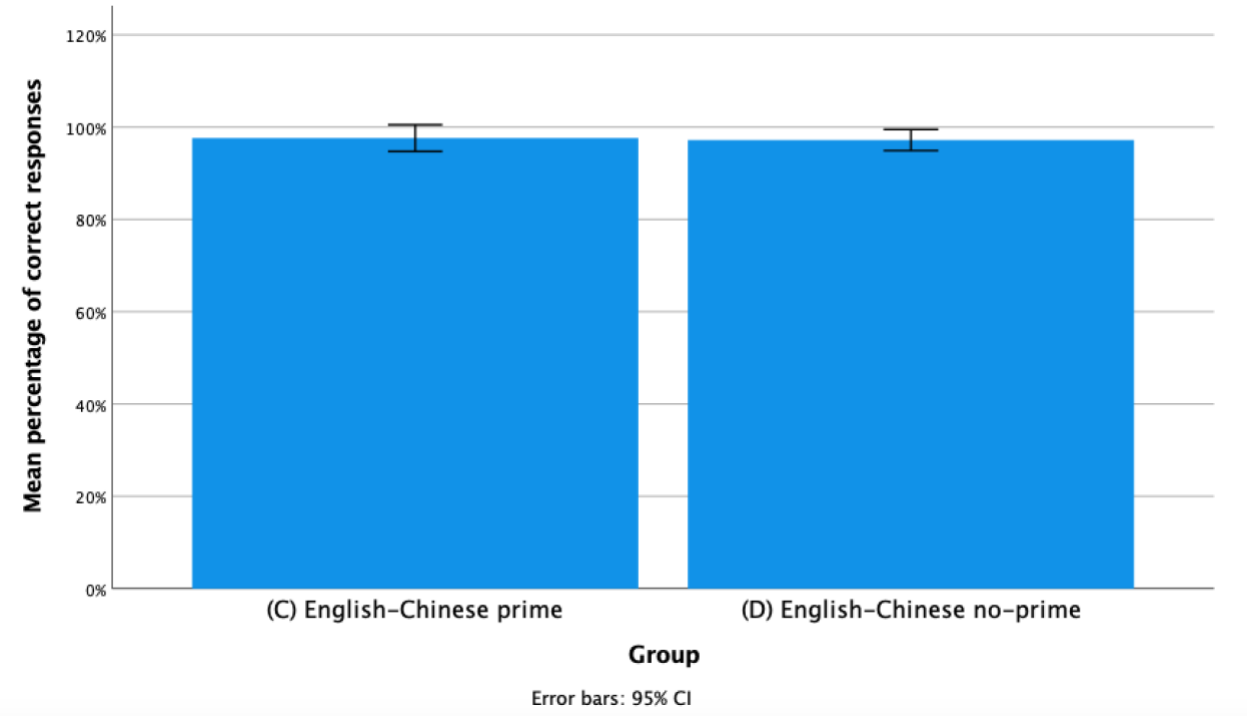


Figure 7. Mean correct rate of comprehension question responses for L2-L1 experiment groups.

4.2.2. Reading times for sentences

4.2.2.1. Reading times for fillers and primes

To find out whether there were significant group differences in self-paced reading speed, the mean RTs for the 10 English active fillers were compared between the groups. An outlier in the English-Chinese prime group was detected using boxplots (see Appendix G), and was reassigned the next highest value in the group. As displayed in Table 14, the variable with the winsorised outlier was normally distributed for both groups, and the assumption of equal variances between groups was met (F=.123, p=.728). An independent samples t-test was conducted (see Table 14), which indicated no significant group differences in the mean RT for fillers. The mean-level difference was 155.83 (95% CI [-450.47, 762.12]).

Table 14. Descriptives of mean RT for fillers per L2-L1 experiment group, with independent samples t-test results comparing the groups.

	Group	*N*	*M (SE)*	*SD*	*Skewness*	*Kurtosis*	*t*	*df*	*Two-tailed p*
Mean RTs for fillers (*ms*)	(C) English-Chinese prime	17	3759.37 (209.01)	861.78	.263	-.438	.523	33	.605
	(D) English-Chinese no-prime	18	3603.54 (211.89)	898.99	.623	-.416			
	Total	35	3679.23 (147.34)	871.68	.422	-.608			

To further ensure that the groups were matched for their general reading speed, a comparison between the groups' mean RTs for the 20 primes was conducted. After four outliers (see Appendix G) were winsorised, the variables were normally distributed. Since the assumption of equal variances was not met (F=4.886, p=.034), an independent samples t-test with unequal variances was performed (see Table 15), which suggested no significant group differences in mean RT for primes. The mean-level difference was -302.69 (95% CI [-1019.02, 413.64]).

Table 15. Descriptives of mean RT for primes per L2-L1 experiment group, with independent samples t-test results comparing the groups.

	Group	*N*	*M (SE)*	*SD*	*Skewness*	*Kurtosis*	*t*	*df*	*Two-tailed p*
Mean RTs for primes (*ms*)	(C) English-Chinese prime	17	3732.86 (174.03)	717.53	-.329	-1.019	-.867	26.969	.394
	(D) English-Chinese no-prime	18	4035.56 (302.63)	1283.95	.746	-.285			
	Total	35	3888.53 (176.48)	1044.08	.840	.718			

4.2.2.2. Reading times for targets

For each of the 10 Chinese garden-path passive RC targets, RTs were analysed by the five sentence regions, adding up to 50 variables per experiment group. A total number of 71 outliers in the 50 variables were identified and winsorised. Appendix I displays a complete list of boxplots used for

detecting outliers and provides the number of outliers found in every variable. With the outliers winsorised, the mean RTs of all targets for each sentence region were calculated into five additional variables. All 55 variables demonstrated normal distribution for both groups.

A series of independent samples t-tests were carried out in order to test whether the groups differed in the RT by sentences per sentence region. The H_0s were that RTs were equal between groups. According to predictions, the H_1s for t-tests on region (3) were that group (C) (English-Chinese prime group) had shorter RTs than group (D) (English-Chinese no-prime group), while the H_1s for the other t-tests were that the groups had different RTs. The t-tests were performed simultaneously with Levene's F-tests for equal variances in SPSS. The results of F-tests and t-tests on the mean RT of all targets per region are reported in Table 16. The group differences in mean RT per region are visualised in Figure 8. For detailed test results about every target per region, see Appendix L.

Table 16. Descriptives of mean RTs per target region for L2-L1 experiment groups, F-test results for equal variances, and independent samples t-test results comparing the groups.

Note 1: According to the hypotheses, the p value was one-tailed for the t-test on sentence region (3), and two-tailed for the other t-tests.

Note 2: 'C' stands for 'Chinese', and 'E' stands for 'English'.

	Sentence region	*M (SE)*		*SD*		*Skewness*		*Kurtosis*		*F (sig.)*	*p*
Group		(C) E-C prime	(D) E-C no-prime	(C) E-C prime	(D) E-C no-prime	(C) E-C prime	(D) E-C no-prime	(C) E-C prime	(D) E-C no-prime		
Mean RTs for targets (*ms*)	(1) DET + NP_1	784.44 (44.75)	723.67 (37.92)	184.49	160.86	.030	.589	-1.067	-.882	.196 (.661)	.306
	(2) V	332.43 (21.42)	340.10 (22.34)	88.31	94.78	.784	.206	-.028	-.768	.373 (.546)	.806
	(3) *de* + NP_2	677.82 (38.75)	666.10 (42.73)	159.77	181.27	.464	.440	-.893	-.751	.158 (.693)	.420
	(4) past-tense VP	737.33 (46.53)	691.67 (43.98)	191.86	186.60	.401	.247	-1.215	-.928	.068 (.796)	.480
	(5) "VP+1"	702.76 (32.08)	683.89 (41.22)	132.25	174.89	.540	.358	-.178	-.751	3.045 (.090)	.722

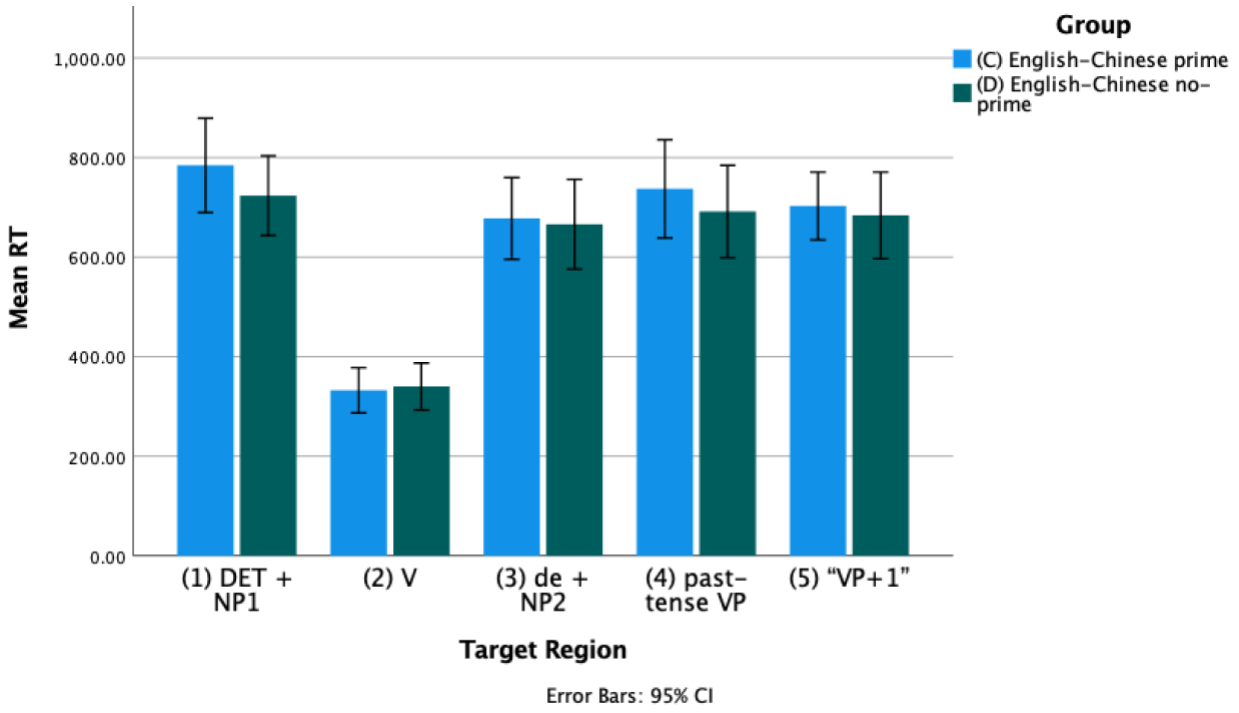


Figure 8. Clustered bar of mean RTs for targets by sentence region per L2-L1 experiment group.

As displayed above, none of the t-tests yielded a significant p value. In other words, participants between the English-Chinese prime and no-prime groups had no statistically-significant RT differences in any sentence region. The findings contradicted the predictions that participants in the prime group (group (C)) would have shorter RTs for region (3) than those in the no-prime group (group (D)).

5. Discussion

The present study delved into bidirectional crosslinguistic structural priming within sentence comprehension, using a self-paced reading experiment targeting Chinese and English passive constructions in relative clauses. Priming effects were observed from the L1 (Chinese) to the L2 (English), but not in the opposite direction. This chapter discusses the results according to the three research questions, and in relation to theoretical accounts and previous findings. Implications for pedagogy and future research are subsequently drawn.

5.1. L1-L2 priming in sentence comprehension

For research question 1), it was predicted that prior experience with L1 passive RCs (primes) would facilitate Chinese EFL learners' processing of L2 garden-path reduced passive RCs (targets). The prediction was borne out in the experiment: participants in the prime group spent significantly less time reading the disambiguating region of targets than participants in the no-prime group, although the two groups were matched for self-paced reading speed (as indicated by their time spent on reading fillers and primes). The result suggested the crosslinguistic priming of the passive structure. Moreover, the group difference in reading time (RT) was found to be significant in all regions of target sentences, which indicated the activation of the target language as a whole.

The finding that passives were primed crosslinguistically provides support for the shared syntax mechanism of bilingual structural representation (de Bot, 2004; Hartsuiker et al., 2004). In the bilingual mind, Chinese and English passive constructions seem to be linked to the same combinatorial node that represents the passive structure, independent of language, thereby allowing priming of passives from one language to the other. Regarding shared syntax and L2 proficiency, this research demonstrates that Chinese EFL learners with upper-intermediate to advanced English proficiency have already developed a shared syntax mechanism. Besides, no correlation was found between participants' L2 proficiency level (LexTALE score) and the priming effects of passives (RT for the disambiguating target region), which contradicted previous findings that higher L2 proficiency would enhance priming effects (Bernolet et al., 2013). The inconsistency could be explained by Hartsuiker and Bernolet (2017)'s developmental account of shared syntax. The L2 proficiency of participants in Bernolet et al. (2013)'s experiments varied from lower-intermediate to advanced, while participants in the present research all attained upper-intermediate English proficiency. Following a developmental account, according to which L2

learners gradually develop shared syntactic representations, it is likely that those who are at a later stage of L2 development (upper-intermediate level and above) already have a fully established shared syntax system. Thus, the participants of this research project, whether they had upper-intermediate or advanced L2 proficiency, probably possessed a fully-fledged shared syntax mechanism and were equally susceptible to priming. By contrast, participants with lower L2 proficiency, such as those in Bernolet et al. (2013)'s study, might not have had developed combinatorial nodes of shared structures, and could not be readily primed.

Turning to whether shared syntax is premised on word order equivalence or lexical repetition, this study demonstrates that neither of them is a prerequisite for shared syntax. Despite the word order difference between Chinese and English passive RCs, the abstract passive structure is shared and could be primed crosslinguistically, which corroborates previous findings regarding sentence comprehension (Hsieh, 2017) and production (Chen et al., 2013). This result supports a two-stage account of syntactic processing: hierarchical structures are analysed and interpreted at the functional stage, and word order is processed at a separate positional stage (e.g., Bock & Levelt, 1994; Hartsuiker, 1999). Although passives in Chinese and English RCs differ in word order, they share the same functional hierarchical structure and mental representation. As for lexical repetition, this study observed crosslinguistic structural priming without repeated use of meaning-equivalent verbs (verbs that had similar meanings) in primes and targets, which indicates that shared structural representation does not require lexical repetition or similarity. This finding accords with the majority of earlier observations (e.g., Chen et al., 2013; Hartsuiker et al., 2016; Hsieh, 2017), but diverges from Chen et al. (2023), who found no lexically-independent crosslinguistic priming in sentence comprehension.

Here are several possible explanations for the difference. First, Chen et al. (2023) examined the priming of double-object datives in Cantonese-Mandarin-English multilinguals. double-object datives in Cantonese/Mandarin have multiple forms, and only one is similar to English double-object datives. Thus, the type of Cantonese/Mandarin double-object sentences chosen by the authors in their experiments might not have had shared representations with English double-object structures. By contrast, the present study focuses on passive constructions in RCs, which have proven to be shared between Chinese and English (Hsieh, 2017). Second, the visual-world eye-tracking paradigm employed by Chen et al. (2023) might not accurately measure linguistic priming, since as discussed in Section 2.2.2.2, there could be interference from nonverbal stimuli. The self-

paced reading paradigm used in this study prevents this problem. In sum, the absence of crosslinguistic lexically-independent structural priming in Chen et al. (2023) cannot prove that shared syntax necessitates lexical repetition within sentence comprehension. Instead, shared syntax is certainly possible without lexical repetition.

Another important discovery in the present study is whole language activation (activation of the entire target language during crosslinguistic priming): Chinese passive RCs primed the English language as a whole. Compared with those in the no-prime group, participants in the prime group spent less time processing each region of English target sentences. This result provides clear evidence for the residual activation account of structural priming (e.g, Branigan et al., 1999; Pickering & Branigan, 1998). In line with de Bot (2004)'s multilingual processing model, once Chinese-English bilinguals process the Chinese passive construction, the English passive construction becomes triggered through the combinatorial node of passives. The information is then relayed to the external language node, which activates the English language as a whole. In other words, crosslinguistic structural priming is realised through the activation of recently-processed structures: L1 passives activate L2 passives, which then activate the entire L2 and facilitate L2 processing.

However, whole language activation was not observed by Hsieh (2017), who only detected significant group differences in RTs for the disambiguating region and the subsequent region of targets. This discrepancy is difficult to explain, but it might be related to the difference in the experiment procedure. To camouflage the priming design, the present study utilised comprehension questions as an additional task; the questions only appeared after each target, which would not interrupt the priming process (i.e., self-paced reading of primes, fillers, and targets). Rather, Hsieh (2017) adopted a grammaticality judgement task. She designed 60 fillers (thrice the number of targets), with one-third of them containing grammatical violations. There were one or more fillers between every two priming trials. Participants were instructed to judge the grammatical accuracy of every self-paced-read sentence, including primes, fillers, and targets. It is possible that the cognitive efforts required for grammaticality judgement after each sentence partly interfered with the priming process, consequently obstructing or concealing whole language activation effects in her experiment.

Whereas residual activation of passives definitely underlies crosslinguistic structural priming in this study, the implicit learning mechanism might also have played a role (Bock & Griffin, 2000;

Chang et al., 2006; Hwang & Shin, 2019; Loebell & Bock, 2003). Under this account, crosslinguistic structural priming is essentially an unintentional procedural learning process. As reading experience with L1 passive structures accumulates, the form-meaning mappings between passive form elements and agent-patient meaning relationships become increasingly strengthened. Then, when reading L2 sentences, the language users would be more inclined to interpret agent-patient meaning relationships based on the passive structure, and would therefore have less difficulty processing L2 garden-path reduced passive RCs. Since it is difficult to ascertain whether there was longer-term cumulative priming in this experiment, the extent to which implicit learning contributed to structural priming remains unknown. Nevertheless, we should acknowledge the possibility that implicit learning, together with residual activation, leads to crosslinguistic structural priming in sentence comprehension.

5.2. L2-L1 priming in sentence comprehension

With regards to research question (2), the prediction was that reading L2 passive RCs would prime Chinese EFL learners' comprehension of L1 garden-path reduced passive RCs. The result of this study failed to confirm this prediction: L2-L1 priming effects were not observed in participants' processing of the disambiguating target region, nor in any other region of target sentences. This result cannot be ascribed to the structural representation of English and Chinese passives in RCs. The existence of L1-L2 priming in this experiment has proven that these structures are indeed shared in the mind of Chinese upper-intermediate to advanced EFL learners, and L2-L1 priming should have occurred. In addition, this result cannot be explained by the impossibility of L2-L1 structural priming, as many studies on bidirectional crosslinguistic structural priming have found L2-L1 priming effects in language comprehension and production (e.g., Bernolet et al., 2013; Chen et al., 2013; Loebell & Bock, 2003).

Then, why was L2-L1 priming of passives unobserved in the present experiment? One explanation is that understanding Chinese garden-path passive targets constituted smaller challenges for the native Chinese participants, as compared with English garden-path targets. It has been well documented that structural ambiguities in garden-path sentences pose difficulties in sentence parsing and comprehension (e.g., Altmann, 1998; Ferreira, 2003; Trueswell et al., 1993), and that language users encounter greater difficulties in processing L2 garden-path sentences than L1 ones (Yang & Shih, 2013). Moreover, for Chinese EFL learners, the English passive construction is particularly difficult to acquire and process because of its different word order and

frequency from the Chinese passives (Chang & Wang, 2013, 2016). For these reasons, participants in L2-L1 priming groups would likely have experienced less difficulty in processing the targets (Chinese garden-path passive RCs), regardless of whether they were primed with passives or not, when compared to participants in L1-L2 priming groups who read English garden-path passive targets. Consequently, L2-L1 structural priming effects in this experiment may not have been readily discernible.

An alternative explanation is that L2-L1 priming of passives occurred due to residual activation, but was obscured by the priming from L2 actives to L1 passives. According to the two-stage account of syntactic processing (which the results of this study seem to support), the functional stage and positional stage are separate in syntactic processing. Thus, similar structures or similar word order alone may result in a shared representation across languages. English and Chinese passive RCs feature the same passive function but differ in terms of word order; English actives and Chinese passive RCs have different functions, yet coincidentally share a similar word order: agent (NP_1) + V + (*de*) + patient (NP_2). Both these pairs of structures are possibly shared in the Chinese-English bilingual mind. Under a residual activation account, the shared structures would be co-activated during language processing, thus bringing about crosslinguistic structural priming effects. For participants in the L2-L1 prime group, prior experience with English passive RCs (primes) might have facilitated the processing of Chinese reduced passive RCs (targets). However, the English active prime sentences might also have activated Chinese passive RCs — thereby assisting their understanding of Chinese garden-path targets as well. If this was the case, participants in the two L2-L1 experiment groups would both have experienced structural priming as a result of residual activation, allowing them to resolve temporary ambiguities in L1 garden-path reduced passive RCs with greater ease. Given that the present study did not include a third L2-L1 experiment group in which primes shared neither word order nor structural functions with targets, and that no precedent research has examined L2-L1 priming of these particular structures within sentence comprehension, it is now not feasible to determine whether crosslinguistic structural priming indeed happened in both L2-L1 experiment groups.

The previous paragraph introduced the possibility that shared syntax, in conjunction with residual activation, contributed to L2-L1 structural priming in both prime and no-prime groups of this experiment. Aside from residual activation, the potential involvement of implicit learning in structural priming cannot be disregarded. If participants had learned structures implicitly during

sentence comprehension in this experiment, it would have led to L2-L1 priming of passives in the prime group. Conversely, for participants in the L2-L1 no-prime group, their previous exposure to L2 actives could not have primed L1 passives through implicit learning. Therefore, in terms of the priming effects fostered by implicit learning, L2-L1 priming of passives would have occurred exclusively in the prime group. When considering the combined crosslinguistic priming effects resulting from implicit learning and residual activation, participants in the L2-L1 prime group would still have experienced greater priming effects compared to those in the no-prime group. Yet, contrary to expectations, these priming effects were not found. It may be that the implicit learning mechanism was not involved in L2-L1 sentence comprehension during the experiment, or that the L2-L1 priming caused by implicit learning was too weak to be detected.

To conclude, the absence of observed L2-L1 priming effects in sentence comprehension cannot be interpreted as a definite absence of priming in reality. L2-L1 priming of passives might have occurred with a relatively small magnitude, and could have been obscured by the possible priming from L2 actives to L1 passives. Additionally, priming effects from L2 to L1 are generally weaker than those in the other direction (e.g., Bernolet et al., 2013; Schoonbaert et al., 2007), especially for sentence comprehension (e.g., Chen et al., 2023; Hsieh, 2017), which further increases the difficulty of detecting L2-L1 priming within sentence comprehension. The relationship between language direction and priming magnitude is explored in the following section.

5.3. Language direction effects in crosslinguistic structural priming

In terms of research question 3), the study has identified differences in the magnitude of priming between the two directions. Confirming the prediction, the observed priming effects from L1 to L2 largely outweighed those from L2 to L1. The result is consistent with previous findings (Bernolet et al., 2013; Chen et al., 2013; Loebell & Bock, 2003; Schoonbaert et al., 2007). The discrepancy between the two language directions could be explained in the following ways.

On the one hand, the language direction effects in this experiment agree with the inverse frequency effect of structural priming, as predicted by the implicit learning account. The inverse frequency effect presumes that structures with lower frequency would induce higher prediction errors in sentence processing, which would then lead to larger changes in connection weights (the strength of connections between form and meaning elements) during implicit learning, and thereby produce stronger structural priming effects (Chang et al., 2006; Ferreira & Bock, 2006). In this experiment, participants in the L1-L2 prime group were primed with Chinese passives, while those

in the L2-L1 prime group were primed with English passives. Given that the overall frequency of Chinese passives is considerably lower than that of English passives (Lian, 1993; Xiao, 2015; Xiao et al., 2006), it was speculated that Chinese passives would generate greater priming effects than English passives would. That is, L1-L2 priming would be stronger than L2-L1 priming in the experiment, which was confirmed by the results. The inverse frequency effect has also been supported by many previous studies, in which the magnitude of structural priming correlated negatively with the frequency of the primed structure (e.g., Bernolet & Hartsuiker, 2010; Chen et al., 2013; Fine & Jaeger, 2013; Hwang & Shin, 2019; Jaeger & Snider, 2013; Kotzochampou & Chondrogianni, 2022; Scheepers, 2003; Shin & Christianson, 2009). It is therefore possible that the implicit learning mechanism contributed to the direction effects in crosslinguistic structural priming of this experiment.

On the other hand, the language direction effects may be partly explained by the residual activation account of crosslinguistic structural priming. Firstly, regarding the non-selective activation of different languages in the bilingual mind, de Bot (2004)'s multilingual processing model postulates that processing a specific language entails inhibiting irrelevant languages, with the L1 being more readily inhibited than the L2. This phenomenon can be ascribed to the well-established and tightly-organised L1 network, which allows for easier deactivation of the L1 as a whole when compared to the L2, and for easier activation of the L2 than the L1. Consequently, when participants were primed from L1 (prime language) to L2 (target language), elements of the target language were activated to a greater extent than they were during L2-L1 priming, thus magnifying the effects of structural priming and whole language activation.

Secondly, concerning the influence of PL on TL during residual activation, Loebell and Bock (2003) have argued that L1 exerts greater effects on L2 than L2 does on L1. The reason is that the L1, as the dominant language in the mind of L2 learners, has more control of the bilingual processing system, and is likely to produce stronger priming effects on TL than L2 does. According to these explanations, the residual activation of shared structures could also account for the different magnitude of priming across the two language directions.

To summarize, the observed language direction effects in this experiment could be attributed to one or both of the theoretical accounts for crosslinguistic structural priming: implicit learning and residual activation. Drawing on the analysis of L1-L2 and L2-L1 priming in the previous sections, the theoretical foundations for crosslinguistic structural priming in this experiment now

become clear. Chinese and English passive constructions in RCs appear to be shared in the mind of upper-intermediate to advanced EFL learners. Residual activation of the shared structures, along with activation of the entire target language, occurred in both priming directions. The implicit learning mechanism may also have contributed to structural priming in both directions, albeit to a lesser extent than the residual activation mechanism did. Finally, in accordance with both theoretical accounts of crosslinguistic priming, L1-L2 priming occurred with greater magnitude than L2-L1 priming. The reason why L2-L1 priming was not detected might be that the priming effects were too weak to be observed, and/or that the L2-L1 priming of passives was obscured by the priming from L2 actives to L1 passives.

5.4. Pedagogical implications

The occurrence of crosslinguistic structural priming of passives in sentence comprehension generates implications for language pedagogy.

First, crosslinguistic structural priming offers an effective method for enhancing language learners' comprehension of garden-path sentences. In view of the difficulty of parsing and processing L2 garden-path sentences (e.g., Hashimoto, 2011; Yang & Shih, 2013), language teachers could utilize priming as a technique to facilitate learners' processing of temporary structural ambiguities. Teachers are suggested to prime learners with L1 passive RCs, before presenting them with L2 garden-path reduced passive RCs. This priming task could be allocated and performed via the computer, as it was during the study. Such techniques of technology-mediated language learning cater to the needs and interests of L2 learners in the present context (Ziegler & González-Lloret, 2022). However, it is worth noting that this pedagogical approach of priming may only be applicable to learners with upper-intermediate to advanced L2 proficiency, who have fully developed a shared representation system of similar structures across languages. For those in the early stages of L2 development, the shared syntax mechanism might still be underdeveloped, so crosslinguistic structural priming may be less likely to occur.

Second, this research has highlighted the differences between Chinese and English passive constructions in RCs, which make acquiring and processing English passives challenging for Chinese EFL learners (Chang & Wang, 2013, 2016). To facilitate Chinese EFL learners' acquisition of the passive construction and their comprehension of L2 reduced passive relative clauses, teachers should assist learners to understand the differences in passives between Chinese and English. The core principle should be to help learners notice these features in L2 input (Schmidt,

1983, 1990; Schmidt & Frota, 1986). For example, teachers can follow the pedagogy of Focus on Form (FonF), during which learners notice the passive forms as they engage in meaning-focused tasks (e.g., reading/listening tasks) (DeKeyser, 1998; Ellis, 2016; Long, 1991). Teachers can manipulate reading/listening materials by integrating English passives and passive RCs into the texts. To increase the likelihood that learners spontaneously notice the passive structures during the tasks, teachers are recommended to repeat these constructions frequently in L2 materials (Pellicer-Sánchez, 2016; Webb et al., 2013), or underline/bold the passives in reading texts (Bishop, 2004). By fostering learners' attention on these constructions, meanwhile underscoring the L1/L2 differences of passives, teachers could promote learners' understanding and acquisition of English passives.

5.5. Limitations and future directions

While this study has endeavoured to answer the research questions using rigorous methods, there may still exist limitations in the research design and scope. These limitations are addressed in line with directions for future research.

This study adopted a between-subject experiment design to prevent interference between different experiment conditions. However, the results are susceptible to individual differences (e.g., demographic characteristics, personal reading habits/preferences), and should be interpreted with caution (e.g., Farmer et al., 2012; Hopp, 2015, 2022). More importantly, participants completed the experiment using various operation systems and browser types. Although the Gorilla platform has proven to outperform other experiment platforms in recording accurate reaction time across all systems and browsers, subtle variations in time accuracy still exist among different system-browser combinations (Anwyl-Irvine et al., 2020; Pronk et al., 2020). These variations may have impacted the experiment results, particularly considering that the self-paced reading paradigm in priming experiments necessitates extremely high levels of time accuracy. To circumvent these problems, future researchers could employ within-subject designs. It is advisable for each participant to complete different priming experiments on separate days (or with an adequate interval of time) to prevent fatigue and potential interfering effects among different experiments.

Next, L2-L1 priming of passives in this experiment may have been obscured by the priming from L2 actives to L1 passive RCs due to their word order similarities. Future researchers examining L2 (English) to L1 (Chinese) priming of passives within sentence comprehension should revise the prime sentences in the L2-L1 no-prime condition, so that participants are primed

with English active sentences that do not share the same word order with Chinese passive RCs. This practice would allow a more accurate investigation into L2-L1 structural priming, and would likely reveal L2-L1 priming effects of the passive construction during Chinese EFL learners' sentence comprehension.

Additionally, as discussed in Section 3.2.1, the ideal sample size for the experiment is 68 participants per group. Future studies may recruit more participants to ensure that the experiment is well-powered for group comparisons.

Furthermore, a few participants sent anonymous messages to the researcher after completing the experiment, acknowledging that they were not motivated to read all sentences carefully, for they understood the regular pattern of sentences and comprehension questions. To maintain the tried-and-tested pattern of 'two primes + one filler + one target' in each priming trial (Hsieh, 2017; Thothathiri & Snedeker, 2008) and ensure that comprehension questions do not disturb the priming process, future experimenters may consider inserting additional fillers (in both Chinese and English) and corresponding questions between the priming trials. The additional fillers and questions should not appear in a fixed pattern. By adopting this approach, participants would not be able to make predictions about which sentences are accompanied by questions, and would thus read all sentences more attentively. The reliability of the experiment would be consequently enhanced.

Finally, while this research examined L1-L2 and L2-L1 priming of passives in sentence comprehension for Chinese upper-intermediate to advanced EFL learners, a number of issues remain to be explored. It will be meaningful to investigate how these priming effects interact with participants' L2 proficiency (beginner/pre-intermediate/upper-intermediate and advanced levels). This investigation can help us model structural priming effects and explore bilingual structural representation mechanisms across various stages of L2 development. It is also worth studying the influence of age on crosslinguistic structural priming during sentence comprehension: can priming occur with the same magnitude in Chinese-English bilingual children of different age groups? Considering the varying stages of children's cognitive and linguistic development at different ages (Kidd, 2012), it is plausible that crosslinguistic priming effects would differ across age groups. Additionally, the present research did not incorporate neurocognitive techniques (e.g., ERPs, fMRIs) due to limited availability of those experimental facilities. Future researchers may adopt these techniques to enrich our understanding of the online process of crosslinguistic structural

priming in sentence comprehension.

6. Conclusion

This research explored L1-L2 and L2-L1 crosslinguistic structural priming of passives in sentence comprehension among Chinese upper-intermediate to advanced EFL learners. It asked whether the prior reading of L1/L2 passive relative clauses (RCs) would facilitate the subsequent processing of L2/L1 garden-path reduced passive RCs. To address this aim, the study employed a non-cumulative self-paced reading experiment paradigm, and analysed the reading time (RT) for specific regions of garden-path target sentences. Four experiment groups were set up, two for each language direction: L1-L2 prime group, L1-L2 no-prime group, L2-L1 prime group, and L2-L1 no-prime group. Priming effects were investigated by comparing participants' RTs for targets between prime and no-prime groups, and across language directions. The study observed crosslinguistic priming of passives and whole language activation effects from L1 to L2, partially replicating Hsieh (2017)'s findings. Priming effects in the opposite direction were not detected. Various interpretations of the results were discussed.

Overall, it was confirmed that Chinese and English passives in RCs were shared in the mind of proficient bilinguals, despite word order differences in the structures. The results supported a two-stage account of syntactic processing in sentence comprehension (Bock & Levelt, 1994; Hartsuiker, 1999), as well as the developmental account of shared syntax (Hartsuiker & Bernolet, 2017). The L1-L2 priming of the passive construction, along with activation effects of the entire L2, provided evidence for the residual activation account of structural priming (Branigan et al., 1999; Pickering & Branigan, 1998), and might be additionally explained by the presence of an implicit learning mechanism (Bock & Griffin, 2000; Chang et al., 2006). In particular, whole language activation is a novel finding that aligns with de Bot (2004)'s speculations, adding to the literature of crosslinguistic priming. Regarding the absence of L2-L1 priming effects, it is probable that L2-L1 structural priming occurred with a weaker magnitude than L1-L2 priming (Bernolet et al., 2013; Chen et al., 2013; Schoonbaert et al., 2007), and was further obscured by the potential priming from L2 actives to L1 passive RCs due to word order similarities. The influence of language direction on crosslinguistic structural priming corroborated the inverse frequency effect as suggested by the implicit learning account (Chang et al., 2006; Ferreira & Bock, 2006), and also confirmed the predictions implicated by the residual activation account (de Bot, 2004; Loebell & Bock, 2003). These findings contribute to the experimental investigations of crosslinguistic

structural priming in sentence comprehension, and shed light on the underlying mechanisms of bilingual structural representation and L2 processing.

Based on the findings, the study has developed recommendations for pedagogy and research. In order to promote language learners' understanding of L2 garden-path reduced passive sentences, teachers can prime learners with L1 passive structures. The priming task could be designed and conducted via the computer, as a form of technology-mediated language learning (Shin, 2008; Ziegler & González-Lloret, 2022). For Chinese EFL learners, teachers should underscore the differences between Chinese and English passive constructions by helping learners notice these different features.

Turning to future research, it is advisable to adopt a within-subject experiment design for priming research within language comprehension, and to avoid fixed patterns of sentences by inserting additional fillers between priming trials. Future studies on L2 (English) to L1 (Chinese) priming of passive RCs should revise the L2 active prime sentences in the comparison group, so that they do not have a similar word order as L1 passive RCs. Finally, future research could explore how crosslinguistic structural priming in sentence comprehension interacts with participants' age and L2 proficiency, and may also utilise neurocognitive experimental techniques to deepen our insights into online sentence comprehension during crosslinguistic structural priming.

References

Altmann, G. T. M. (1998). Ambiguity in sentence processing. *Trends in Cognitive Sciences*, *2*(4), 146-152. https://doi.org/10.1016/S1364-6613(98)01153-X

Altmann, G. T. M., & Kamide, Y. (1999). Incremental interpretation at verbs: Restricting the domain of subsequent reference. *Cognition*, *73*(3), 247-264. https://doi.org/10.1016/S0010-0277(99)00059-1

Anwyl-Irvine, A., Dalmaijer, E., Hodges, N., & Evershed, J. (2020). *Online timing accuracy and precision: A comparison of platforms, browsers, and participant's devices*. [Manuscript in preparation].

Arai, M., van Gompel, R. P. G., & Scheepers, C. (2007). Priming ditransitive structures in comprehension. *Cognitive Psychology*, *54*(3), 218-250. https://doi.org/10.1016/j.cogpsych.2006.07.001

Berkeley Summer Sessions. (2023). *The English Proficiency Requirement (EPR)*. Retrieved May 10, 2023 from https://summer.berkeley.edu/international/english-proficiency-requirement

Bernolet, S., & Hartsuiker, R. J. (2010). Does verb bias modulate syntactic priming? *Cognition*, *114*(3), 455-461. https://doi.org/10.1016/j.cognition.2009.11.005

Bernolet, S., Hartsuiker, R. J., & Pickering, M. J. (2007). Shared syntactic representations in bilinguals: Evidence for the role of word-order repetition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*(5), 931-949. https://doi.org/10.1037/0278-7393.33.5.931

Bernolet, S., Hartsuiker, R. J., & Pickering, M. J. (2013). From language-specific to shared syntactic representations: The influence of second language proficiency on syntactic sharing in bilinguals. *Cognition*, *127*(3), 287-306. https://doi.org/10.1016/j.cognition.2013.02.005

Bever, T. G. (1970). The cognitive basis for linguistic structures. In J. R. Hayes (Ed.), *Cognition and the development of language* (pp. 279-362). John Wiley.

Bishop, H. (2004). The effect of typographic salience on the look up and comprehension of unknown formulaic sequences. In N. Schmitt (Ed.), *Formulaic sequences: Acquisition, processing, and use* (pp. 227-248). John Benjamins Publishing Company.

Bock, K. (1986). Syntactic persistence in language production. *Cognitive Psychology*, *18*(3), 355-

387. https://doi.org/10.1016/0010-0285(86)90004-6

Bock, K. (1989). Closed-class immanence in sentence production. *Cognition*, *31*(2), 163-186. https://doi.org/10.1016/0010-0277(89)90022-X

Bock, K., & Griffin, Z. M. (2000). The persistence of structural priming: Transient activation or implicit learning? *Journal of Experimental Psychology*, *129*(2), 177-192. https://doi.org/10.1037//0096-3445.129.2.177

Bock, K., & Levelt, W. J. M. (1994). Language production. Grammatical encoding. In M. A. Gernsbacher (Ed.), *Handbook of psycholinguistics* (pp. 945-983). Academic Press.

Bock, K., & Loebell, H. (1990). Framing sentences. *Cognition*, *35*(1), 1-39. https://doi.org/10.1016/0010-0277(90)90035-I

Bock, K., Loebell, H., & Morey, R. (1992). From conceptual roles to structural relations: Bridging the syntactic cleft. *Psychological Review*, *99*(1), 150-171. https://doi.org/10.1037/0033-295X.99.1.150

Branigan, H. P., Pickering, M. J., & Cleland, A. A. (1999). Syntactic priming in written production: Evidence for rapid decay. *Psychonomic Bulletin & Review*, *6*(4), 635-640. https://doi.org/10.3758/bf03212972

Branigan, H. P., Pickering, M. J., & Cleland, A. A. (2000). Syntactic co-ordination in dialogue. *Cognition*, *75*(2), B13-B25. https://doi.org/10.1016/S0010-0277(99)00081-5

Buchanan, E. M., & Scofield, J. E. (2018). Methods to detect low quality data and its implication for psychological research. *Behavior Research Methods*, *50*(6), 2586-2596. https://doi.org/10.3758/s13428-018-1035-6

Button, P. (2009). *Configurations of the real in Chinese literary and aesthetic modernity*. Brill.

Cai, Z. G., Pickering, M. J., Yan, H., & Branigan, H. P. (2011). Lexical and syntactic representations in closely related languages: Evidence from Cantonese–Mandarin bilinguals. *Journal of Memory and Language*, *65*(4), 431-445. https://doi.org/10.1016/j.jml.2011.05.003

Carey, P. W., Mehler, J., & Bever, T. G. (1970). Judging the veracity of ambiguous sentences. *Journal of Verbal Learning and Verbal Behavior*, *9*(2), 243-254. https://doi.org/10.1016/S0022-5371(70)80058-5

Carson, J. E., Carrell, P. L., Silberstein, S., Kroll, B., & Kuehn, P. A. (1990). Reading-writing relationships in first and second language. *TESOL Quarterly*, *24*(2), 245-266.

https://doi.org/10.2307/3586901

Chang, F. (2002). Symbolically speaking: A connectionist model of sentence production. *Cognitive Science*, *26*(5), 609-651. https://doi.org/10.1016/S0364-0213(02)00079-4

Chang, F., Baumann, M., Pappert, S., & Fitz, H. (2015). Do lemmas speak German? A verb position effect in German structural priming. *Cognitive Science*, *39*(5), 1113-1130. https://doi.org/10.1111/cogs.12184

Chang, F., Dell, G. S., Bock, J. K., & Griffin, Z. M. (2000). Structural priming as implicit learning: A comparison of models of sentence production. *Journal of Psycholinguistic Research*, *29*(2), 217-230. https://doi.org/10.1023/a:1005101313330

Chang, F., Dell, G. S., & Bock, K. (2006). Becoming syntactic. *Psychological Review*, *113*(2), 234. https://doi.org/10.1037/0033-295X.113.2.234

Chang, X., & Wang, P. 常欣，王沛 (2013). The syntactic processing of English passive sentence for late Chinese-English bilingualists: An ERP study [晚期汉-英二语者英语被动句句法加工的ERP研究]. *Acta Psychologica Sinica*, *45*(7), 773-782. https://doi.org/10.3724/SP.J.1041.2013.00773

Chang, X., & Wang, P. (2016). Influence of second language proficiency and syntactic structure similarities on the sensitivity and processing of English passive sentence in late Chinese-English bilinguists: An ERP study. *Journal of Psycholinguistic Research*, *45*(1), 85-101. https://doi.org/10.1007/s10936-014-9319-1

Chen, B., Jia, Y., Wang, Z., Dunlap, S., & Shin, J.-A. (2013). Is word-order similarity necessary for cross-linguistic structural priming? *Second Language Research*, *29*(4), 375-389. https://doi.org/10.1177/0267658313491962

Chen, X., Wang, S., & Hartsuiker, R. J. (2023). Do structure predictions persevere to multilinguals' other languages? Evidence from cross-linguistic structural priming in comprehension. *Bilingualism: Language and Cognition*, 1-17. https://doi.org/10.1017/S1366728922000888

Cleland, A. A., & Pickering, M. J. (2003). The use of lexical and syntactic information in language production: Evidence from the priming of noun-phrase structure. *Journal of Memory and Language*, *49*(2), 214-230. https://doi.org/10.1016/S0749-596X(03)00060-3

Cohen, J. (1992). Statistical power analysis. *Current Directions in Psychological Science*, *1*(3), 98-101. https://doi.org/10.1111/1467-8721.ep1076878

Comrie, B., Haspelmath, M., & Bickel, B. (2008/2015). *The Leipzig Glossing Rules: Conventions for interlinear morpheme-by-morpheme glosses*. Max Planck Institute for Evolutionary Anthropology. https://www.eva.mpg.de/lingua/resources/glossing-rules.php

Cuetos, F., Mitchell, D. C., & Corley, M. M. B. (1996). Parsing in different languages. In M. Carreiras, J. E. Garcia-Albea, & N. Sebastian-Galles (Eds.), *Language processing in Spanish* (pp. 145-187). Lawrence Erlbaum Associates.

de Bot, K. (1992). A bilingual production model: Levelt's 'speaking' model adapted. *Applied Linguistics*, *13*(1), 1-24. https://doi.org/10.1093/applin/13.1.1

de Bot, K. (2004). The multilingual lexicon: Modelling selection and control. *International Journal of Multilingualism*, *1*(1), 17-32. https://doi.org/10.1080/14790710408668176

DeFrancis, J. (1984). *The Chinese language: Fact and fantasy*. University of Hawaii Press.

DeKeyser, R. (1998). Beyond focus on form: Cognitive perspectives on learning and practicing second language grammar. In C. Doughty & J. Williams (Eds.), *Focus on form in classroom second language acquisition* (Vol. 28, pp. 42-63). Cambridge University Press.

Dell, G. S. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review*, *93*(3), 283. https://doi.org/10.1037/0033-295X.93.3.283

Deng, T., Zhou, H., Bi, H.-Y., & Chen, B. (2015). Input-based structure-specific proficiency predicts the neural mechanism of adult L2 syntactic processing. *Brain Research*, *1610*, 42-50. https://doi.org/10.1016/j.brainres.2015.03.039

Deng, Y., & Huang, G. 邓云华，黄广平 (2014). A typological study of perspective and markedness of passive sentences [英汉被动句视角与标记性的类型学研究]. *Foreign Languages in China*(1), 22-27. https://www.nssd.cn/html/1/156/159/index.html?lngId=49134210

Desmet, T., & Declercq, M. (2006). Cross-linguistic priming of syntactic hierarchical configuration information. *Journal of Memory and Language*, *54*(4), 610-632. https://doi.org/10.1016/j.jml.2005.12.007

Deutsch, A., & Bentin, S. (1994). Attention mechanisms mediate the syntactic priming effect in auditory word identification. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*(3), 595-607. https://doi.org/10.1037/0278-7393.20.3.595

Dienes, Z., & Berry, D. (1997). Implicit learning: Below the subjective threshold. *Psychonomic Bulletin & Review*, *4*(1), 3-23. https://doi.org/10.3758/BF03210769

Dixon, R. M. (1994). *Ergativity*. Cambridge University Press.

Dörnyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative, and mixed methodologies*. Oxford University Press.

Educational Testing Service. (2021, May). *Setting TOEFL essentials score requirements*. Retrieved May 10, 2023 from https://www.ets.org/toefl/score-users/essentials/set-score-requirements.html#accordion-b9e6e4f624-item-349cca9fa2

Ellis, N. (1993). Rules and instances in foreign language learning: Interactions of explicit and implicit knowledge. *European Journal of Cognitive Psychology*, *5*(3), 289-318. https://doi.org/10.1080/09541449308520120

Ellis, N. C. (1994). Implicit and explicit language learning. In N. C. Ellis (Ed.), *Implicit and explicit learning of languages* (pp. 1-32). Academic Press.

Ellis, R. (2016). Focus on form: A critical review. *Language Teaching Research*, *20*(3), 405-428. https://doi.org/10.1177/1362168816628627

Elman, J. L. (1996). *Rethinking innateness: A connectionist perspective on development*. Cambridge, Mass: The MIT Press. https://doi.org/10.7551/mitpress/5929.001.0001

Farmer, T. A., Misyak, J. B., & Christiansen, M. H. (2012). Individual differences in sentence processing. In K. McRae, M. Joanisse, & M. Spivey (Eds.), *The Cambridge handbook of psycholinguistics* (pp. 353-364). Cambridge University Press. https://doi.org/10.1017/CBO9781139029377.018

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). GPower 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191. https://doi.org/10.3758/BF03193146

Ferreira, F. (2003). The misinterpretation of noncanonical sentences. *Cognitive Psychology*, *47*(2), 164-203. https://doi.org/10.1016/S0010-0285(03)00005-7

Ferreira, V. S., & Bock, K. (2006). The functions of structural priming. *Language and Cognitive Processes*, *21*(7-8), 1011-1029. https://doi.org/10.1080/016909600824609

Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). SAGE.

Fine, A. B., & Jaeger, T. F. (2013). Evidence for implicit learning in syntactic comprehension. *Cognitive Science*, *37*(3), 578-591. https://doi.org/10.1111/cogs.12022

Fleischer, Z., Pickering, M. J., & McLean, J. F. (2012). Shared information structure: Evidence from cross-linguistic priming. *Bilingualism: Language and Cognition*, *15*(3), 568-579.

https://doi.org/10.1017/S1366728911000551

Frazier, L. (1987). Sentence processing: A tutorial review. In M. Coltheart (Ed.), *Attention and performance XII: The psychology of reading* (pp. 559-586). Erlbaum.

Fu, S. 傅斯年 (1919). How to compose in vernacular Chinese [怎样做白话文]. *New Trend*, *1*(2).

Gámez, P. B., & Shimpi, P. M. (2016). Structural priming in Spanish as evidence of implicit learning. *Journal of Child Language*, *43*(1), 207-233. https://doi.org/10.1017/S0305000915000161

Garraffa, M., Coco, M. I., & Branigan, H. P. (2018). Impaired implicit learning of syntactic structure in children with developmental language disorder: Evidence from syntactic priming. *Autism & Developmental Language Impairments*, *3*, 1-15. https://doi.org/10.1177/2396941518779939

Gómez, R. (2007). Statistical learning in infant language development. In M. G. Gaskell (Ed.), *The Oxford handbook of psycholinguistics* (pp. 601-616). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198568971.013.0036

Gries, S. T. (2005). Syntactic priming: A corpus-based approach. *Journal of Psycholinguistic Research*, *34*(4), 365-399. https://doi.org/10.1007/s10936-005-6139-3

Hartsuiker, R. J. (1999). Priming word order in sentence production. *Quarterly Journal of Experimental Psychology*, *52*(1), 129-147. https://doi.org/10.1080/713755798

Hartsuiker, R. J., Beerts, S., Loncke, M., Desmet, T., & Bernolet, S. (2016). Cross-linguistic structural priming in multilinguals: Further evidence for shared syntax. *Journal of Memory and Language*, *90*, 14-30. https://doi.org/10.1016/j.jml.2016.03.003

Hartsuiker, R. J., & Bernolet, S. (2017). The development of shared syntax in second language learning. *Bilingualism: Language and Cognition*, *20*(2), 219-234. https://doi.org/10.1017/S1366728915000164

Hartsuiker, R. J., Pickering, M. J., & Veltkamp, E. (2004). Is syntax separate or shared between languages? Cross-linguistic syntactic priming in Spanish-English bilinguals. *Psychological Science*, *15*(6), 409-414. https://doi.org/10.1111/j.0956-7976.2004.00693.x

Hashimoto, K.-i. (2011). Syntactic processing of L2 English relative clause sentences: The effect of proficiency. *ARELE*, *22*, 95-110. https://doi.org/10.20581/arele.22.0_95

He, Y. 贺阳 (2008). A study of the phenomena of Europeanization in modern Chinese grammar [现代汉语欧化语法现象研究]. *Chinese Teaching in the World*(4), 16-31.

https://www.nssd.cn/html/1/156/159/index.html?lngId=28734375

He, Y. (2019). *The neurocognitive exploration of directionality in Chinese/English sight translation: An fNIRS study* (Publication Number 27744387) [Doctoral dissertation, University of Macau]. ProQuest.

Hopp, H. (2015). Individual differences in the second language processing of object–subject ambiguities. *Applied Psycholinguistics*, *36*(2), 129-173. https://doi.org/10.1017/S0142716413000180

Hopp, H. (2022). Second language sentence processing. *Annual Review of Linguistics*, *8*(1), 235-256. https://doi.org/10.1146/annurev-linguistics-030821-054113

Hsieh, Y. (2017). Structural priming during sentence comprehension in Chinese–English bilinguals. *Applied Psycholinguistics*, *38*(3), 657-678. https://doi.org/10.1017/S0142716416000382

Hsin, L., Legendre, G., & Omaki, A. (2013). Priming cross-linguistic interference in Spanish-English bilingual children. *BUCLD 37 Proceedings*.

Hsu, J.-L. (1994). Englishization and language change in modern Chinese in Taiwan. *World Englishes*, *13*(2), 167-184. https://doi.org/10.1111/j.1467-971X.1994.tb00305.x

Hu, S. 胡适 (1917). A preliminary discussion on literature reform [文学改良刍议]. *New Youth*, *2*(5).

Huang, J., Pickering, M. J., Chen, X., Cai, Z., Wang, S., & Branigan, H. P. (2019). Does language similarity affect representational integration? *Cognition*, *185*, 83-90. https://doi.org/10.1016/j.cognition.2019.01.005

Huettig, F., Rommers, J., & Meyer, A. S. (2011). Using the visual world paradigm to study language processing: A review and critical evaluation. *Acta Psychologica*, *137*(2), 151-171. https://doi.org/10.1016/j.actpsy.2010.11.003

Hwang, H., & Shin, J.-A. (2019). Cumulative effects of syntactic experience in a between- and a within-language context: Evidence for implicit learning. *Journal of Memory and Language*, *109*, 104054. https://doi.org/10.1016/j.jml.2019.104054

Hyltenstam, K., Bylund, E., Abrahamsson, N., & Park, H.-S. (2009). Dominant-language replacement: The case of international adoptees. *Bilingualism: Language and Cognition*, *12*(2), 121-140. https://doi.org/10.1017/S1366728908004008

Jackendoff, R. (1990). *Semantic structures*. MIT Press.

Jaeger, T. F., & Snider, N. (2008). Implicit learning and syntactic persistence: Surprisal and

cumulativity. Proceedings of the 30th annual conference of the cognitive science society, Austin, TX.

Jaeger, T. F., & Snider, N. E. (2013). Alignment as a consequence of expectation adaptation: Syntactic priming is affected by the prime's prediction error given both prior and recent experience. *Cognition*, *127*(1), 57-83. https://doi.org/10.1016/j.cognition.2012.10.013

Jiao, X., & Dou, Q. 焦晓婷，窦琴 (2002). On comparison between the notional passive sentences of English and Chinese [英、汉意念被动句比较研究]. *Journal of Northwest Sci-Tech University of Agriculture and Forestry (Social Science)*, *2*(2), 82-84. https://doi.org/10.3969/j.issn.1009-9107.2002.02.019

Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review*, *87*(4), 329-354. https://doi.org/10.1037/0033-295X.87.4.329

Just, M. A., Carpenter, P. A., & Woolley, J. D. (1982). Paradigms and processes in reading comprehension. *Journal of Experimental Psychology: General*, *111*(2), 228-238. https://doi.org/10.1037/0096-3445.111.2.228

Kachru, B. B. (1986). The power and politics of English. *World Englishes*, *5*(2-3), 121-140. https://doi.org/10.1111/j.1467-971X.1986.tb00720.x

Kachru, B. B. (1994). Englishization and contact linguistics. *World Englishes*, *13*(2), 135-154. https://doi.org/10.1111/j.1467-971X.1994.tb00303.x

Kamide, Y., Altmann, G. T. M., & Haywood, S. L. (2003). The time-course of prediction in incremental sentence processing: Evidence from anticipatory eye movements. *Journal of Memory and Language*, *49*(1), 133-156. https://doi.org/https://doi.org/10.1016/S0749-596X(03)00023-8

Kempen, G. (1977). Conceptualizing and formulating in sentence production. In S. Rosenberg (Ed.), *Sentence production: Developments in research and theory* (pp. 259-274). Erlbaum.

Kidd, E. (2012). Individual differences in syntactic priming in language acquisition. *Applied Psycholinguistics*, *33*(2), 393-418. https://doi.org/10.1017/S0142716411000415

Kotzochampou, S., & Chondrogianni, V. (2022). How similar are shared syntactic representations? Evidence from priming of passives in Greek–English bilinguals. *Bilingualism: Language and Cognition*, 1-13. https://doi.org/10.1017/S136672892200027X

Larson, W. (2009). *From Ah Q to Lei Feng: Freud and revolutionary spirit in 20th century China*. Stanford University Press.

Ledoux, K., Traxler, M. J., & Swaab, T. Y. (2007). Syntactic priming in comprehension: Evidence from event-related potentials. *Psychological Science*, *18*(2), 135-143. https://doi.org/10.1111/j.1467-9280.2007.01863.x

Lemhöfer, K. M., & Broersma, M. (2012). Introducing LexTALE: A quick and valid Lexical Test for Advanced Learners of English. *Behavior Research Methods*, *44*(2), 325-343. https://doi.org/10.3758/s13428-011-0146-0

Levelt, W. J. M., & Kelter, S. (1982). Surface form and memory in question answering. *Cognitive Psychology*, *14*(1), 78-106. https://doi.org/10.1016/0010-0285(82)90005-6

Lian, S. 连淑能 (1993). *Contrastive studies of English and Chinese* [英汉对比研究]. Higher Education Press.

Liang, L., Chondrogianni, V., & Chen, B. (2022). Online processing of the grammatical aspect marker by L2 Chinese learners. *Second Language Research*, *38*(4), pp765-786. https://doi.org/10.1177/0267658321996423

Lim, J. H., & Christianson, K. (2013). Second language sentence processing in reading for comprehension and translation. *Bilingualism*, *16*(3), 518-537. https://doi.org/10.1017/S1366728912000351

Loebell, H., & Bock, K. (2003). Structural priming across languages. *Linguistics*, *41*(5), 791-824. https://doi.org/10.1515/ling.2003.026

Long, M. H. (1991). Focus on form: A design feature in language teaching methodology. In K. de Bot, R. B. Ginsberg, & C. J. Kramsch (Eds.), *Foreign language research in cross-cultural perspective* (pp. 39-51). John Benjamins Publishing Company.

Lu, X. (1934/1981). Letters on translation [关于翻译的通信]. In *Complete works of Lu Xun* (Vol. 5). People’s Literature Publishing House.

Marsden, H., Whong, M., & Gil, K.-H. (2018). What’s in the textbook and what’s in the mind: Polarity item “any” in learner English. *Studies in Second Language Acquisition*, *40*(1), 91-118. https://doi.org/10.1017/S0272263117000018

Messenger, K. (2021). The persistence of priming: Exploring long-lasting syntactic priming effects in children and adults. *Cognitive Science*, *45*(6), Article e13005. https://doi.org/10.1111/cogs.13005

Messenger, K. (Ed.). (2022). *Syntactic priming in language acquisition: Representations, mechanisms and applications*. John Benjamins Publishing Company.

https://doi.org/https://doi.org/10.1075/tilar.31

Michas, I. C., & Berry, D. C. (1994). Implicit and explicit processes in a second-language learning task. *European Journal of Cognitive Psychology*, *6*(4), 357-381. https://doi.org/10.1080/09541449408406520

Miralpeix, I., & Muñoz, C. (2018). Receptive vocabulary size and its relationship to EFL language skills. *International Review of Applied Linguistics in Language Teaching*, *56*(1), 1-24. https://doi.org/10.1515/iral-2017-0016

Noppeney, U., & Price, C. J. (2004). An fMRI study of syntactic adaptation. *Journal of Cognitive Neuroscience*, *16*(4), 702-713. https://doi.org/10.1162/089892904323057399

Paradis, M. (2004). *A neurolinguistic theory of bilingualism*. John Benjamins Publishing Company.

Pellicer-Sánchez, A. (2016). Incidental L2 vocabulary acquisition from and while reading: An eye-tracking study. *Studies in Second Language Acquisition*, *38*(1), 97-130. https://doi.org/10.1017/S0272263115000224

Perruchet, P. (2008). Implicit learning. In H. L. Roediger (Ed.), *Cognitive psychology of memory. Learning and memory: A comprehensive reference.* (Vol. 2, pp. 597–621). Elsevier.

Phillips, I. (2018). *Syntactic processing and cross-linguistic structural priming in heritage Spanish speakers and late bilinguals: Effects of exposure to L2 English on processing illicit structures in L1 Spanish* (Publication Number 10932966) [Doctoral dissertation, The City University of New York]. ProQuest.

Pickering, M. J., & Branigan, H. P. (1998). The representation of verbs: Evidence from syntactic priming in language production. *Journal of Memory and Language*, *39*(4), 633-651. https://doi.org/10.1006/jmla.1998.2592

Pickering, M. J., Branigan, H. P., & McLean, J. F. (2002). Constituent structure is formulated in one stage. *Journal of Memory and Language*, *46*(3), 586-605. https://doi.org/10.1006/jmla.2001.2824

Pickering, M. J., & Ferreira, V. S. (2008). Structural priming: A critical review. *Psychological Bulletin*, *134*(3), 427-459. https://doi.org/10.1037/0033-2909.134.3.427

Pickering, M. J., McLean, J. F., & Branigan, H. P. (2013). Persistent structural priming and frequency effects during comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *39*(3), 890-897. https://doi.org/10.1037/a0029181

Pronk, T., Wiers, R. W., Molenkamp, B., & Murre, J. (2020). Mental chronometry in the pocket?

Timing accuracy of web applications on touchscreen and keyboard devices. *Behavior Research Methods*, *52*(3), 1371-1382. https://doi.org/10.3758/s13428-019-01321-2

Rowland, C. (2014). *Understanding child language acquisition*. Routledge. https://doi.org/10.4324/9780203776025

Saffran, J. R. (2003). Statistical language learning: Mechanisms and constraints. *Current Directions in Psychological Science*, *12*(4), 110-114. https://doi.org/10.1111/1467-8721.01243

Salamoura, A., & Williams, J. N. (2006). Lexical activation of cross-language syntactic priming. *Bilingualism: Language and Cognition*, *9*(3), 299-307.

Scheepers, C. (2003). Syntactic priming of relative clause attachments: Persistence of structural configuration in sentence production. *Cognition*, *89*(3), 179-205. https://doi.org/10.1016/S0010-0277(03)00119-7

Scheepers, C., & Crocker, M. W. (2004). Constituent order priming from reading to listening: A visual-world study. In M. Carreiras & J. C. Charles (Eds.), *The on-line study of sentence comprehension: Eyetracking, ERP, and beyond* (pp. 167-186). Psychology Press.

Schmidt, R. (1983). Interaction, acculturation, and the acquisition of communicative competence: A case study of an adult. In N. Wolfson & E. Judd (Eds.), *Sociolinguistics and language acquisition* (pp. 137-174). Newbury House.

Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics*, *11*(2), 129-158. https://doi.org/10.1093/applin/11.2.129

Schmidt, R., & Frota, S. (1986). Developing basic conversational ability in a second language: A case study of an adult learner of Portuguese. In R. Day (Ed.), *Talking to learn: Conversation in second language acquisition* (pp. 237-326). Newbury House.

Schoonbaert, S., Hartsuiker, R. J., & Pickering, M. J. (2007). The representation of lexical and syntactic information in bilinguals: Evidence from syntactic priming. *Journal of Memory and Language*, *56*(2), 153-171. https://doi.org/10.1016/j.jml.2006.10.002

Segaert, K. R., Menenti, L. M. E., Weber, K. M., Petersson, K. M., & Hagoort, P. (2012). Shared syntax in language production and language comprehension: An fMRI study. *Cerebral Cortex*, *22*(7), 1662-1670. https://doi.org/10.1093/cercor/bhr249

Seger, C. A. (1994). Implicit learning. *Psychological Bulletin*, *115*(2), 163-196. https://doi.org/10.1037/0033-2909.115.2.163

Seger, C. A. (1998). Multiple forms of implicit learning. In M. A. Stadler & P. A. Frensch (Eds.), *Handbook of implicit learning* (pp. 295-320). Sage Publications.

Shin, J.-A. (2008). *Structural priming in bilingual language processing and second language learning* (Publication Number 3347510) [Doctoral dissertation, University of Illinois at Urbana-Champaign]. ProQuest.

Shin, J.-A. (2010). Structural priming and L2 proficiency effects on bilingual syntactic processing in production. *Korean Journal of English Language and Linguistics*, *10*(3), 499-518.

Shin, J.-A., & Christianson, K. (2009). Syntactic processing in Korean-English bilingual production: Evidence from cross-linguistic structural priming. *Cognition*, *112*(1), 175-180. https://doi.org/10.1016/j.cognition.2009.03.011

Southern Cross University. (2020, September 9). *English language proficiency IELTS and CEFR equivalency schedule*. Retrieved May 10, 2023 from https://policies.scu.edu.au/download.php?id=449&version=7&associated

Stadler, M. A., & Frensch, P. A. (1998). *Handbook of implicit learning*. Sage Publications.

Szmrecsanyi, B. (2005). Language users as creatures of habit: A corpus-based analysis of persistence in spoken English. *Corpus Linguistics and Linguistic Theory*, *1*(1), 113-150. https://doi.org/doi:10.1515/cllt.2005.1.1.113

Tannen, D. (1987). Repetition in conversation: Toward a poetics of talk. *Language*, *63*(3), 574-605. https://doi.org/10.2307/415006

Thothathiri, M., & Snedeker, J. (2008). Give and take: Syntactic priming during spoken language comprehension. *Cognition*, *108*(1), 51-68. https://doi.org/10.1016/j.cognition.2007.12.012

Tooley, K. M., Pickering, M. J., & Traxler, M. J. (2019). Lexically-mediated syntactic priming effects in comprehension: Sources of facilitation. *Quarterly Journal of Experimental Psychology*, *72*(9), 2176-2196.

Tooley, K. M., & Traxler, M. J. (2010). Syntactic priming effects in comprehension: A critical review. *Language and Linguistics Compass*, *4*(10), 925-937. https://doi.org/10.1111/j.1749-818X.2010.00249.x

Traxler, M. J. (2012). *Introduction to psycholinguistics: Understanding language science*. Wiley-Blackwell.

Traxler, M. J., & Tooley, K. M. (2008). Priming in sentence comprehension: Strategic or syntactic? *Language and Cognitive Processes*, *23*(5), 609-645.

https://doi.org/10.1080/01690960701639898

Trofimovich, P., & McDonough, K. (Eds.). (2011). *Applying priming methods to L2 learning, teaching and research*. John Benjamins Publishing Company. https://doi.org/10.1075/lllt.30

Trueswell, J. C., & Tanenhaus, M. K. (1991). Tense, temporal context and syntactic ambiguity resolution. *Language and Cognitive Processes*, *6*(4), 303-338. https://doi.org/10.1080/01690969108406946

Trueswell, J. C., Tanenhaus, M. K., & Kello, C. (1993). Verb-specific constraints in sentence processing: Separating effects of lexical preference from garden-paths. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19*(3), 528-553. https://doi.org/10.1037/0278-7393.19.3.528

Ullman, M. T. (2001). The neural basis of lexicon and grammar in first and second language: the declarative/procedural model. *Bilingualism: Language and Cognition*, *4*(2), 105-122. https://doi.org/10.1017/S1366728901000220

Vasilyeva, M., & Waterfall, H. (2012). Beyond syntactic priming: Evidence for activation of alternative syntactic structures. *Journal of Child Language*, *39*(2), 258-283. https://doi.org/10.1017/S0305000911000055

Wang, L. 王力 (1958/1980). *The history of the Chinese language* [汉语史稿]. Zhonghua Book Company.

Webb, S., Newton, J., & Chang, A. (2013). Incidental learning of collocation. *Language Learning*, *63*(1), 91-120. https://doi.org/10.1111/j.1467-9922.2012.00729.x

Weiner, E. J., & Labov, W. (1983). Constraints on the agentless passive. *Journal of Linguistics*, *19*(1), 29-58. https://doi.org/10.1017/S0022226700007441

Wheeldon, L., & Smith, M. (2003). Phrase structure priming: A short-lived effect. *Language and Cognitive Processes*, *18*(4), 431-442. https://doi.org/10.1080/01690960244000063

Williams, J. N., & Rebuschat, P. (2012). Statistical learning and syntax: What can be learned and what difference does meaning make. In P. Rebuschat & J. N. Williams (Eds.), *Statistical learning and language acquisition* (pp. 237-264). De Gruyter.

Witzel, N., Witzel, J., & Forster, K. (2012). Comparisons of online reading paradigms: Eye tracking, moving-window, and maze. *Journal of Psycholinguistic Research*, *41*(2), 105-128. https://doi.org/10.1007/s10936-011-9179-x

Wonnacott, E. (2013). Learning: Statistical mechanisms in language acquisition. In P. M. Binder & K. Smith (Eds.), *The language phenomenon: Human communication from milliseconds to millennia* (pp. 65-92). Springer. https://doi.org/10.1007/978-3-642-36086-2_4

Wright, B., & Garrett, M. (1984). Lexical decision in sentences: Effects of syntactic structure. *Memory & Cognition*, *12*(1), 31-45. https://doi.org/10.3758/BF03196995

Wu, S. 武氏河 (2006). *A study on modern Chinese word order* 现代汉语语序研究 [Doctoral dissertation, Nanjing Normal University]. https://doi.org/10.7666/d.y981489

Xiao, R. (2015). Contrastive corpus linguistic studies of English and Chinese: The cases of passive constructions and classifiers. *Journal of Chinese Linguistics Monograph Series*(25), 82-114. https://www.jstor.org/stable/10.2307/26455280

Xiao, R., McEnery, T., & Qian, Y. (2006). Passive constructions in English and Chinese: A corpus-based contrastive study. *Languages in Contrast*, *6*(1), 109-149. https://doi.org/10.1075/lic.6.1.05xia

Xu, J. 许进 (2004). Questioning “symbol passive sentence” [“标志被动句”质疑]. *Journal of Jining Teachers’ College*, *25*(1), 105-109. https://doi.org/10.3969/j.issn.1004-1877.2004.01.024

Yang, P.-L., & Shih, S.-C. (2013). A reading-time study of the main verb versus reduced relative clause ambiguity resolution by English learners in Taiwan. *Applied Psycholinguistics*, *34*(6), 1109-1133. https://doi.org/10.1017/S0142716412000343

Yu, G. 余光中 (1987, October 1). How to improve Englishnised Chinese: The normal and abnormal states of Chinese 怎样改进英式中文——论中文的常态与变态. *Mingpao Monthly*.

Zeng, L. 曾丽苏 (1994). On the functions of the passive and its contextual situation of use [试论被动语态的功能及其使用的语境]. *Foreign Language Education*(1), 57-64. https://www.nssd.cn/html/1/156/159/index.html?lngId=1003324626

Zhang, H.-P., Liu, Q., Cheng, X., Zhang, H., & Yu, H.-K. (2003). Chinese lexical analysis using hierarchical hidden Markov model. Proceedings of the second SIGHAN workshop on Chinese language processing, Sapporo, Japan.

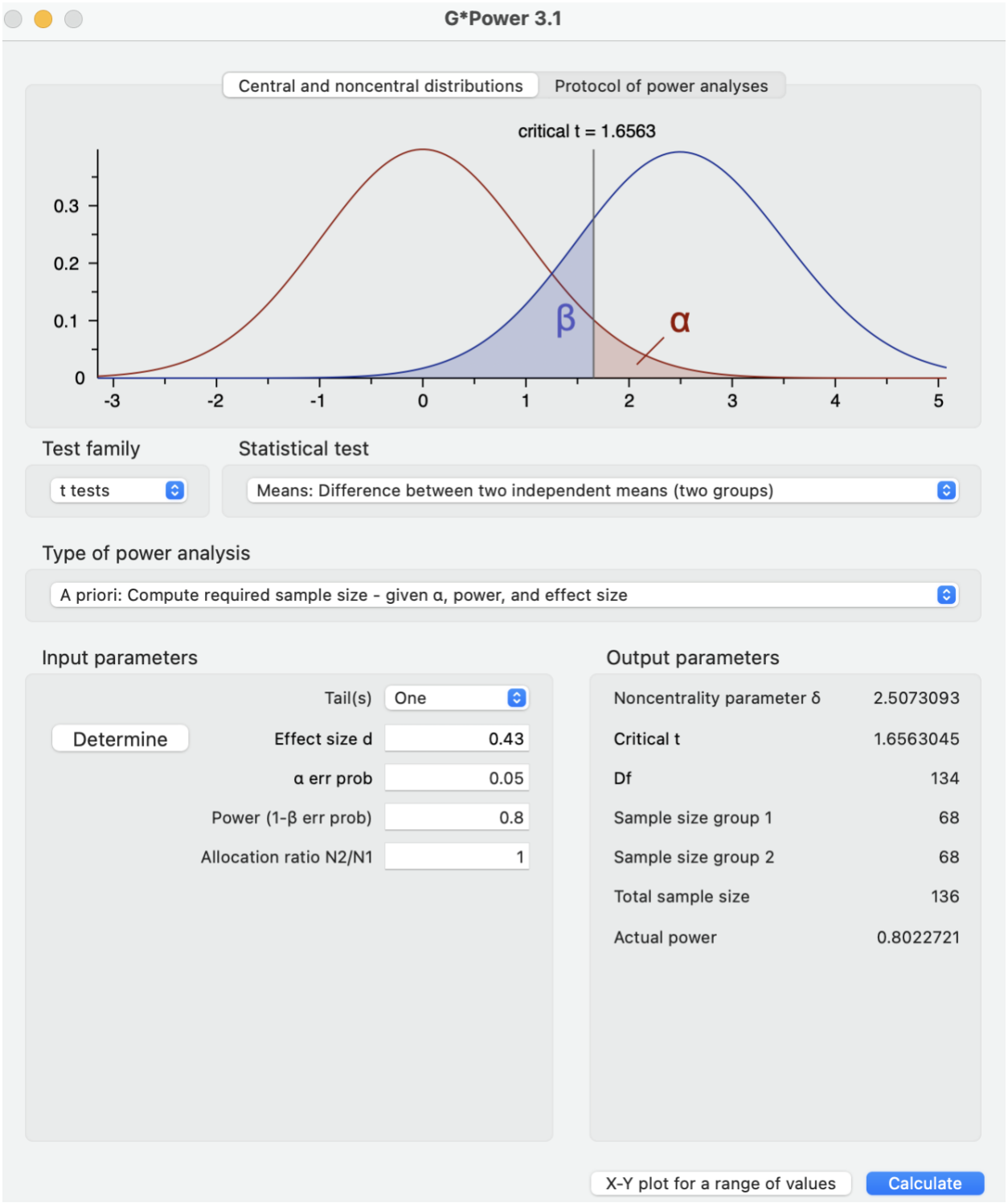
Zhu, C. 朱长瑶 (1987). On the notional passive sentences of Classical Chinese [古汉语意念被动句刍议]. *Journal of Xuzhou Normal University (Philosophy and Social Sciences*

Edition)(4), 45-49. https://www.nssd.cn/html/1/156/159/index.html?lngId=1003086835

Ziegler, N., & González-Lloret, M. (Eds.). (2022). *The Routledge handbook of second language acquisition and technology*. Taylor & Francis. https://doi.org/10.4324/9781351117586

Appendices

Appendix A. Power analysis



Appendix B. Recruitment flyer



The flyer is disseminated with the experiment link:
https://research.sc/participant/login/dynamic/7B6F6FDF-1EB0-42C9-81F6-DA75E500D058

**Note: The flyer above briefly explains the procedures, requirements, and rewards of the experiment, and provides contact information of the researcher. Participants could directly access the experiment by clicking on the accompanying link.*

Appendix C. Post-test questionnaire

**Note: Participants were given a Chinese version of this questionnaire.*

In this section, you will answer some questions about your personal information and language background.

1. What is your age?
    A. 18 to 30
    B. 31 to 50
    C. 50 and above
    D. Prefer not to say

2. What is your gender?
    A. Male
    B. Female
    C. Prefer not to say

3. What is your highest education level (including current)?
    A. Primary school
    B. Secondary school
    C. Bachelor's degree
    D. Master's degree and above
    E. Prefer not to say

4. At what age did you start learning English?
    A. Please specify: _____
    B. Prefer not to say

5. Do you have any English language qualifications? (e.g., CET-4/6, TEM-4/8, IELTS, TOEFL)
    A. Please specify (if possible, please specify your score): _____
    B. Prefer not to say

6. What is the percentage of English in your everyday language use during the past few months?

A. 0-20%

B. 20-40%

C. 40-60%

D. 60-80%

E. 80%-100%

F. Prefer not to say

7. Apart from Mandarin Chinese and English, do you speak other languages fluently?

A. Yes (please specify): _____

B. No (jump to Question 9)

C. Prefer not to say (jump to Question 9)

8. If so, except Mandarin Chinese, is English your best language?

A. Yes

B. No (please specify your best language): _____

C. Prefer not to say

9. Do you speak any other language(s)?

A. Yes (please specify): _____

B. No

C. Prefer not to say

Appendix D. Experiment materials

Sentence type	Function	Session	Sentence
Chinese passive RCs (Nine words)	**Primes** (Condition (A))	Practice	1. 那个 被 守卫 发现 的 难民 跨越 了 边境。
			2. 那个 被 秘书 辅佐 的 经理 参与 了 会议。
			3. 那个 被 医生 治愈 的 士兵 撰写 了 自传。
			4. 那只 被 农民 喂养 的 猪仔 睡得 很 香甜。
		Experiment	1. 那个 被 朋友 邀请 的 女孩 参加 了 聚会。
			2. 那个 被 祖母 溺爱 的 男孩 变得 很 淘气。
			3. 那个 被 校长 喜爱 的 学生 取得 了 高分。
			4. 那个 被 店员 认出 的 演员 感到 很 尴尬。
			5. 那个 被 母亲 批评 的 孩子 哭得 很 伤心。
			6. 那只 被 老虎 追赶 的 兔子 跳进 了 河流。
			7. 那个 被 商人 雇佣 的 司机 收到 了 报酬。
			8. 那个 被 医生 治疗 的 病人 存活 了 很久。
			9. 那个 被 对手 打败 的 选手 感到 很 沮丧。
			10. 那些 被 主人 接待 的 宾客 休息 了 片刻。
			11. 那个 被 恶霸 击打 的 女人 尖叫 了 几声。
			12. 那个 被 保安 逮捕 的 强盗 受到 了 惩罚。
			13. 那个 被 世人 知晓 的 冠军 打破 了 纪录。
			14. 那个 被 市民 选出 的 官员 发起 了 运动。
			15. 那只 被 猫咪 捉住 的 小鸟 扑棱 了 翅膀。
			16. 那个 被 读者 鼓励 的 作家 增加 了 信心。
			17. 那些 被 教授 指导 的 学生 完成 了 任务。
			18. 那个 被 兄弟 咨询 的 律师 提供 了 建议。
			19. 那个 被 新郎 亲吻 的 新娘 笑得 很 幸福。
			20. 那个 被 村民 敬仰 的 首领 颁布 了 规定。

Chinese active sentences (Nine words)	**Primes** (Condition (B))	Practice	1. 那个 绝望 的 难民 跨越 了 国家 的 边境。
			2. 那个 忙碌 的 经理 参与 了 重要 的 会议。
			3. 那个 退伍 的 士兵 撰写 了 厚厚 的 自传。
			4. 那个 勤劳 的 农民 种植 了 丰富 的 蔬果。
		Experiment	1. 那些 年轻 的 女孩 邀请 了 亲密 的 朋友。
			2. 那个 慈祥 的 祖母 溺爱 了 淘气 的 孙子。
			3. 那个 权威 的 校长 表扬 了 勤奋 的 学生。
			4. 那个 本地 的 店员 认出 了 著名 的 演员。
			5. 那个 负责 的 母亲 批评 了 犯错 的 孩子。
			6. 那只 凶猛 的 老虎 追赶 了 可爱 的 兔子。
			7. 那个 富有 的 商人 雇佣 了 合格 的 司机。
			8. 那个 优秀 的 医生 治愈 了 危重 的 病人。
			9. 那个 高明 的 选手 打败 了 天真 的 对手。
			10. 那个 热情 的 主人 接待 了 尊贵 的 宾客。
			11. 那个 暴力 的 恶霸 击打 了 柔弱 的 女人。
			12. 那个 英勇 的 保安 逮捕 了 恶劣 的 强盗。
			13. 那些 着迷 的 观众 看到 了 帅气 的 冠军。
			14. 那些 理智 的 公民 选出 了 政府 的 官员。
			15. 那只 黑色 的 猫咪 捉住 了 漂亮 的 小鸟。
			16. 那些 忠实 的 读者 鼓励 了 杰出 的 作家。
			17. 那位 显赫 的 教授 指导 了 全班 的 学生。
			18. 那对 焦虑 的 兄弟 咨询 了 著名 的 律师。
			19. 那个 英俊 的 新郎 亲吻 了 美丽 的 新娘。
			20. 那些 淳朴 的 村民 拜访 了 伟大 的 首领。
	Fillers (Conditions (A) & (B))	Practice	1. 尽管 我们 很少 见面， 我们 还是 要好 的 朋友。
			2. 虽然 他 变得 非常 富有， 他 仍旧 尊重 我们。

		Experiment	1. 那个 木工 虽然 年纪 轻， 但是 经验 非常 丰富。
			2. 他 走出 大楼 的 时候， 外面 下着 倾盆 大雨。
			3. 为了 讨论 这个 问题， 领导 召开 了 紧急 会议。
			4. 她 到达那个 城市 只 花费 了 半个 小时。
			5. 数学 考试 之前，那个 学生 整个 晚上 没有 睡觉。
			6. 那群 志愿者 成功 拯救 了 火灾 中 的 居民。
			7. 她 购买 了 一条 羊毛 围巾， 但是 弄丢 了。
			8. 我 曾经 每天 晚上 和 家人 一起 看 电视。
			9. 她 变成 亿万 富翁 之后， 周游 了 整个 世界。
			10. 为了 治理 空气 污染， 政府 采取 了 诸多 措施。
English passive RCs (11 words)	**Primes** (Condition (C))	Practice	1. The refugee who was spotted by the guard crossed the borders.
			2. The manager who was assisted by the secretary attended a meeting.
			3. The soldier who was healed by the doctor wrote an autobiography.
			4. The piggy that was fed by the farmer slept very soundly.
		Experiment	1. The girl who was invited by her friends attended the party.
			2. The boy who was spoiled by his grandmother became very naughty.
			3. The student who was favoured by the principal attained good grades.
			4. The actress who was recognised by the salesperson

			felt very embarrassed.
			5. The kid who was criticised by his mother cried very sadly.
			6. The rabbit that was chased by the tiger jumped into river.
			7. The driver who was hired by the businesswoman got weekly pays.
			8. The patient who was treated by experienced doctors managed to survive.
			9. The athlete who was defeated by his opponent felt quite disappointed.
			10. The guests who were greeted by the hostess took a rest.
			11. The woman who was hit by the bullies screamed with fear.
			12. The robber who was arrested by the police received heavy punishment.
			13. The champion who was known by the world broke new records.
			14. The official who was elected by the citizens started a campaign.
			15. The bird that was captured by the cat fluttered its wings.
			16. The writer who was encouraged by the readers gained more confidence.
			17. The students who were supervised by the professor completed the tasks.
			18. The lawyer who was consulted by the brothers offered them suggestions.
			19. The bride who was kissed by the groom smiled with

			happiness.
			20. The chief who was respected by the villagers issued a regulation.
English active sentences (11 words)	**Primes** (Condition (D))	Practice	1. The desperate refugee tried his best to cross the national borders.
			2. The busy manager took time to attend the important annual meeting.
			3. The volunteer soldier wrote an autobiography after he retired last year.
			4. The diligent farmer planted many fruits and vegetables on his farmland.
		Experiment	1. The young girls invited their good friend to the dinner party.
			2. The kind grandmother spoiled her little naughty grandson way too much.
			3. The authoritative principal favoured every hardworking student with very good grades.
			4. The local salesperson recognised that famous actress in the grocery store.
			5. The responsible mother criticised her little kid for being too impolite.
			6. The fierce tiger chased the lovely white rabbit along the river.
			7. The rich businesswoman hired a driver with years of driving experience.
			8. The experienced doctors treated the patient with the most powerful medicine.
			9. The skilful athlete defeated his opponent with a series of strategies.
			10. The hospitable hostess greeted the distinguished

			guests on their first arrival.
			11. The violent bullies hit that weak woman suddenly on the street.
			12. The security guard arrested that notorious robber in the national bank.
			13. The whole world knew that boxing champion during the Olympic Games.
			14. The civil citizens elected the government officials around three years ago.
			15. The black cat captured a singing bird with beautiful blue feathers.
			16. The faithful readers encouraged the column writer to publish more articles.
			17. The eminent professor supervised the entire class of students last semester.
			18. The anxious brothers consulted the human rights lawyer over the telephone.
			19. The handsome groom kissed the beautiful bride during the wedding ceremony.
			20. The rustic villagers respected their great military chief with absolute loyalty.
	Fillers (Conditions (C) & (D))	Practice	1. Although we rarely saw each other, we were still good friends.
			2. Even though he became richer, he still respected me as always.
		Experiment	1. Although the carpenter was quite young, he had much practical experience.
			2. When he walked out of the building, it was raining heavily.
			3. The board of directors held a meeting to discuss the

			problem.
			4. She spent only half an hour to travel to that city.
			5. The student stayed up the whole night before the maths exam.
			6. The group of volunteers successfully rescued the residents from the fire.
			7. She bought a woollen scarf, but she could not find it.
			8. I used to watch television with my family members every evening.
			9. After she became a billionaire, she travelled all around the world.
			10. The government took action to tackle air pollution in the country.

Sentence Type	Function	Session	Sentence (Regions labelled by double slash marks: "//")	Comprehension question (Answer highlighted)
English reduced passive RCs (11 words: 3+1+3+1+3)	**Targets** (Conditions (A) & (B))	Practice	1. The great travellers // guided // by the staff // went // into the cave.	Did the travellers enter the cave? (Yes; No)
			2. The company boss // interviewed // by the reporter // answered // a few questions.	Who answered the questions? (The reporter; The boss)
		Experiment	1. The intelligent painter // praised // by the manager // created // the best products.	Who created the products? (The painter; The manager)
			2. The brave soldier // shot // by the enemy // called // out for help.	Did anyone shoot the soldier? (Yes; No)
			3. The little child // hugged // by the nurse // recovered // from the disease.	Did the child become healthier? (Yes; No)
			4. The strong man // frightened // by the fox // gained // much more courage.	What frightened the man? (The eagle; The fox)
			5. The new employee // appreciated // by the boss // got // a huge salary.	Did the boss like the new employee? (Yes; No)
			6. The old lady // assisted // by the boy // expressed // her heartfelt thanks.	Who felt grateful? (The boy; The lady)
			7. The young thief // discovered // by the police // ran	Did anyone see the thief?

			// away very quickly.	(Yes; No)
			8. The football player // insulted // by the coach // wrote // a complaint letter.	Who had complaints? (The coach; The footballer)
			9. The wild dog // attacked // by the lion // barked // loudly and angrily.	Which animal barked? (The dog; The lion)
			10. The famous scholar // welcomed // by the mayor // made // a public speech.	Who welcomed the scholar? (The professor; The mayor)
Chinese reduced passive RCs (Nine words: (2+1+2+2+2)	**Targets** (Conditions (C) & (D))	Practice	1. 那个 向导 // 引领 // 的 旅客 // 进入 了 // 洞穴 深处。	旅客进入洞穴了吗？ （是；否）
			2. 那个 记者 // 采访 // 的 老板 // 回答 了 // 几个 问题。	谁回答了问题？ （老板；记者）
		Experiment	1. 那个 经理 // 夸奖 // 的 画家 // 创造 了// 优秀 作品。	谁创造了作品？ （经理；画家）
			2. 那个 敌人 // 射中 // 的 士兵 // 发出 了 // 求救 信号。	有人射中了士兵吗？ （是；否）
			3. 那个 护士 // 拥抱 // 的 孩子 // 恢复 了 // 身体 健康。	孩子更健康了吗？ （是；否）
			4. 那个 狐狸 // 吓唬 // 的 男人 // 变成 了 // 一个 傻子。	是什么吓到了男人？ （老鹰；狐狸）
			5. 那个 老板 // 欣赏 // 的 员工 // 收获 了 // 丰厚 薪	老板喜欢那个员工吗？

			资。	（是；否）
			6. 那个 男孩 // 帮助 // 的 妇人 // 表达 了 // 诚挚 感谢。	谁表达了感激？ （妇人；男孩）
			7. 那个 警察 // 发现 // 的 小偷 // 逃跑 得 // 非常 迅速。	有人看到了小偷吗？ （是；否）
			8. 那个 教练 // 辱骂 // 的 队员 // 撰写 了 // 投诉 信件。	谁写了投诉信？ （队员；教练）
			9. 那个 狮子 // 攻击 // 的 野狗 // 吠叫 得 // 十分 大声。	哪个动物叫了？ （狮子；野狗）
			10. 那个 市长 // 欢迎 // 的 学者 // 发表 了 // 公开 演讲。	谁欢迎了学者？ （市长；教授）

Appendix E. CUREC approval for the study

From: Liam Gearon <liam.gearon@education.ox.ac.uk>
Subject: CUREC
Date: 2 March 2023 at 11:22:49 GMT
To: Yingshang Gong < yingshang.gong@education.ox.ac.uk>
Cc: Student CUREC <student.curec@education.ox.ac.uk>, Faidra Faitaki < faidra.faitaki@education.ox.ac.uk>

2 March 2023

Dear Yingshang

Research ethics approval

Research title:

Effects of directionality in crosslinguistic structural priming:
Evidence from sentence comprehension in Chinese proficient EFL learners

Research ethics reference:

EDUC_C1A_23_100

The above application has been considered on behalf of the Education Departmental Research Ethics Committee (DREC) in accordance with the University's procedures for ethical approval of all research involving human participants.

I am pleased to confirm that, on the basis of the information provided to the DREC, ethics approval has now been granted for this study.

Please note the following:

Personal data: It is the responsibility of the PI to ensure that all personal data collected during

the project is managed in accordance with the University's guidance and legal requirements.

In-person activities: Any data collection involving in-person interactions with participants must have an up-to-date fieldwork risk assessment in place; further guidance is available from the Safety Office's website.

Amendments: Please notify the committee if you intend to make any amendments to the information in your ethics application as submitted at date of this approval, as all changes must receive ethical approval prior to implementation. The amendment form is available on the SSH IDREC webpage.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to staff.curec@education.ox.ac.uk / student.curec@education.ox.ac.uk or ethics@socsci.ox.ac.uk.

Yours sincerely

Liam Francis Gearon

DREC Chair

Appendix F. Participant information sheet and consent form

**Note: Participants were presented with a Chinese version of this sheet.*

【About the device】： Please enter the experiment with a computer (phones or iPads are not supported). Remember to turn off the "automatic translation" function in your browser. Thanks!

【Getting stuck?】： If you get stuck for unknown reasons during the experiment, please reload the page and try again. Thanks again!!

【Environment requirement】： Please complete the experiment in a quiet environment (without disturbances from human speech). Much thanks!!!

1.General Information

This research is about bilingual sentence processing. It has received ethics clearance through the University of Oxford Central University Research Ethics Committee [EDUC_C1A_23_100] in March, 2023. You have been invited to participate as you are **(1) a native Chinese speaker**; **(2) a learner of English as a foreign language**; **(3) a relatively-proficient English speaker**; and **(4) an adult**.

In this research, you will **first** take an English vocabulary test (LexTALE). You will **then** read a number of English and Chinese sentences and answer several comprehension questions. Detailed instructions will be presented afterwards. **Finally**, you will answer a few general questions about your language background. The entire process takes about 10-15 minutes.

2. Do I have to take part?

No. Participation is voluntary. If you do decide to take part, you may withdraw at any point during the experiment by closing the browser. The data of participants with incomplete experiment records will be deleted. However, **unfinished participants would not get paid**.

3. How will my data be used?

We will not collect any data that could directly identify you[9]. Your IP address will not be stored. All data will be anonymised, and will be analysed and written up for an MSc dissertation. We will take all reasonable measures to ensure that data remain confidential.

4. Who do I contact if I have a concern?

You could speak to me: Yingshang Gong (yingshang.gong@education.ox.ac.uk), or WeChat (zhendeyaoweixinhaoma, the *pinyin* for "Is a WeChat ID really needed").

If you wish to complain (although I don't >__<), you could contact my lovely Greek supervisor, Dr. Faidra Faitaki (faidra.faitaki@education.ox.ac.uk).

If you have read the information above and agree to participate with the understanding that the data you submit will be processed accordingly, please tick the box below to start.

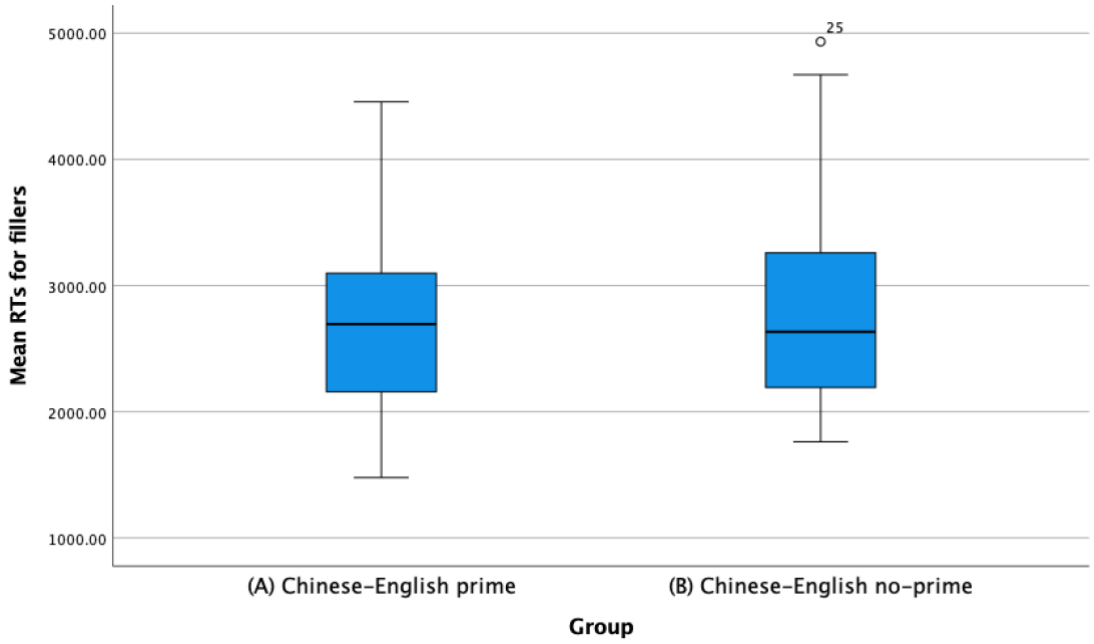
☐Yes, I agree to take part

[9] Participants who were recruited through WeChat had to leave their Alipay account to receive payments. Those participants were presented with an extra first-half of the sentence: "Except your Alipay account (that will only be used for giving payments), …".

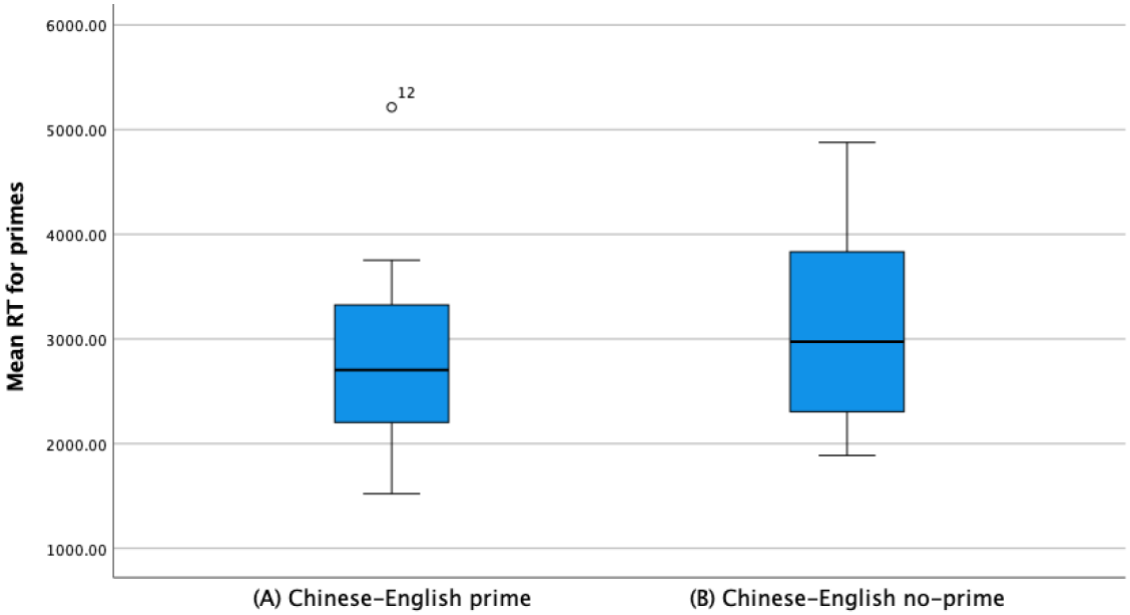
Appendix G. Outliers in reading times for fillers and primes

1. Chinese-English (L1-L2) priming

1) Boxplots for outliers in mean RT for fillers of each L1-L2 experiment group.

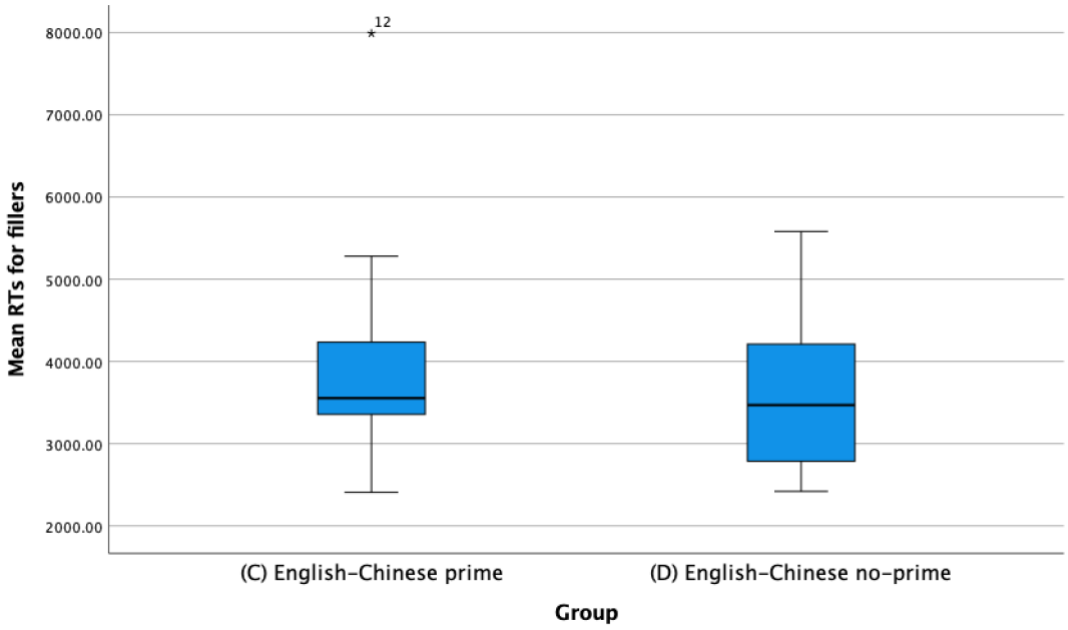


2) Boxplots for outliers in mean RT for primes of each L1-L2 experiment group

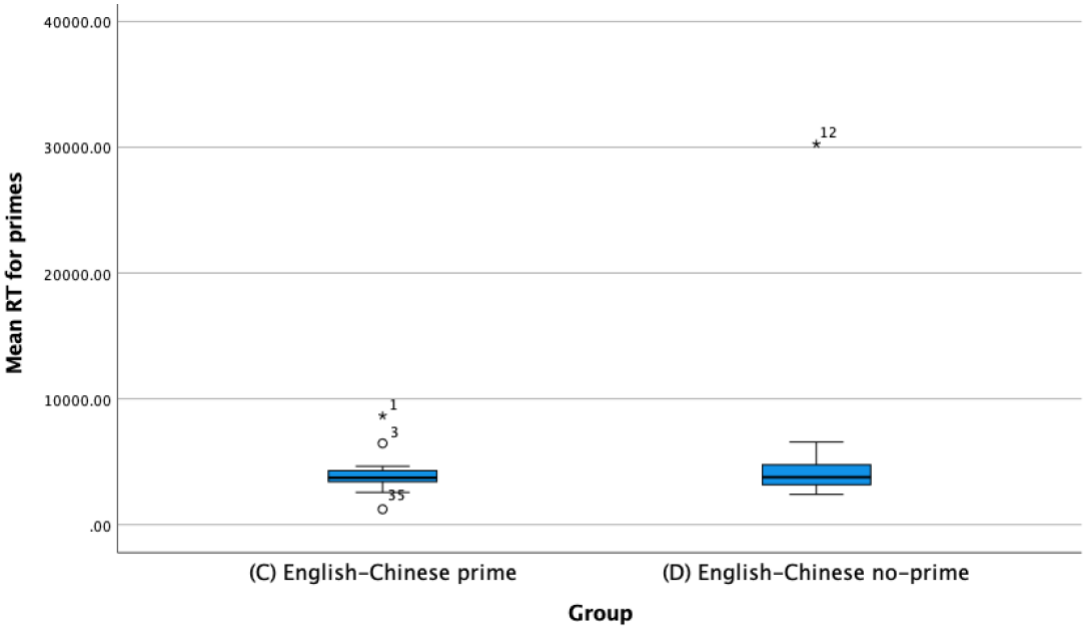


2. English-Chinese (L2-L1) priming

1) Boxplots for outliers in mean RT for fillers of each L2-L1 experiment group.

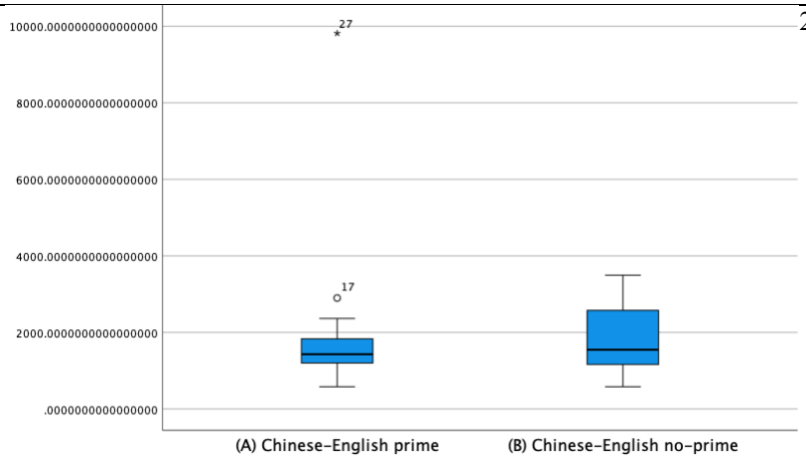


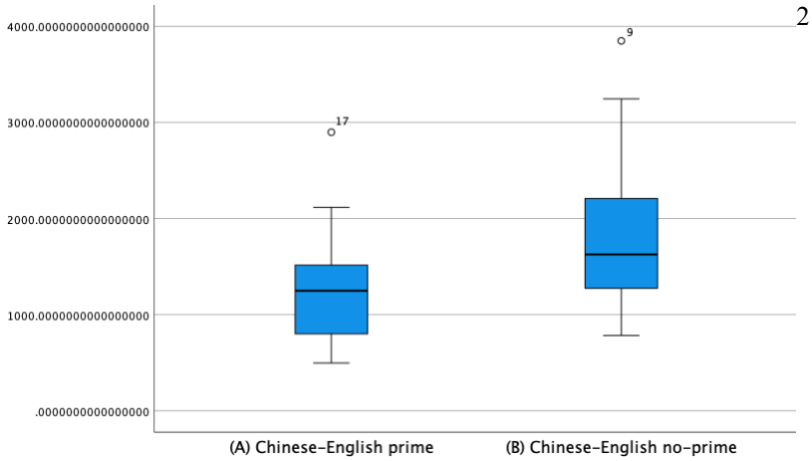
2) Boxplots for outliers in mean RT for primes of each L2-L1 experiment group.

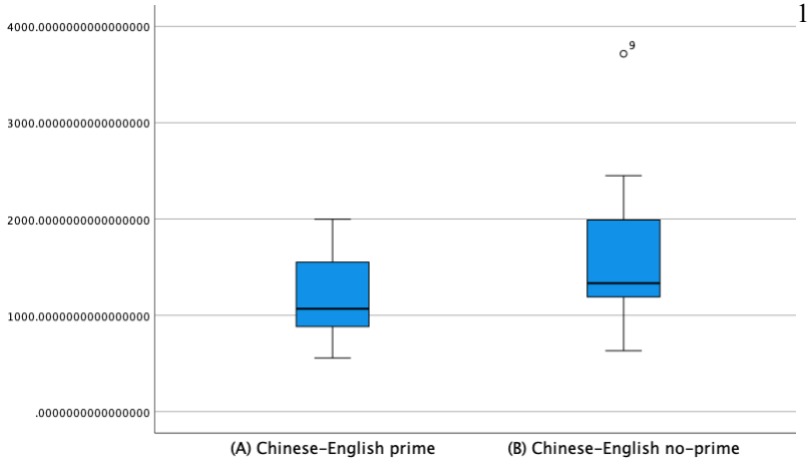


Appendix H. Outliers in reading times for targets per L1-L2 experiment group

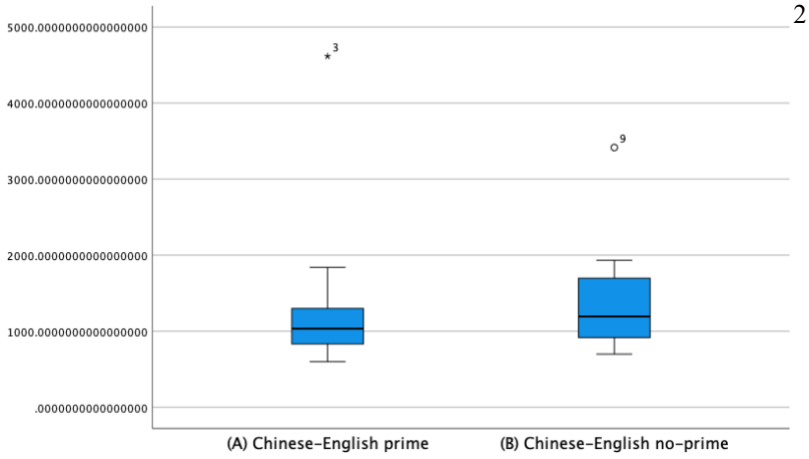
Sentence region	*Sentence number*	*Boxplots for identifying outliers in RTs per sentence region for each sentence in L1-L2 experiment groups*	*Number of outliers*
Reading times (RTs) for targets (*ms*)	(1) DET + NP_1	Target 1	2
		Target 2	2
		Target 3	1



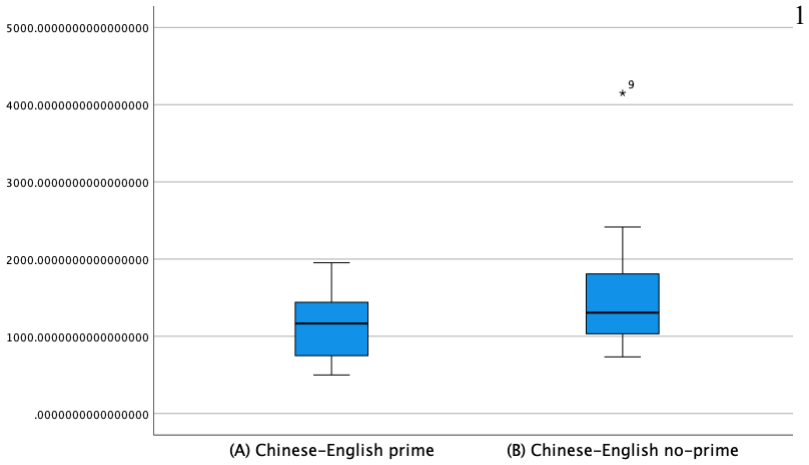




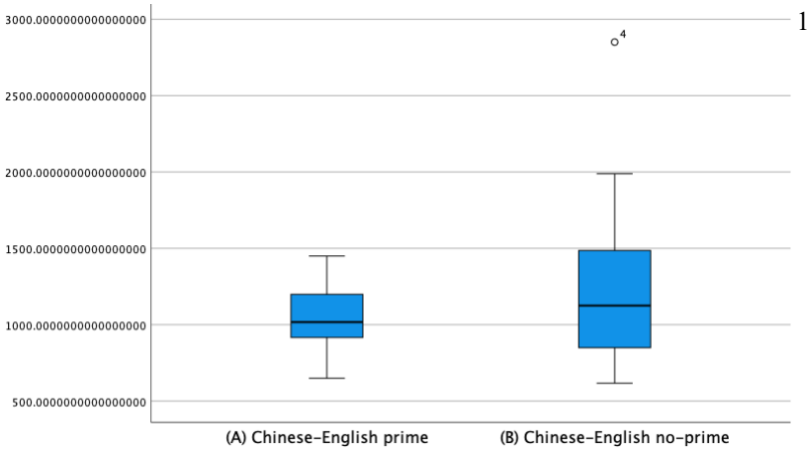
Target 4



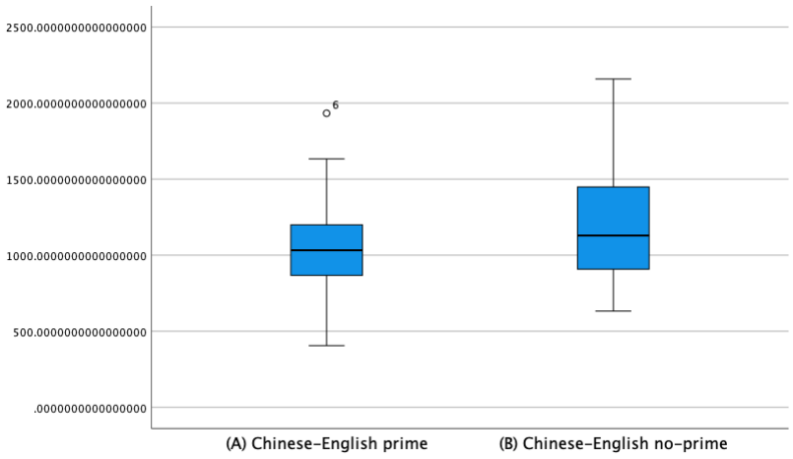
Target 5



Target 6

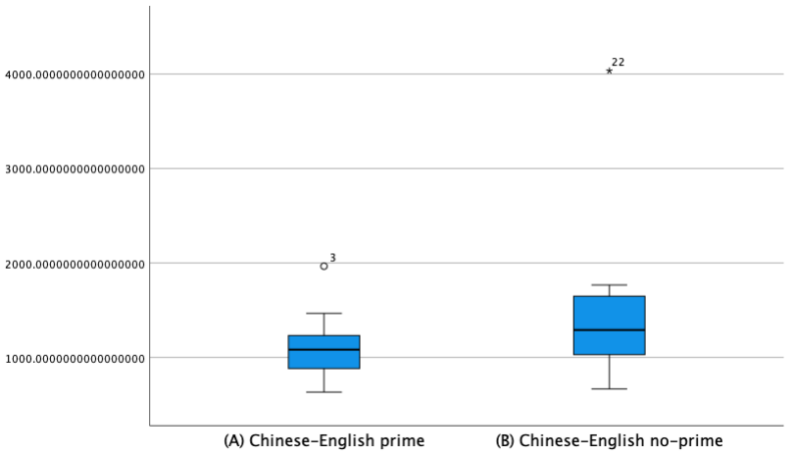


Target 7



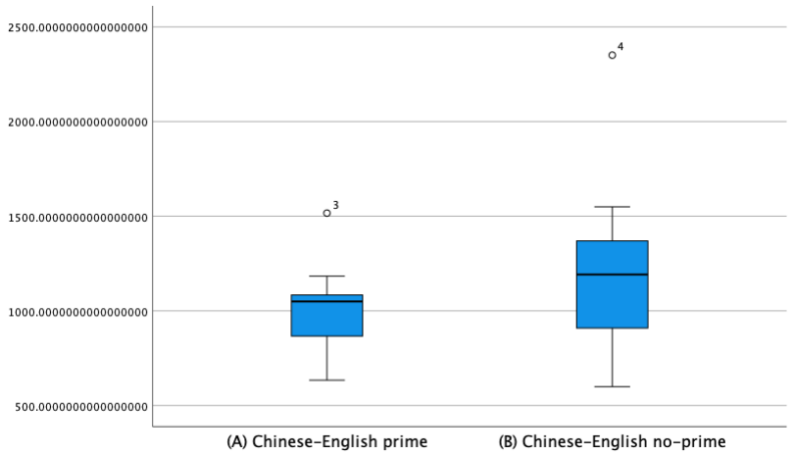
1

Target 8



2

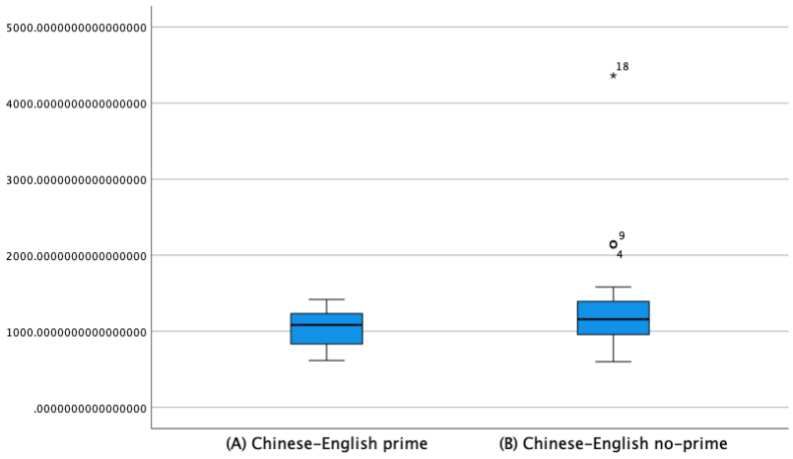
Target 9



2

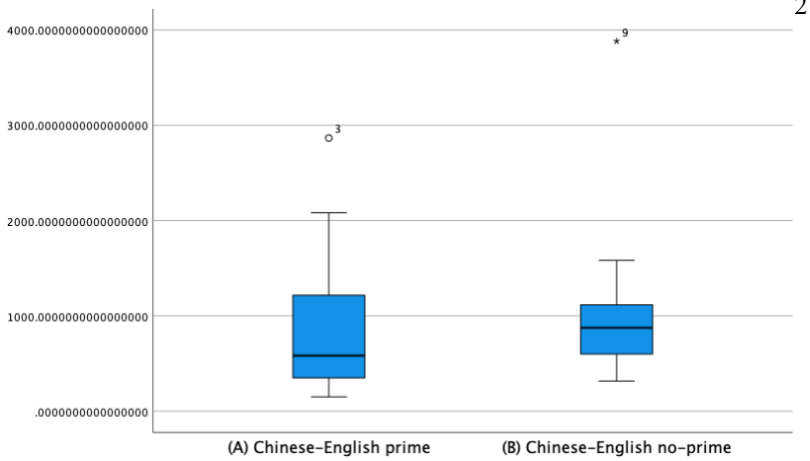
3

Target 10



2

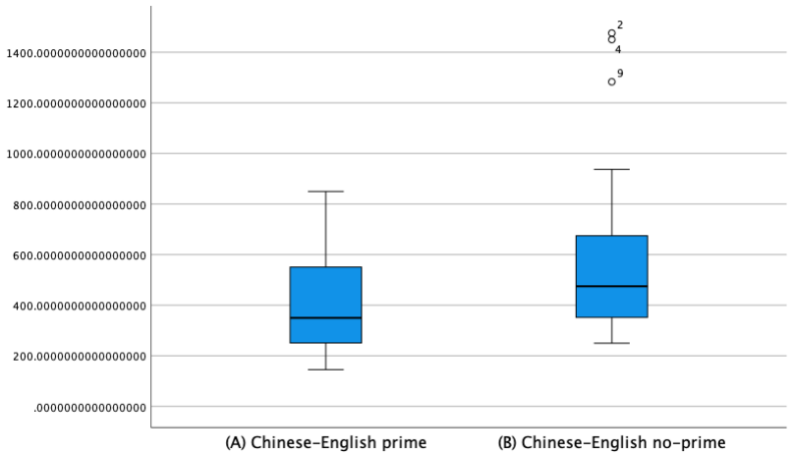
Target 1



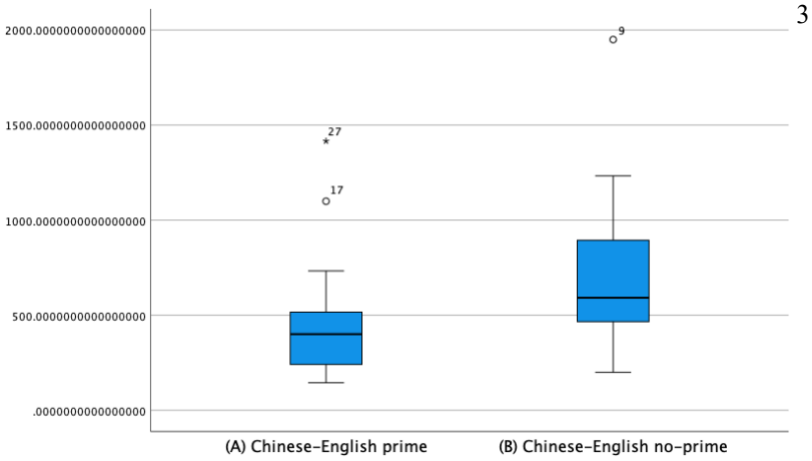
(2) V

3

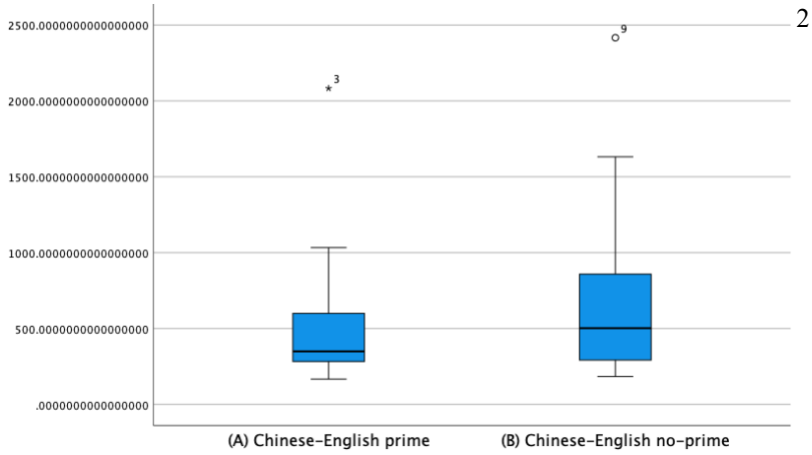
Target 2



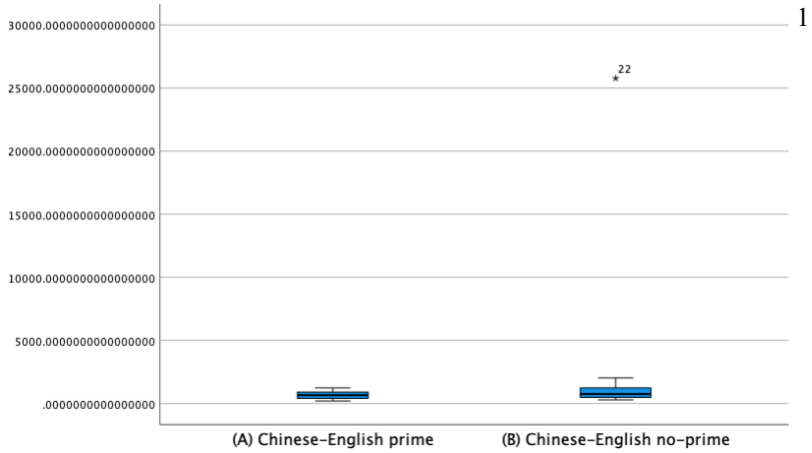
Target 3



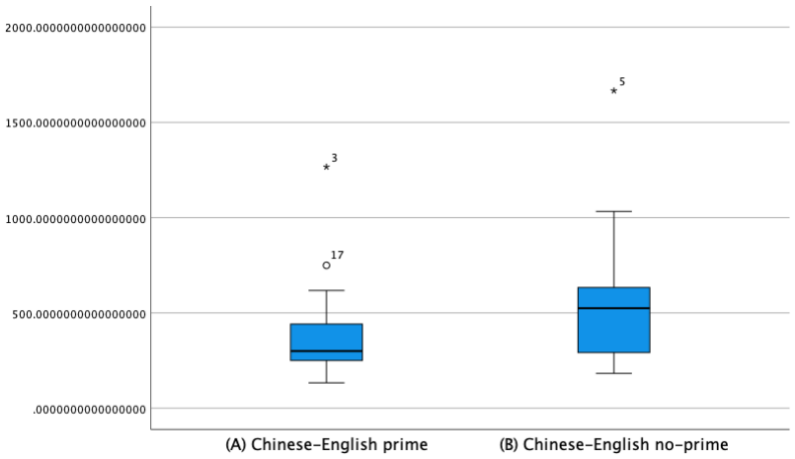
Target 4



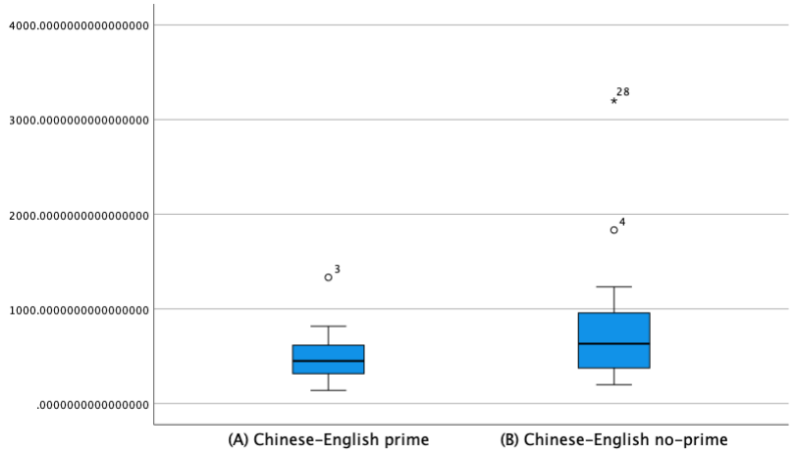
Target 5



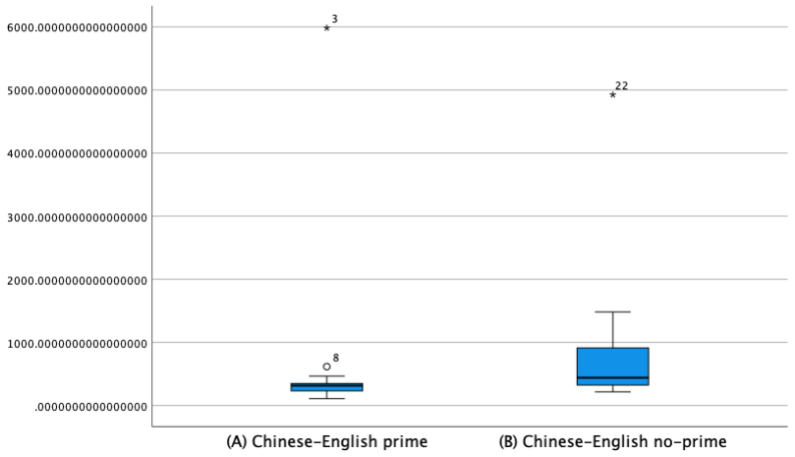
Target 6

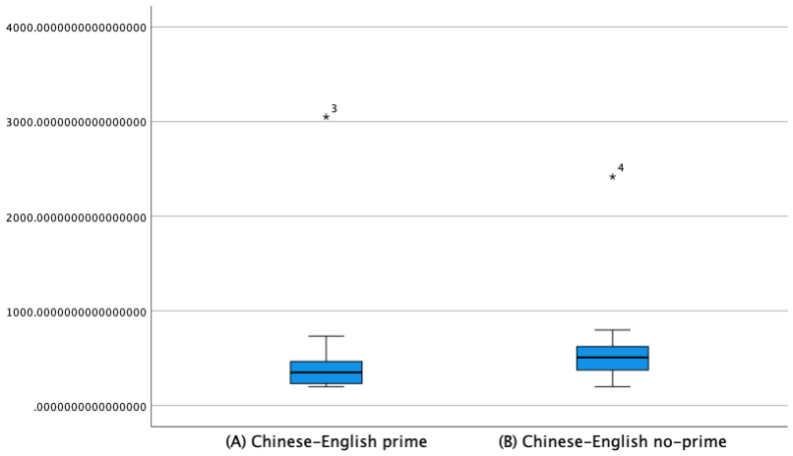
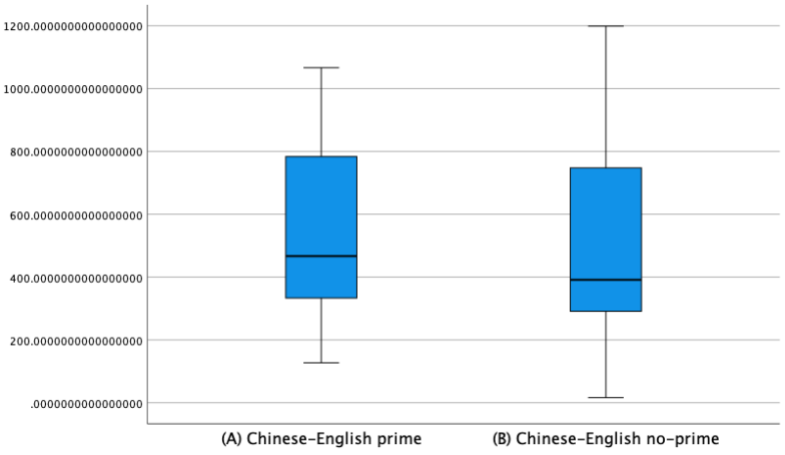
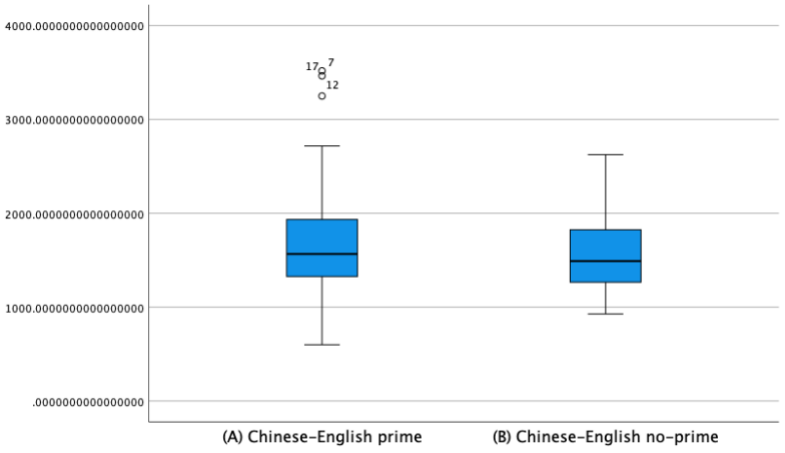


Target 7

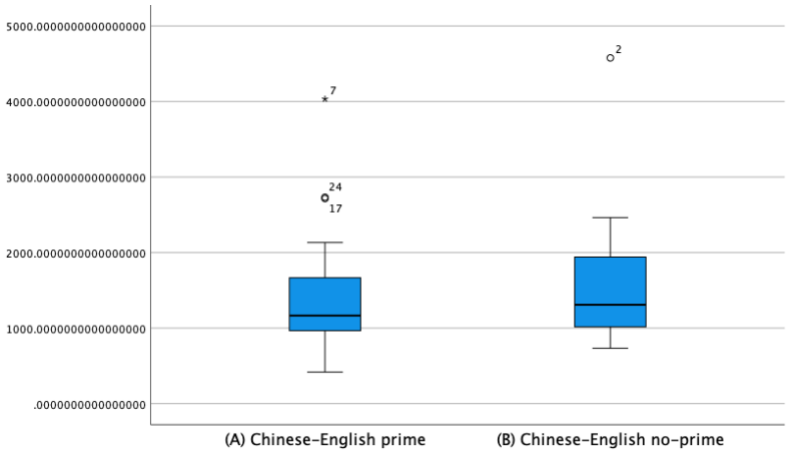


Target 8



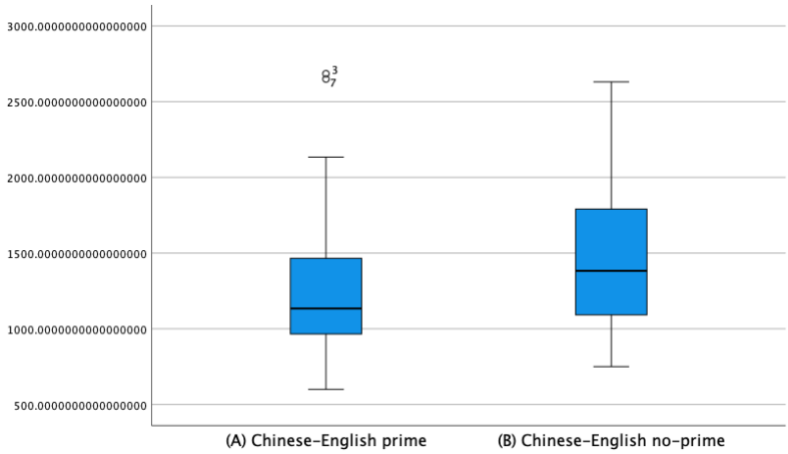
	Target 9		2
	Target 10		0
(3) *by* + NP_2	Target 1		3

Target 2



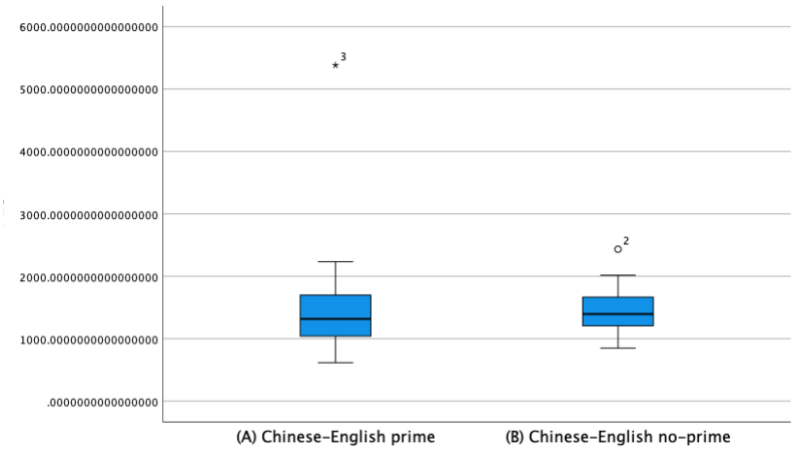
4

Target 3



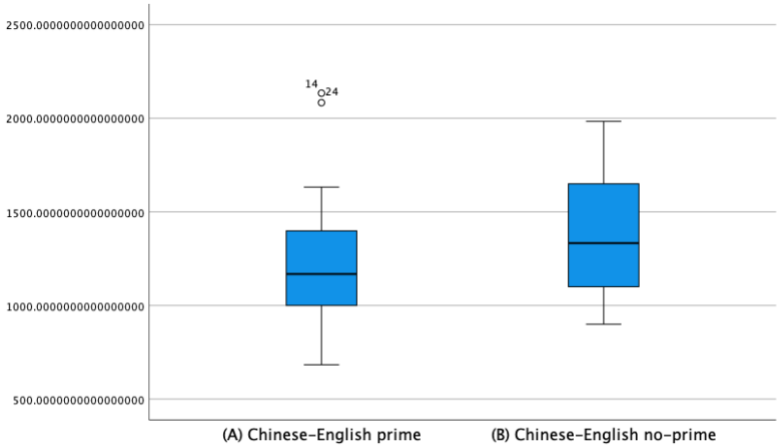
2

Target 4



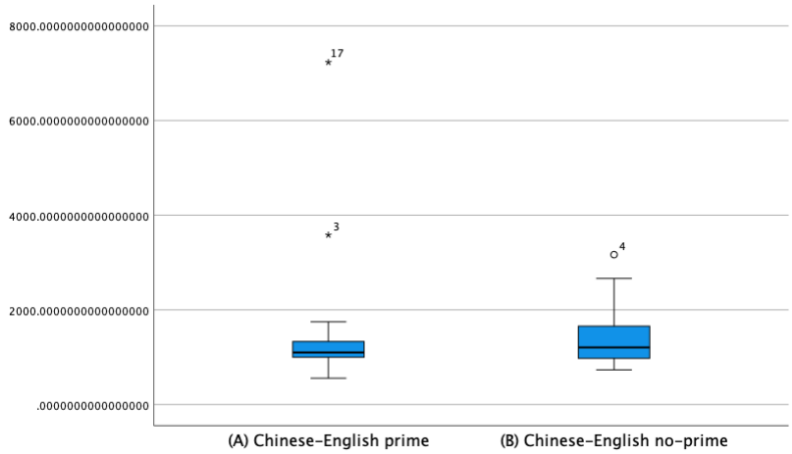
2

Target 5



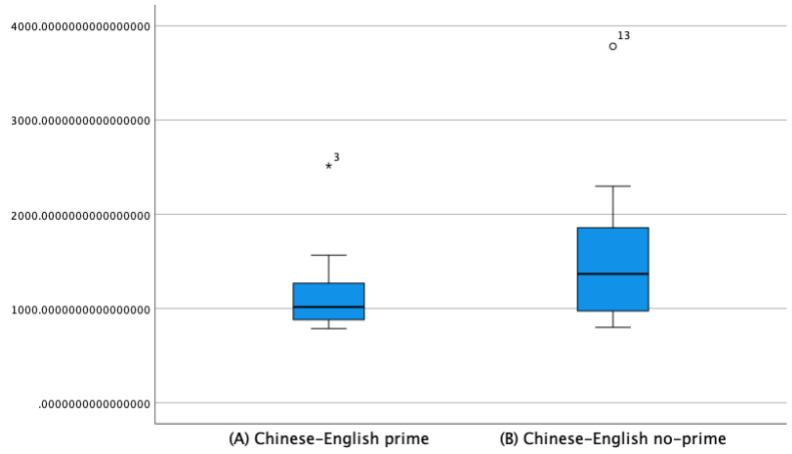
2

Target 6



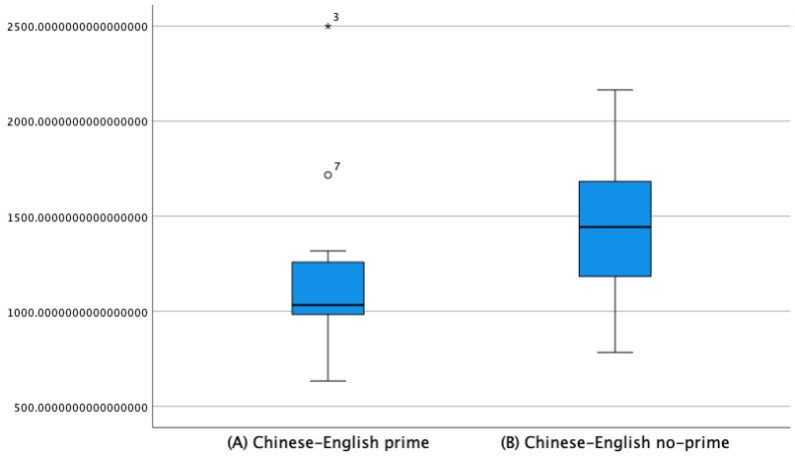
3

Target 7



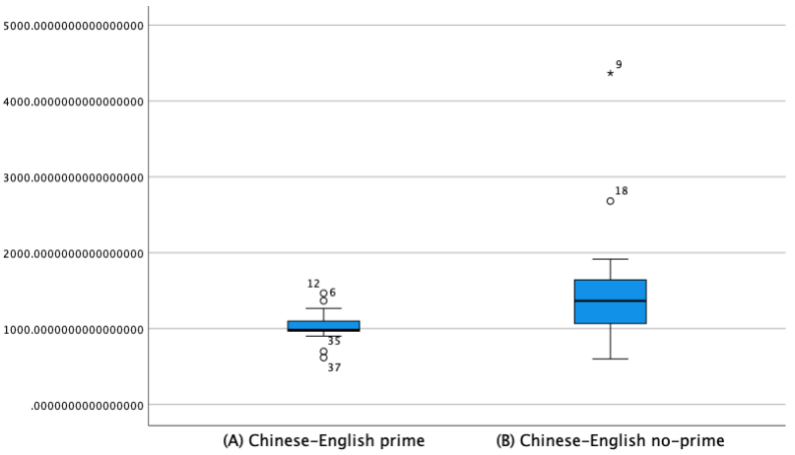
2

Target 8



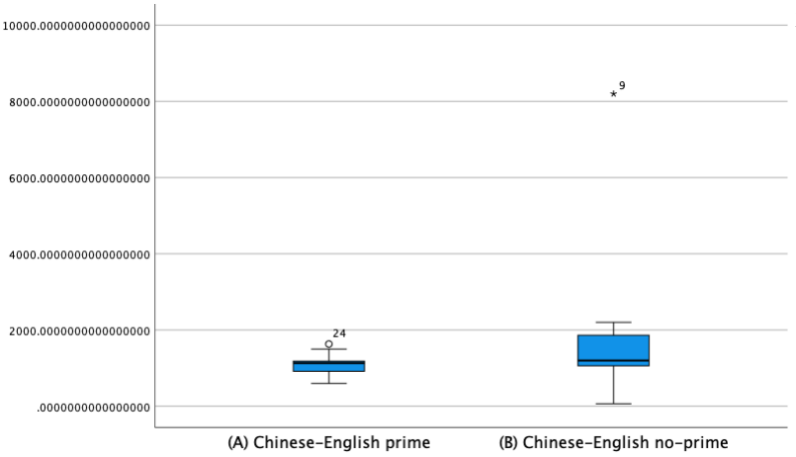
2

Target 9

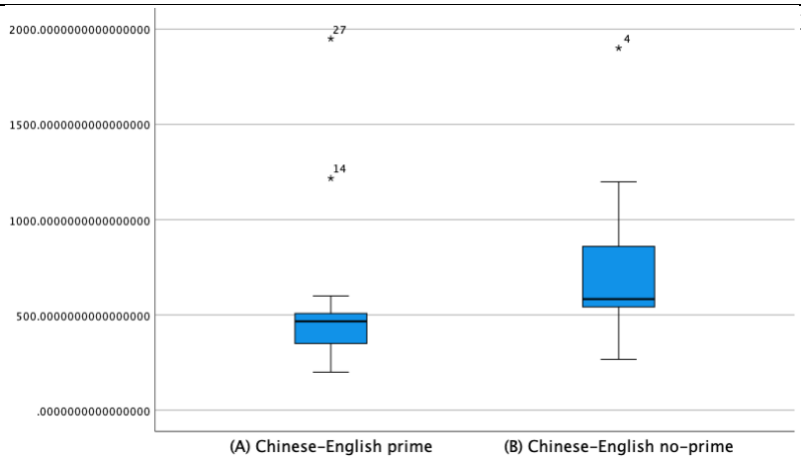
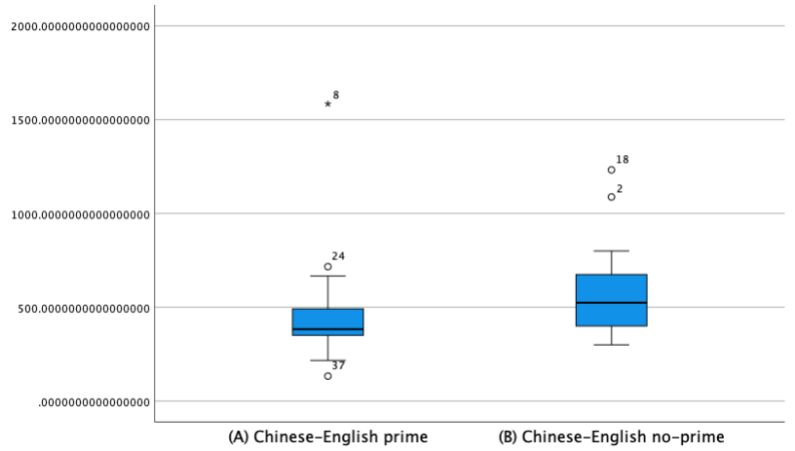
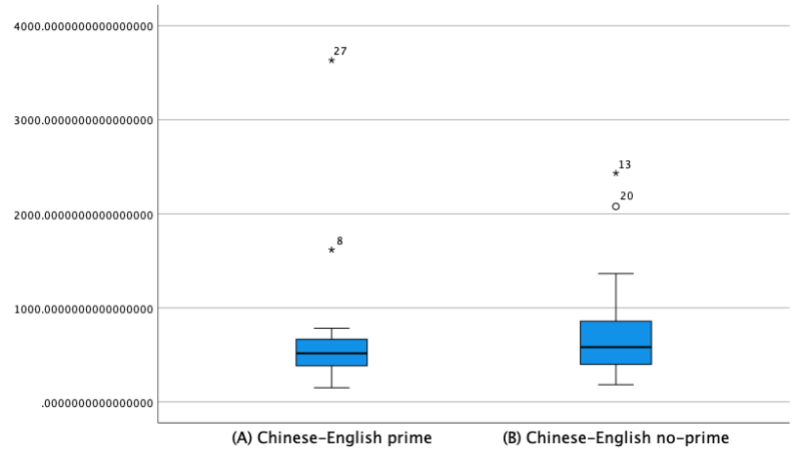


6

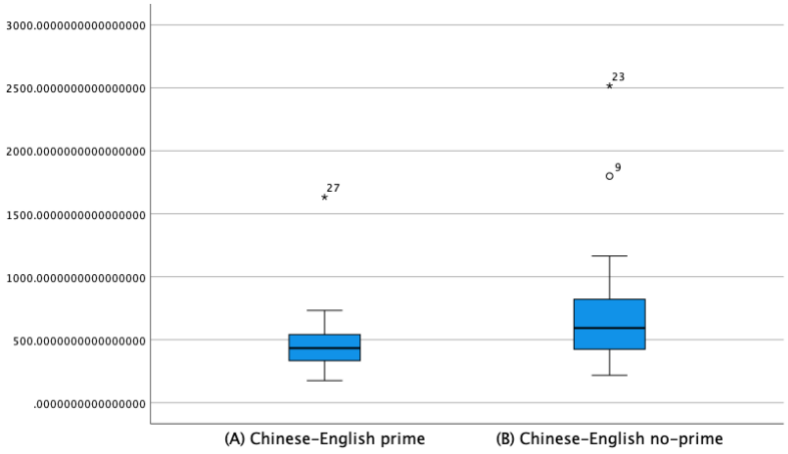
Target 10



2

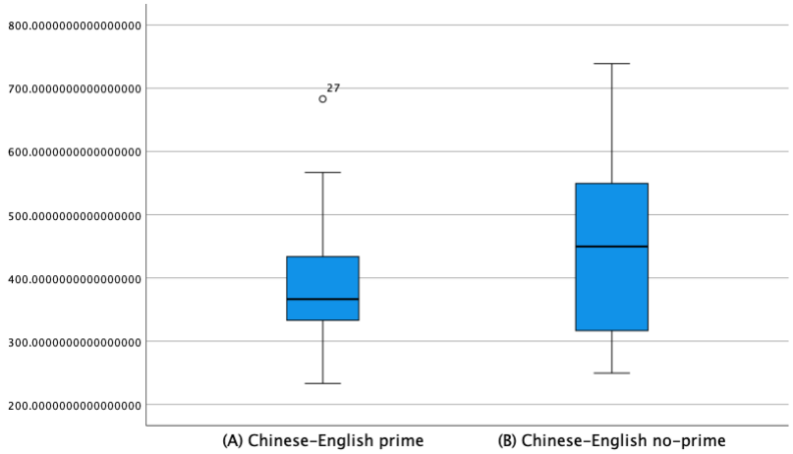
(4) past-tense VP	Target 1		3
	Target 2		5
	Target 3		4

Target 4



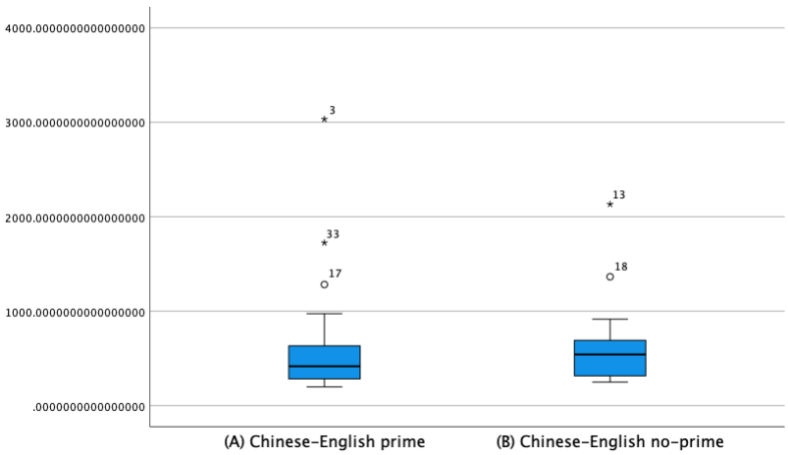
3

Target 5



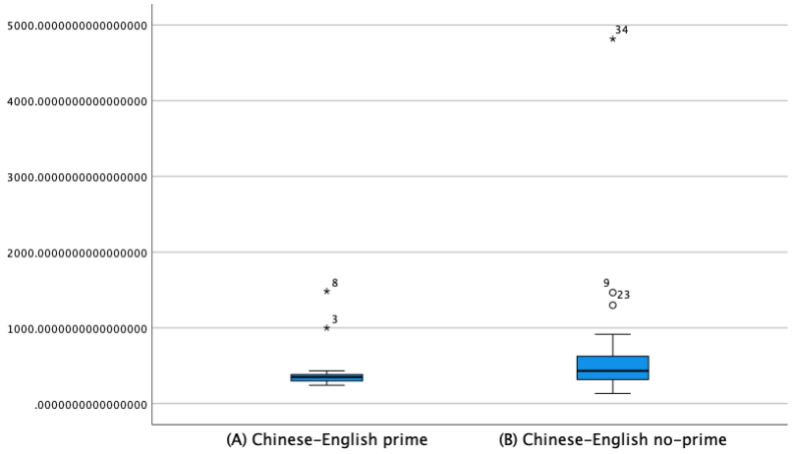
1

Target 6



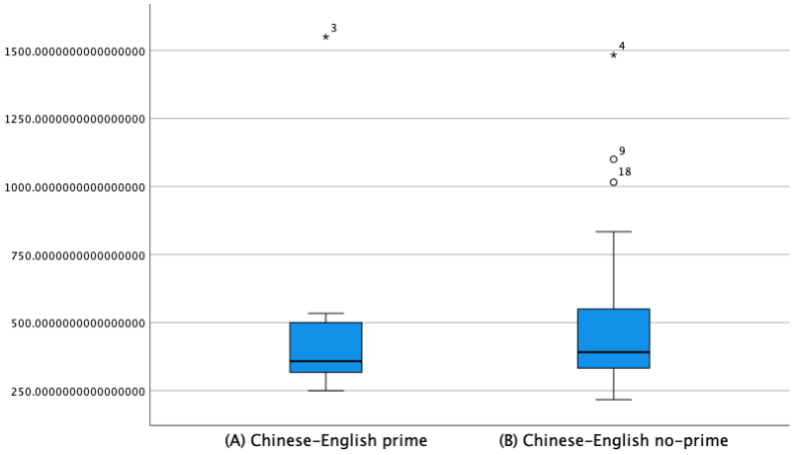
5

Target 7



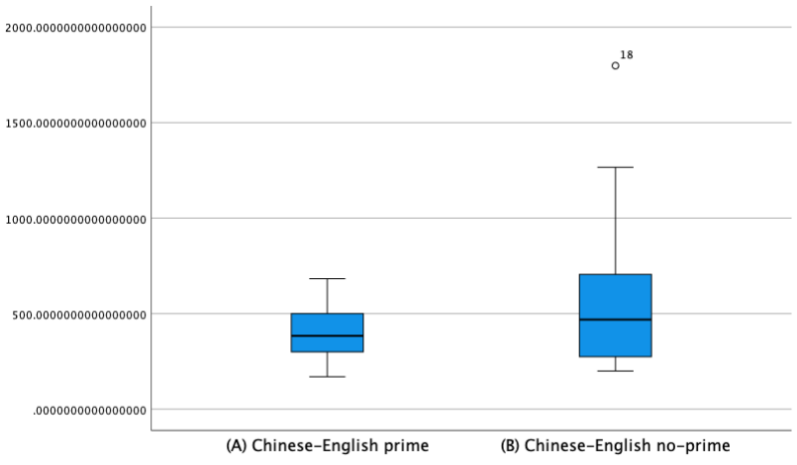
5

Target 8



4

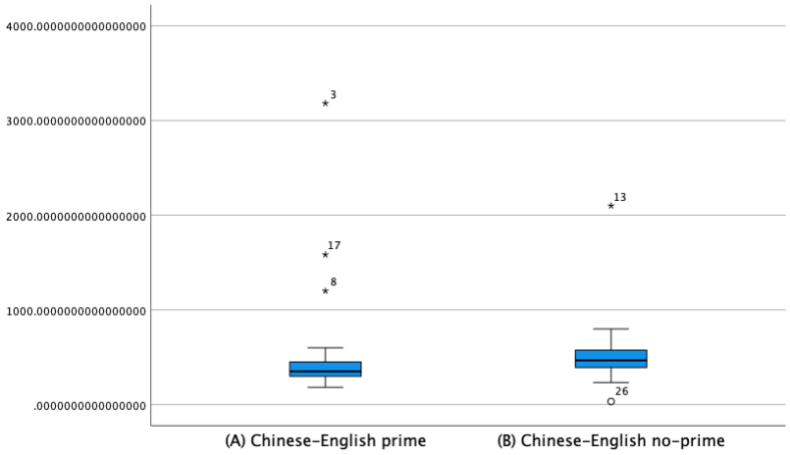
Target 9



1

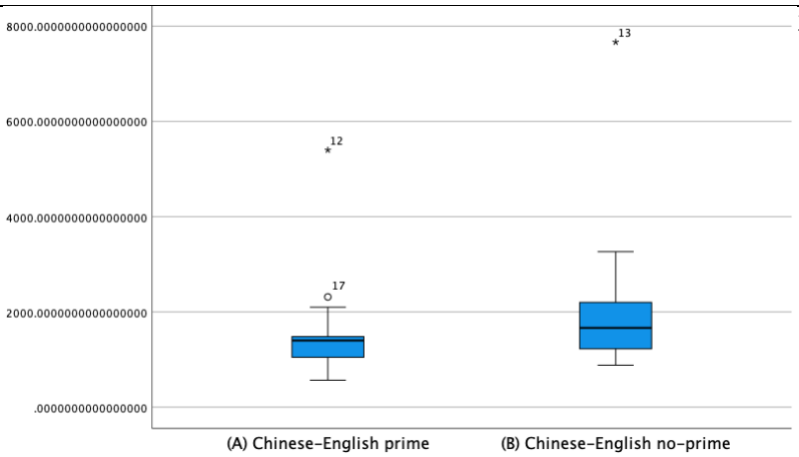
4

Target 10



3

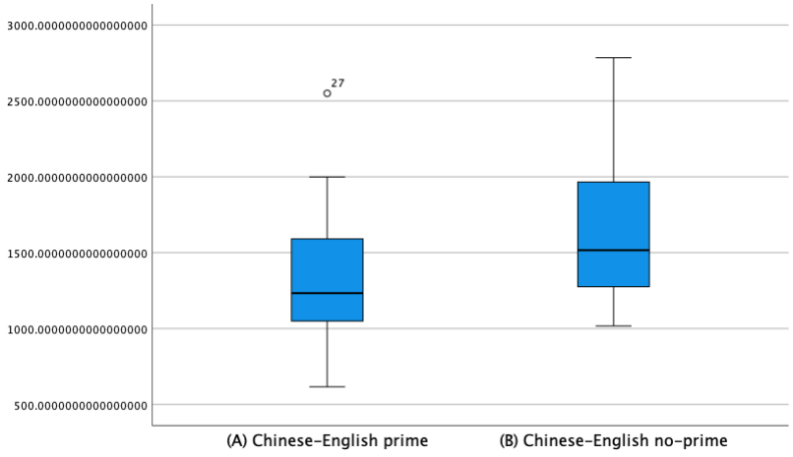
Target 1



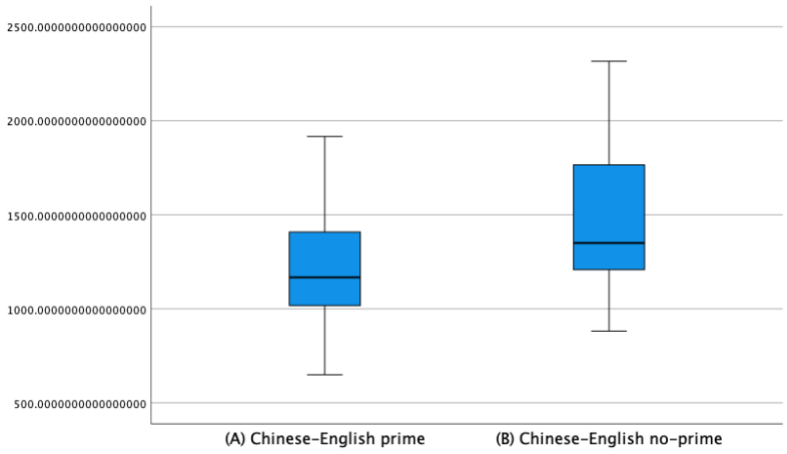
(5) “VP+1”

1

Target 2

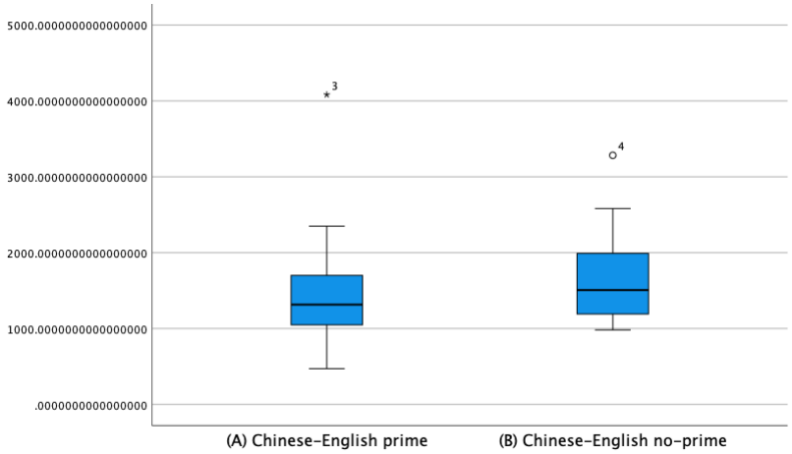


Target 3



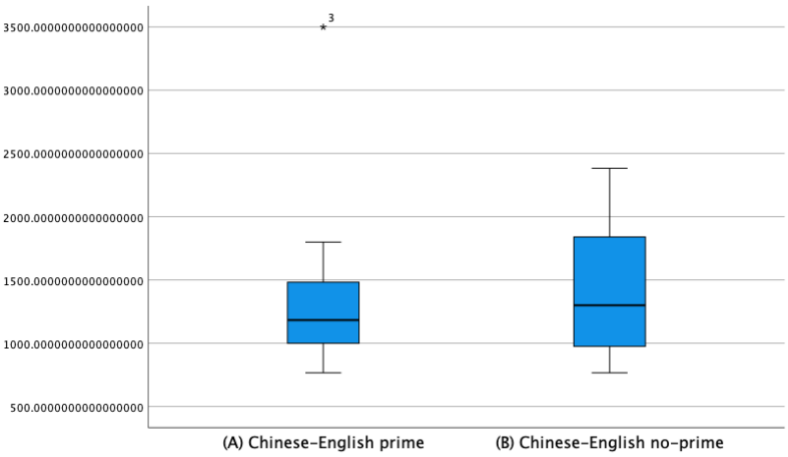
0

Target 4



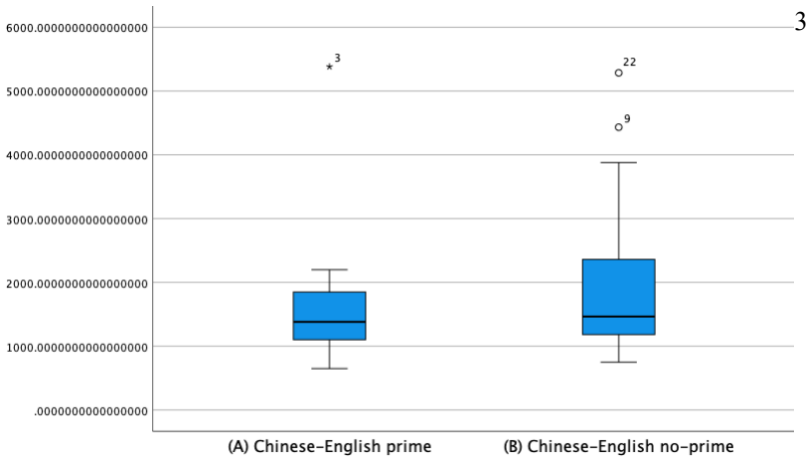
2

Target 5



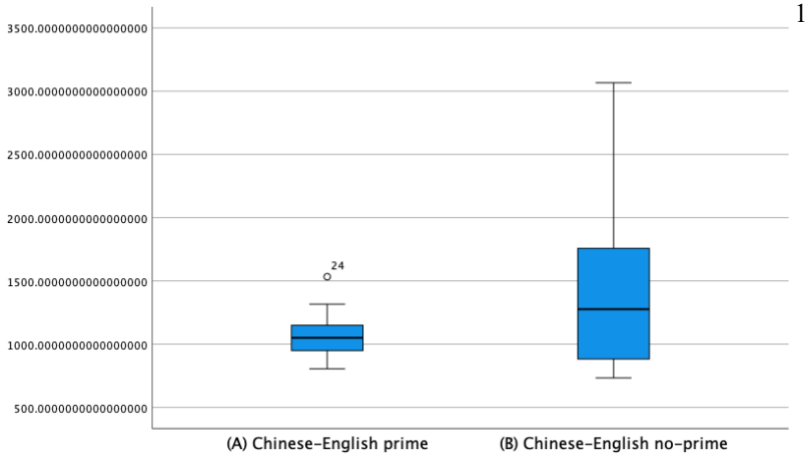
1

Target 6



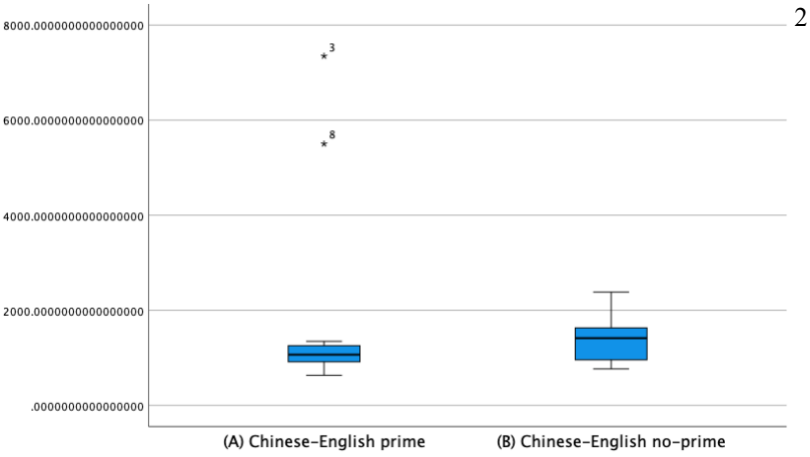
3

Target 7



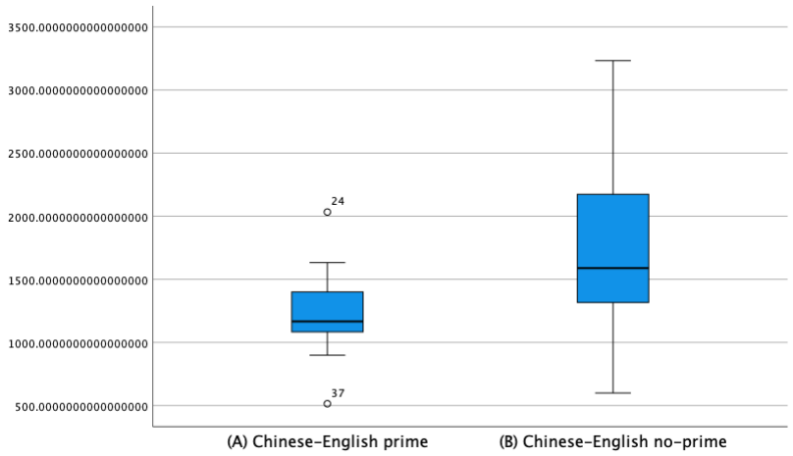
1

Target 8

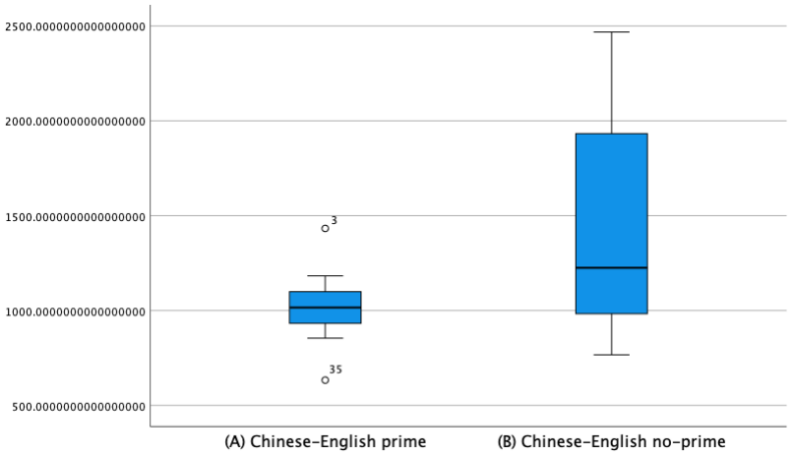


2

Target 9



Target 10



Appendix I. Descriptives of RTs for targets per L1-L2 experiment group, F-test results for equal variances, and independent samples t-test results comparing the groups' RTs per sentence region, by sentences and on average.

Note: According to the hypotheses, p values were one-tailed for t-tests concerning sentence region (3), and two-tailed for the other t-tests reported in this table.

Sentence region	*Sentence number*	*M (SE)*		*SD*		*Skewness*		*Kurtosis*		*F (sig.)*	*p*	*Cohen's d [95% CI]*
Group		(A) C-E prime	(B) C-E no-prime	(A) C-E prime	(B) C-E no-prime	(A) prime	C-E(B) no-prime	C-E(A) prime	C-E (B) no-prime			
	Target 1	1541.64 (134.21)	1831.37 (209.43)	553.36	936.58	.235	.650	-.759	-.947	5.887 (.021)	.253	
	Target 2	1226.67 (122.39)	1777.40 (158.94)	504.62	710.79	.453	.703	-.714	-.056	2.277 (.140)	.011	-.881 [-1.554, -.197]
	Target 3	1193.23 (111.24)	1489.36 (117.68)	458.64	526.28	.394	.345	-.936	-.528	.232 (.633)	.079	
	Target 4	1116.21 (97.32)	1231.36 (88.86)	401.28	397.40	.540	.487	-.649	-1.018	.012 (.913)	.388	
	Target 5	1124.47 (98.81)	1439.34 (112.83)	407.40	504.59	.242	.584	-.589	-.636	1.567 (.219)	.047	-.681 [-1.342, -.010]
(1) DET + NP_1	Target 6	1033.20 (55.59)	1201.74 (96.14)	229.22	429.96	-.003	.519	-.743	-.880	9.291 (.004)	.140	
	Target 7	1081.80 (83.29)	1191.46 (96.95)	343.41	433.58	.133	.827	-.212	-.035	1.112 (.299)	.406	
RTs for targets (*ms*)	Target 8	1060.53 (62.14)	1315.59 (76.07)	256.22	340.19	-.183	-.172	-.773	-1.212	3.280 (.079)	.016	-.837 [-1.507, -.156]
	Target 9	973.93 (42.67)	1127.51 (72.46)	175.91	324.05	-.723	-.549	-.352	-.917	6.028 (.019)	.078	
	Target 10	1033.22 (61.00)	1172.05 (65.01))	251.50	290.71	-.316	-.051	-1.097	-.735	.343 (.562)	.133	
	Mean	**1138.49 (67.81)**	**1377.72 (87.98)**	**279.58**	**393.47**	**-.093**	**.411**	**-.138**	**-.980**	**3.151 (.085)**	**.043**	**-.691 [-1.353, -.020]**
	Target 1	791.72 (148.62)	878.29 (81.08)	612.76	362.59	1.100	.387	.389	-.357	4.706 (.037)	.614	
	Target 2	411.81 (52.19)	536.80 (53.45)	215.18	239.03	.758	.733	-.612	-.758	.274 (.604)	.106	
(2) V	Target 3	412.05 (47.18)	661.84 (70.74)	194.51	316.36	.447	.604	-.799	-.366	2.970 (.094)	.008	-.933 [-1.610, -.245]
	Target 4	450.72 (67.10)	621.48 (97.73)	276.65	437.08	1.243	1.311	.444	1.040	2.636 (.113)	.173	
	Target 5	686.71 (71.29)	925.51 (125.39)	293.96	560.78	.110	.933	-.891	-.234	5.324 (.027)	.108	

	Target 6	354.23 (38.35)	520.86 (57.16)	158.10	255.62	.692	.698	-.784	-.205	3.069 (.089)	.026	-.769 [-1.435, -.093]
	Target 7	463.81 (48.90)	661.82 (77.56)	201.61	346.85	.349	.449	-.763	-.986	4.742 (.036)	.039	-.684 [-1.345, -.013]
	Target 8	316.89 (31.43)	630.55 (92.89)	129.57	415.41	.446	1.132	-.104	-.064	16.873 (<.001)	.004	-.985 [-1.665, -.293]
	Target 9	377.96 (43.89)	506.73 (41.03)	180.96	183.49	.967	-.027	-.171	-.855	.003 (.955)	.039	
	Target 10	507.49 (65.99)	518.89 (75.37)	272.07	337.06	.574	.860	-.633	-.139	.819 (.372)	.912	
	Mean	**477.34 (42.97)**	**646.28 (50.81)**	**177.16**	**227.24**	**.251**	**.319**	**-.123**	**-.827**	**1.656 (.207)**	**.018**	**-.821 [-1.490, -.141]**
	Target 1	1725.94 (157.30)	1579.96 (98.72)	648.58	441.51	.459	.775	-.638	.476	2.859 (.100)	.212	
	Target 2	1306.49 (135.09)	1488.29 (125.22)	557.00	560.02	.416	.517	-.984	-.951	.000 (.997)	.165	
	Target 3	1263.26 (121.97)	1449.18 (101.54)	502.91	454.09	.747	.802	-.499	.807	.086 (.771)	.123	
	Target 4	1391.68 (122.91)	1432.15 (80.58)	506.76	360.35	.374	.193	-.585	-.799	1.791 (.189)	.389	
	Target 5	1197.75 (69.78)	1392.12 (74.21)	287.70	331.86	.101	.329	-.683	-1.105	1.281 (.265)	.034	-.622 [-1.281, .045]
(3) *by* + NP_2	Target 6	1169.58 (86.98)	1389.02 (128.08)	358.65	572.81	.352	1.159	-.319	.591	3.407 (.073)	.089	
	Target 7	1085.52 (61.15)	1475.33 (113.83)	252.14	509.06	.712	.257	-.455	-1.373	16.452 (<.001)	.003	-.946 [-1.623, -.257]
	Target 8	1060.68 (51.89)	1457.58 (85.07)	213.96	380.46	-.504	.106	-.576	-.449	4.354 (.044)	<.001	-1.258 [-1.961, -.541]
	Target 9	1033.27 (31.21)	1345.15 (89.94)	128.70	402.21	.946	-.188	-.223	-.774	13.869 (<.001)	.002	-1.010 [-1.692, -.315]
	Target 10	1077.29 (57.07)	1353.58 (123.01)	235.32	550.13	.050	-.182	.185	.137	8.574 (.006)	.026	-.634 [-1.294, .033]
	Mean	**1231.05 (68.09)**	**1436.24 (76.10)**	**280.76**	**340.34**	**-.282**	**.225**	**-.816**	**-.888**	**.417 (.523)**	**.028**	**-.652 [-1.312, .016]**
	Target 1	432.33 (30.35)	680.33 (58.94)	125.13	263.60	-.462	.452	-.405	-.284	9.462 (.004)	<.001	-1.171 [-1.865, -.462]
	Target 2	430.92 (33.90)	549.22 (36.51)	139.79	163.27	.432	.251	-.329	-1.271	1.439 (.238)	.023	-.773 [-1.439, -.097]
	Target 3	504.93 (49.83)	674.19 (83.53)	205.45	373.54	-.126	.875	-.985	-.321	4.473 (.042)	.092	
(4) past-tense VP	Target 4	447.98 (39.16)	641.39 (67.22)	161.46	300.61	.207	.491	-.475	-.644	5.589 (.024)	.019	-.783 [-1.450, -.106]
	Target 5	393.66 (25.74)	440.99 (32.44)	106.12	145.07	.456	.376	-.711	-.929	3.503 (.070)	.261	
	Target 6	506.78 (70.98)	538.71 (50.10)	292.66	224.05	.818	.364	-.855	-.949	1.346 (.254)	.709	

	Target 7	349.60 (14.95)	515.15 (55.08)	61.65	246.32	-.028	.538	-1.003	-.766	23.116 (<.001)	.008	-.889 [-1.562, -.204]
	Target 8	403.17 (24.16)	478.41 (45.24)	99.60	202.30	.161	.947	-1.683	-.377	6.383 (.016)	.153	
	Target 9	405.12 (36.43)	554.14 (73.74)	150.21	329.75	.448	1.085	-.595	.336	7.098 (.012)	.081	
	Target 10	389.19 (33.31)	485.37 (35.92)	137.35	160.63	.504	.485	-.744	-.081	.122 (.729)	.061	
	Mean	**426.37 (26.29)**	**555.79 (40.64)**	**108.41**	**181.74**	**-.429**	**.452**	**-.279**	**-.497**	**3.705 (.062)**	**.015**	**-.848 [-1.518, -.166]**
	Target 1	1420.95 (111.88)	1790.08 (164.97)	461.30	737.76	.182	.832	-.519	-.200	4.098 (.051)	.083	
	Target 2	1326.67 (96.76)	1630.27 (106.49)	398.96	476.24	.332	.898	-.683	.236	.482 (.492)	.045	-.686 [-1.347, -.015]
	Target 3	1197.45 (73.83)	1478.53 (93.34)	304.40	417.42	.503	.730	.726	-.329	2.270 (.141)	.027	-.760 [-1.425, -.084]
	Target 4	1397.59 (132.45)	1622.36 (115.18)	546.12	515.08	.283	.750	-.485	-.615	.086 (.772)	.207	
	Target 5	1238.58 (78.33)	1428.92 (114.93)	322.95	513.97	.441	.466	-.881	-1.054	5.262 (.028)	.181	
(5) "VP+1"	Target 6	1439.27 (111.96)	1875.71 (224.82)	461.63	1005.44	.135	1.188	-.762	.247	7.020 (.012)	.093	
	Target 7	1049.90 (36.50)	1434.81 (144.42)	150.50	645.88	.144	1.205	-.299	1.046	16.628 (<.001)	.017	-.791 [-1.458, -.113]
	Target 8	1065.15 (52.91)	1391.16 (100.60)	218.16	449.89	-.272	.548	-.845	-.264	7.275 (.011)	.008	-.899 [-1.572, -.213]
	Target 9	1232.38 (59.74)	1742.71 (154.33)	246.31	690.18	.268	.642	-1.047	.062	11.014 (.002)	.005	-.954 [-1.631, -.264]
	Target 10	1015.79 (24.76)	1406.65 (116.80)	102.09	522.35	.046	.463	-.788	-1.086	39.059 (<.001)	.004	-1.000 [-1.681, -.306]
	Mean	**1238.37 (60.50)**	**1580.12 (92.98)**	**249.46**	**415.82**	**.004**	**.350**	**.895**	**-.996**	**6.858 (.013)**	**.004**	**-.977 [-1.657, -.285]**

As shown in the table, when examined sentence by sentence, five of the ten targets yielded significant t-test results of RTs for region (3): target number five [t(35)=-1.886, p=.034], seven [t(28.710)=-3.017, p=.003], eight [t(30.719)=-3.983, p<.001], nine [t(23.449)=-3.276, p=.002], and ten [t(26.597)=-2.037, p=.026]. The effect sizes were medium for target five (d=-.622) and ten (d=-.634), and large for target seven (d=-.946), eight (d=-1.258), and nine (d=-1.010). The groups did not differ significantly in the RTs for region (3) of the other five targets.

For region (1), three out of the ten sentences saw significant group differences in RT: target two [t(35)=-2.671, p=.011, d=-.881], five [t(35)=-2.603, p=.047, d=-.681], and eight [t(35)=-2.538, p=.016, d=-.837].

For region (2), four out of the ten targets saw significant group differences in RTs: target three [t(35)=-2.829, p=.008, d=-.933], six [t(35)=-2.332, p=.026, d=-.769], seven [t(31.244)=-2.160, p=.039, d=-.684], and eight [t(23.237)=-3.199, p=.004, d=-.985].

RT for region (4) was significantly different between groups in four of the ten sentences: target one [t(28.066)=-3.741, p<.001, d=-1.171], two [t(35)=-2.344, p=.023, d=-.773], four [t(29.984)=-2.486, p=.019, d=-.783], and seven [t(21.763)=-2.901, p=.008, d=-.889].

RT for region (5) had significant group differences in six of the ten sentences: target two [t(35)=-2.079, p=.045, d=-.686], three [t(35)=-2.302, p=.027, d=-.760], seven [t(21.401)=-2.584, p=.017, d=-.791], eight [t(28.387)=-2.868, p=.008, d=-.899], nine [t(24.468)=-3.084, p=.005, d=-.954], and ten [t(20.696)=-3.274, p=.004, d=-1.000].

Appendix J. Regression results concerning the effects of experiment group and mean RT for fillers on mean RTs for target regions (1), (2), and (4) for L1-L2 experiment groups.

As mentioned in Section 4.1.2.3, regression results for target region (3) were similar to those of regions (1), (2), and (4). The SPSS regression outputs for the latter three regions are pasted below.

1. Regression results for target region (1)

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.788[a]	.621	.611	225.90473	.621	57.451	1	35	<.001
2	.827[b]	.684	.665	209.44684	.062	6.717	1	34	.014

a. Predictors: (Constant), Mean RT for fillers

b. Predictors: (Constant), Mean RT for fillers, Experiment group

c. Dependent Variable: Mean RT for target region (1)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2931874.95	1	2931874.95	57.451	<.001[b]
	Residual	1786153.08	35	51032.945		
	Total	4718028.04	36			
2	Regression	3226516.74	2	1613258.37	36.775	<.001[c]
	Residual	1491511.30	34	43867.979		
	Total	4718028.04	36			

a. Dependent Variable: Mean RT for target region (1)

b. Predictors: (Constant), Mean RT for fillers

c. Predictors: (Constant), Mean RT for fillers, Experiment group

2. Regression results for target region (2)

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					R Square Change	F Change	df1	df2	Sig. F Change
1	.572[a]	.328	.308	183.11996	.328	17.054	1	35	<.001
2	.659[b]	.435	.402	170.33051	.107	6.453	1	34	.016

a. Predictors: (Constant), Mean RT for fillers

b. Predictors: (Constant), Mean RT for fillers, Experiment group

c. Dependent Variable: Mean RT for target region (2)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	571859.014	1	571859.014	17.054	<.001[b]
	Residual	1173652.22	35	33532.920		
	Total	1745511.23	36			
2	Regression	759086.875	2	379543.438	13.082	<.001[c]
	Residual	986424.355	34	29012.481		
	Total	1745511.23	36			

a. Dependent Variable: Mean RT for target region (2)

b. Predictors: (Constant), Mean RT for fillers

c. Predictors: (Constant), Mean RT for fillers, Experiment group

3. Regression results for target region (4)

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.563[a]	.317	.297	137.59264	.317	16.210	1	35	<.001
2	.657[b]	.432	.398	127.28896	.115	6.896	1	34	.013

a. Predictors: (Constant), Mean RT for fillers

b. Predictors: (Constant), Mean RT for fillers, Experiment group

c. Dependent Variable: Mean RT for target region (4)

ANOVA[a]

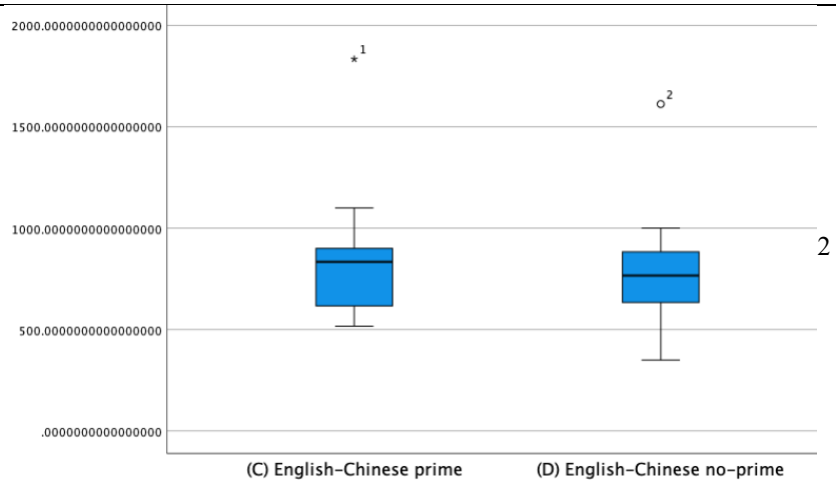
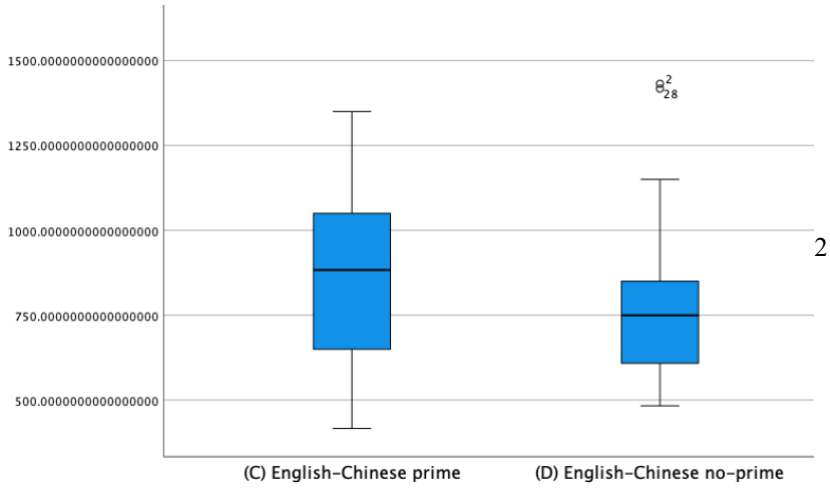
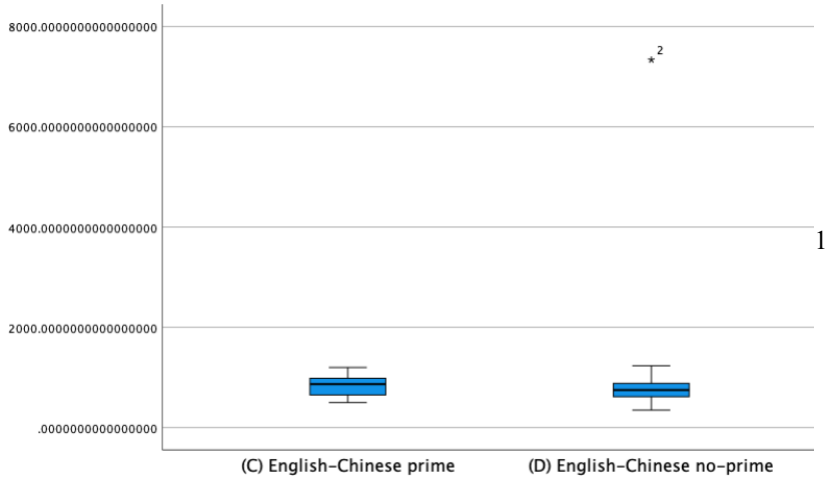
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	306882.232	1	306882.232	16.210	<.001[b]
	Residual	662610.751	35	18931.736		
	Total	969492.983	36			
2	Regression	418608.726	2	209304.363	12.918	<.001[c]
	Residual	550884.256	34	16202.478		
	Total	969492.983	36			

a. Dependent Variable: Mean RT for target region (4)

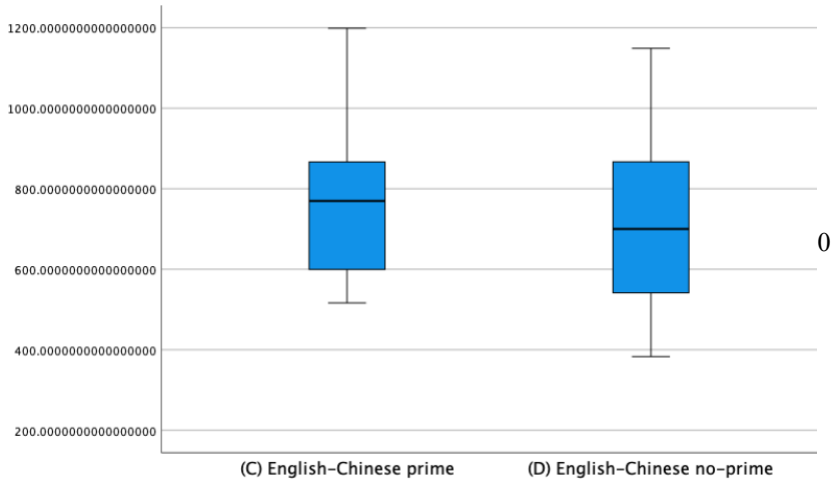
b. Predictors: (Constant), Mean RT for fillers

c. Predictors: (Constant), Mean RT for fillers, Experiment group

Appendix K. Outliers in reading times for targets per L2-L1 experiment group

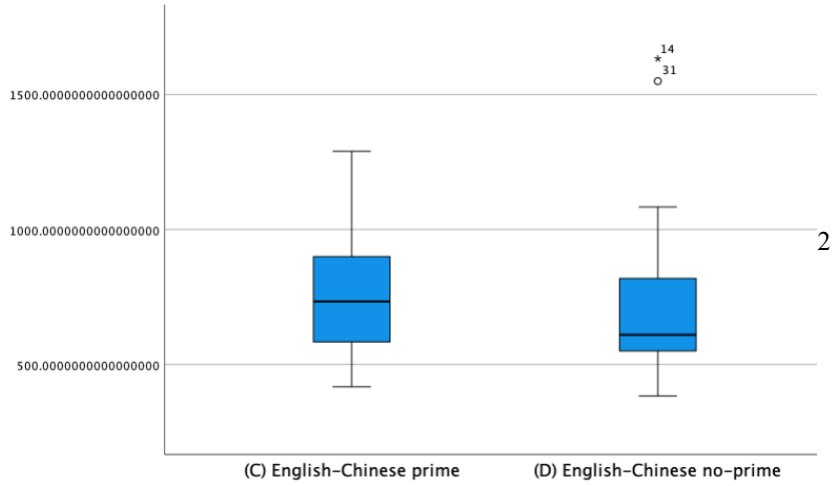
	Sentence region	*Sentence number*	*Boxplots for identifying outliers in RTs per sentence region for each sentence in L2-L1 experiment groups*	*Number of outliers*
Reading times (RTs) for targets (*ms*)	(1) DET + NP_1	Target 1		2
		Target 2		2
		Target 3		1

Target 4



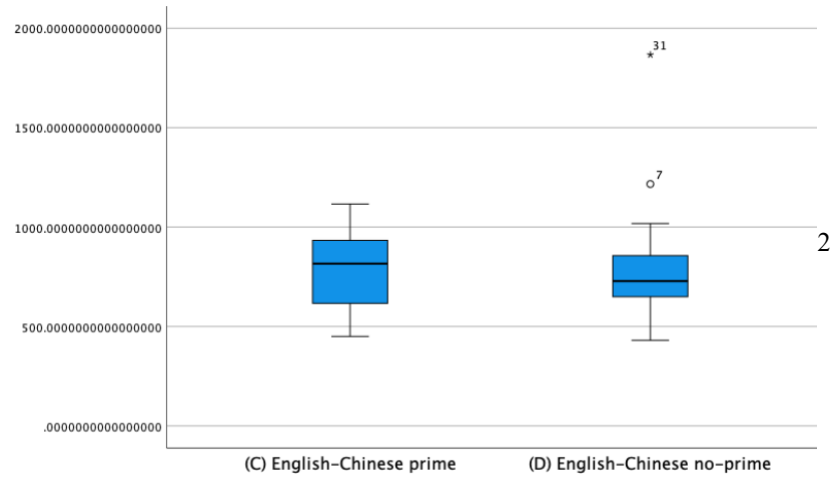
0

Target 5



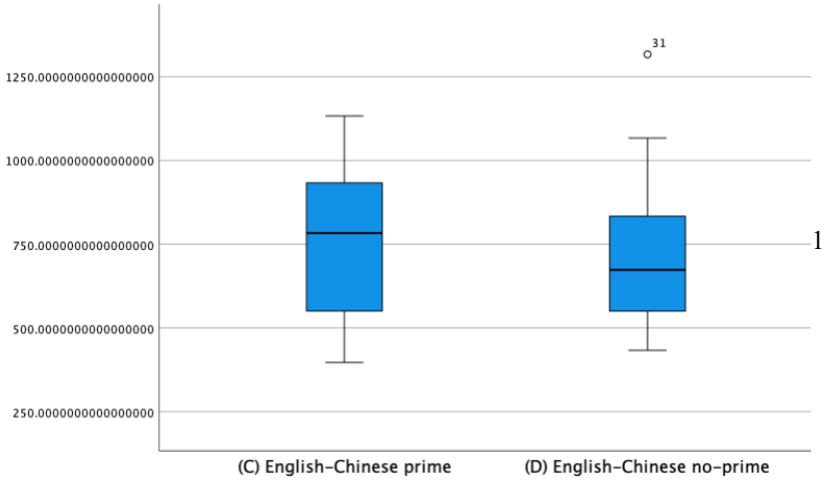
2

Target 6



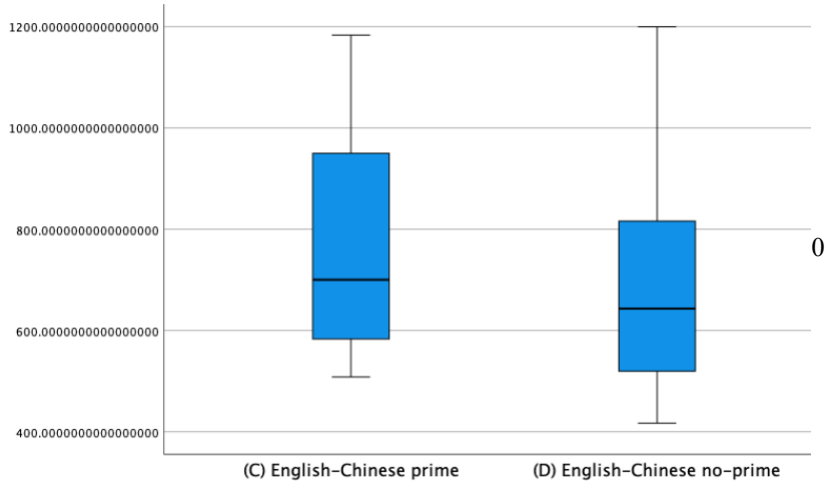
2

Target 7



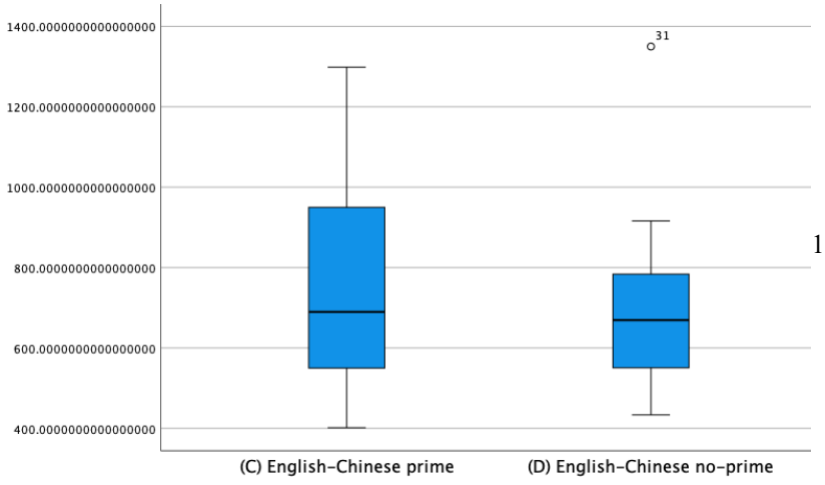
1

Target 8



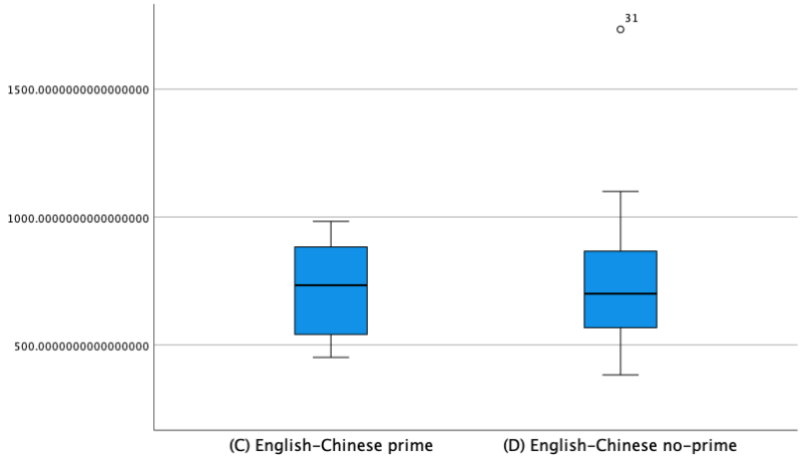
0

Target 9



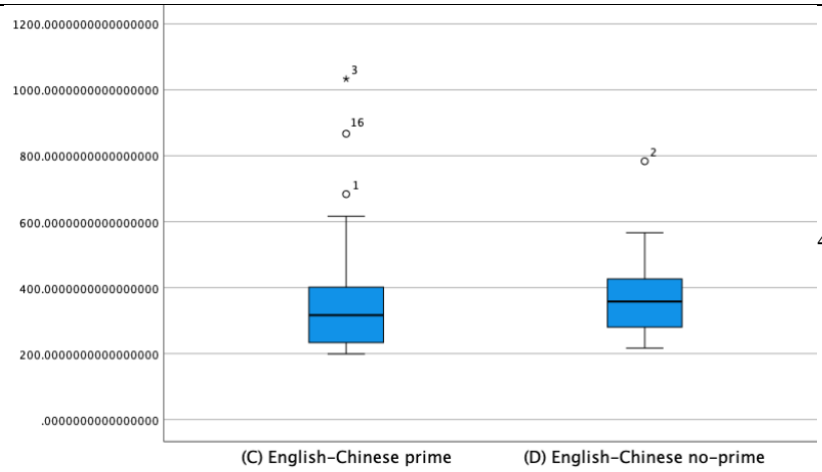
1

Target 10



1

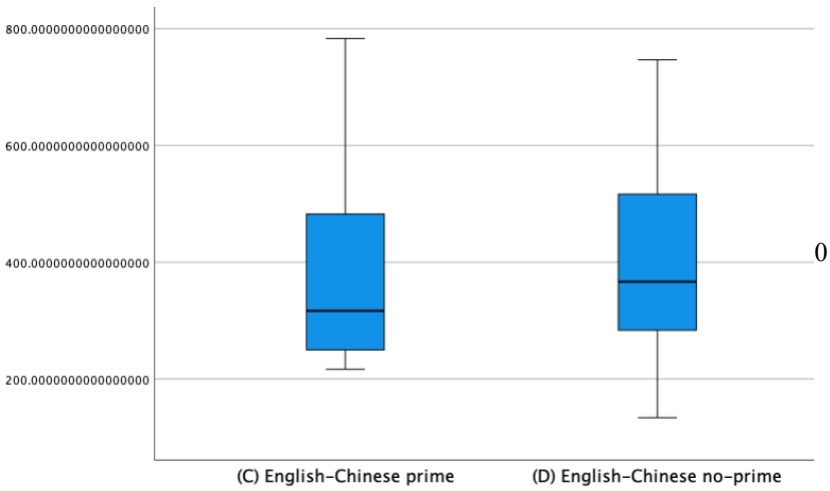
Target 1



4

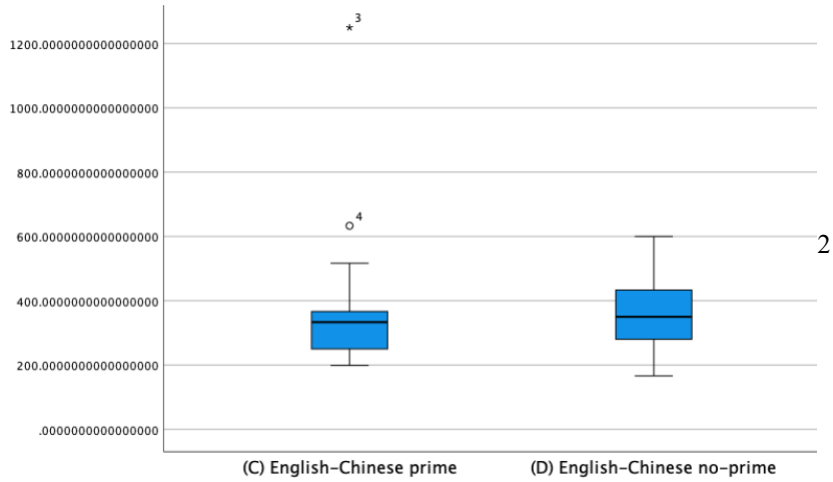
(2) V

Target 2



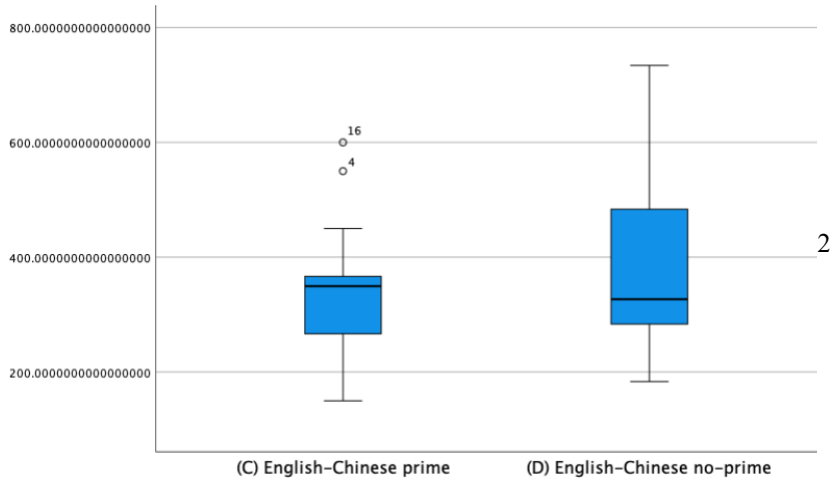
0

Target 3



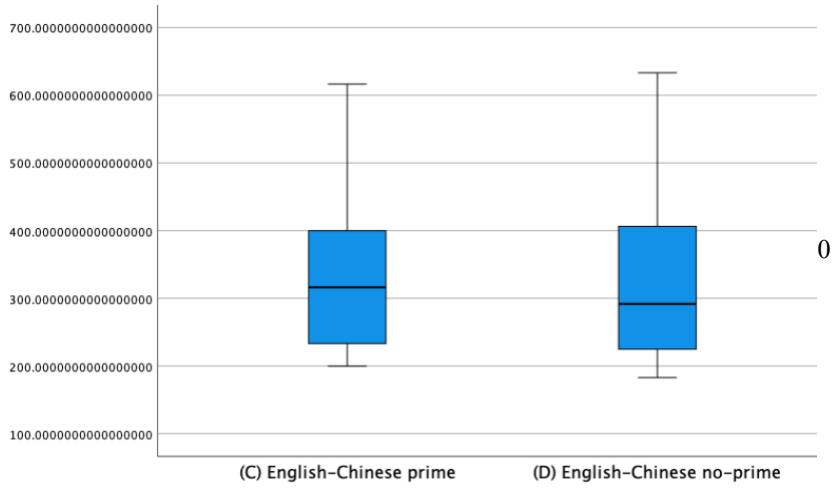
2

Target 4



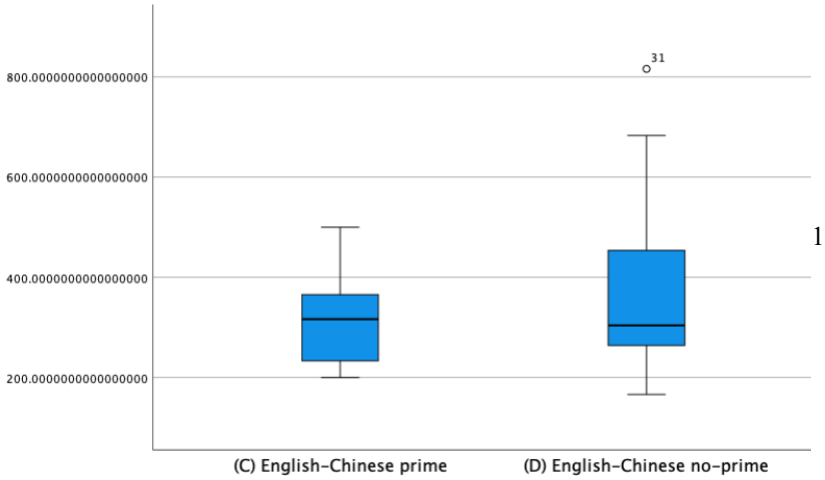
2

Target 5



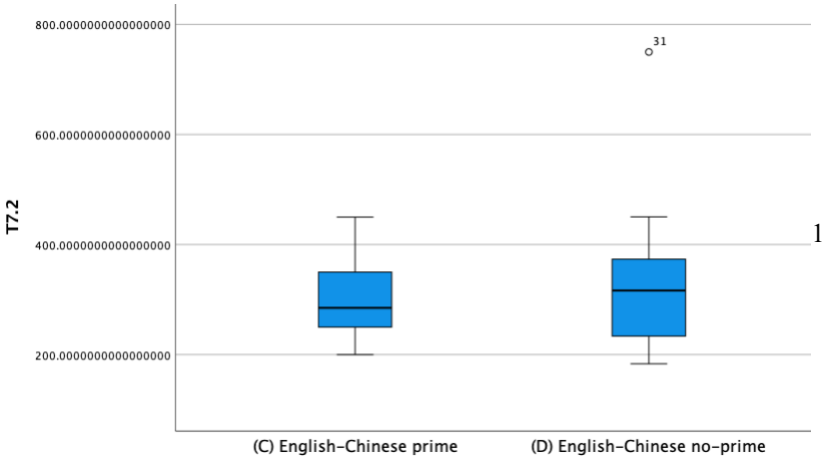
0

Target 6



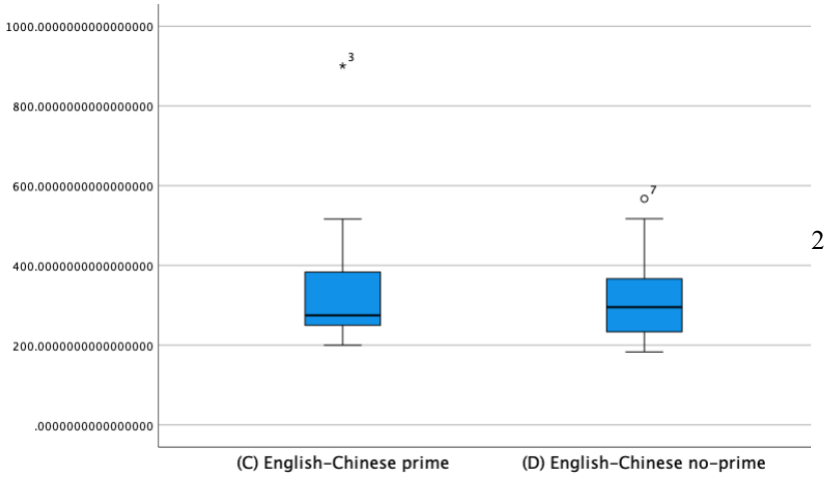
1

Target 7

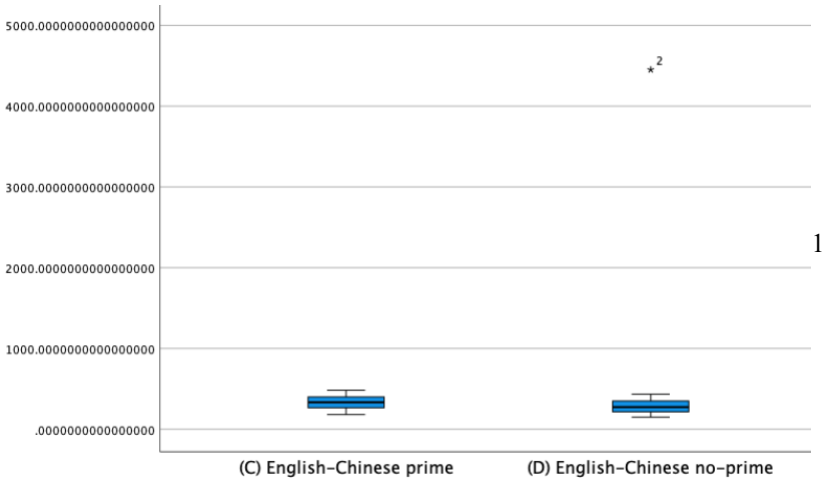
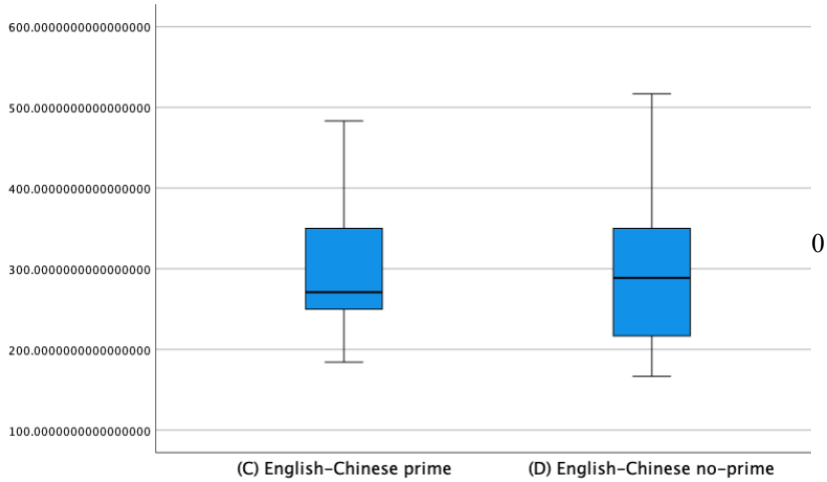
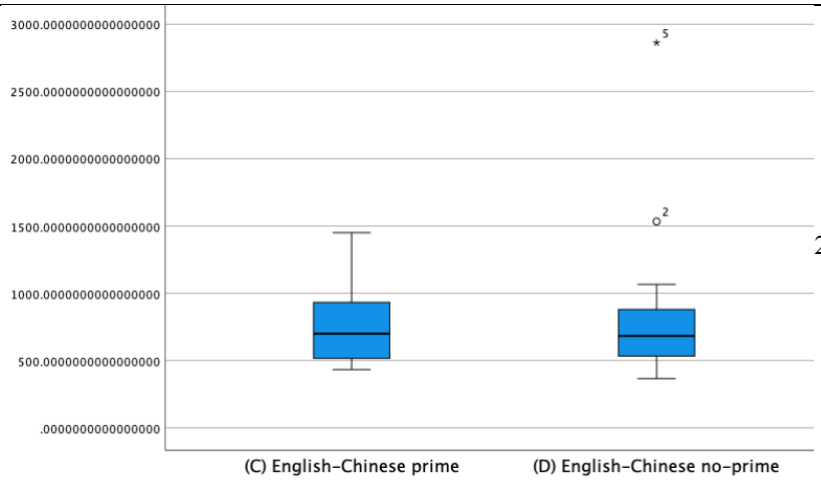


1

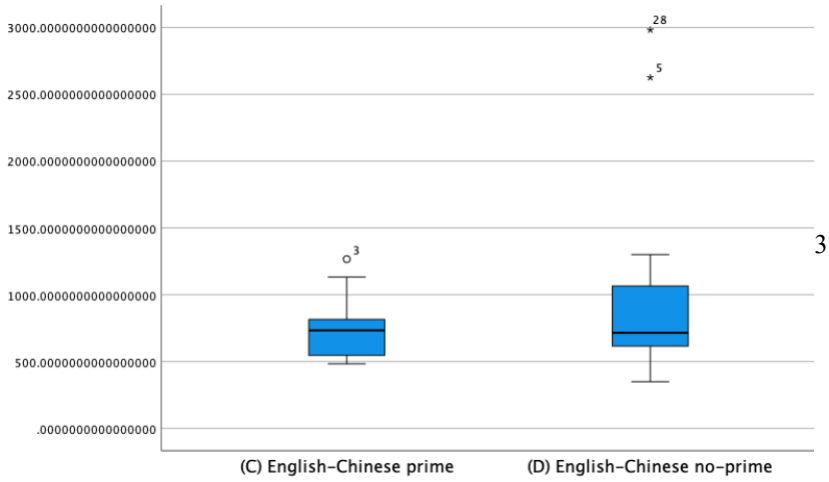
Target 8



2

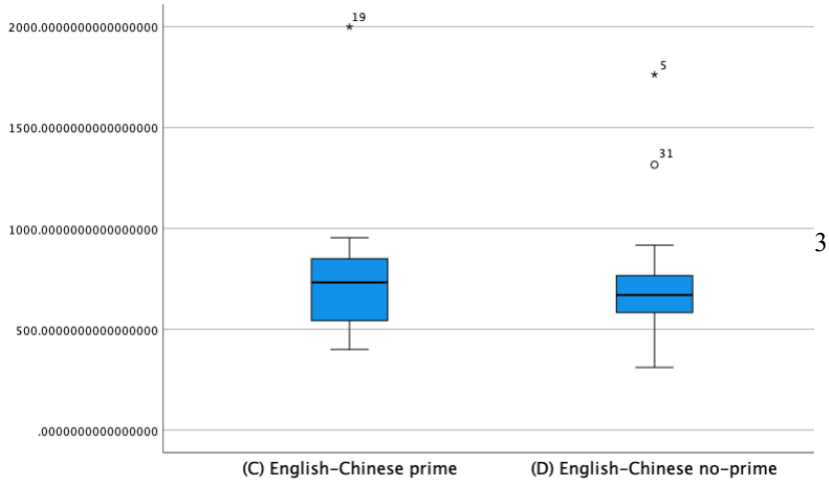
	Target 9		1
	Target 10		0
(3) *de* + NP_2	Target 1		2

Target 2



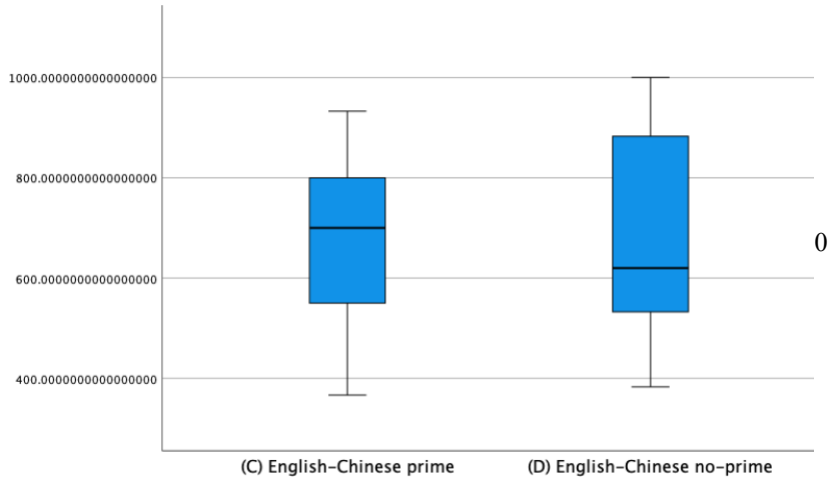
3

Target 3



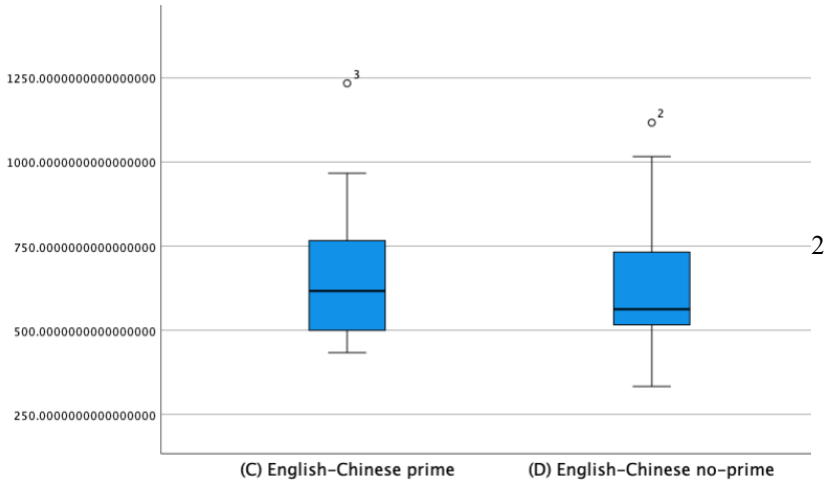
3

Target 4



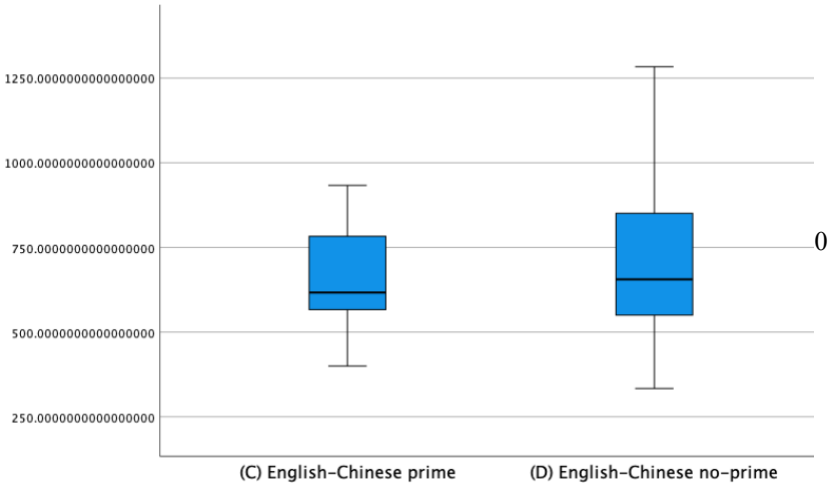
0

Target 5



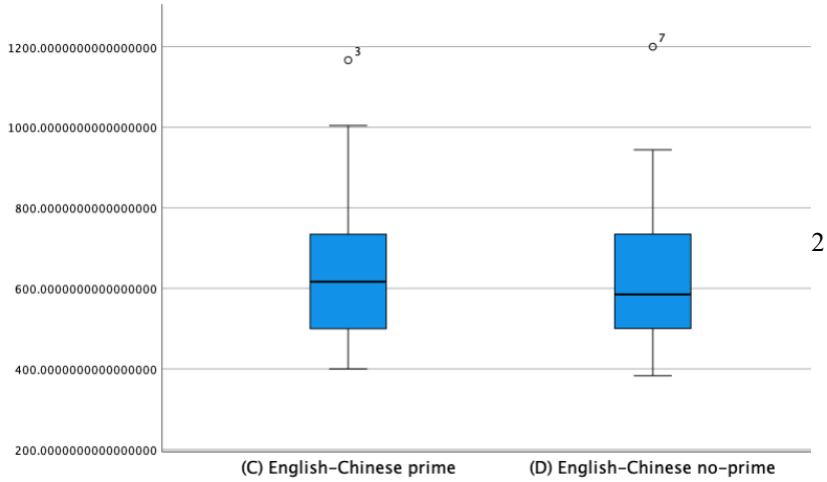
2

Target 6



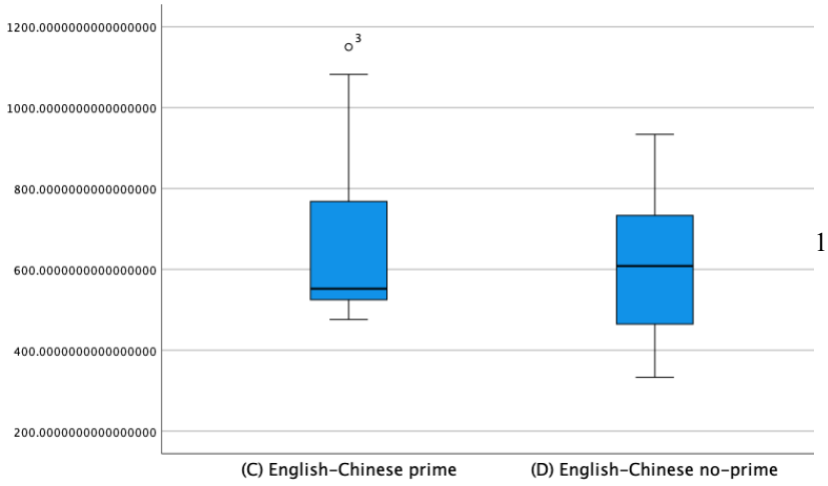
0

Target 7



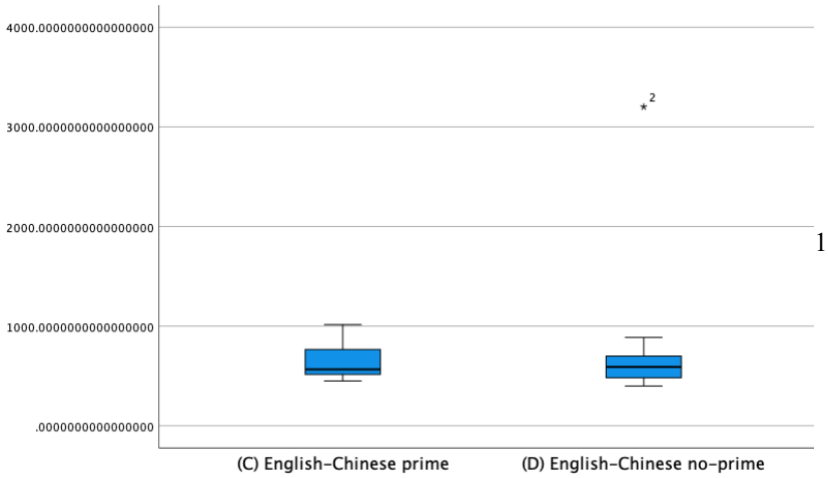
2

Target 8



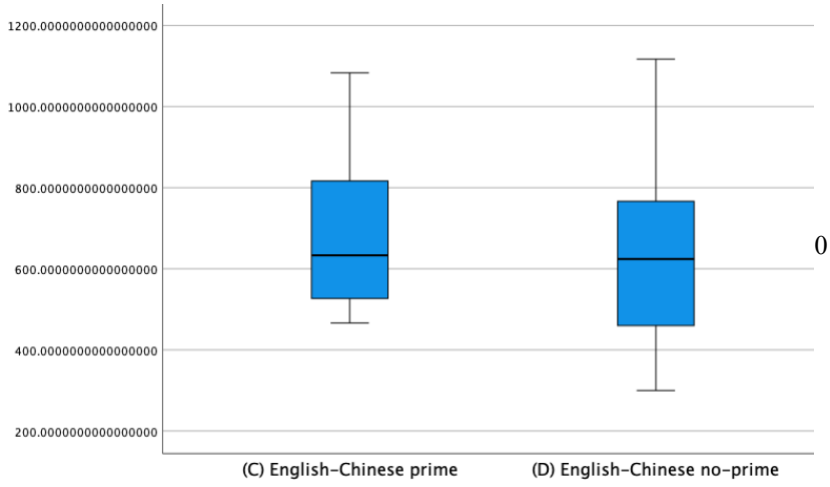
1

Target 9

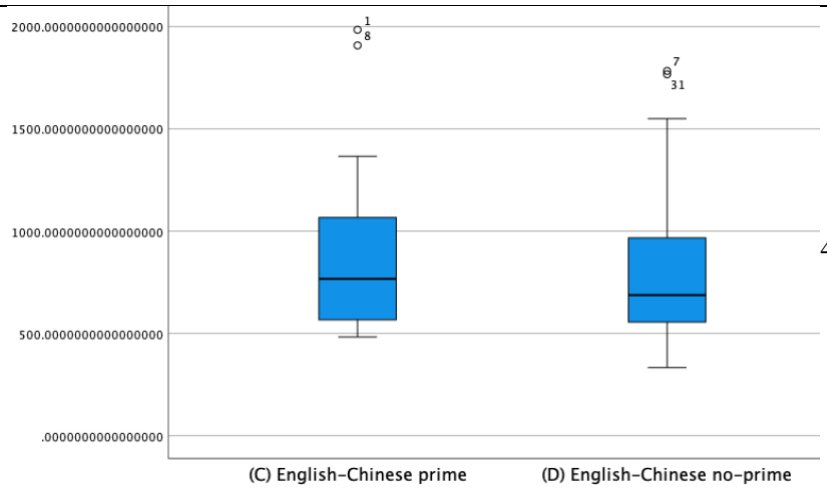
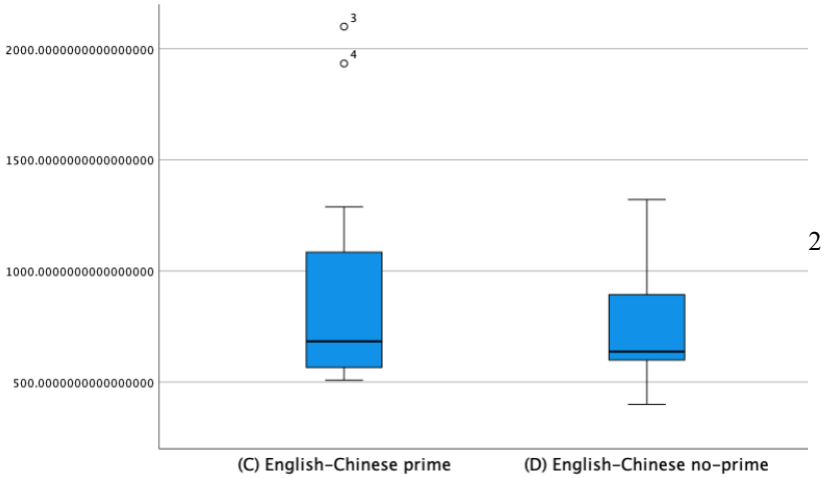
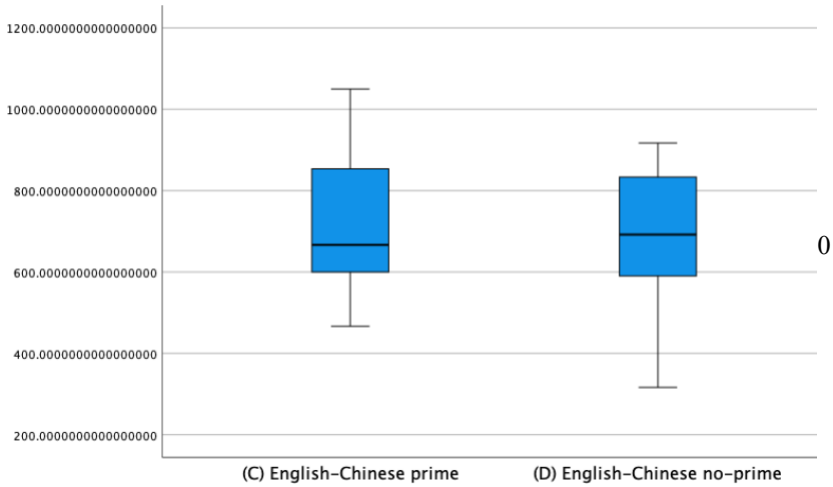


1

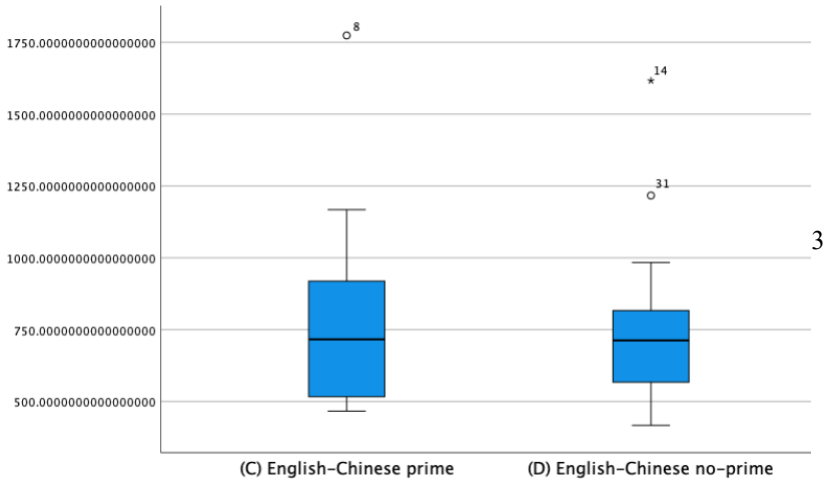
Target 10



0

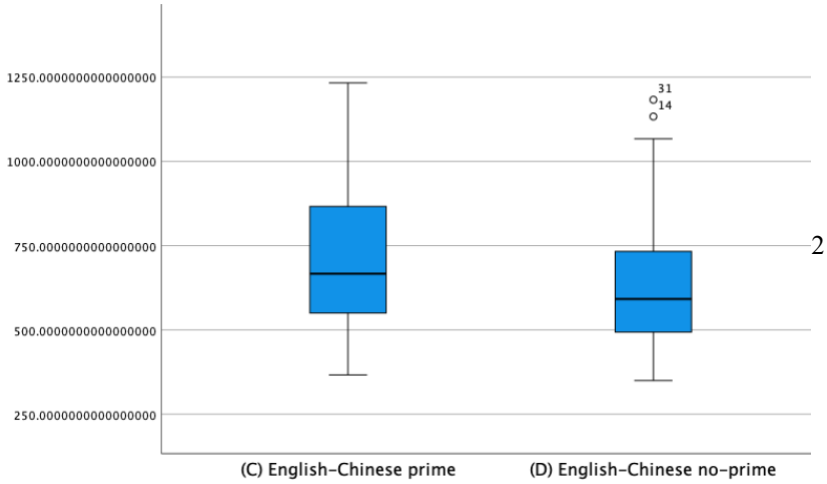
(4) past-tense VP	Target 1		4
	Target 2		2
	Target 3		0

Target 4



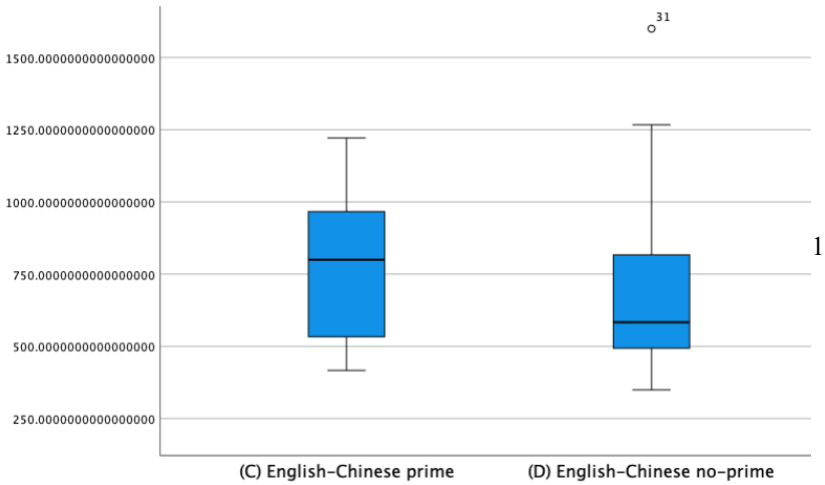
3

Target 5



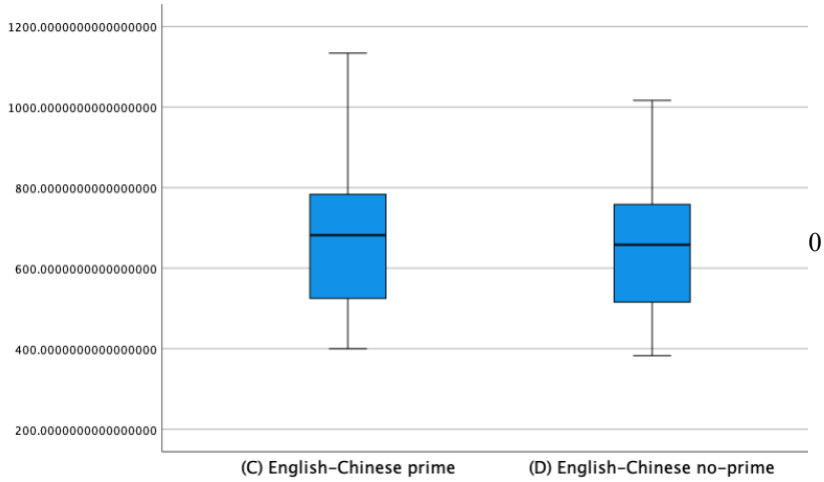
2

Target 6



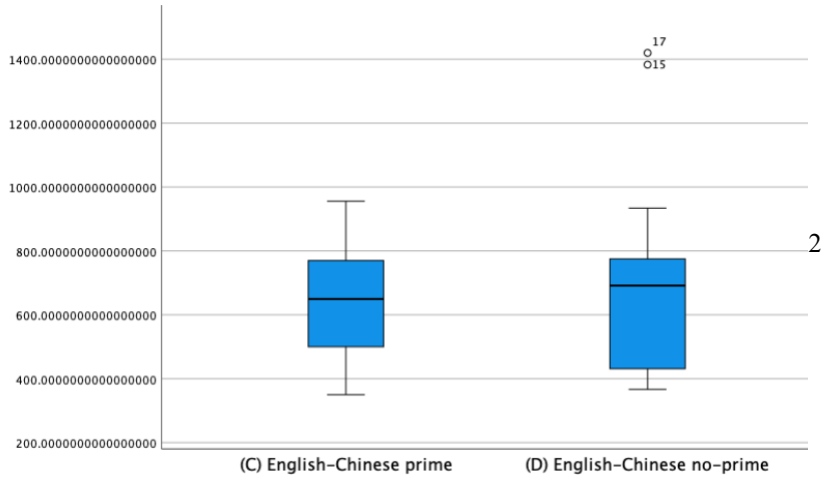
1

Target 7



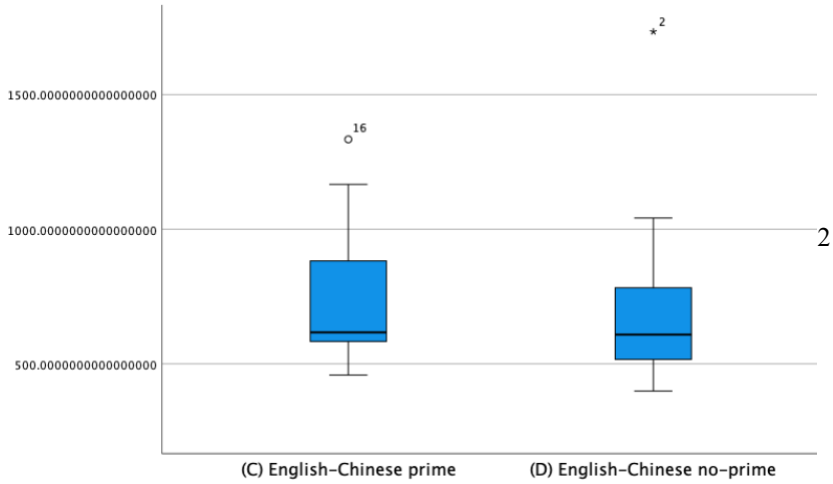
0

Target 8



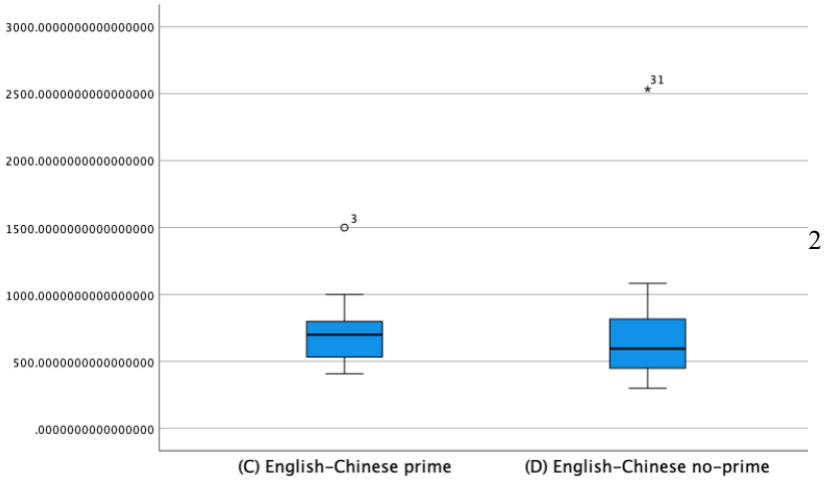
2

Target 9



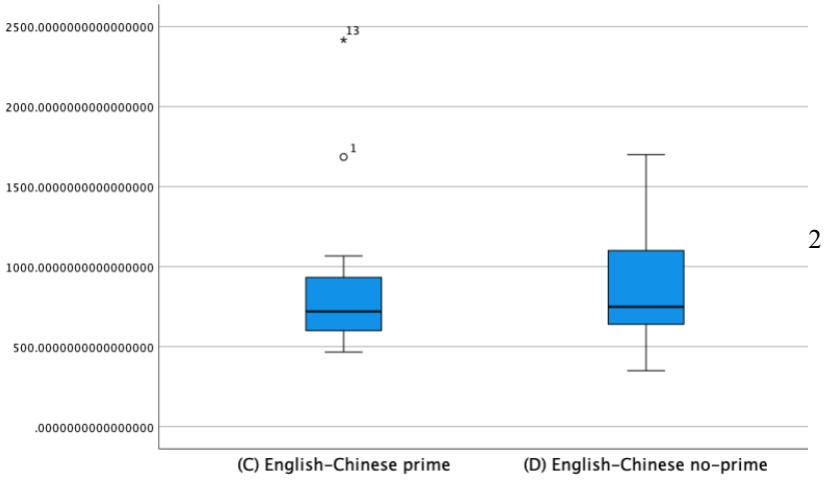
2

Target 10



2

Target 1

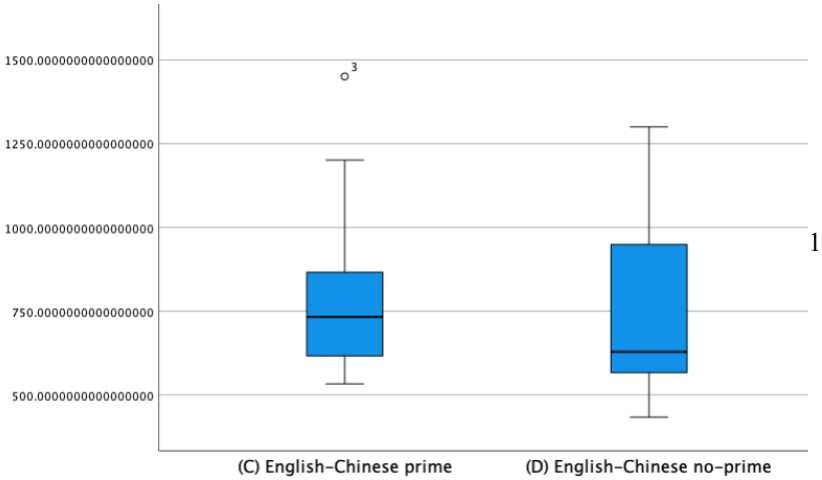


2

(5)

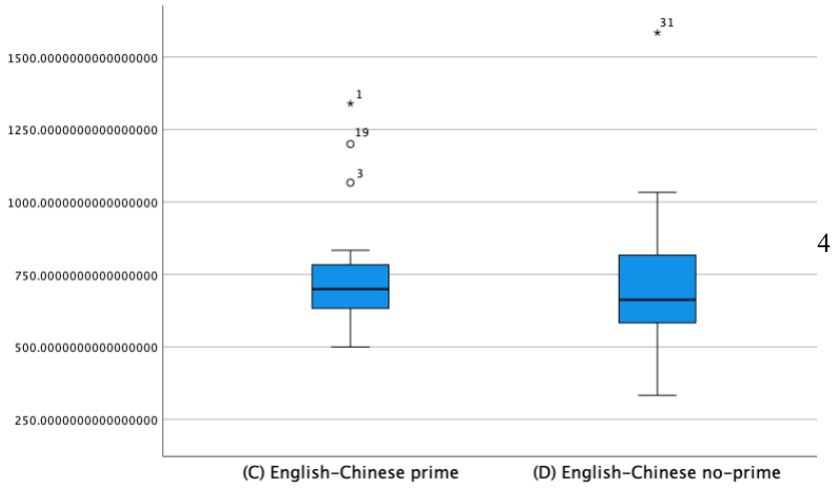
"VP+1"

Target 2



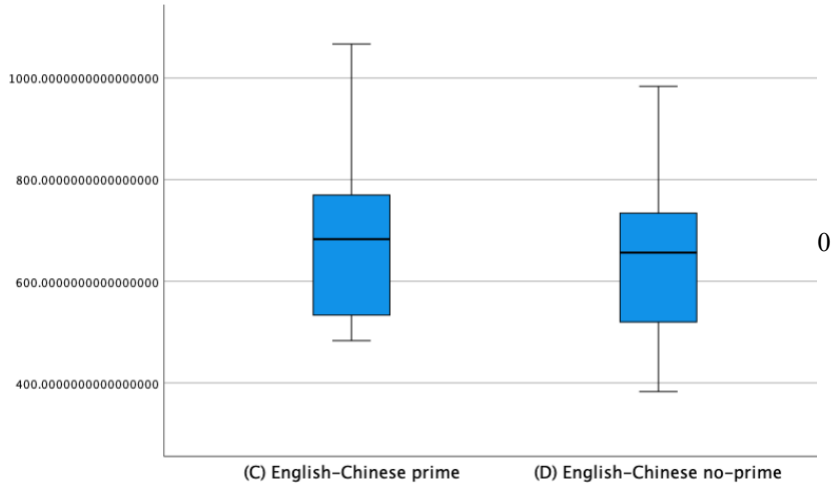
1

Target 3



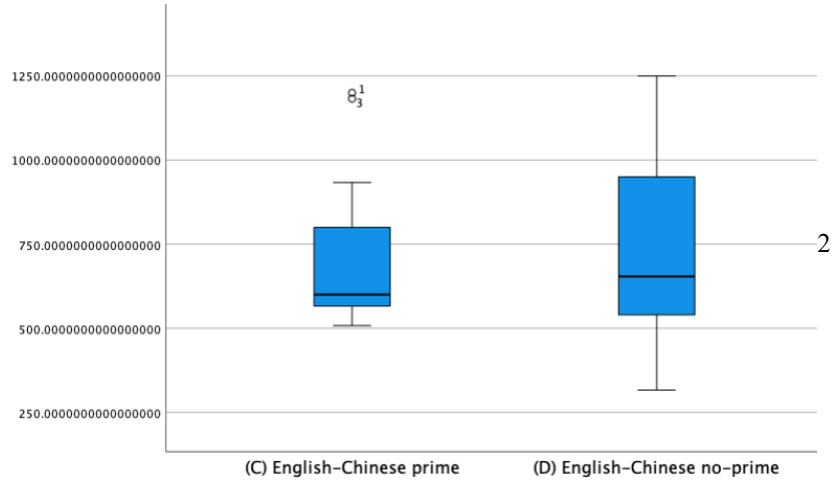
4

Target 4



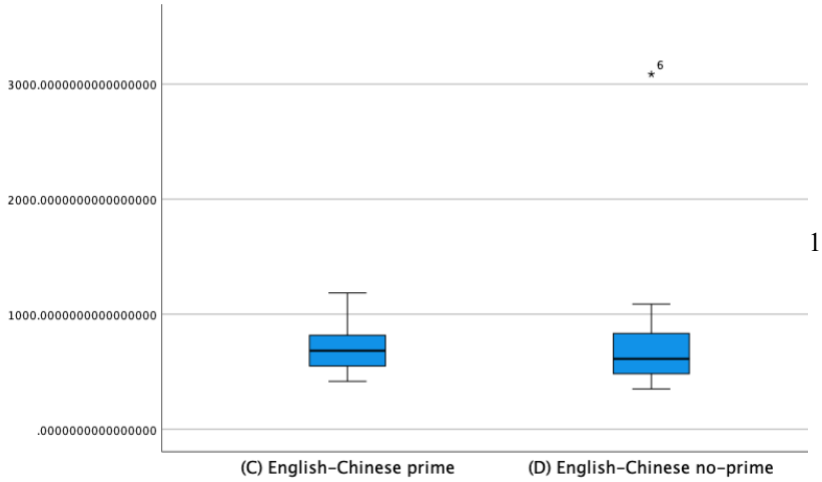
0

Target 5



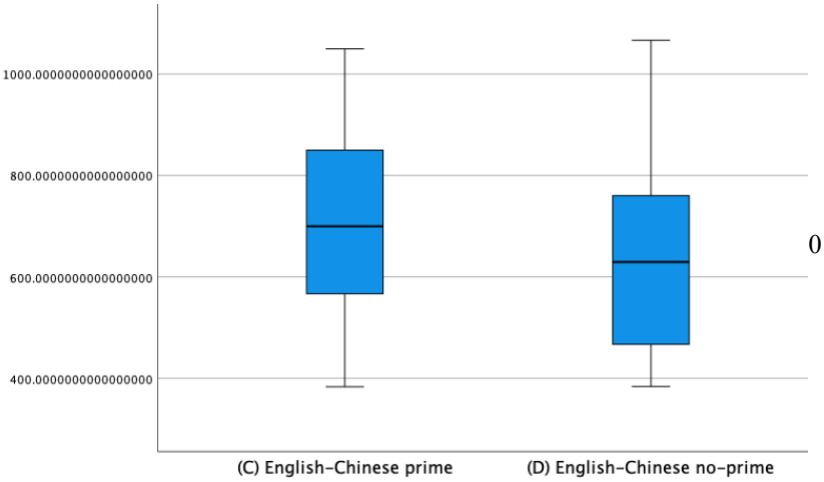
2

Target 6



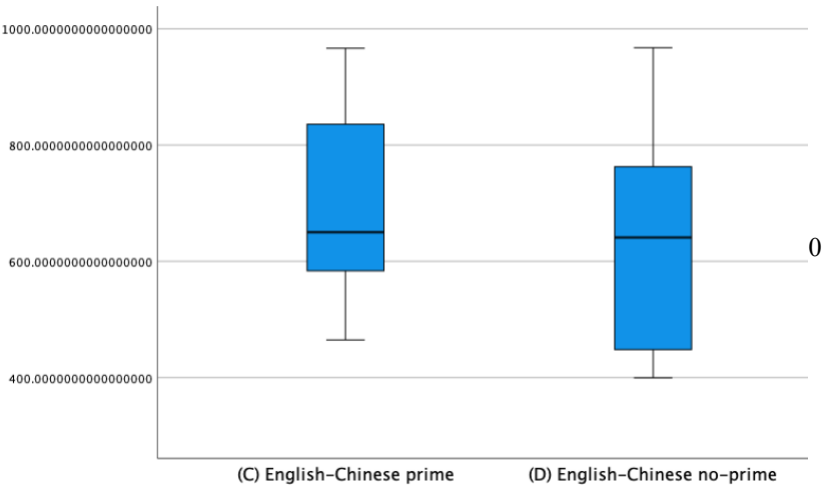
1

Target 7



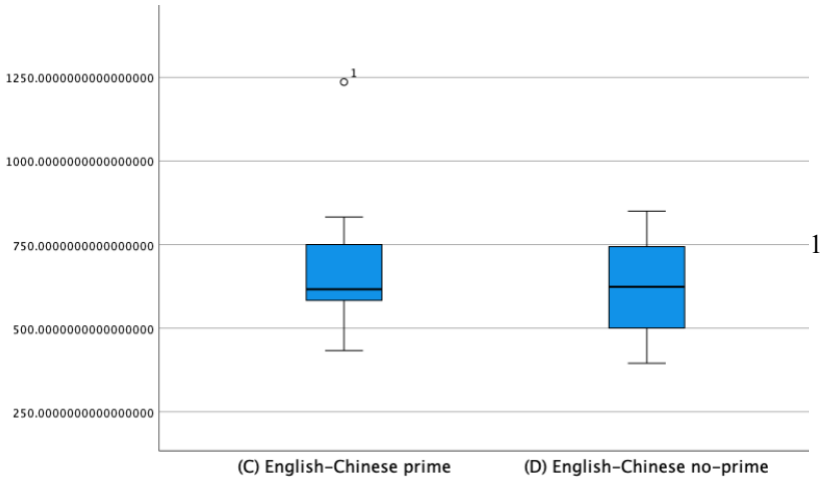
0

Target 8



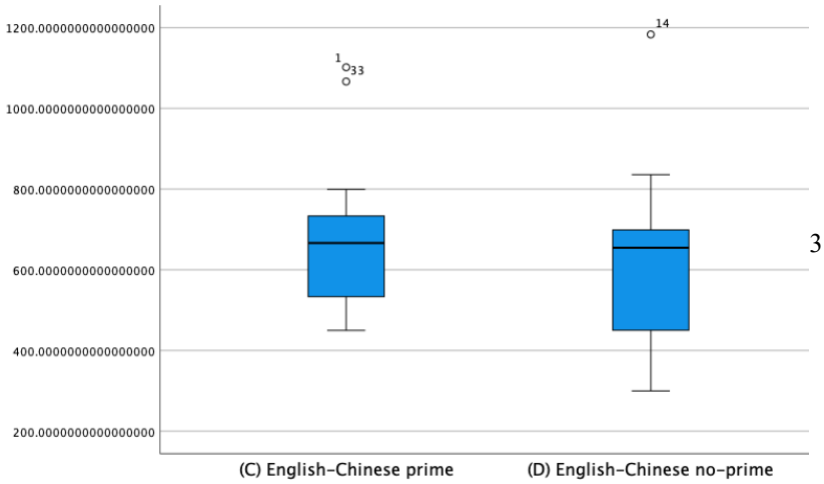
0

Target 9



1

Target 10



3

Appendix L. Descriptives of RTs for targets per L2-L1 experiment group, F-test results for equal variances, and independent samples t-test results comparing the groups' RTs per sentence region, by sentences and on average.

Note: According to the hypotheses, p values were one-tailed for t-tests concerning sentence region (3), and two-tailed for the other t-tests reported in this table.

	Sentence region	*Sentence number*	*M (SE)*		*SD*		*Skewness*		*Kurtosis*		*F (sig.)*	*p*
Group			(C) E-C prime	(D) E-C no-prime	(C) E-C prime	(D) E-C no-prime	(C) E-C prime	(D) E-C no-prime	(C) E-C prime	(D) E-C no-prime		
RTs for targets (*ms*)	(1) DET + NP_1	Target 1	809.83 (47.39)	751.90 (44.08)	195.40	187.00	-.076	-.514	-.895	-.342	.016 (.901)	.377
		Target 2	868.83 (65.62)	781.83 (48.76)	270.57	206.89	.088	.706	-.779	-.396	1.863 (.182)	.291
		Target 3	820.57 (51.19)	762.39 (59.21)	211.08	251.22	.118	.420	-1.093	-.057	.041 (.840)	.465
		Target 4	801.95 (51.69)	709.98 (48.78)	213.12	206.95	.640	.392	-.512	-.549	.030 (.864)	.204
		Target 5	762.37 (57.71)	678.42 (53.08)	237.95	225.18	.686	.776	-.219	-.321	.164 (.688)	.291
		Target 6	767.52 (47.12)	740.79 (41.69)	194.28	176.87	-.129	.015	-1.023	-.459	.771 (386)	.673
		Target 7	768.60 (57.02)	710.88 (45.71)	235.12	193.92	-.115	.464	-1.410	-.647	1.739 (.196)	.433
		Target 8	759.19 (50.96)	700.78 (50.94)	210.11	216.11	.447	.693	-.971	-.047	.026 (.872)	.424
		Target 9	768.78 (66.13)	665.62 (36.39)	272.66	154.41	.715	.329	-.408	-.926	6.577 (.015)	.184
		Target 10	716.80 (43.91)	734.10 (49.69)	181.04	210.82	-.059	.374	-1.436	-.606	.181 (.673)	.797
		Mean	**784.44 (44.75)**	**723.67 (37.92)**	**184.49**	**160.86**	**.030**	**.589**	**-1.067**	**-.882**	**.196 (.661)**	**.306**
	(2) V	Target 1	362.00 (38.59)	374.64 (27.97)	159.12	118.67	.826	.611	-.887	-.859	2.061 (1.61)	.791
		Target 2	375.87 (40.20)	397.43 (36.36)	165.76	154.27	1.201	.500	.744	-.004	.019 (.890)	.693

	Target 3	330.65 (25.46)	352.67 (26.99)	104.98	114.50	.745	.268	-.346	-.053	.186 (.669)	.558
	Target 4	323.50 (21.28)	374.68 (35.42)	87.76	150.28	-.178	.966	-.553	.416	3.232 (.081)	.231
	Target 5	341.91 (34.01)	329.97 (29.89)	140.24	126.83	.922	.915	-.618	.280	.209 (.650)	.793
	Target 6	309.64 (21.94)	355.43 (36.59)	90.45	155.24	.775	1.003	.062	.302	4.684 (.038)	.293
	Target 7	306.71 (17.38)	316.96 (20.12)	71.66	85.36	.533	.149	-.602	-1.197	1.063 (.310)	.704
	Target 8	329.19 (25.92)	315.98 (24.06)	106.87	102.06	.707	.699	-.791	-.107	.253 (.618)	.711
	Target 9	335.99 (22.67)	286.18 (21.55)	93.45	91.42	.002	.401	-1.087	-1.143	.001 (.976)	.121
	Target 10	308.88 (22.14)	297.07 (21.49)	91.29	91.15	.762	.714	-.534	.444	.044 (.835)	.704
	Mean	**332.43 (21.42)**	**340.10 (22.34)**	**88.31**	**94.78**	**.784**	**.206**	**-.028**	**-.768**	**.373 (.546)**	**.806**
	Target 1	768.15 (69.34)	722.12 (54.75)	285.89	232.29	.989	.272	.546	-1.070	.359 (.553)	.302
	Target 2	726.17 (49.60)	808.33 (71.59)	204.51	303.71	.721	.624	-.052	-.842	3.010 (.092)	.179
	Target 3	700.07 (44.58)	661.45 (41.30)	183.79	175.20	-.058	-.343	-1.192	-.139	.184 (.671)	.264
	Target 4	678.01 (42.12)	676.75 (47.85)	173.68	203.03	-.119	.306	-1.162	-1.267	.493 (.487)	.492
(3) *de* + NP_2	Target 5	651.75 (41.94)	632.69 (49.11)	172.92	208.36	.681	.761	-.681	-.466	.621 (.436)	.385
	Target 6	661.07 (36.30)	682.17 (58.90)	149.69	249.91	.162	.705	-.862	.402	3.044 (.090)	.381
	Target 7	651.39 (48.51)	631.51 (41.18)	200.01	174.71	.690	.414	-.766	-.785	.231 (.634)	.378
	Target 8	651.18 (49.17)	611.04 (40.05)	202.74	169.90	1.312	.133	.513	-.842	.480 (.493)	.265
	Target 9	625.39 (39.14)	602.87 (36.59)	161.38	155.24	1.073	.428	.3773	-.698	.058 (.812)	.338

	Target 10	665.01 (43.83)	632.10 (50.75)	180.71	215.32	.868	.607	.019	-.148	.895 (.351)	.314
	Mean	**677.82 (38.75)**	**666.10 (42.73)**	**159.77**	**181.27**	**.464**	**.440**	**-.893**	**-.751**	**.158 (.693)**	**.420**
	Target 1	843.96 (75.26)	823.58 (94.33)	310.31	400.20	.707	.996	-.797	-.300	.978 (.330)	.868
	Target 2	795.13 (74.73)	733.58 (59.54)	308.11	252.62	.915	1.014	-1.004	.370	1.617 (.212)	.522
	Target 3	707.46 (41.57)	682.11 (42.66)	171.41	180.99	.514	-.629	-.601	-.294	.064 (.801)	.674
	Target 4	749.25 (58.32)	698.18 (43.30)	240.47	183.72	.574	.160	-.915	-.987	1.433 (.240)	.484
	Target 5	729.37 (61.40)	645.21 (54.28)	253.16	230.30	.720	.939	-.369	-.209	.234 (.632)	.311
(4) past-tense VP	Target 6	796.21 (63.25)	685.56 (64.46)	260.79	273.48	.274	1.127	-1.101	.516	.003 (.960)	.230
	Target 7	675.54 (45.92)	659.70 (42.67)	189.35	181.04	.675	.351	.632	-.359	.003 (.955)	.802
	Target 8	651.09 (42.00)	652.42 (48.17)	173.16	204.37	.188	-.051	-.778	-1.451	.951 (.337)	.984
	Target 9	721.49 (52.59)	672.82 (51.63)	216.84	219.06	1.017	.499	.120	-1.055	.045 (.834)	.514
	Target 10	703.76 (44.64)	663.53 (56.02)	184.06	237.65	.220	.576	-.909	-.612	1.377 (.249)	.581
	Mean	**737.33 (46.53)**	**691.67 (43.98)**	**191.86**	**186.60**	**.401**	**.247**	**-1.215**	**-.928**	**.068 (.796)**	**.480**
	Target 1	758.26 (53.84)	831.97 (78.22)	221.98	331.88	.140	1.122	-1.473	1.413	1.101 (.302)	.448
	Target 2	799.88 (56.32)	739.99 (61.63)	232.21	261.47	.836	.847	-.754	-.435	.526 (.473)	.480
(5) "VP+1"	Target 3	688.93 (29.31)	698.30 (49.17)	120.85	208.60	-.351	.123	-1.152	-.574	3.567 (.068)	.873
	Target 4	696.86 (43.10)	653.77 (40.35)	177.70	171.19	.778	.442	-.024	-.329	.001 (.973)	.470
	Target 5	676.66 (38.91)	726.52 (64.23)	160.43	272.49	.889	.375	-.914	-.958	6.426 (.016)	.512

Target 6	718.76 (51.96)	673.44 (57.08)	214.22	242.17	.700	.646	-.047	-.833	.442 (.511)	.563
Target 7	702.28 (46.45)	645.23 (43.77)	191.53	185.68	.202	.507	-.761	-.017	.016 (.902)	.377
Target 8	702.75 (41.70)	643.89 (42.44)	171.92	180.04	.203	.142	-1.303	-.965	.002 (.963)	.330
Target 9	642.62 (29.68)	624.85 (33.10)	122.36	140.43	.088	-.038	-.855	-1.216	.982 (.329)	.693
Target 10	640.60 (30.13)	600.87 (37.47)	124.22	158.98	-.105	-.181	-1.505	-.921	1.551 (.222)	.419
Mean	**702.76 (32.08)**	**683.89 (41.22)**	**132.25**	**174.89**	**.540**	**.358**	**-.178**	**-.751**	**3.045 (.090)**	**.722**

As shown in the table, no significant group differences were observed in the RT for any target region of any sentence.