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TABLE OF CONTENTS

Abstract 4

Acknowledgments 5

Chapter 1 – Introduction

1.1. Introduction 6

1.2. Background 6

1.3. Gap in literature and research novelty 8

1.4. Justification and significance of the research 9

1.5. Research objectives and research questions 10

1.6. Outline of chapters 10

Chapter 2 – Literature Review

2.1. Introduction 12

2.2. The BIA+ model and Multilingual Processing model in bilingual word recognition 12

2.3. The Multilink model 14

2.4. Empirical evidence on same-script bilingual word recognition 14

2.4.1. Limitations 16

2.5. Empirical evidence on cross-script masked priming 17

2.5.1. Japanese-English bilinguals 18

2.5.2. Hindi-English bilinguals 19

2.5.3. Mandarin Chinese-English bilinguals 20

2.5.4. Limitations 21

2.6. L2 proficiency as an affecting factor 22

2.7. Research questions and predictions 23

Chapter 3 – Methodology

3.1. Summary on research design 25

3.1.1. Masked priming paradigm 25

3.1.2. Durations of prime, target and masks 26

3.2. Participants 26

3.3. English proficiency assessment 26

3.4. Test Materials 27

3.5. Experiment condition 1 Procedure 29
3.6. Experiment condition 2 Procedure 30

Chapter 4 – Results
4.1. Comparisons of reaction times and accuracy rates: Cantonese character versus Jyutping as primes 33
4.2. Effects of priming directions on reaction times and accuracy rates 34
4.3. Effects of L2 proficiency on reaction time and accuracy rates across priming Directions 36
4.4. A brief conclusion 36

Chapter 5 – Discussion
5.1. An overview of the study and findings 37
5.2. Finding 1: significant effect of script on AR with no effect on RT 38
5.3. Finding 2: the effect of L1/L2 priming direction on accuracy rate 40
5.4. Finding 3: the interaction of L2 proficiency and Jyutping script 42

Chapter 6 – Conclusion 45

References 47
Appendix 1 54
Appendix 2 55
Appendix 3 56
Appendix 4 57

Abstract

Title: The activation of phonological representations in Cantonese-English bilingual young adults with different levels L2 proficiency

This study delves into the contentious issue of lexical activation and access in bilinguals, primarily focusing on whether the process is selective or nonselective. Selective activation means that only one of the two language systems in a bilingual individual is activated while processing. Conversely, nonselective activation means both language systems are activated simultaneously. While previous research largely supports the nonselective hypothesis, the roles of second language (L2) proficiency and the influence of different language scripts remain largely unexplored.

To elucidate these aspects, the study involved 42 Cantonese-English bilinguals, a less investigated demographic and employed a phonological relatedness judgement task, a seldom-used approach. Findings revealed that neither the direction of language priming nor the use of different scripts significantly influenced the participants' reaction times. However, the script and direction of priming markedly impacted accuracy rates, providing new insights into cross-script bilingual word recognition. These results offer a deeper understanding of bilingual lexical access and carry significant educational and theoretical implications such as teaching English as a second language for Cantonese-English bilinguals, the awareness on the education of Jyutping and theories of bilingual language processing such as the BIA+ model.

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CHAPTER 1 INTRODUCTION

1.1. Introduction

The process of lexical activation – how an individual selects an appropriate word from their mental lexicon in response to an external stimulus – seems straightforward in monolingual speakers as all the lexical information are in a single mental lexicon. However, understanding the lexical retrieval process becomes more complex when we consider bilingual speakers. A question that arises is whether bilinguals store the phonological representations of their two languages together or separately, which has intrigued researchers in the fields of psycholinguistics and second language (L2) acquisition since the 1960s (Jiang, 2015). However, despite consistent academic interest in how bilingual access and activate their phonological representations, it was not until the 21st century that the discussion on language selectivity in bilingual phonological activation truly began (Jiang, 2015).

Thus far, the pivotal point of contention regarding bilingual lexical activation and access pertains to the selectivity of the process. A substantial body of extant research corroborates the nonselective stance (e.g., Jared & Kroll, 2001; van Heuven, Dijkstra & Grainger, 1998; Zhou, Chen, Yang & Dunlap, 2010), yet certain areas demand more comprehensive exploration. One such area involves the impact of L2 proficiency on phonological access, an issue that remains relatively under-examined. The controversy on how L2 proficiency affects bilingual phonological activation is evident from the divergent results emanating from studies on bilingual individuals with varying L2 proficiency levels (e.g., Nakayama, Sears, Hino & Lupker, 2012; Zhou et al., 2010). Furthermore, interpretations of cross-script phonological priming effects are far from unanimous, and scant research conducted on the interaction between logographic and alphabetic language systems, such as those in Chinese and English respectively (e.g., Zhou et al., 2010).

1.2.Background

The critical issue of language selectivity in bilingualism was initially presented by Altenberg and Cairns (1983). They questioned whether bilingual individuals simultaneously activate both of their language processing systems or if one system becomes non-responsive depending on the language context. These two contrasting perspectives were introduced as the Interaction Hypothesis and the Independence Hypothesis (Altenberg & Cairns, 1983), respectively.

This foundational discussion was further built upon by Beauvillain and Grainger (1987) who introduced two additional contrasting hypotheses: the Language-selective Hypothesis proposes that one of the language systems in the bilinguals is selected for processing, while the Language-nonselective Hypothesis contends that language processing is independent of the specific language in use. These perspectives have significantly contributed to the ongoing debate on language selectivity in bilingualism for over two decades (e.g., Altenberg & Cairns, 1983; Grainger, 1993; La Heiji, 2005).

Evidence favouring to the selective hypothesis comes from an array of early studies on bilingual code-switching that use different methdologies (e.g., MacNamara & Kushnir, 1971; Soares and Grosjean, 1984). However, the studies most pertinent to the current discussion employed the lexical decision task (LDT). In this task, participants are presented with a stimulus (the prime) and then respond to the subsequent target.

Soares and Grosjean (1984) conducted a study using a lexical decision task, where they discovered that bilingual individuals responded faster to cognate words - words sharing similar meaning and form across both languages - than to noncognate words. This indicated that cognates were processed as if they were words from the bilinguals' dominant language, providing evidence in favor of language selectivity.

In a similar vein, Scarborough and colleagues (1984) conducted research that further corroborated the language-selective hypothesis. In their study, bilingual participants were tasked with a monolingual lexical decision task. The researchers observed that the time taken to respond to a word in the specified language was comparable to the response time for low-frequency nonhomographic words in the same language. This suggested that the bilingual individuals were capable of selectively accessing the lexical system designated by the context.

In summary, these studies employed methods like LTDs to demonstrate that bilingual individuals seem to have the ability to selectively process language. Costa, Miozzo and Caramazza's (1999) study further reinforced the language-selective hypothesis using a picture-naming task with Catalan-Spanish bilinguals. In this task, participants had to name a picture in either of Catalan or Spanish with a cognate or semantically related word in another language presented at the same time. Participants named pictures in their first language (L1) quicker when presented with a related L2 distractor word than an unrelated one. This finding suggested

that, despite the activation of the nonresponse language, the lexical selection mechanism in bilingual individuals is language-specific, providing further support for the language-selective hypothesis.

The Bilingual Interactive Activation (BIA) model proposed by Dijkstra and van Heuven (1998) marked a shift in the bilingual research field towards the nonselective hypothesis, which subsequent studies tended to adopt (e.g., Dijkstra, Timmermans & Schriefers, 2000; Marian, Spivey & Hirsch, 2002; Ju & Luce, 2004). The BIA model features four levels: the feature level, including lines and curves of each letter; the letter level; the word level, and the language nodes. It posits that simultaneous activation occurs from the letter level to the word level, suggesting that the recognition of a letter activates all words containing that letter, irrespective of the language. This theory offers a fitting explanation for languages sharing the same writing systems. However, it is not as well-equipped to account for the processing of languages with different scripts, such as English, an alphabetic system, and Chinese, a logographic system.

While numerous studies (e.g., Jared & Kroll, 2001; van Heuven et al., 1998; Zhou et al., 2010), corroborating the nonselective hypothesis draw upon the BIA model to explain their findings, its applicability to different-script languages raises compelling questions within the bilingual research sphere.

1.3 Gap in literature and research novelty

Studies investigating cross-script phonological priming in different-script bilinguals have yielded somewhat equivocal results. These results are attributable primarily to three factors. Firstly, several of these studies include languages with a moderate degree of orthographic overlap, such as Japanese Katakana and English (Nakayama et al., 2012). The orthographic similarities might have clouded the results pertaining to the selectivity mechanism, as the writing systems are not entirely distinguishable.

Secondly, there is a scarcity of studies involving truly distinct logographic and alphabetic language pairs. Among the few studies that exist, those focusing on Chinese-English bilinguals are particularly noteworthy. The unique aspect of these studies is the use of Chinese Romanization (Pinyin), which allows for an intriguing comparison with English words. This

offers a valuable avenue for investigating the language selectivity mechanism in different-script bilinguals.

Thirdly, discrepancies emerge in cross-script studies when L2 proficiency is considered as a potential influencing factor. Certain studies (e.g., Nakayama et al., 2012) reported that L2 proficiency is not likely to be a dominant of phonological priming. Conversely, other studies (e.g., Zhou et al., 2010) reported variations in the phonological priming effect between bilinguals with high and low L2 proficiency. This inconsistency further contributes to the inconclusive nature of the findings in this research area.

The present study offers several novel contributions to the existing body of research on bilingual lexical processing, particularly for Cantonese-English bilinguals. One unique aspect of this study is the focus on Cantonese Jyutping, which differs from Mandarin Chinese Pinyin in that it includes tone markings in the romanisation system, making it less similar to the English alphabetical system. This difference may have implications for the cross-linguistic activation patterns observed among bilinguals, offering new insights into the interaction between orthographic and phonological representations.

Additionally, Cantonese-speaking bilinguals typically do not learn Jyutping through formal education, unlike Mandarin speakers who acquire Pinyin in school from an early age (Zhou et al., 2010). However, some Cantonese speakers may utilise Jyutping in casual text messages or as a computer input method (Wei, Tsang, Wong & Lok, 2020). This distinct learning context could potentially influence the extent to which Jyutping primes facilitate or hinder lexical processing, as well as the overall pattern of cross-script priming effects in Cantonese-English bilinguals.

1.4 Justification and significance of the research

This study aims to bridge these research gaps by probing the phonological access mechanisms in Cantonese-English bilinguals — which is a largely unexplored demographic in this field, to the best of my knowledge. The study will primarily center on the role of L2 proficiency and the implications of cross-script bilingualism on lexical activation and access.

By examining these unique aspects of Cantonese-English bilingualism, this study will provide valuable insights into the processes underlying cross-script bilingual lexical access, thereby

contributing to the refinement and development of the BIA+ model. A more comprehensive understanding of how different bilingual populations access their mental lexicon can inform the creation of more effective vocabulary teaching and learning strategies, ultimately enhancing language acquisition outcomes for diverse learners.

1.5 Research objectives and research questions

The primary objective of this research is to examine the activation of phonological representations in Cantonese-English bilinguals, with a specific focus on whether their activation patterns corroborate the language selectivity hypothesis. Moreover, the study seeks to discern the influence of L2 proficiency on this activation process. To address these objectives effectively, the study is structured around the following four pertinent research questions:

1. Is there a shared repository for the phonological representations of Cantonese and English within the mental lexicon of Cantonese-English bilinguals?
2. Will the presentation of Cantonese characters versus Jyutping as primes influence reaction times during the phonological similarity judgement task?
3. Will the direction of priming, given the dominance of Cantonese as the first language (L1), result in disparate reaction times?
4. To what degree does L2 proficiency modulate the reaction time observed in both directions of priming?

1.6 Outline of chapters

This study, comprising seven chapters, delves into language selectivity in Cantonese-English bilingual individuals, with each chapter serving a specific purpose in addressing the research questions:

- Chapter 1 – Introduction: This chapter sets the stage, outlining the hypotheses on bilingual language selectivity, research gap, significance of this study, and research objectives and questions.
- Chapter 2 – Literature Review: This section presents the theoretical foundations related to bilingual word recognition. It also critically reviews studies on both same-script and cross-script priming.
- Chapter 3 – Methodology: This section details the experimental paradigm and procedures employed in the study and offers a summary of participant demographics.

- Chapter 4 – Data Analysis: This chapter presents the statistical findings from the experiments, supplemented by figures and graphs for clarity.
- Chapter 5 – Discussion: This chapter draws upon the data to provide a comprehensive discussion, correlating the results with the reviewed literature from Chapter 2.
- Chapter 6 – Conclusion: The final chapter delineates the constraints and potential shortcomings of the current study. It lists out the factors that might have influence the results. This chapter also provides a conclusion on the influence of L2 proficiency in Cantonese-English bilingual cross-script priming. Additionally, it outlines potential directions for future research in this area.

CHAPTER 2 LITERATURE REVIEW

2.1. Introduction

This chapter presents a comprehensive and critical review of pertinent studies on the activation of bilingual phonological representations during word recognition. The exposition commences with an exploration of theoretical models that provide explanatory frameworks for bilingual word recognition (Sections 2.2 and 2.3). Subsequently, the chapter transitions to an overview of the studies on word recognition in same-script bilinguals (Section 2.4), before delving into the realm of different-script bilingual word recognition (Section 2.5), where the focus will be on Chinese-English, Japanese-English, and Hindi-English bilingual populations.

The selection of this literature has been informed by their direct relevance to the present study, as well as the valuable insights they can potentially lend to the design of the current research, considering their respective merits and limitations (Subsections 2.4.1 and 2.5.4).

Given the significance of L2 proficiency in influencing priming effects — a factor that not only bears relevance to the current study but also features prominently in more recent research endeavors (e.g., Nakayama et al., 2012; Singh, Wang & Faroqi-Shah, 2022) — Section 2.6 is dedicated to a concise review of this aspect. Lastly, this chapter recapitulates the research questions and predicts the potential outcomes based on the empirical literature and theoretical models under review (Section 2.7).

2.2. The BIA+ model and Multilingual Processing model in bilingual word recognition

Bilingual language processing, particularly the manner in which individuals comprehend and process words from their respective languages, has long been a subject of interest in cognitive research. Two prominent models have been proposed to elucidate this process: the Bilingual Interactive Activation Plus (BIA+) model (Dijkstra & van Heuven, 2002), and De Bot's Multilingual Processing model (2004).

The BIA+ model posits a shared lexical store for both languages in bilingual individuals. This unified storage implies that both languages are simultaneously activated during any linguistic processes – be it reading, speaking, or listening - essentially suggesting a nonselective language activation process.

In the BIA+ model, processing begins with the recognition of a string of letters, which activates the corresponding orthographic nodes, and by extension, all words containing the same letter strings. Activation then spreads to phonological and semantic nodes. A key distinction of the BIA+ model from its predecessor, the BIA model, is the consideration of languages employing different scripts. According to the BIA+ model, languages using diverse writing systems, such as Chinese characters and English letters, exhibit less coactivation.

Conversely, if the languages are represented in similar orthographic forms, like Chinese Pinyin and English words, the model suggests that interlingual activation will be enhanced. This may be reflected in terms of reaction times, such that a higher orthographic overlap should ideally reduce the time it takes participants to react to a stimulus. Several empirical studies corroborate this hypothesis (Jared & Kroll, 2001; van Heuven et al., 1998; Zhou et al, 2010), though a few studies offer contrasting results (Costa & Caramazza, 1999; Gerard & Scarborough, 1989). Subsequent sections of the chapter will delve into the detailed evaluation of these pertinent studies, thereby providing a comprehensive understanding of the BIA+ model and its implications.

De Bot's (2004) Multilingual Processing Model broadens the understanding of multilingual language processing as suggested by the BIA+ model, by introducing a more fluid and dynamic approach. This model portrays the interconnectedness of a multilingual speaker's linguistic systems, with their activation levels fluctuating based on numerous factors such as language proficiency and the context in which the language is used. The model proposes that frequent usage and high proficiency in a language strengthens the language’s activation within this network. As a consequence, an individual with a high proficiency in their L1 may face challenges in minimizing its activation when processing their L2, since suppressing a highly activated system is difficult.

Both the BIA+ model and the Multilingual Processing model underscore language proficiency as a pivotal factor in bilingual word processing and provide support for the nonselective language hypothesis. They propose that increased L2 proficiency leads to more language-specific mental processing, thus facilitating the separation of the two languages. Conversely, less proficient bilinguals may encounter difficulties in segregating their languages, leading to inefficient language processing.

Despite the existence of these comprehensive models, the exact mechanism underlying the interplay of language activation remains ambiguous due to mixed research findings. A plausible explanation for the mixed findings might lie in the potential intricate relationship between language activation and proficiency, which is reviewed in Section 2.6. By considering language proficiency as a crucial factor in the activation process, we can gain a more nuanced understanding of bilingual language processing and reconcile the contrasting empirical results in the field.

2.3. The Multilink model

The Multilink model, proposed by Dijkstra, Wahl, Buytenhuijs, van Halem, Al-Jibouri, de Korte and Rekké in 2019, is a sophisticated computational framework that accounts for several factors, including L2 proficiency. It aims to provide a comprehensive explanation for bilingual word comprehension, lexical-semantic processing, and word production. Like many spreading activation models, such as the one proposed by Collins and Loftus in 1975, the Multilink suggests that, for a word or node to be recognized, it needs to shift from a resting state, also known as resting-level activation (RLA), to an active state.

One of the innovative aspects of Multilink is how it incorporates L2 proficiency into its mechanisms. It proposes that higher proficiency in L2, often linked with more frequent and recent language use, can elevate the RLA of L2 words. This increase in RLA can potentially reduce the amount of stimulation and processing time needed to activate these words, thereby making it easier to observe priming effects from L2 to L1.

In simpler terms, if a bilingual person is more proficient in their L2 and uses it often, they might find it easier to recognise and process words in that language. Moreover, a higher L2 proficiency could also influence how they process corresponding words in their L1. As a higher L2 proficiency implies a higher RLA of the L2 words, it may propose challenges for more proficient L2 speakers to activate L1 words as they need to suppress the strong RLA of the L2 words.

2.4. Empirical evidence on same-script bilingual word recognition

Research exploring same-script bilingualism often focuses on priming studies that use translation equivalents, cognates (words in two languages that share the similar form and

meaning) and interlingual homographs. The goal of such studies is to elucidate whether lexical access in bilinguals' mental lexicon operates on a language-selective or non-selective basis. Generally, a consistent pattern emerges from these investigations, indicating that bilingual individuals exhibit both accelerated and enhanced accuracy in cognate recognition as opposed to non-cognates (e.g., de Groot, 1992; de Groot, Dannenburg & van Hell, 1994; Dijkstra, Grainger & van Heuven, 1999). Conversely, the recognition of interlingual homographs has been found to be slower and less accurate when compared to non-homograph words (e.g., de Groot, Delmaar, & Lupker, 2000; Jared & Szucs, 2002; Smits, Martensen, Dijkstra & Sandra, 2006).

The cognate facilitatory effect can be elucidated through the lens of the Bilingual Interactive Activation Plus (BIA+) and Multilink models, both of which ascribe this phenomenon to an orthographic-semantic priming effect. Notably, cognates — due to their overlapping semantic and orthographic representations across languages — trigger these shared associations upon being presented, thereby facilitating a more efficient recognition process as compared to non-cognates (Dijkstra, Miwa, Brummelhuis, Sappelli, & Baayen, 2010; Dijkstra et al., 2019).

This principle was exemplified in a recent masked priming study by Dijkstra, Peeters, Hieselaar, & van Geffen (2023) with Dutch-English bilingual participants. The researchers presented four test conditions, namely nonidentical cognates (cognates that are highly similar in form), noncognate translations (translation equivalents), orthographic neighbours (words with similar spelling but disparate meaning), and unrelated word pairs. The findings unveiled a significant facilitation effect for non-identical cognate pairs, which was a greater facilitation effect than noncognate translation pairs. This finding underscores the argument that the orthographic overlap inherent in cognates bolsters the primed processing of cognates.

The interference effect observed in the processing of interlingual homographs is anticipated by the BIA+ model, which posits that the irrelevant meaning of a homograph is invariably activated regardless of the language context (i.e., no matter if L1 or L2 is in use). This was empirically confirmed in a study involving Polish-English bilinguals who performed a semantic relatedness judgment task with interlingual homographs and their English translations of the corresponding Polish meanings (Durlik, Szewczyk, Muszyński & Wodniecka, 2016). The results demonstrated a significant homograph interference effect. Notably, both the relevant and irrelevant meanings of the homographs were activated during the task. This

finding underlines the pervasive linguistic interference that occurs when the representations of the non-target language are unintentionally invoked during bilingual lexical processing.

While the existent research provides compelling evidence in favor of the language non-selective hypothesis, there is a conspicuous lack of consideration for the potential influence of phonological overlap in the tested items. Increased phonological similarity may decrease reaction times in lexical decision tasks (Dijkstra, et al., 2010). The shorter reaction time can be attributed to the fact that orthographic similarity triggers the activation of overlapping representations in both languages, leading to a more rapid recognition.

To address this issue, Carrasco-Ortiz, Midgley, and Frenck-Mestre (2012) conducted a study involving both native English speakers and French-English bilinguals. Participants were tasked with a semantic categorization activity, during which their neurophysiological responses were captured via Event Related Potentials (ERPs). The experiment required participants to semantically categorize visually presented English words. The principal aim of the research was to discern the impact of phonological overlap on bilingual lexical processing. The stimuli encompassed English–French interlingual homophones (e.g., 'knee' in English, 'nid' in French, signifying 'nest'), contrasted with corresponding English control words (e.g., 'kiss').

The study revealed that bilingual participants gave quicker and more precise responses to interlingual homophones compared to the control words. Notably, this facilitatory effect was sustained even for experimental stimuli that were pseudohomophones – phonetically similar yet non-lexical entities(e.g., ‘bleek’, resembling ‘bleak’ in English). Among the bilingual participants, a reduced N400 amplitude was observed for interlingual homophones. This finding suggests a facilitatory processing effect of interlingual homophones. Based on the study, it can be inferred that bilingual individuals inherently activate phonological representations of both languages while engaging in silent reading in their L2. This indicates that phonological overlap aids bilingual word recognition.

2.4.1. Limitations

Indeed, it is crucial to note that cognates and interlingual homographs inherently possess a measure of orthographic and semantic overlap across two languages. Findings by Comesaña, Ferré, Romero, Guasch, Soares, and García-Chico (2015) suggest that as orthographic overlap within cognates diminishes, the corresponding facilitatory effect on cognate recognition

similarly wanes. Orthography is indeed an important factor that affects cognate recognition (Bowers, Mimouni & Arguin, 2000), which implies a complex interplay between phonological and orthographic overlap in the recognition process of bilingual lexical items. Importantly, most same-script bilingual research focuses on alphabetic languages, which presents a challenge in excluding the potential influence of orthographic overlap on word recognition facilitation. This problematic issue underlines the need to include different-script bilingual studies to further dissect the influences of phonological and orthographic overlap, by minimizing the confounding orthographic factors present in same-script language pairs.

2.5. Empirical evidence on cross-script masked priming

While significant evidence in support of language non-selective *lexical* activation has been generated in different-script bilingual studies focusing on cognate recognition (e.g., Hoshino & Kroll, 2008; Voga & Grainger, 2007; Zhang, Wu, Zhou & Meng, 2019), it is not possible to generalize these findings to *phonological* activation. This caveat stems from two main issues: First, with regards to different-script bilingual speakers, cognates usually make up a minor portion of the total vocabulary (Moon & Jiang, 2012), commonly confined to borrowed words (e.g., the Japanese Katakana). Thus, cognates' ability to depict the overall process of lexical access across languages might be limited. Second, the fundamental nature of cognates, which involves a significant overlap in both form and meaning across two languages, may account for the frequently observed facilitation effect in cognate recognition. However, the high degree of orthographic and semantic similarities may overshadow the effects of script and phonological variations in bilinguals who use different scripts. Consequently, the potential influences of script differences and phonological resemblances remain insufficiently explored due to the dominant impact of orthographic and semantic similarities in cognates. Nonetheless, the use of cognates as stimuli in different-script bilingual studies does not straightforwardly support the non-selective access to lexical representations in every case (Moon & Jiang, 2012).

Studies that circumvent the potential influence of cognates on priming effects merit close attention as they provide a more accurate examination of phonological activation in bilinguals. Such investigations have often employed experimental protocols involving pseudowords (e.g., Hindi-English: Singh et al., 2022), naming tasks (e.g., Chinese-English: Zhou et al., 2010; Slevc, Davey & Linck, 2016), and lexical decision tasks (e.g., Japanese-English: Nakayama et

al., 2012; Chinese-English: Keatley, Spinks & de Gelder, 1994). Given the focus of the present review on the activation of bilingual phonological representations, the following subsections will considere different-script bilingual phonological priming studies.

2.5.1. Japanese-English bilinguals

Nakayama et al. (2012) investigated the extent to which phonological similarities facilitate lexical decision responses in a cross-language masked priming task involving Japanese and English and examined the effects of processing fluency on both phonological and cognate translation priming. In the task, primes were in Japanese Katakana, a script used for foreign words, while targets were their English cognates. Three experimental conditions were set: 1) The cognate condition, where the English word "GUIDE" followed its cognate ガイド (/gaido/); 2) The phonologically related but semantically distinct condition, where "GUIDE" came after サイト (/saido/); and 3) The unrelated condition, where "GUIDE" was preceded by コール (/koRru/). The study involved 72 undergraduate and postgraduate students from a Tokyo university with TOEIC scores higher than 700, who were asked to complete a lexical decision task. The task used 60 low frequency and 60 high frequency English words, each of which was paired with three types of Japanese primes (cognate translation equivalent, phonologically similar but semantically unrelated, and phonologically and semantically unrelated). The participants were asked to decide if the target is a real word in English as fast as possible. The study found that response latencies were slower for low-frequency targets and faster for cognate and phonologically similar primes. Phonological priming effects remained consistent for both low and high-frequency targets, indicatng that processing fluency (assessed by the word frequency and *English proficiency* of the participants; with a higher score in TOEIC means a more fluent processing) did not impact *phonological priming*. In contrast, a more pronounced cognate priming effect was observed for low-frequency targets, suggesting that processing fluency played a role in *cognate translation*.

The findings support the BIA+ model, suggesting that phonological representations are shared even between languages with different writing systems. This finding was replicated by a study involving masked phonological priming, in which the visibility of the primes and targets were reduced using a string of symbols (Van den Bussche, Van den Noortgate & Reynvoet, 2009). The study used Japanese Katakana as primes and English words as targets and ERP as the method (Ando, Matsuki, Sheridan & Jared, 2015). The study suggested that sublexical

phonological representations are shared store between Japanese and English and were activated as the BIA+ model suggests.

2.5.2. Hindi-English bilinguals

Singh et al. (2022) aimed to investigate the influence of using Romanagari compared to Devanagari on English word recognition by Hindi-English bilinguals. The researchers hypothesised that phonological priming effects would occur regardless of the type of Hindi script (Devanagari and Romanagari), that the effect of diacritics might extend to Romanagari, and that lexical proficiency would affect phonological priming. The study involved 36 participants who were tested for lexical proficiency in both English and Hindi using Lexical Decision Tasks (LDT) before participating in a masked priming LDT. The experiment included two conditions: cross-script (Devanagari-English) and same-script (Romanagari-English), with 96 English targets, half of which were non-words.

The findings showed that both Devanagari and Romanagari led to faster response times, with Romanagari being quicker than Devanagari. Prime words with diacritics in the phonologically related condition also led to faster response times, but the effect was weaker with Romanagari primes. High lexical proficiency in Devanagari and English facilitated phonological priming, but higher proficiency in Romanagari decreased phonological priming levels.

In conclusion, the presence of phonological priming effects occurred with both scripts, indicating that the L1 (Hindi) scripts are connected in the bilingual brain. Evidence from faster response times with Romanagari suggests a higher processing cost when switching between different scripts. The findings imply that Hindi-English bilinguals process Romanagari words via the Devanagari route in their brain, and a higher proficiency in the script equates to a higher language switching cost.

Singh et al.’s (2022) study invites intriguing comparisons with other languages, such as Cantonese, where younger generations commonly use a 'romanised' form for texting. However, unlike Hindi, the 'romanisation' of Cantonese is not standardised, and is seldom used by older generations. Therefore, it would be captivating to explore whether the use of a romanised script versus traditional Cantonese characters leads to different priming effects.

2.5.3. Mandarin Chinese-English bilinguals

Zhou et al. (2010) recruited four groups of Mandarin-English bilingual university students, dividing them into more proficient and less proficient groups. These participants were recruited from a Beijing university, and each group took part in either a naming task or a lexical decision task (from L1 to L2 or L2 to L1).

The test materials were designed to induce phonological priming effects in bilingual lexical access. The researchers paired Chinese characters that had similar Pinyin phonological features (i.e., form and sound) with real English words. Chinese characters were used as primes in the L1 to L2 priming direction and English words were used as primes in the L2 to L1 direction. The findings that phonological facilitatory effect were found in both naming and lexical decision tasks regardless of the priming direction supported the BIA+ model, suggesting that lexical access in bilinguals is nonselective, even when the two languages have very different writing systems.

The researchers attributed these results to the Chinese Pinyin system using the same alphabets as the English writing system. They also proposed that it is plausible for Chinese-English bilinguals to transfer their L1 phonology processing to L2 phonology processing, thus rejecting the claim in Ando et al. (2015) that bilingual phonological coactivation may happen in the sublexical level. If bilingual phonological coactivation were mainly sublexical, one would expect interactions between phonological elements of both languages even within smaller word constituents such as consonant clusters. However, considering that Chinese is a logographic language and thus resists such sublexical phonological breakdown, the results in Zhou et al's (2010) study lean more towards a holistic L1 to L2 phonological transfer.

While Zhou et al. (2010) only used Chinese characters, Slevc, Davey and Linck's (2016) provided insights into the impact of script differences *within* the same language by including both Chinese characters and Pinyin as stimuli. Interestingly, Slevc and colleagues (2016) observed faster response times for participants in Character to English switching tasks compared to Pinyin to English tasks. This indicates a distinct switching cost associated with naming words in Pinyin versus Chinese characters, with English words being named more quickly than Pinyin counterparts. The switching costs identified in univalent stimuli, regardless of the language of the stimuli, likely stem from language control processes, such as the inhibition of non-target languages and the activation of target languages. This suggests a degree

of cognitive effort associated with language-switching that is contingent upon script system and language proficiency.

These findings put forth the notion that in bilingual individuals, the degree of linguistic control and the associated challenges of switching between languages might be influenced by their proficiency levels in each language. In a language-switching context, no switching costs would be experienced by a less proficient L2 speaker as the activation level of the L2 words is low. Conversely, if a person's L2 proficiency is high, using L2 words may involve linguistic control similar to that exercised over the L1 as the activation level of both languages is similar. This would introduce a higher switching cost which would, however, typically be lower than the one associated with the L1. As proficiency in the L2 increases, there is a likelihood of an increased switching cost, which can be reflected in slower reaction times (Jiang, 2013). While these observations originates from a production task as opposed to a recognition task, it is crucial to acknowledge the significant role that L2 proficiency plays in bilingual phonological activation. Section 2.6 offers an in-depth discussion on the effect of L2 proficiency in the aforementioned bilingual word recognition studies.

2.5.4. Limitations

The aforementioned studies present significant limitations, primarily related to the grouping of participants and the direction of priming. For instance, in Zhou et al. (2010), the four experiments — which varied in priming directions and stimulus types — were conducted using different participant groups. While an initial TOEIC test was used to control for proficiency differences, the cross-group comparison of results in terms of L2 proficiency was difficult as the proficiency level was not the same across the four groups. Therefore, the exact extent of the priming effect remains unclear. Singh et al. (2022) excluded L2 to L1 priming from their research design. The omission of this priming direction could have potentially obscured additional findings within the masked priming task. In the study by Nakayama et al. (2012), the observed priming effect across different proficiency levels were only a nuanced one. This was primarily due to the negligible difference in proficiency levels amongst the chosen participants, which made it challenging to draw definitive conclusions. These limitations have underscored the need to include both priming directions and a more varied range of L2 proficiency within a study.

2.6. L2 proficiency as an affecting factor

Investigations into the role of L2 proficiency in bilingual word recognition are relatively sparse (e.g., Christoffels, de Groot & Kroll, 2006; Jared & Kroll, 2001). Within this limited body of research, it is common to categorize participants into high and low proficiency groups prior to conducting the experiment (e.g., Zhou et al., 2010). However, only a handful of studies have considered L2 proficiency as a continuous variable (e.g., Chaouch-Orozco, Alonso & Rothman, 2021). Considering L2 proficiency as a spectrum offers a more detailed understanding of its role in influencing linguistic processes. As L2 proficiency increases, lexical processing may shift towards being more language-specific. This is because it might not be efficient for highly proficient L2 speakers to expend significant cognitive resources on inhibiting a robustly activated L2 (La Heij, 2005). Thus, viewing L2 proficiency on a continuum, rather than through rigid proficiency groupings, allows for a more adaptable and accurate interpretation of results.

Findings pertaining to the role of L2 proficiency across same-script and different-script priming tasks have been varied. For instance, Duyck, Diependaele, Drieghe and Brysbaert (2004) carried out a study which involved two groups of Dutch-French bilinguals, categorised based on their proficiency levels in French: one group consisted of those with higher proficiency (simultaneous bilinguals who learned French and Dutch from birth from their caregivers) and the other of those with lower proficiency (sequential bilinguals who started learning French in school at the age of 9-10). The research aimed to discern whether bilinguals who exhibited a superior proficiency in their L2 relied less on phonological cues during L2 word recognition compared to their less proficient peers. The study utilised both interlingual homographs and homophones n a masked word priming paradigm. Notably, the results showed no interplay between L2 proficiency and the observed cross-lingual phonological priming effect.

In contrast, Haigh and Jared (2007) recruited a group of English-French and French-English bilinguals and asked them to complete English lexical decision tasks while exposed to interlingual homophones. Findings indicated that the English-French bilingual participants did not exhibit significant response time or accuracy effects in relation to the interlingual homophones as opposed to control words. These results suggested that the proficiency level in L2 and the salience of the L2 may have affected the activation of phonological representations during the process of word recognition.

When it comes to different-script bilinguals, findings seem to be contradictory to studies involving same-script bilinguals. While Nakayama et al. (2012) found a significant priming effect in Japanese-English bilinguals, as shown in subsection 2.5.1, they reported highly similar phonological priming effects for both low and high-frequency bilinguals, suggesting that L2 proficiency had no effect on phonological priming. The finding in the study by Ando et al. (2015) supports this observation, as their data also showed no significant interaction between L2 proficiency and phonological priming effect in terms of reaction time and error rate. Similarly, Zhou et al. (2010) did not find significant interaction between L2 proficiency and phonological priming effect in groups of Mandarin-English bilinguals although high-proficient bilinguals showed longer reaction time than low-proficient bilinguals.

Indeed, the lack of consensus in previous studies underscores the need for a more rigorous examination of the role of L2 proficiency in bilingual word recognition. It is this research gap that the current study seeks to fill, specifically focusing on different-script bilingual word recognition. A review on the research questions of the current study is provided in the following section.

2.7. Research questions and predictions

The preceding discussion in this chapter highlights a couple of gaps in current knowledge concerning bilingual word recognition: the paucity of comprehensive studies addressing different-script bilinguals, especially between logographic and alphabetic languages, and the mixed findings related to the influence of L2 proficiency. The current study aims to address these gaps by exploring the following research questions and formulating the associated predictions:

RQ1. Do Cantonese and English phonological representations co-exist in the mental lexicon?
Prediction: Based on the prevailing research, which largely supports the notion of non-selective activation of phonological representations, it is postulated that phonological representations of Cantonese and English may share a unified storage space in the mental lexicon.

RQ2. Does the use of Cantonese characters and Jyutping as primes influence reaction times?
Prediction: Existing research on Mandarin Chinese has indicated that the use of Pinyin as a priming system accelerates the priming effect due to its familiarity. However, this scenario may

differ for Cantonese speakers who typically do not use Jyutping in the course of language acquisition. Therefore, the influence of Jyutping on reaction times remains an open question.

RQ3. Does the direction of priming, considering L1 as the dominant language, influence the reaction times?
Prediction: Given the conflicting evidence in the literature, it is challenging to propose a definitive prediction. The BIA+ model, however, suggests the possibility of a "temporal delay" - hence, priming from L2 to L1 might yield slower reaction times than the converse. The potential interaction between L2 proficiency and priming direction merits further investigation.

RQ4. How does L2 proficiency affect reaction times in both priming directions when treated as a covariance?
Prediction: While L2 proficiency has not been a central concern in this field of study, numerous reports suggest that with increasing L2 proficiency, the corresponding reaction times may lengthen. This might stem from the necessity to suppress the stronger L2 activation during L1 use, thus introducing a switching cost.

CHAPTER 3 METHODOLOGY

3.1 Summary on research design

The present study comprised two separate experiments, both designed to explore the effects of priming on response speed and accuracy on the target (Shao & Meyer, 2017). The first experiment focused on the priming direction from Cantonese (L1) to English (L2), while the second experiment investigated the inverse priming direction from English (L2) to Cantonese (L1). Despite the difference in priming direction, both experiments shared the same experimental design and utilized the same sets of primes and targets.

Unlike many previous studies in cross-script bilingual priming which typically employ lexical decision tasks (e.g., Nakayama, Ida & Lupker, 2016; Zhou et al., 2010), this study opted for a phonological relatedness decision task. This choice was driven primarily by the challenges associated with designing Cantonese non-words due to the lack of a comprehensive Cantonese corpus. Therefore, participants in this study were tasked with determining the phonological similarity between the prime and the target.

3.1.1 Masked priming paradigm

To curb the potential strategic use of the primes by participants during the task, the experiments employed the masked priming paradigm, a technique recognized for its effectiveness in various studies (e.g., Jiang & Forster, 2001; Forster, Mohan & Hector, 2003). Masked priming paradigms typically follow one of two types: the four-field paradigm, which follows a mask-prime-target-mask sequence (Evett & Humphreys, 1981), and the three-field paradigm with a mask-prime-target sequence (Forster et al., 2003). The inclusion of forward and backward masks is a common practice in Chinese-English priming studies (e.g., Li, 2021; Zhou et al., 2010).

However, this study adopted a unique variation of the first type of paradigm, where the sequence of mask-prime-target presentation was adjusted. The presentation commenced with a forward mask represented by a row of hash marks (######), followed immediately by the prime and then a backward mask, depicted as a string of ampersands (&&&&&&). The target was then presented after the backward mask.

The intention behind this change in the order of presentation was to further minimize the chance of participants consciously recognising the prime. The use of the masked priming technique, especially with the modified presentation sequence, is particularly effective for exploring the initial stages of word recognition, which might remain unobservable if the processing of the prime word is allowed to reach completion as the participant could become consciously aware of the prime (Forster et al., 2003).

3.1.2. Durations of prime, target and masks

The parameters for the experiment were carefully calibrated to ensure precision. Forward masks were programmed to last for 500 ms, with the backward masks set at a duration of 300 ms. The priming duration was specified at 60 ms, aligning with the traditional range's upper limit of 30 to 60 ms (Li, 2021). This duration is optimal for facilitating subliminal priming, where participants remain unaware of the ongoing word recognition process. Target exposure was set at a duration of 150 ms, a timeframe that encourages participants' effective word identification, thereby enabling them to adequately respond to the decision task presented on the subsequent screen. The cumulative durations of the prime and backward mask result in a stimulus onset asynchrony (SOA) of 210 ms. Past research has documented observable priming effects within SOA ranges of 57 to 243 ms (Zhou et al., 2010).

3.2. Participants

The study engaged a varied group of 53 participants, based in Hong Kong and ranging in age from 18 to 25 years, who were recruited online (see Appendix 1). The recruitment strategies encompassed snowball sampling and the utilization of various social media platforms. The participant pool incorporated both secondary school and university graduates. Each participant self-identified as a native speaker of Cantonese, and while English fluency was universally reported, their proficiency level in English was different. The participants were randomly assigned to one of two distinct experimental conditions. This research was ethically approved by CUREC (refer to Appendix 2). As a token of appreciation, three participants were selected through a lucky draw to receive a digital shopping voucher.

3.3. English proficiency assessment

Participants in this study reported the English language scores from the Hong Kong Diploma of Secondary Education (HKDSE) exam. The HKDSE involves a proficiency range from Level 1 to Level 5**, and the participants ranged from Level 3 to Level 5*. According to the

benchmarks provided by the Hong Kong Examination and Assessment Authority (n.d.), a Level 5** on the HKDSE aligns approximately with Band 8 on the International English Language Testing System (IELTS). Despite the absence of precise conversions for HKDSE Levels below Level 3, the collected data suggests that participant IELTS band scores would likely range from Band 5 to Band 7.5. Consequently, the sampled cohort exhibits a wide range of English proficiency, spanning from low to advanced levels.

To augment the self-reported HKDSE results and facilitate a more comprehensive assessment of English proficiency, the Lexical Test for Advanced Learners of English (LexTALE; Lemhöfer & Broersma, 2012), a reliable and swift measure of English proficiency, was employed in the study. This assessment tool has been utilized extensively in research on bilingual activation (e.g., Singh et al., 2022; Zhang, Wu, Zhou & Meng, 2019). The LexTALE comprises 63 items that include a blend of legitimate English words and fabricated non-words. Participants were challenged to determine the validity of each item. Across the participant pool, the mean LexTALE score was 58.31%, with a spectrum of individual scores extending from 34.92% to 93.65%. Given that a score of 60% on the LexTALE denotes intermediate English proficiency, participants' English language competencies, as assessed via the LexTALE, spanned from low proficiency to advanced levels.

Following the LexTALE assessment, an Independent Samples t-test was conducted on the two priming direction groups – the L1 to L2 and the L2 to L1. This test, $t(40) = -.74$, $p = .46$, revealed no significant difference between the mean scores of the groups. This outcome suggests that, as per the LexTALE assessment, the two groups demonstrated comparable levels of English proficiency.

3.4. Test Materials

The experimental stimuli consisted of a total of 24 Cantonese-English word pairs (see Appendix 3), 12 of which were phonologically similar while the remaining 12 were phonologically unrelated. These pairs were used across two groups, so the only difference between groups was the direction of language priming.

The selection of these pairs was guided by three critical criteria. First, within the phonologically similar set, the Cantonese and English words demonstrated high phonological resemblance. The extent of this similarity was quantitatively assessed by a separate group of 18 native

Cantonese speakers who possess advanced proficiency in English. They rated the phonological similarity of potential word pairs, culled from a pool of 81 pairs, on a 5-point Likert scale (1= completely dissimilar, 5= identical). The average similarity rating for the chosen 12 phonologically similar pairs was 4.06, whereas the 12 unrelated pairs had an average rating of 1.16. A significant disparity in ratings between the two subsets was confirmed by an independent samples t-test: $t(22) = 18.79$, $p < .001$.

The second criterion ensured that Cantonese words that were cognates or literal translations of English counterparts were excluded. Introducing such words could have brought in potential semantic confounding factors, muddying the investigation of pure phonological relationships. The use of English loanwords in Cantonese was also avoided. Despite their common use and integration into the Cantonese language (Lipski, 2005), such loanwords could bias the task outcomes, due to their familiarity.

The third criterion involved the use of monosyllabic words, owing to the logographic nature of the Cantonese language wherein every morpheme can function independently as a meaningful word. Multisyllabic Cantonese words typically have a higher stroke count, making it challenging to pair them with English words in terms of word length, which usually consist of fewer letters.

An independent samples t-test was conducted to ensure that the unrelated and phonologically similar pairs were matched in terms of stroke count, Jyutping length, and word length. No significant differences were found between the two groups regarding these parameters (stroke count: $t(22) = -0.288$, $p = .776$ (two-sided); Jyutping length: $t(22) = -1.368$, $p = .185$ (two-sided); word length: $t(22) = 1.043$, $p = .308$ (two-sided)). This demonstrates that the selected word pairs were well-controlled in these aspects.

Nevertheless, the potential influences of word frequency and phonological neighbourhood on priming effects were not controlled for in this study, despite existing evidence suggesting their relevance (Marian, 2008; Shan & Meyer, 2017). The reason for this omission was the unavailability of an appropriate Cantonese corpus that could be used for frequency control. Existing Cantonese corpora either sourced words from inapplicable domains (e.g., 20th-century movies: Chin & Tweed, 2019), or lacked data on word frequency and phonological neighbourhood (e.g., The Hong Kong Cantonese Corpus: Luke & Wong, 2015; The Hong

Kong Cantonese Adult Language Corpus: Leung & Law, 2001). This absence of suitable linguistic resources thus poses an inherent constraint on the present study.

3.5. Experiment condition 1 Procedure

Condition 1 was conducted via Gorilla, an online platform specifically designed for the administration of social science and psychological experiments (Anwyl-Irvine et al., 2020). The principal objective of this experiment was to prime participants from their first language, Cantonese (L1), to their second language, English (L2). The requirement was for participants to use a laptop or desktop computer to carry out the tasks. Before beginning the trial session, participants were shown a consent form in Chinese (see Appendix 4). They were instructed to read the contents and express their agreement by clicking on the box at the end of the form.

Of the 53 participants initially recruited, a subset of 26 were randomly assigned to participate in Condition 1. The experimental design comprised a trial block, two separate experiment blocks, and a 5-minute interval interspersed for participant rest. Each block started with a fixation point, represented by "+", which was centrally displayed on the screen for a period of 500 ms. This was sequentially followed by the forward mask, the prime, the backward mask, and finally, the target. Subsequent to the presentation of the target, participants were asked to respond to a phonological judgement question: “Do the previous pairs sound similar?” Instructions were provided in both Cantonese and English, and emphasised the importance of speed and accuracy in the participants’ responses. These instructions were relayed prior to the commencement of the trial and experiment blocks.

The initial block of the experiment functioned as a trial session comprising four practice trials. The first two trials introduced Cantonese characters as primes and English words as targets, while the subsequent two trials presented Jyutping as primes and English words as targets. Notably, none of the trial words were reused in the subsequent experimental blocks.

The second block formed the initial part of Condition 1, where participants were tasked to discern the phonological similarity of the displayed pairs. Here, the primes constituted Cantonese characters, and the targets English words. All 24 pairs were randomized, with each participant encountering each pair only once.

A pivotal feature of the experimental design was the inclusion of a five-minute break between the first and second sections of the experiment. The break served the dual purpose of reducing

cognitive load and mitigating potential carry-over effects given the use of the same set of stimuli in the succeeding block (albeit presented in a different order and with Jyutping replacing the Cantonese-character primes). In the third block, the same 24 pairs from the second block were represented, but with Jyutping substituting the Cantonese characters. Tone was included in the Jyutping primes.

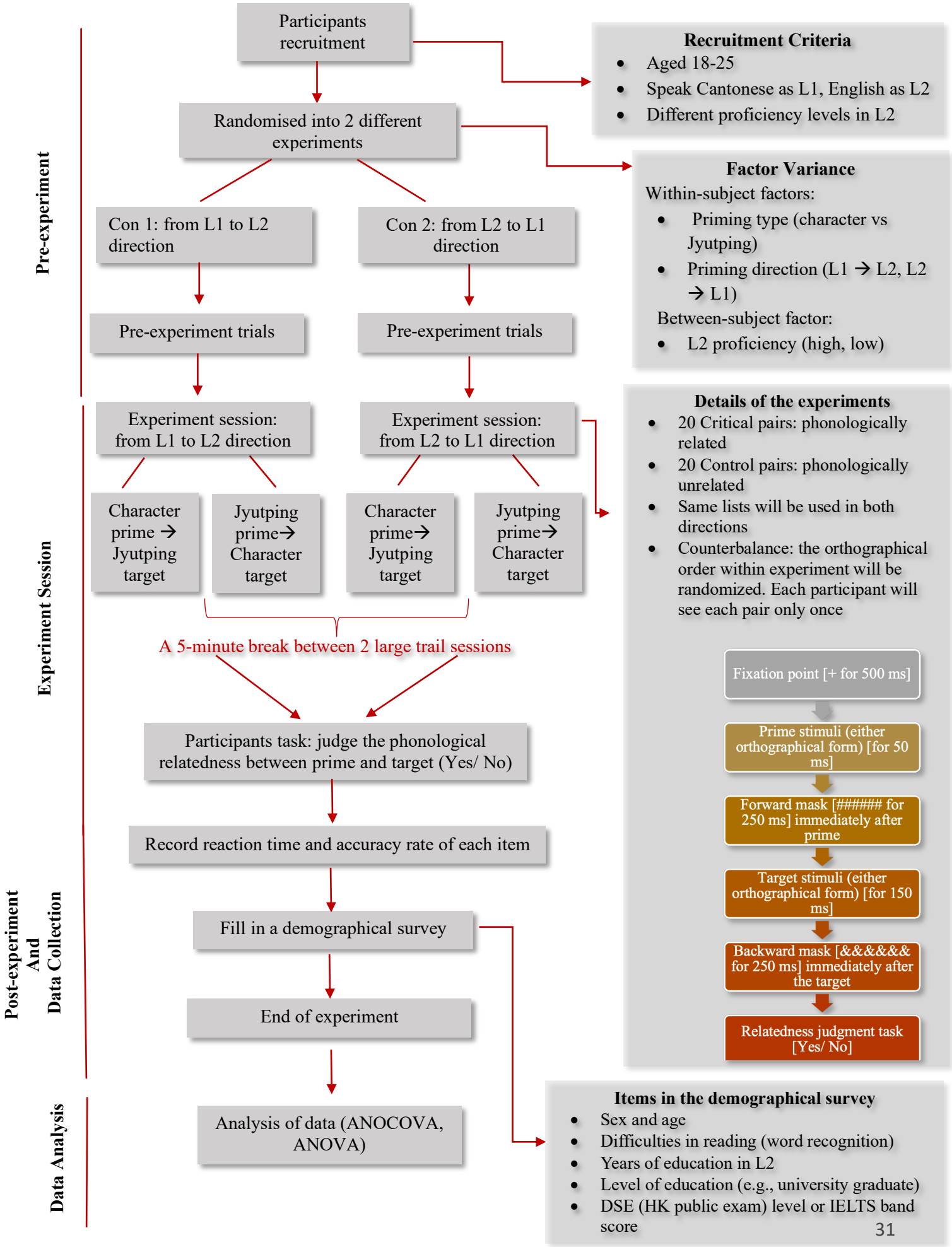
Following the completion of the experiment, participants filled in a demographic survey providing information on age, education level, English proficiency, and language background. As a final task, participants undertook the LexTALE test to assess their English proficiency.

3.6. Experiment condition 2 Procedure

To establish a rigorous and equitable comparison between the two groups, the materials used in Condition 2 remained identical to those employed in Condition 1. The procedure for Condition 2 paralleled that of Condition 1, save for a key modification in the priming direction. This experiment was designed specifically to investigate the priming effect from English (L2) to Cantonese (L1). Consequently, in this experiment, primes were presented in English, while targets were displayed in Cantonese, incorporating both characters and Jyutping. Out of the initial pool of 53 participants, 27 were randomly chosen to engage in this particular experiment. These participants received the same set of instructions as those in Condition 1 and were later required to complete both the demographic survey and the LexTALE test.

An overview of the experimental procedure is shown in Figure 1.

Figure 1: Procedures of the Relatedness Judgement Priming Task



CHAPTER 4 RESULTS

This chapter methodically presents the findings from the two conducted experiments, systematically addressing each research question (RQ) in sequence. The chapter begins with Subsection 4.1, focusing on the results from the first experiment which investigated reaction times and accuracy rates when utilizing Cantonese characters and Jyutping as primes. This subsection provides critical insights that answer the second RQ. Subsection 4.2 delves into the differential effects of priming direction. More specifically, it examines the disparities in reaction times and accuracy rates when priming from L1 to L2 and vice versa. The data from this section effectively responds to the third RQ. The final subsection, 4.3, presents the outcomes of the experiments focusing on the role of L2 proficiency as a covariate, with specific attention to its impact on reaction times and accuracy rates in both priming directions. The information uncovered here will answer the last RQ. Upon evaluation of the results presented in these subsections, a comprehensive conclusion addressing the first RQ will be provided.

The data analysis started with data cleaning. Primarily, the data's normality was scrutinized through descriptive statistical analyses in SPSS. Any data points that extended beyond three standard deviations in relation to the mean reaction time and accuracy rate were eliminated from the dataset. This is a common practice in previous similar studies (e.g., Zhou et al., 2010). Furthermore, the skewness and kurtosis values were inspected to ensure the revised data adhered to a normal distribution, a prerequisite for subsequent parametric analysis.

After the data was suitably refined, quantitative analysis were carried out. The analysis for this research focused on two primary data points: the participants' response time and their accuracy in discerning phonological similarities between the prime and target.

To address Research Question 2 (RQ2), a one-way Analysis of Variance (ANOVA) was applied, supplemented by a separate paired samples t-test. For Research Question 3 (RQ3), two independent t-tests were conducted for both reaction time and accuracy rate. For Research Question 4 (RQ4), an Analysis of Covariance (ANCOVA) was employed, with second language (L2) proficiency serving as a covariate. The assumptions for each statistical test including normality and homogeneity were verified before performing the tests. Post-hoc tests were also performed, providing further insight into RQ2 and RQ4.

4.1. Comparisons of reaction times and accuracy rates: Cantonese character versus Jyutping as primes

Condition 1 involved a total of 27 participants,, who completed the experiment in the direction L1 (Cantonese) to L2 (English). After the initial cleaning of data following the above procedures, this led to a final participant count of 21 for the first experiment condition. The mean reaction times and accuracy rates are provided in Table 1.

A slight increase in speed was observed when Cantonese characters were used as primes (1218 ms) as opposed to Jyutping (1221 ms). However, a one-way ANOVA employed to investigate the influence of different scripts on reaction times, showed no significant effects associated with the use of scripts, $F(1, 40) = .000$, $p = .987$, with an effect size of partial $\eta^2 = .000$.

The mean accuracy rate when using character as prime (97.6%) was greater than when using Jyutping as prime (81.5%). A separate one-way ANOVA indicated a nonsignificant effect of script on accuracy, $F(1, 40) = 29.43$, $p < .001$, with an effect size of partial Eta Squared = .424, yielding a significant effect size.

These findings suggest that the choice of script does not exert a significant influence on participants' reaction time but has a significant effect on participants' accuracy rate. Thus, while the speed of responses was unaffected by scripts, the correctness of the participants' responses was strongly impacted.

Table 1: Mean reaction times and accuracy rates for the priming task in the direction from L1 to L2

Script	Mean RT (SD)	Mean accuracy (SD)
Character	1218 (427)	97.6 (2.49)
Jyutping	1221 (478)	81.5 (13.3)

Note: RT (reaction time) in ms. AR (accuracy rate) in percentages. Standard deviation in parenthesis.

4.2. Effects of priming directions on reaction times and accuracy rates

The influence of priming directions on reaction times and accuracy rates was examined using two independent t-tests, each focusing on a different dependent variable.

In the first t-test, where reaction time served as the dependent variable and priming direction was the independent variable, no significant effect of priming direction was observed, irrespective of the scripts used ($p > .05$).

Conversely, in the second t-test with accuracy rate as the dependent variable and priming direction as the independent variable, a notable impact of priming direction was evident. Specifically, this effect was considerably more significant in the character script ($p < .001$) compared to Jyutping ($p < .005$).

Examining the mean accuracy rates for both scripts across the two priming directions yielded further insights. Regardless of the priming direction, the character script consistently led to higher accuracy rates compared to the Jyutping script (97.6% for characters vs. 81.5% for Jyutping in the L1 to L2 direction; 74.2% for characters vs. 65.9% for Jyutping in the L2 to L1 direction). This suggests that character script, whether used as a primes or a target, is more effective at prompting accurate responses than Jyutping script.
A comparison of the mean accuracy rates across the two priming directions as mentioned in the previous paragraph revealed that both scripts had higher accuracy rates in the L1 to L2 direction compared to the L2 to L1 direction.

Table 2: The effect of priming directions on reaction times ana accuracy rates

	Levene's Test		t	p-value
RT and AR	F	Sig.		
RT_Cha	0.89	0.35	-0.44	0.66
RT_Jyut	0.06	0.81	1.14	0.26
AR_Cha	44.6	<0.001	6.14	<0.001
AR_Jyut	3.64	0.06	3	0.005

Note: RT (reaction time). AR (accuracy rate).

4.3. Effects of L2 proficiency on reaction time and accuracy rates across priming directions

The influence of L2 proficiency and priming direction on reaction times and accuracy rates was examined using an ANCOVA with a 2 x 1 design (reaction time and accuracy rate as the dependent variables and priming direction as the independent variable), with L2 proficiency as a covariate. As depicted in Table 3, no significant impact of L2 proficiency on reaction times

was found ($p > .05$), indicating that L2 proficiency did not influence reaction times. In contrast, there was a significant main effect of L2 proficiency on accuracy ($p < .001$) with a moderate effect size (Partial Eta Squared = .13), suggesting that as proficiency in the L2 increases, so does the accuracy rate in the priming task.

Furthermore, Table 3 reaffirms the data presented in subsection 4.2; no significant effect of priming direction on reaction time was observed ($p > .05$), whereas there was a notable main effect of priming direction on accuracy ($p < .001$) with a considerable effect size (Partial Eta Squared = .37). Thus, it can be concluded that both L2 proficiency and the direction of priming primarily influence accuracy rates, but not reaction times.

When script was included as a fixed factor in the previous model, the direction of priming continued to significantly predict accuracy ($p < .001$), maintaining a large effect size (partial eta squared = .37). L2 proficiency also remained a significant predictor of accuracy ($p < .001$), with a moderate effect size (Partial Eta Squared = .13).

A subsequent post-hoc ANOVA comparing L2 proficiency with different script types demonstrated an interesting divergence. L2 proficiency did not significantly predict accuracy for character scripts ($F(1,40) = .089$, $p = .767$), but it significantly predicted accuracy for Jyutping scripts ($F(1,40) = 7.551$, $p = .009$). Therefore, this implies that, as L2 proficiency improves, so does the accuracy, but this effect is only evident in the Jyutping scripts.

Table 3: The effect of L2 proficiency on reaction time and accuracy rates across priming directions

Source	Dependent variable	Mean square	F	Sig.	Partial Eta squared
L2 Proficiency	AR	2309	11.75	<0.001	0.13
L2 Proficiency	RT	314456	1.28	0.26	0.016
Direction	AR	8938	45.51	<0.001	0.37
Direction	RT	98878	0.04	0.53	0.005

Note: RT (reaction time). AR (accuracy rate).

4.4. A brief conclusion

The findings show that the reaction times were consistent regardless of priming direction, script, or L2 proficiency. This suggests that both Cantonese and English are processed at a similar speed by the bilingual participants. However, there were significant differences in accuracy rates based on these factors. The next section will further explore these differences.

CHAPTER 5 DISCUSSION

This chapter elucidates the findings presented in Chapter 4, drawing comparisons with prior research and bilingual word recognition models to offer a comprehensive understanding. The chapter comprises four subsections:

- 5.1 Summary and study uniqueness: This section restates the main findings and underscores the unique contributions of the present study.

- 5.2 Analysis of the first finding: Here, the first key finding that there was a significant effect of script on accuracy rate but not reaction time is explained and analyzed in detail, highlighting its relevance and implications in the field of bilingual word recognition. This answers RQ2 that the use of different scripts as primes will not slow down the reaction times.

- 5.3 Examination of priming direction effect: The focus of this section is the second finding pertaining to the impact of priming direction on reaction times and accuracy rates. This answers RQ3 that the dominance of Cantonese as L1 only affects the accuracy rates but not the reaction time. The potential reasons and implications of these findings are explored.

- 5.4 Role of L2 proficiency in bilingual word recognition: The final section dissects the third finding that relates to the influence of second language proficiency on bilingual word recognition. This section provides an answer to RQ4 that a higher L2 proficiency enhances accuracy, particularly in Jyutping script. This section draws on the data to understand how and why L2 proficiency plays a crucial role in this context.

5.1. An overview of the study and findings

This study presents an innovative exploration of language activation between Cantonese and English - two linguistically distinct languages characterized by their unique writing systems: logographic and alphabetic. A unique aspect of this research was the incorporation of a Romanization system, Jyutping, which is not typically familiar to native Cantonese speakers in standard educational contexts. Furthermore, instead of employing traditional methodologies

like the lexical decision task and naming task, a phonological similarity judgment task was utilized.

Interestingly, the results indicated no significant influence of script type on reaction time but a significant effect on accuracy. Moreover, a facilitatory effect on accuracy was observed during L1 to L2 priming. This effect appeared to be associated with L2 proficiency, particularly noticeable when the Jyutping script was in use. These findings suggest that during Cantonese-English word recognition, the activation of phonological representations tends to be nonselective, which means that Cantonese-English bilingual speakers activate both of their languages simultaneously during lexical recognition.

Significantly, Cantonese, which employs characters to represent morphemes or words, stands apart from English with its use of letters to form words. While there are commonalities with Mandarin Chinese – a frequently researched target language in previous studies such as Zhou et al., (2010), Cantonese has its unique sounding system and vocabulary. As such, this study offers fresh insights into the nonselective language hypothesis involving languages of different scripts.

5.2. Finding 1: significant effect of script on AR with no effect on RT

The findings from this study contribute to the ongoing discourse on the validity of the BIA+ model – the main tenet that bilingual lexical activation is nonselective, with a particular concern in the activation of phonological representations in bilingual speakers through either a lexical or a non-lexical route. The lexical route involves the activation of whole-word orthographic units by sub-lexical orthographic units such as the onset, nuclear and coda of a word (Dijkstra & van Heuven, 2002), which subsequently stimulate their corresponding whole-word phonological units. In contrast, the non-lexical route involves the direct activation of corresponding sub-lexical phonological units by sub-lexical orthographic units, which then collectively trigger the whole-word phonological representation.

This study suggests that the lexical route might be more operative than the non-lexical route in Cantonese-English bilingual word processing, as indicated by the comparable reaction times across Cantonese characters and Jyutping scripts. This pattern might suggest that language activation among Cantonese-English bilinguals predominantly occurs at the whole-word level via the lexical route. Had the bilinguals been relying primarily on the non-lexical route for processing, faster reaction times would have been expected when using Jyutping scripts as

primes. This is because Jyutping is also expressed in letter strings and phonetically based, akin to English words. If Cantonese-English bilinguals were using this sound- and structure-based route for word recognition (i.e., the non-lexical route), they should be quicker in reacting to Jyutping prime, given the script's phonetic transparency.

The result from the present study align with Zhou et al.'s (2010) research, which suggested a preference for the lexical route among Mandarin-English bilinguals. This confluence of findings underscores the theory that, in logographic languages where there are no straightforward grapheme-phoneme correspondences, language activation predominantly hinges on the lexical level.

In a recent study by Shetty, Hebbar, Shenoy, Peter, and Krishnan (2022), it was observed that the absence of orthographic overlap diminishes the processing advantage typically provided by phonological similarity between prime and target words. This finding implies that phonological similarity benefits are enhanced when accompanied by orthographic overlap. Essentially, when words are similar both in sound and appearance across languages, their mutual activation is stronger. Conversely, when words sound alike but do not share visual similarities, this processing advantage can wane or disappear. This concept aligns with predictions from the BIA+ model, suggesting that pairs of words without orthographic similarities are unlikely to activate cross-linguistically.

However, findings from the present study present a contrast. Higher mean accuracy rate were observed with the Cantonese character, a script that distinctively differs from English, in comparison to Jyutping, which shares greater orthographic similarity with English. This discrepancy in mean accuracy rate suggests that factors other than just orthographic overlap may influence accuracy rates in bilingual word recognition.

The differential accuracy observed between the scripts may hinge on participants' familiarity with each type of scripts. As outlined in Chapter 3, participants predominantly encounter Jyutping in limited contexts, such as digital communication, while their exposure to Cantonese characters is more pervasive in daily life. The ease with which individuals decode and comprehend a script is profoundly influenced by their familiarity with it. Being well-acquainted with a script allows for easier and more rapid interpretation of its visual elements and sequence (Witzel, Qiao & Forster, 2011). As such, the participants' broader experience with Cantonese

characters likely facilitated more intuitive processing and comprehension, leading to heightened accuracy. On the other hand, their limited exposure to Jyutping might have posed interpretive challenges, reflecting in lower accuracy. In light of Shetty et al.'s (2022) findings, this study posits script familiarity as an integral component influencing bilingual word recognition, complementing factors such as orthographic overlap.

The Implication of this finding is twofold. Firstly, it implies that the current understanding of how the brain recognizes written words is not solely rooted in phonetics and orthography. Individual familiarity of a script could be equally influential, if not more so. Secondly, this observation challenges the BIA+ model's assumption that shared sound structure accelerates processing due to activation of similar mental pathways.

Moreover, the current study found no significant switching costs between Cantonese characters and Jyutping scripts, as indicated by the equivalent reaction times. This differs from the findings of Singh et al.'s (2022) Hindi-English study, where differences in scripts (Devanagari versus Romanagari) resulted in varied response times. It suggests that Cantonese-English bilinguals might not process Cantonese characters and Jyutping through separate routes in the brain, but rather, through a shared or similar cognitive route that is efficient and does not create differential processing burdens. This shared processing route aligns well with the sub-lexical route in the BIA+ model, as it involves processing at the level of smaller language units, such as phonemes or graphemes, likely shared between different scripts of the same language.

This interpretation is tentative and invites further investigation. The non-lexical route's involvement cannot be overlooked, especially considering the interaction effect between L2 proficiency and the Jyutping script on accuracy (more discussion in 5.3). It is possible that the non-lexical route, encompassing sub-lexical phonological information, might play a role, particularly among more proficient bilinguals.

5.3. Finding 2: the effect of L1/L2 priming direction on accuracy rate

This study presents intriguing findings that advance our understanding of the processes involved in bilingual word recognition. The similar reaction times observed for L1 to L2 and L2 to L1 priming indicate that the initial activation of phonological representations from orthographic input occurs at a comparable pace, irrespective of the priming direction. This

outcome, along with the previous finding, provides substantive support for the language nonselective hypothesis.

Interestingly, while the priming direction appeared to exert no influence on reaction times, it did have a notable impact on accuracy rates. This asymmetrical nature of language switching costs has been observed at the stage of word selection (e.g., Schwieter & Sunderman, 2008). The current finding resonates with the findings of Keatley et al. (1994), who reported a more pronounced priming effect in the L1 to L2 direction, although their evidence was anchored in differences in reaction times. They attributed this finding to stronger connections between representations within the L1 memory system compared to the L2 and proposed a model that featured separate yet interconnected bilingual memory systems. However, the current study challenges this interpretation. The first two findings, namely the homogeneity in reaction time regardless of script and priming direction present compelling evidence that phonological representations across both languages are shared.

Instead, the asymmetrical priming effect observed in this study may be better explained by the relative dominance of the L1 over the L2. It is typical for bilingual individuals to possess more established and robust phonological representations in their L1 compared to their L2 (Bordag, Gor & Opitz, 2022). This claim is supported by the results in Zhang et al.'s (2019) study, in which they reported a larger priming effect in the direction from L1 to L2 than the direction from L2 to L1 for Chinese-English speakers with a lower proficiency in English (L2). This result means that a stronger L1 (indicated by their low L2 proficiency) can significantly influence the ease and speed with which one processes and comprehends their L2, particularly when the L2 proficiency is comparatively lower.

Consequently, an L1 word employed as a prime could effectively activate the corresponding L2 representation, leading to higher accuracy in the recognition of the L2 target word. In contrast, an L2 word might not prime the L1 representation as efficiently, leading to reduced accuracy for L1 target words. Tsui, Tong, and Chan (2019) reported a language switching cost for Cantonese-English bilinguals when transitioning from English (their non-dominant language) to Cantonese (their dominant language) in language production. The current study extends this finding, suggesting that Cantonese-English bilinguals exhibit this switch cost not only during language production but also at the lexical selection stage. This implication may signal that switching costs emerge early in bilingual processing.

This finding also challenges the prediction made by the Multilink model, which suggests that a higher L2 proficiency could enhance the priming effect from L2 to L1. The discrepancy might be attributed to the uncontrolled factor of word frequency in this study, as mentioned in Chapter 3. Indeed, both L2 proficiency and word frequency play significant roles in language processing. Higher L2 proficiency, often associated with frequent use and exposure to the language, can heighten the activation level of L2 words. Meanwhile, the frequency of specific word use also affects how readily these words are recognized. Therefore, controlling these factors in future studies may provide a more nuanced understanding of the interaction between L2 proficiency, word frequency, and the observed priming effects.

Upon considering the combined effects of priming directions on both reaction time and accuracy rates, it can be inferred that while the activation of phonological representations may be nonselective and occur at a similar speed, the ensuing processing stages, leading up to the final recognition of the target word, could be influenced by the individual's proficiency in the respective languages (i.e., Cantonese and English). In other words, greater proficiency in L1 (Cantonese) may result in more accurate recognition and access to whole-word phonological representations. In the present study, while L1 proficiency was not assessed using standardized tests, it's notable that all participants began their journey with Cantonese from birth and only started learning English in kindergarten. This indicates that all participants are sequential unbalanced bilinguals with Cantonese as the dominant language. This approach mirrors the method used by Duyck et al. (2004), who differentiated language proficiency levels based on the onset of acquisition. A significant implication of these findings is the reaffirmation of the importance of maintaining and enhancing L1 proficiency during the acquisition of L2 as the proficiency in L1 can affect the accuracy of bilingual word processing. This is not to undermine the value of L2 learning, but to highlight that the development of L2 should not come at the expense of L1. In fact, the importance of a strong L1 basis in learning L2 has been emphasized in a substantial amount of studies (e.g., Cummings, 1979; Cummings, 2017). Indeed, the proficiency and strength of L1 appear to serve as a crucial foundation upon which L2 acquisition can more effectively build, at least in the case of Cantonese-English bilinguals.

5.4. Finding 3: the interaction of L2 proficiency and Jyutping script

This subsection discusses the role of L2 proficiency in shaping accuracy rates and reaction times during word recognition in Cantonese-English bilinguals. According to third finding, L2 proficiency significantly impacted accuracy rates but not reaction times, suggesting a

distinction between initial word recognition, an automatic and quick process, and later stages of word processing, which contribute to accuracy. These observations align with the BIA+ model, which proposes two distinct systems: a word identification system and a task system, responsible for automatic language activation and strategic word selection, respectively. The results suggest that L2 proficiency, together with the dominance of L1 as shown in 5.2 are more likely to affect the task system rather than the word recognition system.
An interesting aspect of the present study's findings is the stronger impact of L2 proficiency on accuracy rates with the Jyutping script compared to the character script. While a potential explanation for this could be the orthographic overlap between Jyutping and English, we must consider that Jyutping also includes Cantonese tones represented by numbers, which reduces script similarity. This suggests a broader influence of L2 proficiency on accuracy rates, possibly rooted in a deeper understanding of the language's phonology as proficiency improves.

Moreover, the structure or composition of Jyutping might inherently rely more heavily on phonological representations, aligning more closely with English phonemes or phonological rules. As a result, higher L2 proficiency may lead to more accurate activation of appropriate phonological representations, thereby increasing accuracy rates. This concept is supported by Zhou et al. (2010), who proposed a phonology processing approach transfer from L1 to L2 in Mandarin-English bilinguals.

Interestingly, the current study found that the priming effect was only evident with the Jyutping script, which suggests a potential educational advantage. Even without formal education in Jyutping, akin to Mandarin-English bilinguals learning Pinyin at an early age, the Cantonese-English bilinguals who took part in this study demonstrated a priming effect on accuracy with Jyutping. This indicates that using a script that heavily relies on phonological representations aligned with an L2 could enhance the learning process of the L2, a suggestion with notable implications for language education.

In the realm of English language instruction for Cantonese-English bilinguals, an excessive focus is traditionally placed on delineating the phonological differences between English and Cantonese. This approach may inadvertently overlook the pedagogical benefits that can be derived from elucidating the phonological similarities between the two languages. According to the findings of this study, a beneficial strategy for teachers would be to explicitly draw comparisons between the phonologies of both languages.

Implementing Jyutping, a phonetic transcription system for Cantonese, could serve as a potent tool in this context. Jyutping can provide a visually transparent representation of the shared phonological elements between Cantonese and English. This increased transparency can facilitate a deeper understanding of these shared elements among students, thereby promoting more efficient word recognition and bolstering overall language proficiency.

Moreover, the study's findings indicate a differential influence of language proficiency across various stages of word recognition. It appears that while language proficiency exerts a more pronounced impact on the later stages of word recognition, its influence on the initial stages is relatively subdued. This suggests that the early stages of language learning could be strategically tailored to emphasize phonology. Establishing a robust phonological foundation during these early stages could equip students with a solid base for mastering the more complex language skills demanded at the later stages of learning. This restructured approach, with its focus on emphasizing phonological similarities and early-stage phonology instruction, could significantly enhance the effectiveness of English language teaching for Cantonese-English bilinguals.

CHAPTER 6 CONCLUSION

Despite employing a novel experimental approach – the phonological similarity judgment task – this study's findings align well with prior research utilizing lexical decision tasks and naming. Such consistency lends credibility to the study's methodology and reinforces the reliability of these investigative techniques in understanding bilingual language processing.

However, the present study faced constraints that could potentially influence the findings. For instance, as discussed in Chapter 3, uncontrollable variables such as the lack of comprehensive Cantonese corpora may have affected the outcomes. For instance, the number of words that are orthographically and phonologically similar to the target can affect the participants' reaction time (Marin, 2017). Unfortunately, without the availability of Cantonese corpora, it was not possible to calculate the neighbourhood density in Cantonese. This situation emphasises the urgent need for the development of large, systematic corpora for the Cantonese language. The availability of such resources could lead to a more profound understanding of bilingual word recognition by allowing better control over factors like orthographic neighbourhood effects and word frequency.

Another limitation of the current study lies in the relatively small sample size. With a total of 42 participants divided evenly across two experiments, the study offers a limited scope in terms of the variety of L2 proficiency levels, ranging from beginner to near-native. A larger sample size would be likely to offer a more diverse proficiency range, potentially resulting in the observation of broader effects. This limitation was addressed in the current study by treating L2 proficiency as a continuous factor rather than segregating participants into distinct proficiency groups.

While statistical testing has confirmed the comparability of English proficiency levels among participants in Experiments 1 and 2, some variation could still exist. Consequently, future studies might consider implementing both directions of priming within a single group to control for this factor more effectively. Another important consideration is the measurement of Cantonese proficiency. There are numerous standardized tests available for assessing English proficiency; however, comparable objective measures for Cantonese proficiency are lacking. Despite all participants identifying Cantonese as their native language, without authoritative evaluation methods, we cannot definitively rule out the impact of varying degrees of Cantonese

proficiency. This underscores a clear need for the development and implementation of standardized testing methods for Cantonese proficiency in future research.

Despite these limitations, this study provides valuable insights into cross-script bilingual language processing, particularly within the context of Cantonese-English bilingualism. In summary, the findings lend support to the BIA+ model, suggesting that phonological activation in Cantonese and English is nonselective. Moreover, this study expands our understanding of the role of L2 proficiency in the BIA+ model by highlighting its impact on the model's task system.

One noteworthy implication from the study is the potential advantage of incorporating Jyutping, the romanization of Cantonese, into the education of Cantonese-English bilinguals. By enhancing the understanding of phonological representations shared between the two languages, Jyutping may bolster the overall language proficiency of these bilingual individuals. Furthermore, this study underscores the importance of preserving the development of the L1 alongside the acquisition of L2. While the pursuit of proficiency in an L2 is often given prominence in bilingual education, this research highlights the fact that a strong grounding in one's first language can facilitate accuracy in recognizing words in an L2.

It is important to note that this research primarily focused on word recognition — a receptive aspect of bilingual language processing — across different scripts. As such, there is ample room for further exploration, particularly in relation to productive language use, such as speaking and writing. For instance, future studies could investigate whether the nonselective activation of phonological representations, observed in this study during word recognition, also comes into play during word production. Further research could also consider the influence of L2 proficiency on the speed and accuracy of word production. This could be achieved by drawing on a broader range of participants with varying proficiency levels, thus offering a more comprehensive view of bilingual language processing in its productive aspect.

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APPENDIX 1

The online recruitment poster



APPENDIX 2

Approval letter from CUREC

Research ethics approval

Research title: Activation and selection of phonological representations from the Cantonese-English bilinguals

Research ethics reference: EDUC_C1A_23_203

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 Guilfoyle

Dr Liam Guilfoyle
DREC member

APPENDIX 3

Unrelated Cantonese-English pairs used in Experiments 1 and 2

Number	***Cantonese character***	***Jyutping***	***Number of stroke***	***Length of Jyutping***	***English word***	***English word length***	***Cantonese word meaning***
1	反	faan2	4	5	bad	3	opposite
2	好	hou2	6	4	kill	4	good
3	有	yau5	6	4	sad	3	have
4	走	zau2	7	4	cup	3	to walk
5	見	gin3	7	4	fish	4	to see
6	劾	gui6	10	4	sky	3	tired
7	畀	bei2	10	4	seem	4	to give
8	曳	yai6	11	4	fin	3	naughty
9	揸	zaa1	12	4	best	4	grasp
10	搵	wan2	12	4	ice	3	to find
11	嘥	sai1	15	4	tin	3	waste
12	都	dou1	15	4	lip	3	both

Phonologically similar Cantonese-English pairs used in Experiments 1 and 2

Number	*Cantonese character*	*Jyutping*	*Number of stroke*	*Length of Jyutping*	*English word*	*English word length*	*Cantonese word meaning*
1	分	fan1	4	4	fun	3	score
2	冰	bing1	6	5	bing	4	ice
3	希	hei1	7	4	hey	3	hope
4	星	sing1	9	4	sing	4	star
5	點	dim2	9	4	dim	3	a dot
6	烤	haau1	10	5	how	3	grill
7	通	tung1	10	5	tone	4	to pass through
8	師	si1	10	3	see	3	teacher
9	啱	ngaam1	11	6	arm	3	right
10	新	san1	13	4	sun	3	new
11	賣	maai6	15	5	my	2	sell
12	糕	gou1	16	4	go	2	cake

APPENDIX 4

Chinese consent form for the participants

歡迎！

您已被邀請參加此實驗。請仔細閱讀所提供的資訊。如果您有任何問題，請通過電郵與研究人員聯繫。如果您選擇參加，請在下一頁表示同意。

研究目的

本研究的目的是研究粵語為母語的英語二語使用者心理詞彙中語音表徵的激活和選擇。

我的數據將如何被使用？

我們不會收集任何可以直接識別您身份的數據。

您的IP位址不會被儲存。我們將採取一切合理措施確保數據保密。

您提供的回復將存儲在牛津大學安全伺服器上受密碼保護的電子檔中，並可用於學術出版物、會議演示和外部組織的報告。

研究數據將在研究工作發表或公開發佈後存儲 3 年。

我的數據 將如何被存取？

您提供的數據可能會與牛津大學教育系的學生研究人員及其主管共用。

我們還希望您允許在未來的研究中使用這些數據，並與其他研究人員共享數據（例如在網上學術資料庫中）。數據在與其他研究人員共享或公開結果之前將被去識別化。

研究結果將寫成碩士學位論文。

知情同意書

這項研究已獲得牛津大學跨部門和部門倫理委員會的批准，參考ID號為EDUC_CIA_23_203。 這項研究由Tse Ling Mak完成，她是牛津大學教育系應用語言學和第二語言習得碩士學生。

- 已閱讀上一頁的資訊。（如果您想再次閱讀該資訊，請按兩下」上一頁。
- 瞭解我若有疑問，可以直接電郵聯繫她的導師 Dr Faitaki (faidra.faitaki@education.ox.ac.uk) 或 Tse Ling Mak (tse.mak@st-hughs.ox.ac.uk)。
- 已被告知個人聯繫以回答有關研究和我作為參與者的權利的相關問題。
- 瞭解我可以在分析數據之前退出實驗，這不會對我產生任何負面影響。
- 瞭解我有機會贏得電子購物券作為獎勵。
- 同意出於研究目的（包括研究出版物和會議）處理我的數據。
- 瞭解我的數據將被視為嚴格保密。
- 符合參加此實驗的標準。

要參與此實驗，您必須滿足以下條件：

1. 您以粵語為母語，以英語為第二語言。這代表您從父母/照顧者那裡學習粵語，並主要從學校學習英語。
2. 您的英語達到A2水平（可以處理基本的英語對話）。
3. 您的年齡介乎 18 至 25 歲之間。
4. 您沒有閱讀障礙或任何其他語言障礙。

實驗過程中**請勿**關閉瀏覽器、返回上一頁或訪問其他網站。 按照說明進行操作，直到看到“finish, thank you for taking part”。

這個實驗是無聲的。 請根據你對廣東話和英語的了解判斷實驗中詞對的讀音是否相似。詞對會快速從螢幕上閃過， 請細心留意。

若你同意以上資料，請勾選下面的方格

☐ 我已閱讀以上資料，並會參加此實驗。