

Language Processing and Cross-Language Influence of Late Chinese-English
Bilinguals

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Abstract

This article uses a literature review from different perspectives to investigate and explore different research on late Chinese-English bilinguals and their cross-language processing. Through reviewing different articles, the author hopes to probe into cutting-edge research and present the results for the mutual influence between late Chinese-English bilinguals' first language and second language. Behavioral, neural and linguistic studies are summarized and compared in this article. Various research methods and analysis approaches are also reviewed and evaluated in order to draw a clear and detailed picture of the cross-language processing of late Chinese-English Bilinguals.

Keywords: Late Chinese-English Bilinguals, Bilingualism, Psycholinguistics, Language Development, Cross-language Influence

Background

Today, over 50 percent of the world's population speaks more than one language. Bilinguals normally learn their first language (L1) since they were born while usually receiving linguistic input in their home where L1 has been used, and then develop their second language (L2) later in childhood (Verhoeven, 2007). Meanwhile, late-bilinguals learn L2 in later stages of their life, such as after the age of 6 or 7, adolescence or in adulthood. Differently, early bilinguals usually are exposed to L1 and L2 since they were infants (Kalia et al., 2014), while late bilinguals learn their L2 after a sound lexical, syntactic, and semantic system has been created for their L1 (Kalia et al., 2014). It is also worth noting that late bilinguals usually acquire their L2 by using their existing experiences (Martin et al., 2013). This article aims to explore language processing and practice of late Chinese-English bilinguals who started to learn English after they developed systematic Chinese language skills.

Before delving into the specific topics regarding late Chinese-English bilinguals, it is important to understand several fundamental differences existing between Chinese and English. Chinese and English are differentiated on many dimensions. First, unlike English, Chinese doesn't use alphabet. Instead, it has a logographic system that is used in its written language. The Chinese system uses symbols that represent words, which means a single word is not written with letters, whereas the words made of letters from alphabet are used in the English language. Second, they are highly dissimilar in phonological and morphological structures (Xue et al., 2020). To be specific, there are five lexical tones in the Chinese language including the neutral tone which is rarely

used. These tones allow Chinese syllables to be expressed in several ways to emphasize the four or more different meanings of the word being spoken, yet, people speaking English would normally use tones express or stress emotions. Third, grammatically, English has a stricter order within a sentence than Chinese. Gender forms or tenses for verb do not exist in Chinese, therefore, contexts are often used to judge the time when the action or verb happens, which makes the grammar of Chinese simpler than that of English. What is more, there is not an equivalent of articles such as “the, a, an” in Chinese. Instead, Chinese speakers use qualifiers to indicate the amount or features of the nouns.

Knowing some other nuanced features would also help understand the differences between Chinese from English. For example, English often uses complicated and lengthy sentences with multiple layers of modifiers for expression. In contrast, sentence structure with several short sentences linked with a comma are more common in Chinese. Another language usage phenomenon is that Chinese speakers use active voice more often than passive voice. For example, instead of saying, "it is widely believed that...," in Chinese, people would express as “people generally believe that...”

Understanding these fundamental language differences between Chinese and English will facilitate the understanding not only of the possible learning strategies that late Chinese-English bilinguals might take to learn English, but also of the specific operations and study designs from the research articles we are going to explore.

One useful fact to know is that in the top five American cities, an average of 48% speak a foreign language at home, mostly Spanish or Chinese (Center for Immigration

Studies). However, most bilingual research has been carried out to learn about Spanish-English bilinguals in the U.S. Based on the rising number of late Chinese-English bilinguals and their increasing roles in schools and communities, it is important and beneficial to learn more about the language practice and processing of late Chinese-English bilinguals. This article aims to review some influential research from the recent decades and collect their findings from both linguistic and cognitive investigations with the hope to raise perspectives for future research and to add more knowledge on late Chinese-English bilinguals and their language development.

Research Questions

Contrasting to previous predominant theory that being bilingual or speaking two languages predicts lower academic achievement, in recent years, large amounts of research have proposed the cognitive advantages that bilinguals have in areas of cognitive control (Bialystok & Martin, 2004; Wang et al., 2020), cognitive flexibilities (Comeau, Genssee, & Mendelson, 2007), and social skills (Gampe et al., 2019).

Yet, topics on how bilinguals actually select and use the language are still full of mysteries and need more and closer investigation. Language processing studies involve exploring how communications are processed and understood when human use words to communicate. In the past decades, researchers from different academic fields such as linguistics, education, psychology and neuroscience have adopted a wide variety of methods to seek and add knowledge on second language acquisition, bilingualism language processing and development. They adopt behavioral and neuroimaging techniques such as picture naming, eye-tracking, MRI and electrode caps to examine

cognitive controls and brain responses during bilingual language processing, as well as the linguistic and second language acquisition outcomes from their language learning under different contexts.

There are studies investigating language activation mechanisms among bilinguals. Whether the native language of bilingual individuals is active during second-language use is the topic of lively discussion. One theory is the Switch Hypothesis from Macnamara and Kushir (1971) in investigating a bilingual's capacity to translate linguistically mixed passages and suggests that bilinguals selectively activate one of the languages. In the experiment of bilinguals making comparative judgements over concrete concept pairs and abstract concept pairs, Popiel (1987) found an evidence against the Switch Hypothesis. Later, Spivey and Marian (1999) proposed the Parallel Activation Hypothesis suggesting that bilinguals activate both of the two languages in general.

With a certain level of similarity to the Parallel Activation Hypothesis, the theory of Revised Hierarchical Model (RHM) was proposed by Kroll and Stewart (1994). They performed three tasks of picture naming and bilingual translation and found that less proficient bilinguals tend to learn L2 words by translating from L1 while proficient bilinguals with higher L2 level depend less on the translation or mediation. As bilinguals become more proficient with their L2, independent and direct semantic links progressively develop between conceptual and lexical representations.

Based on these influential theories, this literature review aims to obtain more knowledge of and insight into the important studies and findings offered by the

researchers who have invested time and resources into the topic of late Chinese-English bilinguals. The research questions central to this review are:

- (1) Do late Chinese-English bilinguals activate both of their languages during language processing? And if so, how is this activation processed?
- (2) How does late Chinese-English bilinguals' L1 influence their L2 learning and vice versa?

The first research question derives from the psycholinguistic perspective, where the relationship between linguistic behaviors and psychology is investigated. Based on the given theories mentioned earlier on whether bilinguals activate both of their languages when just using one language, here, the author tends to investigate the studies focusing on late Chinese-English bilinguals. The second research question aims to study the cross-language or cross-linguistic phenomenon of late Chinese-English bilinguals. Specifically, how does their Chinese influence the learning of English and how does their increased English proficiency impact their Chinese.

Through reviewing different articles, the author hopes to find answers and insights for these two research questions where we learn about late Chinese-English bilinguals' language processing and language practices from linguistic and cognitive perspectives. Possible factors influencing the issues will further be discovered. At the end, implications for future research will also be presented.

Methodology

The key terms 'bilingualism', 'Mandarin-English bilinguals', 'late Chinese-English bilinguals', 'bilingual language processing', and 'second language acquisition'

are used in the process of searching research-based and empirical articles at ProQuest database and Google Scholar. For the topic of bilingual language processing, the author synthesizes that of the specialized late Chinese-English bilinguals with the general bilingual group. In other words, the author looks at the studies on the broader bilingual group first and then moves to the ones that investigate Chinese-English bilinguals. Then, the author selected the studies that focus on late Chinese-English bilinguals. Several popular theories and hypotheses regarding bilingual language processing that have been discussed and tested are also included. Meanwhile, some of the most recent and cutting-edge research investigating this topic is reviewed. With the consideration of being up to date, the review is mainly focused on articles published after the year of 2000 with several exceptions. In doing so, a total of 35 articles from peer-reviewed journals are identified and reviewed.

Findings

Language Processing of late Chinese-English Bilinguals

As discussed above, there are mainly two different theories about bilinguals' language activation: Switch Hypothesis (Macnamara and Kushir, 1971) suggesting bilinguals selectively activate one of the languages and Parallel Activation Hypothesis (Spivey and Marian, 1999) claiming bilinguals activate both of their languages. In order to examine the same issue with Chinese-English bilinguals, Guo and Peng (2006) conducted a systematic study consisting of three phases, including an English word naming phase, a picture study phase, and a picture naming phase. 41 college students aged from 20-23 years old participated in the experiment. All participants had learned

English as a second language at or after age of 12. Although their English level varied, they could use and comprehend English to some extent.

In the experiment tasks, participants were first given an English word naming task, where they were concurrently presented a word visually and its recorded pronunciations. The second phase was a picture study, during which pictures were displayed to two different groups. Participants were instructed to study the names, as they were to use them to name pictures during the experiment. Following this learning phase, there was a testing phase in which pictures were presented individually to the participants, who were then asked to produce the name they had been provided with.

The study used the event-related potential (ERP) technique to investigate time course and neural mechanisms that are involved in language processing. It is worth noting that ERP technique has high temporal resolution and can provide different sources of information on the neural mechanism of cognitive processing. Guo and Peng (2006) used it for measuring the brain activities of the late Chinese-English bilinguals in the experiments. They also carried out paired t-tests to find the correlation between time course and distribution for the cross-language activities and yielded to several results. First, N400, an ERP component indicating semantic violation, found to be greater for the unrelated words. At the same time, difference between the mean amplitudes of N400 for English names and unrelated words was found to be significant. Their findings indicate that parallel activation of both languages is common in bilingual speech production. That is to say, both languages are activated simultaneously even when Chinese-English bilinguals speak words in one of their two languages.

Thierry and Wu (2007) gathered behavioral and electrophysiological data from the study involved 15 late Chinese-English bilinguals and 15 English monolingual controls who were performing semantic relatedness tasks on English word pairs. They specifically measured the reaction time, error rate and neural activities through investigating ERP components. In the experiment, semantic relatedness between the prime and target words was the main dependent variable. For example, post-mail was a semantically related word pair while train-ham was not. Half of the word pairs shared a common feature when being translated into Chinese, which is unknown to the participants. Take train-ham for instance, their Chinese translations Huo Che (train) and Huo Tui (ham) share a same Chinese character Huo at the beginning. This task design is balanced with two linguistic factors: one explicit factor is the semantic relatedness, and one hidden factor is the character repetition of Huo in Chinese. The feature of the hidden Chinese character repetition has facilitated exposing the significant effect in demonstrating the spontaneous activation of the late bilingual's L1 while using their L2.

As a result, English monolingual participants reflected a faster response to the semantically related word pairs than the unrelated one, as expected. Meanwhile, English monolingual participants showed no difference in hidden Chinese character repetition. Interestingly, the researchers did not find a significant difference between late Chinese-English bilinguals and English monolinguals when considering the hidden Chinese character repetition. However, when examining ERP effects, they discovered a significantly smaller effect of semantic relatedness in Chinese-English bilinguals than

English monolinguals. Most importantly, there was a hidden Chinese character repetition effect among the bilinguals. These findings have indicated a native-language activation as an unconscious correlate of second-language comprehension.

To ensure a minimal influence from experimental tasks while investigating bilingual language access, a few years later, Wu and Thierry (2011) adopted a new pattern in translation tasks where language processing was not explicitly stimulated. Specifically, 15 late Chinese–English bilinguals were showed several square or circle strings and made quick shape-dependent responses as they were not aware that some of the English words shared a sound repetition with the word “square” or “circle” when translated into Chinese. Participants made a reaction by pressing a key on a response box for the stimuli in a randomized sequence, half of which were filler trials comprising a thread of squares or circles. There were 300 words as the verbal stimuli presented in the matched sized to the strings of circles and squares. Participants offered the first translation that came to their mind and could not change their responses.

The purpose of their task manipulation was to prompt a response through implicit lexical translation into Chinese, while the participants have adopted nonverbal, low-level visual processing. The rationale behind the study design is that if bilinguals have combined lexical representations for both languages, translation equivalents in the non-presented language, such as Chinese, should be triggered when they spontaneously process English words at the same time, which would lead to an implicit manipulation effect while translating into Chinese. Some native English monolingual participants were also tested as the control group.

Both results from ANOVA and ERP components have demonstrated no effect of implicit influences in Chinese translations among English monolingual control participants. However, Chinese–English bilinguals showed different features in their results. Critically, the time course of the ERP effects suggested the concurrent lexical processing of explicitly offered English words and their implicit Chinese translations. Similar to Guo and Peng (2006), these results also support the concept that Chinese–English bilinguals activate both of their languages.

Different from studies mentioned above, Xue et al. (2020) investigated the underlying phonological competition effects in Mandarin and English and found evidence supporting interactive-activation models of bilingual spoken word recognition by comparing Mandarin and English spoken word processing among 34 adult Mandarin-English bilinguals in a picture-spoken word matching task. They found a significant effect in longer reaction times for English than for Mandarin, as suggested by the behavioral data of late Mandarin-English speakers, which can be observed as a reflection to the lower proficiency in English compared with Mandarin of the late Mandarin-English bilinguals.

Studies of English suggest that basic lexical groups such as nouns and verbs are represented in different brain regions, while research in Chinese identified overlying brain regions for nouns and verbs. Yang et al. (2011) adopted a method of fMRI study to examine the neural representations of nouns and verbs among late Chinese–English bilinguals and found that the late Chinese-English bilinguals demonstrated no significant differences in brain activation for nouns versus verbs in their L1 Chinese.

Surprisingly, minimal neural distinction between nouns and verbs were found in L2 English among the late Chinese-English bilinguals, suggesting that the group was using native language mechanisms when the processing the second language stimuli.

Using the same fMRI technique, Wang et al. (2007) investigated neural activities of second-language learners when they switched languages. Specifically, 12 Chinese college students who were learning English as their second language were scanned when they performed language switching tasks of naming pictures in both Chinese and English with being provided response cues. Greater brain activation was identified during language switching than the non-switching conditions. The direction of switching caused different results. Specifically, switching from L1 to L2, but not from L2 to L1, activated several brain regions that were related to executive functions, indicating that neural associates of language switching vary depending on the direction of the switch.

By reviewing the studies above, it has been demonstrated that late Chinese-English bilinguals activate both Chinese and English when they speak even just one of them, yet further exploration on how the two languages influence each other are still needed.

Cross-Language Influence Between L1 and L2

In this section, research that focuses on the cross-language influences among late Chinese-English bilinguals will be presented in order to obtain a comprehensive understanding on how their L1 Chinese influences L2 English learning and how their L2 English proficiency impacts their L1 Chinese.

Late bilinguals' learning of L2 is greatly impacted by their L1 (Xie, 2018). In Quam and Creel's study (2017), 51 Chinese-English bilinguals and 26 English speakers without tone experience were taught Mandarin novel words with tones. Results has indicated that the Mandarin-English bilinguals out-performed English speakers in the tasks. Quam and Creel (2017) claimed a correlation between the overall accuracy with Mandarin dominance among the Mandarin-English bilinguals.

Quam and Creel (2017) also investigated whether Mandarin-English bilinguals could process the pitches differently in a Mandarin context or an English context in three word-learning tasks among the Mandarin-English bilinguals. The results indicated that Mandarin-English bilinguals did not they did not process tone better than the English speakers did in the task of learning English-like words; while learning Mandarin-like words, they performed better than the English speakers did when using tones. This result indicated that the bilinguals processed tones in accordance with the language context, providing strong evidence that Mandarin-English bilinguals could process tone-language.

In order to examining L1 influence on L2 for late Chinese-English bilinguals through investigating object categorization in vocabulary, Pan and Jared (2020) specifically studied how verbal labels influence Chinese-English bilinguals by looking into how Chinese word structure impacted bilinguals' categorization processes in two experimental tasks. As the result, Chinese-English bilinguals showed a greater typicality effect for objects without category cues than objects with cues, which was

different from their English monolingual counterparts. The result suggested the linguistic information effects from bilinguals' L1 on their L2 categorization processes.

Although there is a prediction of bilinguals' reliance on their L1 when processing their L2, how their brain processes grammatical features of L2 remains rather mysterious. Yan et al. (2016) explored how Chinese-English bilinguals recognized English modulated verbs that are not being used in Chinese in a semantic consistency judgment task. They found that proficient late bilinguals understood regular and irregular changes in a similar way as English monolinguals. Meanwhile, brain imaging results showed different patterns in bilinguals' brain activity when they used L1 syntax and semantics than when they processed syntax and semantics in their L2. Another interesting finding is that late bilinguals with high L2 proficiency rely more on their cognitive control system when processing syntax rather than semantics in L2. This result indicates that when bilinguals get high proficiency bilinguals, they tend not to rely on L1 syntax to process L2 grammar.

One 9-month longitudinal study of on 139 late Chinese-English bilinguals (Xue et al., 2017) aiming to explore the developmental relationship between bilingual morphological awareness and reading revealed that Chinese complex morphology could be accountable for a greater number variance of English reading in the post-test than the pre-test. The result also suggested the relationship between bilingual reading and morphological awareness was associated with the morphological similarities between L1 and L2 and proficiency level of L2 of late Chinese-English bilinguals.

Second-language learning research traditionally examines the transfer from L1 to L2 and assumes that the L1 level of bilinguals stays rather stable (Odlin, 1989). Separately, language attrition research investigates changes to L1 when increasing L2 usage. L1 and L2 strongly influence each other (Schmid & Köpke, 2007). However, in order to achieve alternative perspectives on the cross-language influence of Chinese-English bilinguals, we also need ways to examine the mutual influences between bilingual's L1 and L2. To that end, reviews of late Chinese-English bilinguals and their cross-language influences hold an important position in improving our understanding of their language acquisition and development of late Chinese-English bilinguals.

As mentioned before, on the term of cognate effect in picture naming, bilinguals' L2 tends to have larger effect than in L1, suggesting that L1, the more dominant language, is more likely to influence L2, the less dominant language. L2 proficiency has significant influence on Chinese-English bilinguals' cognitive control (Xie, 2018). At the same time, phonology interaction is activated in both languages and contests in bilinguals' language selection (Costa et al., 1999). Gottardo et al. (2017) examined the processes underlying English and Chinese word reading in Chinese-English bilinguals according to their experiences with their L2 English using practice with varied lengths of time in an English-speaking environment. They measured phonological awareness, morphological awareness, and vocabulary of late Chinese-English bilinguals living in Canada and found that vocabulary knowledge was directly related to English and Chinese word reading in the group which spent a short time in an English-speaking

environment. However, phonological awareness was not related to English word reading in this group, while reading processes in the two languages were less similar for participants in a different group. Moreover, the writing system of the L1 also impacted L2 reading in the levels that were associated with language experiences. This study reveals that the L1 and L2 of late Chinese-English bilinguals influence each other in the changing patterns according to their L2 proficiency and usage.

Quam and Creel (2016) also tried to determine whether the phonetic processing of tones in their L1 was influenced by the degree of language dominance of Chinese-English bilinguals' languages and whether their L2 proficiency was linked with reduced successful word recognition in tone clarification trials. 72 late Mandarin-English bilingual participants viewed two photographs at a time while being presented with a familiar Mandarin word referring to a photograph. The names of the two photographs differed in tone, vowels, or both. Word recognition was evaluated and compared in conditions of accuracy, reaction times, and an online measurement. They found relative proficiency in English was linked with reduced word recognition success in tone-clarification trials, but not in vowel-clarification trials. Although all the bilinguals had learned their L1 Chinese since their birth, this selective attrition for tone content happened. In other words, increased experience with English undermined their tone use in Chinese. Their findings suggest one of the significant influences from late Chinese-English bilinguals' L2 proficiency on their L1.

With the same intention to examine influence from L2 experience, Malt et al. (2015) compared naming patterns of English monolinguals, Mandarin monolinguals, and late

Mandarin-English bilinguals. Their results also showed changes in the word use of both L1 and L2, implying that the lexical system stays flexible over an extended time period. What's more, the interconnections between L1 and L2 promote their impacts on each other. In other words, it leads to a more dynamic lexical representation where L1 and L2 continually interact in cross-language semantic relations and interactions.

One interesting and common linguistic phenomenon existing among late Chinese-English bilinguals is their lower sensitivity to English lexical gender information. Two EPR experiments in a study aimed to investigate the pattern of gender constraint rules functioning for Chinese-English bilinguals in Chinese and English reflexive pronoun resolution (Liang et al.,2018). Specifically, Chinese-English bilingual participants responded to Chinese and English reflexive pronouns that were either congruent or incongruent with their antecedents. Researchers observed a gender incongruity effect in Chinese and found that the rule of gender constraint functioned in a similar pattern in L1 and L2 reflexive pronoun resolution by Chinese-English bilinguals. In other words, gender constraint was applied in the resolution in both L1 and L2.

In order to understand the mutual linguistic influence of bilinguals, it is also useful to examine whether late bilinguals develop shared or specific representation for cross-linguistically different and similar structure and how do they establish the shared syntactic representations. The separate syntax account (Ullman, 2001) argues that bilinguals store and approach syntactic information separately for the two languages. Thus, it expects a syntactic transfer reduction as L2 proficiency increases. In contrast, late bilinguals share syntactic representations between their two languages, and the

grammatical rules of one language have an influence on the syntactic processing in the other. Cross-language priming also increases with L2 proficiency, while low proficient bilinguals tend to their learning on L2 syntax with separate representations (Hwang, et al., 2018). According to the shared syntax account, Chinese-English bilinguals increase shared representation for similar structures in both their L1 and L2 as their English proficiency grows.

To provide neural evidence, Abutalebi and Green (2007) investigated bilingual language production with the method of fMRI and found that executive function is involved among bilingual to inhibit lexical competition between the two languages in order to successfully select the intended language. It implies that bilinguals' brain activities decline as their L2 proficiency increases, due to structural changes that facilitates the control mechanisms. This study has offered a neural evidence for bilinguals' reduced dependence on L1 when they grow more proficient in L2.

In order to provide both cognitive and neural evidence on the influence of L2 proficiency, Chang and Wang (2016) performed behavioral and ERP study on 40 late Chinese-English bilinguals with intermediate or high L2 proficiency to also examine the syntactic similarity on English passive sentence processing. Bilingual participants were asked to read the sentences carefully and to judge whether they were correct or not. Results indicated a shorter reaction times and higher accuracy rates in the high-proficient group than the intermediate-proficient group. ERP results indicated that intermediate-proficient group showed larger semantic violation while high-proficient group had bigger syntactic violation, suggesting the influence of L2 proficiency and

syntactic similarity on L2 sentence processing. In conclusion, L2 proficiency has played a significant role on late bilinguals' sentence processing.

Li et al. (2018) found the weaker links and cross-language intervention during their investigation on the two prominent theoretical accounts for the bilingual effect. In their study, highly proficient Mandarin–English bilinguals and English-speaking monolinguals perform picture-naming tasks, while the effects of grammatical class, word frequency and translatability were measured. Results showed faster reactions among monolinguals than the bilinguals in both L1 and L2. Meanwhile, bilingual effect had a smaller effect for verbs than for nouns. They also found the words advantage that bilinguals showed with greater translatability, which was not demonstrated among grammatical categories.

On term of neural evidence, Wang et al (2020) provided fMRI data of the L2 picture naming task, in comparison with the data from L1 processing, indicating more neural activation in cognitive control and language control areas and the increased correlation with the bilinguals' L2 proficiency. Their findings shed light on the neural flexibility of bilinguals' L2 learning and also suggested the shared influences on the bilingual brain from both their L1 and L2 experiences.

To conclude, studies discussed above have demonstrated the cross-language influences from different linguistic perspectives and provided both cognitive and neural evidence. But it is still necessary to examine the broader implication of these results.

Discussion

Compared with the broader bilingual research, research on Chinese-English bilinguals requires more consideration over the specific features of their L1 Chinese. As we know, it is different with English on many dimensions. Therefore, the verbal stimuli are different with the ones used in other languages similar to English.

Translation equivalence has been a significant factor in studies that aim to address word comprehension and production among bilinguals. Although with adopting various measurements, such as behavioral or neural methods, most of studies have not reflected the influences of the language processing context to observe the language non-selective approach in bilingual language processing.

However, from the literatures reviewed, we can answer the first research question of whether late Chinese-English bilinguals activate both their languages when just using one of them. Evidence from both behavioral and neural data from the different studies have suggested that late Chinese-English bilinguals activate both Chinese and English in their daily language practices. The studies have offered evidence from different angles and analyzed bilinguals and their monolingual counterparts to support it. Guo and Peng (2006) and Xue et al. (2020) recruited only late Chinese-English bilinguals in their studies, while others looked at both of bilinguals and monolinguals. However, the varieties of tasks in the experiments, data collection, and analysis methods provide rich connections and sound evidences. It is worth mentioning that previous studies of bilingual language processing have used language stimuli such as cognates and homographs or performed experimental tasks, for example, word

translation to promote language activation (Wu & Thierry, 2010), while studies we have in this review have also adopted additional ones. For example, picture naming is one of the most adopted approaches in the studies since it can be accepted commonly, given the limited choices on linguistic stimuli that can be selected for all of the participants speaking either Chinese or English.

Researchers also learn from each other to optimize their studies. When Xue et al. (2020) compared the timing and nature of the neurocognitive processes underlying phonological competition effects in L1 Mandarin and L2 English, they made the efforts to avoid cross-linguistic interference in lexical activation (Wu & Thierry, 2010). By doing so, more comprehensive and persuasive research outcomes can be presented to promote a better understanding on late Chinese-English bilingual language processing.

For the second research question of what the mutual influences between L1 and L2 of late Chinese-English bilinguals are, researchers from different countries and areas have contributed to add knowledge. Based on the fact that there are large amounts of college students who are learning English in China, studies on them are more often to see, yet the researchers have taken attempts from different linguistic angles, such as semantics, phonology, lexical, vocabulary and writing system to examine the cross-language influences.

It is also important to recognize the connection between behavioral results and the neural ones. For example, in examining lexical influences, while Malt et al (2015) found evidence from results of behavioral tasks, Liang et al (2020) also provided data from brain images. In general, we can see the agreement between them, that is to say,

the both behavioral and neural measurement have demonstrated sufficient evidence to show the patterns of the cross-language influences among the late Chinese-English bilinguals. While, in some studies that involve both behavioral and neural tests, some effect can be more apparent or explicitly shown in neural tests than the behavioral one. I think it is worthy to analyze the possible reasons behind in future studies.

Several of the studies suggest that as proficiency in the second language increases, the links between the lexical representations of the second language and the semantic representation become stronger, which agrees to Kroll and Stewart (1994)'s theory of Revised Hierarchical Model. Some results therefore propose that the magnitude of the activation of the nontarget language is modulated by the proficiency level of two languages. However, in the future, the degree of how much L1 and L2 influence each other and the influential factors still is a topic that needs further investigation for our better understanding on the late Chinese-English bilinguals' cross-language influences.

Conclusion

Through reviewing over different articles, sufficient background and mechanism knowledge for late Chinese-English bilingual language processing under different contexts have been displayed. The review presented here has drawn on the prediction, experiences and perspectives of 35 studies involving behavioral and neural research in order to understand late Chinese-English bilinguals and their language processing. Although possible factors influencing both language processing and cross-language influences can be complicated and difficult to draw a definite conclusion, the results

from our analysis of the 55 publications enable us to draw several conclusions about the central questions to this article.

A first insight would be for the question whether bilinguals activate both of their languages during language processing and how late Chinese-English bilinguals process differently in various contexts? Behavioral, neural, and linguistic evidence have indicated bilinguals activate both of their language during language processing, yet they have the mechanism and ability to rule out the interruption according to different language cues. It is also safe to state that similar to other bilinguals, late Chinese-English bilinguals access both Chinese and English when they use one of the languages. However, with the consideration on the particular dissimilarity between Chinese and English typologically, phonologically and morphologically, late Chinese-bilinguals have their own features when processing languages under different contexts. Behavioral, neural, and linguistic evidence also suggest the mutual influences between L1 and L2, not only L1's influence on L2. What's more, the patterns can vary during different stages of language learning. For example, for early second language learners, they tend to depend more on L1 when learning L2. As their L2 proficiency increase, L1 is influenced by L2. Both behavioral and ERP data have revealed the influence of L2 proficiency and syntactic similarity on L2 sentence processing. L2 proficiency played a predominate role (Chang & Wang, 2016; Wang et al., 2020).

Limitations and Implications

The findings of this current review of literature are limited by several factors. First, there was only a small number of studies on bilingual language processing found which

focus on late Chinese-English bilinguals due to the fact that many researchers tend to investigate not only in one bilingual group but other bilingual group, especially in the U.S. where many languages are spoken. Second, most of the researchers are based in the U.S., or Mainland, China, thus, it is less likely to obtain perspectives from other countries and areas, therefore may reduce the representativeness and the generalizability of findings. Third, there was little analysis on the features of bilinguals' first language in the studies. The comparison between the language of Chinese and English are also limited.

The evidence for the questions is sufficient yet not conclusive. There are many factors whose influence needs further investigation. Based on the fact that the participants are all Chinese-English bilinguals (Yan et al., 2016). In the future, it would be useful to explore more linguistic factors, specifically, a comparison between Chinese and English, whether the similarity and differences between the two languages can influence the results to a large extent. More research regarding L2 proficiency and age of L2 acquisition can also be conducted in order to provide various lenses for us to understand better about language processing and acquisition of late Chinese-English bilinguals.

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