Language Variation in Dual Immersion Preschools:
Teaching and Learning Mandarin Chinese as a Heritage Language

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Abstract

This dissertation draws on both qualitative and quantitative approaches to investigate the linguistic practices of teachers and children who are learning Mandarin Chinese as a Heritage Language (CHL) in two dual immersion preschools in California. CHL children have been interpreted as novice members in local speech communities who actively explore the linguistic repertoire of their multilingual environment and use their languages or language varieties strategically. This research focuses on Mandarin variation patterns by both teachers and children in school and explores the use of sociolinguistic variables in language input and child production. Specifically, it examines the variation in Mandarin syllable-initial sibilants /s/ and /ʂ/ which are two distinctive phonological categories but are often mixed in several Mandarin varieties.

Chapter 2 reviews relevant studies from the perspectives of child language development, bilingual teaching and learning, and sociolinguistics. Chapter 3 introduces the interdisciplinary background of sociolinguistics, then discusses the ethnographic methodology, followed by a detailed explanation of the research methods of the current study. The characteristics of language input and how teachers use sociolinguistic variables in their Mandarin instruction are interpreted in Chapter 4. Chapter 5 examines the bilingual development of CHL children and how this is affected by their age, gender, home language, and enrollment length in the programs. The extent to which children perceive and reproduce the Mandarin sociolinguistic variables in their heritage language is analyzed in Chapter 6. Chapter 7 presents other developmental patterns in Mandarin and English observed in CHL children. Lastly, Chapter 8 summarizes the key findings, highlighting the practical and theoretical implications as well as limitations so as to propose directions for future research.

The findings suggest that teachers adjusted their use of variants according to the contexts and that children's language backgrounds may serve as one of the reasons for their choice of variants. CHL children in the classroom had been exposed to a range of sociolinguistic variables in the school setting. In addition, language use in families plays a key role in explaining the diverse language proficiencies among CHL children. The differences in language proficiency, along with other factors such as age, discourse context, input, and gender significantly affected the ways CHL children chose to use the sibilants in their heritage language. Besides sibilant variation, other developmental and variation patterns have also been identified.

From an interdisciplinary perspective, this study contributes to the current knowledge of the acquisition of variation by expanding the research scale into CHL communities where heterogeneous language resources are available for children to explore. It also reveals the potential connection between language input and child language production to illustrate the acquisition process where different variation patterns may compete for salience. In this age group, children start exploring and experimenting with various language features and styles with adults and peers. In addition, this research illustrates the potential of dual immersion to support early childhood development in both CHL and English. By combining children from diverse linguistic backgrounds in the same class, dual immersion programs provide multiple sources of language input and varying contexts to practice the use of different language varieties and styles. They also offer children opportunities to actively establish their own sociolinguistic network with peers with whom they may creatively use their full linguistic repertoire in different languages and varieties.

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Glossing Conventions

Linguistic examples in each chapter are presented based on the Leipzig glossing rules as follow (Comrie et al., 2008).

1	Chinese character
2	Mandarin pinyin
3	Word-to-word English gloss
4	English full-sentence translation

List of standard abbreviations

1 = first person

2 = second person

3 = third person

CLF = classifier

COMP = complementizer

COP = copula

DE = Mandarin morphosyntactic particle

LE = Mandarin morphosyntactic particle (perfective aspect marker or marker for currently relevant status)

NMLZ = nominalizer

PASS = passive

PFV = perfective

PL = plural

Q = question particle

REFL = reflexive

SG = singular

Bold and underlined word = target feature

Italic word = key term

1. Introduction

1.1 Acquisition of variation

Learning a language means not only mastering the grammatical structures in a target language but also becoming a legitimate member of the target speech community. It requires knowledge about and access to hierarchies of language varieties, norms of style shifting, meanings of jargon and slang, and rules of using dialectal features. This knowledge about how to recognize and produce contextually appropriate language, or sociolinguistic competence, has been examined by measuring the native-like patterns of specific sociolinguistic variables or practices (Bayley & Regan, 2004; Lyster, 1994; Regan et al., 2009; Yu, 2005). In her analysis of the third wave of variation study, Eckert (2012) interprets sociolinguistic variables as vehicles that semiotically reflect and construct social meaning. The meaningful heterogeneity inherent in all speech reveals the variable nature of language, and much of this is informative for language learners (E. K. Johnson & White, 2020; Smith et al., 2007).

However, due to their different cognitive capacities, language proficiency, and social experiences, children and adult learners often demonstrate different sensitivities to language varieties and registers in the target language. Systematic use of sociolinguistic variables, such as the production of intervocalic /t/ in British English, has been observed in monolingual children as young as age two (Foulkes et al., 2001). In general, younger children tend to produce more standard forms than vernacular ones because standard variables are often preferred in language input by caregivers (Smith & Durham, 2019). As age increases, children are exposed to more heterogeneous language practices. Regarding the -ing vs. -in variation and /t, d/ deletion by children aged 6-9 in Philadelphia, Labov (1989) suggested that the social and stylistic constraints

on variation may emerge first, followed by language-specific grammatical and articulatory constraints. Some variables may be learned earlier than others, and this may depend on the characteristics of the variable under study (E. K. Johnson & White, 2020; N. L. Shin, 2016; Smith & Durham, 2019).

If the age of onset of a foreign language starts after early childhood, differences in developmental trajectories may be observed. For example, Polish teenage migrants (aged 12-18) in the UK were found to not only replicate the local patterns of -ing variation but they also introduced novel ways that were not attested in their local peers (Schleef et al., 2011). Based on data mainly collected from university students, studies of variation in second and foreign languages (L2/FL) have revealed that the social meanings embedded in the variables were associated with learners' language attitudes and ideology (Davidson, 2022; Pozzi, 2022; Regan, 2022). For example, in the case of Spanish learning by U.S. students in Buenos Aires, the non-stigmatized features were quickly adopted while the widely stigmatized variable /s/-weakening was resisted (Pozzi, 2022). Chappell and Kanwit (2022) demonstrated that language experience and explicit instruction had facilitated L2 Spanish learners to link the reduced /s/ to the region of origin and social status of the speaker. In sum, based on findings of monolingual variationist studies, L2 variation research has not only examined if learners exhibited native-like variable patterns but also explored how the social context and the position of the learner within that context influence their language acquisition (Preston et al., 2022).

Based on these empirical findings, several theoretical accounts have been proposed. In the *abstract variable rule formation*, Labov and others suggested that the acquisition of variation starts from variable rules manipulating abstract categories which would later be adjusted according to adult use (Labov, 1972, 1989; Nardy et al., 2013; Roberts, 1994, 1997a; Smith et

al., 2007). This has been questioned by the *case-by-case concrete learning* account which attributes children's variation to strong lexical conditioning (Nardy et al., 2013). Scholars such as Wolfram, Chevrot, and Díaz-Compos propose that frequency may play a key role in variation acquisition: the more frequent a lexical item, the more opportunities children would have to reproduce the same pattern that it represents (Chevrot et al., 2000; Díaz-Campos, 2005; W. Wolfram, 1989a). *Exemplar theory* (J. Bybee, 2006) links surface forms with the ability to infer more abstract categories. It posits that frequent units would be represented by more exemplars than the less frequent ones, and language input is mediated by other factors including attention and saliency (Nardy et al., 2013). However, this model has not been supported by empirical data such as subject pronoun variation in Mandarin Chinese (X. Li & Bayley, 2018) and has been challenged for its inadequacy in explaining the abstract representations in production and perception (Foulkes, 2006). On the other hand, *usage-based theories* emphasize the role of use in the understanding of linguistic systems (Tomasello, 2003). From this perspective, it is believed that the two sets of cognitive skills, namely intention-reading and pattern-finding, facilitate the process of language acquisition.

Viewing variation acquisition as an interdisciplinary field of language variation and change, child language development, and second/heritage language acquisition, the current study seeks to explore what kind of language input is provided for heritage language learning children and to what extent children may perceive and reproduce the input patterns. This question is addressed through ethnographic observation and quantitative analyses of the language practices of teachers and children in two dual-immersion preschools where Mandarin Chinese is learned as a heritage language.

1.2 Chinese as a heritage language

Research on Chinese as a heritage language (CHL), among studies of other immigrant heritage languages such as Spanish, Russian, Korean, Japanese, Hindi-Urdu, Turkish, Arabic, and others, has emerged as a trending topic in recent decades (He & Xiao, 2008; Montrul, 2010). Many of these heritage languages are mainly used at home and are rarely viewed as a national resource in the US (Fishman, 2012). Concerns such as language loss, language anxiety, and identity issues have been raised not only in heritage language learners but also in families, schools, and local communities.

"Chinese" in CHL stands as an umbrella term for various Chinese varieties, including Mandarin, Cantonese, Taiwan Mandarin, Teochew, Hakka, and Taishan dialect among others, which can be found in many Chinese immigrant families. Growing up in such a family usually means becoming multilingual: using one Chinese variety with the parents, speaking another dialect with the grandparents, talking in English with siblings and peers, and perhaps learning other foreign languages at school. The heterogeneous linguistic resources in the environment provide the child with tremendous opportunities to capture the distributional patterns of variables, test various ways to use them, and verify the social meanings behind language practices. This also requires the child to be sensitive to the differences among languages and varieties, the changes in contexts and genres, and their relationships with the interlocutors.

On the other hand, increasing Chinese learning programs, including bilingual preschools, after-school Chinese classes, weekend Chinese schools, and online programs, have become available for CHL children. These programs not only provide formal (although sometimes unsystematic) Chinese instruction but also enrich the diversity of Chinese varieties and registers

for young language learners. English-Mandarin dual immersion programs[1], which support the development of both languages by having approximately equal numbers of language minority and language majority students in the same class with instruction in both languages, recently have emerged as a prominent educational model for CHL families in the United States (Baker, 2011; S. H. Chen et al., 2021; Lindholm-Leary, 2011; Lü & Koda, 2011). Sometimes, CHL children attend bilingual or dual immersion preschools beginning at three years old or younger, which is a critical period when children intensively develop their linguistic, cognitive, and socio-emotional skills. These programs serve as the first transitional step from home to the wider social environment where children start their independent socialization and language practices (Schwartz & Palviainen, 2016). The programs also provide a context to establish a multilingual speech community in which various Chinese varieties may be adopted in class and a linguistic hierarchy may be formed (Starr, 2016).

1.3 Main research questions

To investigate the acquisition of variation in bilingual early childhood contexts, this study focuses on Mandarin variation patterns by teachers and children in two English-Mandarin dual immersion preschools. Following the tradition of variationist research, the study adopts ethnographic and quantitative methods to explore the use of sociolinguistic variables in language input and child production. Specifically, this research aims to address the following questions:

[1] Among different forms of bilingual education, sometimes two languages are both used for teaching and learning, and students are expected to learn in both languages. This type of program has been named with different terms, such as two-way immersion, dual language immersion, two-way dual language immersion, or two-way bilingual immersion. These terms are sometimes interchangeable, but different terms emphasize on nuanced differences in their implementation and focus. The term "dual immersion" is adopted here because (1) it covers the fundamental practices in a strong form of bilingual education, (2) it highlights the involvement of students from different language backgrounds, and (3) it is the term used by the two preschools for their own program design.

(1) How do teachers use Mandarin dental sibilant /s/ and post-alveolar sibilant /ʂ/ as sociolinguistic variants when talking to CHL children in class?

(2) How does CHL children's English and Mandarin language proficiency develop during their enrollment in the dual immersion programs?

(3) How do CHL children use the two Mandarin sibilants /s/ and /ʂ/ as a sociolinguistic variable in their heritage language? And if this is influenced by their enrollment in the dual immersion programs and other linguistic and social factors?

1.4 Chapter structure

The rest of the dissertation unfolds as follows. Chapter 2 reviews relevant studies from the perspectives of child language development, bilingual teaching and learning, and sociolinguistics. Chapter 3 introduces the interdisciplinary background of sociolinguistics, then discusses the ethnographic methodology, followed by a detailed explanation of the research methods of the current study. The characteristics of language input and how teachers use sociolinguistic variables in their Mandarin instruction are interpreted in Chapter 4. Chapter 5 examines the bilingual development of CHL children and how this is affected by their age, gender, home language, and enrollment length in the programs. To what extent children perceive and reproduce the Mandarin sociolinguistic variables in their heritage language is analyzed in Chapter 6. Chapter 7 presents other developmental patterns in Mandarin and English observed in CHL children. And lastly, Chapter 8 summarizes the key findings, highlighting the practical and theoretical implications as well as limitations so as to propose future directions for research.

2. Literature review

The social meaning of language variation has moved from being considered incidental fallout from social space to an essential feature of language as it reflects the social identities in which speakers place themselves through stylistic practice (Eckert, 2012). Most variation studies have focused on language use by adult speakers from various social-economic backgrounds, gender groups, and contexts. Only a few have addressed the process of how sociolinguistic variation is passed on from one generation to the next along with obligatory structures in the area of child language variation (Roberts, 2005). Previous research has shown that variation exists not only in language input but also in child speech (Smith & Durham, 2019). Young children can be active learners of variation and creative language change leaders (Foulkes et al., 2005; Senghas & Coppola, 2001). For monolingual children, L1 acquisition consists of both understanding what is grammatical and how to use the language in contextually appropriate ways. For bilingual children, the task is more challenging, especially when the exposure to the non-dominant language is limited and highly heterogeneous. For example, due to the complex composition of Chinese-speaking populations in the U.S., the language used in a Chinese school may consist of multiple varieties among which the teachers and students must negotiate as the standard variety for teaching, learning, and administration (Starr, 2016). From an interdisciplinary perspective of sociolinguistic variation, language acquisition, and bilingualism, this study aims to investigate the variation in Mandarin learning by Chinese heritage emergent English-Mandarin bilingual children in two dual immersion preschool classrooms. As the first formal learning setting for young learners, the preschool classroom serves as a hub where they come to learn which language to use, what to say, when to stop, and how to express their needs with teachers and peers (Palviainen et al., 2016).

Studies about language teaching and learning by bilingual children vary in terms of the current developmental stages of the children, languages they are learning, ecological environments and instructional modes, and the theoretical perspectives and methodologies applied in the research. To serve the interdisciplinary nature of the current study, I review relevant studies from the perspectives of child language development, bilingual teaching and learning, and sociolinguistics. In the following sections, I first introduce the target linguistic features, and summarize current knowledge about the language development of English-Mandarin/Mandarin-English bilingual children, then move to educational and sociocultural environments in which bilingual development occurs. After this, characteristics of child-directed speech (CDS) as the major language input are discussed, followed by a detailed explanation of the phonetic and phonological development of English-Mandarin bilingual children. The acquisition of sociolinguistic variables is interpreted at the end.

2.1 Target linguistic features

As several Chinese varieties were spoken in the research settings, and different orthographies were presented in the classrooms. This section explains the linguistic, geographic, and sociocultural relationships among these Chinese varieties and the linguistic structure of Mandarin, which is the target variety of the current study.

2.1.1 Chinese language and varieties

Among different opinions toward classifying Chinese varieties or dialects, the earliest linguistic analysis in English identified nine branches under the Chinese language. In recent years, scholars have tended to classify Chinese varieties into six groups: Mandarin, Wu, Xiang, Gan, Hakka, Yue or Cantonese, and Min (Norman, 1988). Furthermore, within the Mandarin

category, which is widely spoken in China and the Chinese diaspora, there are three subgroups: Northern Mandarin, Southwestern Mandarin, and Jiang-Huai Mandarin (Ho, 2003).

Mandarin, or Putonghua as it is called in mainland China, is the official language in China. In the National Conference on Script Reformation in 1955, Putonghua was identified as "the standard form of modern Chinese". In the State Council Instruction concerning Spreading Putonghua, Zhou Enlai, the first Premier of the People's Republic of China, proposed using Putonghua in teaching, working, mass media, foreign affairs, and dictionaries. The emergence of Hanyu Pinyin, a phonetic scheme for Putonghua, supported the promotion of Putonghua in China. In the National Conference on Language and Script in 1986, a new agenda for promoting Putonghua was proposed. It suggested that Putonghua should become the instructional language in schools, the working language in government, the language used in mass media, and the lingua franca among dialect speakers (P. Chen, 1999). It was believed that establishing and promoting a standardized and national language was the basic need of economic and social development, and it was a social and historical task that any country that aimed to achieve industrialization must accomplish. This national-scaled language planning, with its specific political, economic, and sociocultural aims, has been practiced for decades now. This has been mainly implemented through adopting Putonghua as the language of instruction in school, which greatly improved the literacy rate in rural areas and therefore made social mobility accessible to people who used to be illiterate in rural villages. According to the Chinese Ministry of Education, the penetration rate of Mandarin reached 80.72% in 2020. When Mandarin was promoted as the dominant language in China, some language maintenance practices towards local varieties in local communities also started to emerge.

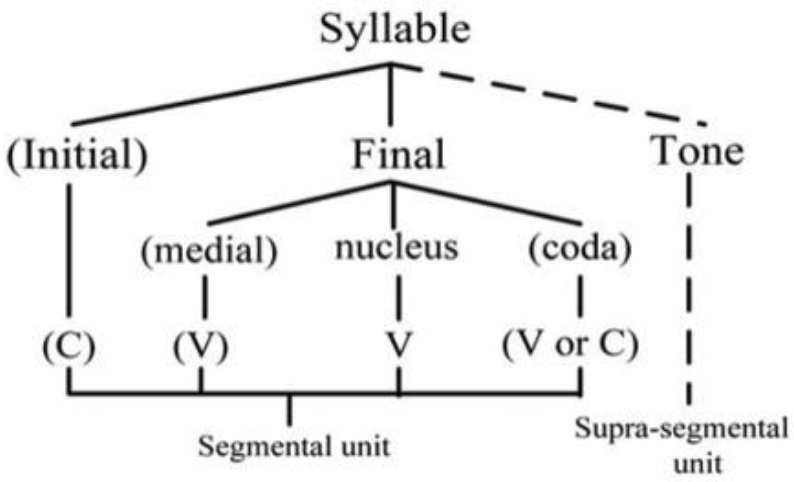
The status of Mandarin, or Guoyu, in Taiwan is also prestigious. In 1946, the Taiwan Provincial Guoyu Promotion Council was established. It proposed that all dialects other than Guoyu should be strongly discouraged or even prohibited in schools and mass media (P. Chen, 1999). Taiwanese or Taiwanese Hokkien has been used by a significant portion of Taiwanese people who descended from Holko immigrants of southern Fujian since the 17th century. Following the republic of China's assumption of control over Taiwan in 1945 under the Kuomintang (KMT), Mandarin was established as the official language and mandated for educational instruction. Through language contact, Taiwan Mandarin has been formed with several typical dialectal features, including the merger of dental and alveolar sibilants (Lee-Kim & Yun-Chieh, 2022; S.-W. Liao, 2010; Su, 2005). Now Mandarin is the primary language for most residents in the northern areas of Taipei, Taoyuan, and Hsinchu, while Taiwanese is commonly used in the south of Taiwan (S.-W. Liao, 2010; Su, 2005). Chinese is usually written in traditional script in Taiwan.

The status of Mandarin in Hong Kong is less prestigious compared to Cantonese which is the dominant language of the vast majority of the population. Since the handover of Hong Kong in 1997, the "biliteracy and trilingualism" language policy identified both English and Chinese (the specific variety was not specified) as the official languages. Trilingualism refers to the fact that three languages, namely Cantonese, English, and Mandarin, are used for spoken languages in the territory. Historically, Cantonese was the dominant language in Hong Kong. Decades after the handover, although there have been debates about maintaining Cantonese, its prestige is still maintained in all aspects, including policy, education, and daily language use (Bauer, 2016; Groves, 2010; K. Lee & Leung, 2012). As in Taiwan, Chinese is usually written in traditional script in Hong Kong.

2.1.2 Mandarin syllable structure

As the current study mainly focuses on phonological features in language production by the subjects, this section briefly explains the syllable structure and phonology in Mandarin. A Mandarin syllable consists of a segmental unit and a suprasegmental unit (F. Chen et al., 2017). As shown in Figure 2.1, the basic syllable structure is (C)V(C) which allows optional consonants in the initial and coda (Lin & Johnson, 2010). The suprasegmental unit refers to the lexical tone which is used to distinguish the meanings of /bā/ (八) for "eight" and /bà/ (爸) for "dad" (Singh & Fu, 2016). In modern Mandarin, there are four lexical tones, namely Tone 1 (high level), Tone 2 (rising), Tone 3 (dipping), and Tone 4 (falling). And only limited consonants are eligible for the coda, including dental nasal /n/ and velar nasal /ŋ/.

Figure 2.1 Diagram of Mandarin syllable structure



Source: (F. Chen et al., 2017)

2.2 Language development in bilingual children

Depending on the time when an L2 is acquired, bilinguals can be categorized into *sequential learners* who acquire another language after the mastery of their first language, and *simultaneous learners* who come to learn the two languages nearly at the same time from birth (Baker, 2011). For simultaneous bilinguals and sequential learners who start their L2 learning in early childhood, children need to 1) differentiate between the two languages and 2) effectively store the two languages for both input and output (Baker, 2011, p. 95). Psycholinguistic studies (e.g., Byers-Heinlein et al., 2010) show that newborns can distinguish their two languages even before birth due to the input patterns they received in the womb. However, there has been a debate about how the information about the two languages is stored in the brain. Some believe that categorical elements from two languages are stored in one system, while other proposes that there are different systems for each language (Genesee, 1989). Recent studies seem to move in a new direction which integrates the two sides of the previous debate that the languages are represented in underlying differentiated ways, but the two systems interact with each other as supported by some cross-linguistic effects (Genesee, 2001; Genesee & Nicoladis, 2007; V. Yip & Matthews, 2007b).

Previous studies examined the language development of Mandarin-English/English-Mandarin bilingual children in terms of their vocabulary performance (C. Cheng et al., 2011; Sheng et al., 2011; Teoh et al., 2012; Xuan & Dollaghan, 2013), lexical-semantic skills (Sheng, 2014; Sheng et al., 2006), phonological awareness (Marinova-Todd et al., 2010), biliteracy acquisition (M. Wang et al., 2005, 2009), syntactic structure (V. Yip & Matthews, 2007a), narrative skills (Y. Hao et al., 2019), and processing and production of code-switching (Byers-Heinlein et al., 2022; Yow et al., 2018).

In the early vocabulary in bilingual children, nouns outnumber verbs, which resembles the findings in monolingual children (Xuan & Dollaghan, 2013). However, in terms of vocabulary size, monolingual children outperform their bilingual peers, especially for the minority language which comes with limited input resources (Hoff et al., 2012; Sheng et al., 2011; Teoh et al., 2012). Hoff et al. (2012) point out that the total vocabulary achievement in bilingual children is comparable to that of monolingual children, and language development should be measured as a function of the relative amount of exposure. Sheng and colleagues conducted a series of longitudinal studies (Sheng, 2014; Sheng et al., 2006, 2011) to examine the lexical-semantic skills in Mandarin-English bilingual children aged 3;1 to 8;5. Results show that bilinguals and monolinguals demonstrated similar patterns of responses in the lexical-semantic tasks. However, for the bilinguals who lived in Austin, Texas, and were exposed to English in daycare or preschool programs at around three years of age, there was an apparent language shift from their home language to English as measured by lexical-semantic skills. A similar comparison between bilingual and monolingual children has been conducted to measure their phonological awareness. Marinova-Todd et al. (2010) tested phonological awareness in both languages by Mandarin-English bilingual children from Vancouver, Canada. This was compared with the skills of monolingual Mandarin-speaking children from Shanghai, China and monolingual English-speaking children from Vancouver. Results resemble the previous findings about phonological awareness in other bilingual children (e.g., English-Spanish bilinguals); bilinguals outperformed monolinguals in both languages. This *bilingual advantage* was explained by children's early exposure to different languages. Scholars also noticed the language-specific features in English and Mandarin as two languages that differed typologically. Min Wang and colleagues (M. Wang et al., 2005, 2005) investigated the contributions of phonology, orthography, and morphology in

Mandarin-English biliteracy acquisition. Findings revealed a strong cross-language phonological transfer from Mandarin to English, but phonological transfer from English to Chinese did not occur. Their studies suggest that there is a joint function of shared phonological processes in biliteracy acquisition, and the asymmetry in the transfer may be attributed to the different morphophonological systems in the two languages. Yip and Matthews (2007b) conducted a longitudinal study by observing six Cantonese-English learning children aged 1;03 to 4;06 in Hong Kong. This work profiles the syntactic development of bilingual children in early childhood as insight into the one vs. two systems debate. Strong evidence for interaction between the two linguistic systems has been observed, and the cross-linguistic influence has been attributed to language dominance and language input.

With the increasing attention to bilingual development, recent studies have moved from the developmental stages of bilingual children to explore how they actually use and process the two languages. Hao et al. (2019) examined the narrative skills in two languages of Mandarin-English bilingual children by adopting the *macro-structure* or the global organization of a story and the *micro-structure* which refers to the usage of complex syntactic structures and specific types of words. Bilingual children aged 4;06 – 9;07 from Texas with their English onset around age two were recruited to complete a story-retelling task and a story-telling task. Results show that children had better narrative performance in English than in Mandarin with the increased cumulative English experience. However, at the same time, they might experience a plateau in Mandarin due to insufficient language input. This echoes the language shift identified by Sheng (2014) in bilingual children in Austin. As code-mixing and codeswitching often occur in adult bilingual practices, studies have also explored how this affects the perception and production of bilingual children. Byers-Heinlein et al. (2017) revealed that bilingual infants might practice

controlling their two languages during listening in daily speech, and this may lead to bilingual cognitive advantages. Yow et al. (2018) demonstrated that the use of codeswitching by older English-Mandarin bilingual children aged between 5;05 and 6;07 reflected their linguistic competence in both languages. This implies that children may actively use one language for the learning of another one through bilingual practices such as code-switching.

2.2.1 Different groups of learners

Due to limited language input and various language backgrounds, learners of CHL differ from native and L2 Chinese speakers in their acquisition of language-specific features. The next sections summarize the developmental stages of Mandarin and English monolingual children, English-Mandarin/Mandarin-English (EM/ME) bilingual children, and CHL learners in each language. Most of the studies focused on the acquisition of obligatory structures and features such as phonetic contrasts or tense and aspect marking, but only a few examined the use of variables in bilingual learners.

2.2.1.1 Mandarin monolingual children

Table 2.1 demonstrates the general developmental stages of Mandarin monolingual children reported in two previous studies (Erbaugh, 1992; Zhu & Dodd, 2000). Based on her longitudinal observation of four Mandarin-acquiring children (aged 1;10 – 3;10) from local families in Taibei, Erbaugh (1992) illustrated the overall course of their language development from age two to four. Her analysis mainly focused on syntactic structure. Before the age of two, child speech is simple with one-word utterances, which are predominantly nouns and verbs. Multi-word utterances emerge between 1;08 to 2;05, and SVO order seems the clearest overt syntactic marker. Children start to produce fluent speech around 2;03 – 3;02, with the mean length of utterance (MLU) between 3.0 to 4.0. After the age of 3;02, the MLU is above 4.0, and

children usually have good control of full sentence syntax. On the other hand, Zhu and Dodd (2000) investigated the phonological acquisition of 129 Mandarin-learning children in Beijing aged from 1;06 to 4;06. Their study profiled the details and orders in which the phonetic contrasts emerged and stabilized in child language. They also analyzed several phonological processes or the consistent differences between children's realizations and adult production of the target forms. Findings revealed that the phonetic contrasts were mastered in the following order: tone > syllable-final consonants and vowels > syllable-initial consonants. Typical errors in child language were also identified, and the mean number of errors decreased with age. The order of acquisition was explained in terms of *phonological saliency* which is a syllable-based, language-specific concept. It is determined and affected by several factors, including the status of a component in the syllable structure, the capacity of a component to differentiate lexical meaning, and the number of permissible choices within a component in the syllable structure. According to this, lexical tone has the highest saliency in Mandarin and thus is mastered earlier than vowels and consonants. However, vowels also have high saliency in Mandarin, but are mastered later than tones (Clumeck, 1980; Singh & Fu, 2016). Another possible explanation for the early acquisition of tone is that tone contours are relatively easier for infants to produce.

Table 2.1 The general developmental stages of Mandarin monolingual children

Erbaugh (1992)		Zhu & Dodd (2000)[1]	
Age	Syntactic structure development	Age	Phonetic/phonological development
Before 2	One-word utterance MLU below 2.0 Predominance of nouns and verbs	1;6 – 2;0	Emergence of consonants: /t, t^h, k, m, n, x, tɕ, $tɕ^h$, ɕ/ Able to produce all simple vowels Tone production is correct Emergence of neutral tone Emergence of rhotacization
1;8 – 2;5	The emergence of strong SVO order SV or VO sentences, but few SVO Start to use modals The majority of verbs are agentive actions The use of aspect marker -*le* at sentence-final positions	2;1 – 2;6	Emergence of consonants: /f, s, tʂ/
2;3 – 3;2	Fluent speech MLU between 3.0 – 4.0 SVO sentences Emphasize transitive relations	2;7 – 3;0	Emergence of consonants: /p, l/
After 3;2	Good control of full sentence syntax MLU above 4.0 Sentences with agent, action, and patient become common Several events can be ordered withing a sentence	3;1 – 3;6	Emergence of consonants: /p^h, k^h, $tʂ^h$/
		3;7 – 4;0	Emergence of consonants: /ʂ/
		4;1 – 4;6	Emergence of consonants: /ts, ts^h, ɹ/ The production of neutral tone is 36%
Note 1: Age of emergence of consonants based on 90% criterion			

Table 2.2, based on Clark's work (2016, p. 13), shows the general developmental stages of monolingual English-acquiring children. Clark (2016) illustrated the process in terms of perception and production. The initial comprehension of frequent words emerges around the age of 8 to 10 months. At the end of the first year or later, infants start to produce their first words. At about 14- to 22-months-old, they begin to combine gestures and words, produce two or more words together, and start to add suffixes such as the plural marker -s and small function words like “the” and “of”. By age five or six, most children have mastered all the basic elements of grammar and are able to use the language fluently.

Table 2.2 The general developmental stages of English monolingual children

Age/stage	Comprehension	Production
6-8 months	2-4 frequent words	Early babbling
9-12 months	10-30 words Frequent routine phrases	Babbling 1-2 words
13-22 months	Simple instructions Answer simple questions	10-50 words Word-combinations
2;0 – 2;6	Answer more question types Understand 1000-1500 words	100-600 words Many question types Start to produce more complex constructions
2;6 – 3;6	Increasing skill in turn-taking Further increases in vocabulary size	Initiate many interactions Propose new topics Ratify new information
3;6 – 5;0	Near adult timing in turn-taking Up to 14,000 words by age 6;0	Variety of complex constructions Vocabulary of 6,000+ words by age 5 Regular addition of new information in two turns Some rudimentary storytelling
After 5;0	Good comprehension Follow instructions	Persuade Give instructions Tell more structured stories Keep track of characters
Note: this table is modified based on the general developmental stages of English-learning children in comprehension and production in Clark (2016, p. 13).		

2.2.1.2 English-Mandarin/Mandarin-English bilingual children

While the process of first language acquisition is well explained, how bilingual children come to understand and use their two languages is still under study. Recent English-Mandarin/Mandarin-English (EM/ME) bilingual research has focused on the acquisition of tense/aspect marking and the acquisition of lexical tones, as these two features represent typical

language-specific characteristics. Mandarin does not mark tense on verbs as consistently as English does. To express a time-related concept, Mandarin uses adverbs such as "yesterday" and leaves temporality unmarked in subsequent utterances until the temporal reference changes (Erbaugh, 1992; P. Li & Bowerman, 1998). In addition, Mandarin marks the aspect of the verb to indicate the completion of the state/event or its current relevant status (C. N. Li & Thompson, 2009).

In a study of grammatical development, Brebner et al. (2016) investigated the use of tense markers by 481 English-Mandarin bilingual children aged 3;9 – 4;8, also in Singapore. They focused on the acquisition of present progressive marker *-ing*, regular past tense marker *-ed*, present tense marker for third person singular form *-s*, irregular past tense verbs, and irregular past-participle forms. Results revealed that children in different language dominance groups differ in rates and patterns of verb-tense marking in English: English-dominant children showed a similar pattern of development as their English monolingual peers, while Mandarin-dominant children were not using any morphological marking of verbs in English in the oldest group (6;8). The authors suggested that 1) a non-dominant language is often learned more slowly and 2) this may reflect the low frequency of use of morphological markers in the local English spoken in Singapore. However, evidence has shown that past tense marking in Singapore English is rarely dropped, and the absence of *-ed* may be attributed to the frequent phonological process of /t, d/ deletion as a variable sociolinguistic feature (Gut, 2009). Nicoladis et al. (2020) also focused on the acquisition of tense marking in English. They examined the use of past tense verbs in English through a story-retelling task by bilingual children from Alberta, Canada, English monolingual children from the same area, and Mandarin monolingual children from Beijing. The study revealed that the bilingual children were more accurate with irregular past

forms than regular forms and they used most *-ed* with telic verbs (which has been identified in other child and adult English learners cross-linguistically, see more in Bayley, 1991; Dulay & Burt, 1974; Larsen-Freeman, 1976; Wolfram, 1989b). This suggests morphophonological transfer from Mandarin to English in tense/aspect marking. In addition, En et al. (2014) reported on the acquisition of English vowels and consonants by English-Mandarin bilingual preschoolers aged 4;0 – 4;5 in Singapore. Results show that English-dominant children performed similarly to their monolingual peers, while Mandarin-dominant children had significantly less accurate consonant production. The study highlighted the importance of language background and language dominance in bilingual phonological development.

The phonemic inventories in English and Mandarin differ in that English syllables consist of consonants and vowels, while Mandarin syllables also bear lexical tones, or tonemes, which play a significant role in distinguishing meaning (Tong et al., 2014). The acquisition of lexical tones in Mandarin begins quite early but may extend for a relatively long period until the children can perform as native adults in production and perception (Erbaugh, 1992; C. N. Li & Thompson, 2009; Rhee et al., 2021; P. Wong, 2013; P. Wong & Strange, 2017). The change of fundamental frequency (F0), which is one of the primary cues for tone perception, serves different roles in Mandarin and English (Rhee et al., 2021; Singh & Fu, 2016; P. Wong et al., 2005). The change of F0 or pitch contour bears more phonological saliency in lexical meaning in Mandarin, while it serves discourse purposes in English (Zhu & Dodd, 2000). Besides the language-specific differences, the acquisition of tones is also challenging for non-native speakers due to its phonetic nature which requires complex motor control for production (Singh & Fu, 2016; P. Wong, 2012). Studies reported that L2 adult learners had difficulties in tone production and perception and tonal L1 (e.g., Cantonese) speakers may not have the advantages in learning

Mandarin tones compared with non-tonal L1 (e.g., English) learners (Y.-C. Hao, 2012; Ning et al., 2014; Zhao et al., 2022). Yang and Liu (2012) examined the categorical perception of lexical tones in monolingual and English-Mandarin bilingual children aged 6 to 8 in Austin. The results of tone identification tasks and tone discrimination tasks showed that Mandarin monolingual children performed best in the tasks, followed by bilingual children, then English monolingual children. It is suggested that the categorical perception of tones was dependent on children's tone language experience and that F0 cues at the syllable level may be critical for tone acquisition.

2.2.1.3 CHL learners

Recent studies have begun to explore language development by CHL speakers and L2 learners. Linguistic structures or features that have been examined include discourse patterns (Curdt-Christiansen, 2006; He, 2001, 2013), morphosyntactic structures (J. Hao & Chondrogianni, 2023; R. Jia & Paradis, 2020; Mai et al., 2018; Staicov, 2020; X. Zhang, 2021), perfective aspectual marker *-le* (L. Jia & Bayley, 2008), phonetic contrasts (C. B. Chang et al., 2011; C. B. Chang & Yao, 2016), and biliteracy development (M. Wang et al., 2005, 2009). For example, Jia and Bayley (2008) found that linguistic constraints, the primary language at home, and age of the speakers were influential factors in constraining the use of the aspect marker *-le* by CHL learners. These findings suggest a decline of CHL proficiency is associated with increasing length of time in the U.S. and highlight the need to provide additional opportunities for CHL practice beyond home and community language schools. Chang et al. (2011) compared phonetic and phonological contrasts in CHL speakers, native speakers, and late learners in read-aloud tasks. Results supported their hypothesis that CHL speakers would outperform late learners in producing language-internal phonological and cross-linguistic phonetic contrasts. The authors conclude that 1) there may exist a more fine-grained, less language-specific perceptual

capability in CHL speakers due to their early exposure to both languages; 2) some CHL speakers had dissimilated similar vowel categories resulting in a polarized phonetic space for their L1 and L2. In short, the phonetic and phonological contrasts from both languages may be stored together but have been well distinguished which results in a larger phonetic space. In a summary of phonetic studies on other heritage languages, Polinsky (2018) echoes this finding that other HL speakers tend to amplify the properties that separate their two languages and minimize the similarities opting for a compromise in the representation of a particular segment.

2.2.2 Bilingual educational programs

There are mainly two ways how bilingual children learning and using their two languages: they may either be exposed to both languages in the home or to one language at home and another at school.

Regarding family language use, at least four types of modes are possible (Baker, 2011). *Type 1* consists of families who adopt *one parent – one language policy* for home language practice. Although this may seem like an ideal setting to raise balanced bilingual speakers, De Houwer's study (2007) based on feedback from 1,899 families in Flanders, Belgium reported that it does not provide a necessary nor a sufficient context for the growth of bilingualism in children. *Type 2* is where the home language is different from the language used outside of the family. Parents, who are not necessarily both native speakers of the home language, use the heritage/minority language with the children at home and the children learn the dominant language at school, in the street, and other outside social activities. *Type 3* involves families who use the two languages mixed together with codeswitching. The choice of language varies according to the interlocutors, activities, circumstances, and the purpose of the speakers. *Type 4* includes families where the introduction of the dominant language is delayed. This strategy may

ensure a strong foundation in the heritage language before the dominant one becomes pervasive. It is suggested that Type 1 and 2 have come to be regarded as successful strategies and Type 3 and 4 are more negatively evaluated (Piller, 2001). This is because that the strategies are associated with the social-economic status of the families – Type 1 is often associated with elite and middle-class families while Type 3 and 4 are often found among relatively economically disadvantaged groups. However, the association identified here may be difficult to generalize to a variety of contexts. Most of the CHL children studied in the present research are from middle-class immigrant families but have a variety of language practices at home: some use mixed English and Mandarin, some use mainly English in their nuclear family but Mandarin with extended family members who are native speakers, and some have parents who are monolingual English speakers.

Formal bilingual education programs vary in their philosophy of bilingualism, age range of the children, languages provided in teaching, composition of the student body, and how each language is used. Baker (2011) proposed a typology of bilingual education in three categories: 1) monolingual forms of education; 2) weak forms of bilingual education; and 3) strong forms of bilingual education. Monolingual forms aim to assimilate language minority students in ways such as mainstreaming, submersion, sheltered English, content-based English-as-a-Second-Language (ESL), and segregationist. Weak forms of bilingual education, although adopting minority languages for instruction at the different levels, still aims to integrate minority language students as soon as possible into English mainstream when they are denied access to programs or schools attended by majority language students. Programs in this type include transitional bilingual education, mainstream with foreign language teaching, and separatist programs. Lastly, the strong forms of bilingual education fully support the bilingual and biliteracy development.

Dual language programs aim to have approximately equal number of language minority and language majority students in the same classroom and uses both languages for instruction. This type of programs is named as *dual immersion* programs in this dissertation to match the program design of the research settings. The target children of the current study were enrolled in two English-Mandarin dual immersion preschool programs. Details about dual immersion program and its effects on language learning will be discussed in Chapter 5. *Heritage language programs* are more concerned with the preservation of the heritage language and have a large preponderance of language minority children. *Immersion bilingual programs* usually contain only language majority children learning much or part of the curriculum through the L2. *Bilingual education with majority languages* uses two or more majority languages in school; this mode often occurs in areas where much of the population is already bilingual or multilingual (e.g. Europe and Quebec in Canada) or where there are significant numbers of natives or expatriates wanting to become bilingual.

How dual immersion prepares preschoolers for bilingual development, school readiness, and socio-emotional development remains understudied (Hammer et al., 2011; Hickey & de Mejía, 2014; Lindholm-Leary, 2021). Current studies have explored various characteristics of the programs including models and implementation (Lindholm-Leary, 2021; Schwartz & Palviainen, 2016), pedagogies and instructions (Goldenberg et al., 2013; Gort & Pontier, 2013; Partika et al., 2021; Pontier & Gort, 2016), and language practices in the classroom (Gort & Pontier, 2013; Partika et al., 2021). Findings have demonstrated that dual immersion is supportive of children's bilingual development. Barnett et al. (2007) compared the effects of English–Spanish dual language and monolingual English immersion preschools on children's learning outcomes. Results showed that children in both programs experienced substantial gains in all tested aspects

and no significant differences were identified in their English proficiency. In addition, the dual-immersion program improved Spanish proficiency in both English language learners and native English children (Barnett et al., 2007). Similarly, Partika et al. (2021) demonstrated that instructional support in a Spanish dual-immersion preschool classroom was positively correlated with children's progress in Spanish expressive vocabulary skills and quantitative reasoning skills in English. Schwartz and Gorbatt (2016) interpreted the interactions in an Arabic–Hebrew dual-immersion preschool in Israel and revealed that children used metalinguistic skills, especially discourse management skills, to try to establish their social networks and enhance their ethnic identities. Lu Yang et al. (2018) found that students in a Cantonese-English dual immersion public school exhibited relatively high levels of listening, reading, writing, and speaking abilities in Cantonese, and this was closely related to their positive attitudes toward Cantonese learning. Sung (2022) identified well-developed Mandarin oral narrative skills in Mandarin-English dual immersion learners, and the different performances between age groups have been attributed to the typological differences in Mandarin and English.

In the U.S., dual immersion has shown its impact on education equality (Lindholm-Leary, 2021; Lyster & Genesee, 2019). Language-minority students have long been expected to catch up with their English monolingual peers in English proficiency and their knowledge of home languages and language learning potential as bilingual speakers have been underestimated. By exposing students to two languages used by peers and teachers, dual immersion can contribute to social cohesion and increase cultural diversity tolerance, support heritage language maintenance and revitalization, and prevent the marginalization of minority groups by facilitating the formation of peer-group networks through the minority language (Hickey & de Mejía, 2014).

Dual immersion has been shown to effectively close the achievement gap in English and support home-language development (Collier & Thomas, 2004).

However, challenges also exist in dual immersion as an innovative model. For instance, the relationship between the two languages is not always perceived equally inside and outside the classroom. The acquisition of English is expected in minority children, while the learning of the non-English language is enthusiastically applauded in English-monolingual children, and "children are aware of these differences" (Valdés, 1997, p. 417). In addition, diversity within minority groups has rarely been addressed in implementation, instruction, or learning outcome assessments. Children from newcomer immigrant families and those from second and third generations may demonstrate different bilingual proficiency and attitudes toward heritage language maintenance (Valdés, 2005). In addition, it is necessary to differentiate language varieties under the same named languages, such as Cantonese and Mandarin under the umbrella of "Chinese," because these varieties are distinctive in terms of linguistic inventories, orthographies, and sociolinguistic milieus (L. Yang et al., 2018).

2.3 Sociocultural environment, bilingual education, and language development

2.3.1 Heritage languages in the larger society

Any discussion of bilingualism cannot be isolated from the sociocultural environment in which it occurs. Regarding the development of immigrant and heritage languages, many have studied the process of language shift from home language to the dominant language and the necessity of supporting the maintenance of minority languages (e.g., Fillmore, 1991; Fishman, 1965; Peyton et al., 2001; Polinsky, 2018; D. Zhang & Slaughter-Defoe, 2009). Fishman (2001) categorized heritage languages into indigenous languages, colonial heritage languages, and immigrant heritage languages, which are rarely regarded as a national resource in the US and

have “suffered the same sad fate around the world” (p. 85). The achievement gap of language minority students used to be attributed to their English proficiency instead of other factors such as their social-economic status (Fillmore, 1991). However, this subtractive bilingualism did not result in true bilingualism where balanced bilingualism, biculturalism, and biliteracy are fully embraced, but in the erosion of the home language, which may happen within three or four generations (Valdés, 2001). Efforts have been made to support the maintenance and development of heritage languages. Sociolinguistic studies have explored the current situation of heritage language practice and development in various local communities. The following review focuses on the development of CHL in US and other English-speaking countries.

Xiao (2010) points out that speakers of CHL in the US are shifting to the dominant English due to 1) the discontinuity between home language and English as the language of instruction at school; 2) the limited resources for CHL learning and developing literacy skills; 3) the dilemma of immigrant parents in preparing their children for successful adult life; and 4) the marginalization of Chinese ethnic identities. She also highlights the opportunities and efforts to maintain and develop CHL including 1) the building and expanding the community Chinese schools; 2) transportation and internet communication between China and the US; and 3) several top-down federal initiatives to support the teaching of Chinese language. Zhang and Slaughter-Defoe (2009) revealed the different attitudes of first-generation parents and second-generation children on CHL maintenance and called for cooperation between mainstream schools and community-based CHL programs. Curdt-Christiansen (2006) interpreted the learning of CHL in a weekend Chinese school in Montreal, Canada as a negotiation of cultural practices and a negotiation between teachers and students where they co-constructed the shared understanding of the language and culture. Several other studies (e.g., Fang & Duff, 2018; He, 2004; W. Li, 2011,

2014; W. Li & Zhu, 2013; K. Wong & Xiao, 2010) have focused on the construction and reconstruction of learners' identities during the teaching and learning of CHL. For instance, He's work (He, 2004, 2006, 2011) illustrated the process how CHL learners constructed and reconstructed their ethnic and individual identities in CHL classroom learning. She also proposed the *identity theory* to examine CHL development in a three-dimensional framework with intersecting planes of time, space, and identity (He, 2006). Similarly, but from another perspective, Li Wei and García (García & Li, 2014; W. Li, 2011) proposed the concept of *translanguaging space* where language has been reconceptualized as a dynamic and multimodal practice that encompasses various semiotic resources so that speakers are empowered to use their full linguistic repertoire for meaning-making. During this process, the agentive role of CHL speakers in their local communities is emphasized.

2.3.2 The development of CHL

Duff et al. (2017) summarized CHL studies of learning and retention in Canada, the US, the UK, and Australia from a lifespan perspective. The study echoes Xiao's (2010) findings and points out that CHL development is changing due to 1) the migration and mobility of the Chinese population overseas, 2) the emergent new technologies for transportation and communication, 3) the abilities of local communities to support CHL education, and 4) the rising status of China. These changes have been reflected in the teaching and learning of CHL in local families, communities, and institutions. At home, there might be formal or informal language policies regarding oral and even written Chinese practices. Additionally, cross-generation communication and return migration would support CHL development. Otherwise, language shift will take place. CHL education at the community level faces more challenges in terms of curriculum, classroom instruction, and language ideologies. CHL curriculum for community-based language programs

has heavily relied on textbooks donated by foreign governments. These textbooks often adopt traditional pedagogy, focus on literacy skills, and may help cultivate privileged traditional and stereotyped cultural values. Through classroom interactions, teachers also attempted to socialize children into "Chinese" identities and Chinese ways of schooling. Instruction focused on tradition and literacy, which led some students to drop out of the programs and shifted their languages from Chinese to English. Facing the varieties of CHL, institutions and teachers also have to decide which Chinese variety to teach in both spoken and script forms. Few studies have examined CHL learning in public schools. CHL education in community-based programs and Chinese programs in public schools have not been connected and more research is needed here. Lastly, studies of CHL in postsecondary programs found that there is a lack of accommodation for CHL learners (Kelleher, 2008; D. Li & Duff, 2008). The binaries of CHL and non-CHL categories are problematic in terms of student placement and classroom instruction. Moving from a synchronic perspective to a diachronic perspective, Duff et al.'s (2017) study highlights the importance of realizing the legitimacy of CHL in local communities and shows that the developmental trajectory is nonlinear.

2.4 Language input: child-directed speech

As mentioned in section 2.2, language learning relies on language input that children are exposed to in the environment. Child-directed speech (CDS) is an important part of language input. This register is also known as parental speech, maternal speech, or motherese (Grieser & Kuhl, 1988; Liu et al., 2009; Tare et al., 2008; Zellou & Scarborough, 2015). CDS has been examined in terms of its unique modifications compared with other registers (e.g., Adult-directed speech or ADS, Foreigner-Directed-Speech or FDS, and Lombard Speech or speech in a noisy

environment), and the possible functions of these adjustments and the effects on child language development have been examined (Snow, 1995, 2019).

Universal characteristics in CDS have been identified across languages, including short utterances, longer duration, repetition, parental addition, phonetic clarification and enhancement, simplified structures, and salient prosodic patterns (e.g., Foulkes et al., 2005; Grieser & Kuhl, 1988; Han et al., 2018; Kuhl et al., 1997; Lahey & Ernestus, 2014; Tang et al., 2017). Phonetically, CDS is modified with the enhanced articulation of contrastive categories. For instance, Kuhl et al. (1997) compared the realization of three corner vowels /i, a, u/ in English, Russian, and Swedish Infant-Directed Speech (IDS) and found that the vowels were hyperarticulated with a stretching vowel space area. They explained that an expanded vowel space increased the acoustic distance between vowels which allowed distinctive representation of different vowel categories. Similar results were identified in English, French, and Japanese IDS (Dodane & Al-Tamimi, 2007), and Mandarin IDS and CDS (Liu et al., 2009; Tang et al., 2017). Consonantal categories such as sibilants were also enhanced (Cristià, 2010). For adjustments on morphological units, Kempe et al. (2001) examined the diminutive derivations in German, Russian, and Mexican Spanish CDS addressed children aged 1;11 - 2;4. Results demonstrated that diminutives were more frequently used in Spanish and Russian CDS. They suggested that this language-specific usage of diminutives would potentially facilitate the learning of the grammatical category of the case. Cameron-Faulkner et al. (2003) investigated the constructional categories of CDS for English-learning children (1;9 – 2;6). They found that only a few (15%) utterances were formed in SVO, while most consisted of two words or morphemes, which is consistent with the previous findings of the simplified structures in CDS.

Why are IDS and CDS modified in these particular ways? In general, it is believed that IDS/CDS serves two basic functions – social and analytical (Garnica, 1977). Language units are simplified, enhanced, or even exaggerated so that the language input for the young learner is easier to process. For instance, Kuhl et al. (1997) proposed that vowels were hyperarticulated in IDS to "provide exceptionally well-specified information about the linguistic units that form the building blocks for words" (p. 684). Liu et al. (2009) also supported the analytical function of acoustic exaggerations in CDS. They further explained, based on their findings in Mandarin IDS, that a larger vowel space in IDS would enhance the intelligibility of language input and therefore support speech discrimination. However, whether language input is simplified in an effective way for language development is still in doubt. As Soderstrom (2007) pointed out, IDS is not the ideal teaching tool as it is not grammatical and does not even constitute the majority of the speech environment of the infant (p. 520). These adjustments in CDS are also believed to support the social and emotional interaction between the child and the adult. With increased pitch and exaggerated prosodic patterns, CDS is modified to facilitate commutation better and maintain the infant's attention during this process (Soderstrom, 2007; Trainor & Desjardins, 2002; P. Wong, 2018; P. Wong & Ng, 2018).

Until now, CDS studies have examined the language input provided by monolingual parents to monolingual children in very limited contexts. Other factors that may affect the characteristics of CDS and its influence on language learning have not been fully investigated, such as language input from adults other than parents, CDS addressing bilingual and multilingual children, the dynamics of CDS to children in different age groups, and language learning resources in various models. First, current studies mainly focus on the characteristics of CDS by mothers, while only a few mentioned CDS from other family members. For instance, in contrast

to mothers, fathers only increased their pitch for two-year-olds. They tended to treat the five-year-olds as adult speakers (Warren-Leubecker & Bohannon, 1984). Additionally, when the mother used her language mostly for interaction, the father talked to the child more for regulatory functions. Older siblings also contributed to the language input by providing more informative utterances (Matychuk, 2005). Language input from other caregivers, peers, and adults outside of the family remains understudied. Second, children who are born in bilingual and multilingual families face more complex language input. As De Houwer (2020) pointed out, factors such as parental input, educational institutions, and child agency all affect language outcomes. The analysis of language input outside the family may provide more evidence to describe the whole picture of language learning. Third, the adjustments in CDS mainly reflect the perceptual needs of younger children and may not exist in language input for older children (Snow, 1995). However, some language-specific structures (e.g., Mandarin lexical tones) have not been mastered by the age of six when some CDS acoustic modifications are no longer identified (P. Wong, 2018; P. Wong & Strange, 2017). At that point do some modifications remain in CDS to further support the child's language production? Moreover, for children who just start to learn a new language in preschool, teachers may tend to provide additional support for their students to understand the language better. Consequently, modifications in CDS may last longer for young L2 learners. Lastly, language learning resources for young bilingual children are also available in other approaches, such as online videos. Due to the recent pandemic, many early childhood education programs have shifted to an online format. Will similar CDS modifications be identified in this online instruction which serve as additional language input for children?

2.5 Phonological development of bilingual learners

As the current research aims to examine the phonetic and phonological development of English-Mandarin bilingual children, the following review summarizes the acquisition of contrast phonemes such as consonants and vowels, the learning of Mandarin lexical tones, and the development of bilingual phonological awareness in both languages.

2.5.1 The acquisition of phonetic contrasts

Mandarin and English have different phonetic inventories in both consonants and vowels. There are different interpretations of Mandarin vowels, but according to Lee and Zee (2003, 2018), Mandarin has six simple vowels, nine diphthongs, and four triphthongs. Compared with this (Table 2.3), General American English (as English hereafter) has more monophthongs but fewer possible combinations for diphthongs and no triphthongs (Wells, 1982). In addition, as shown in Table 2.4, consonants in Mandarin and English mainly differ in voicing and aspiration while most of them share the same places and manners of articulation (Lin & Johnson, 2010). For instance, /p/ is voiceless and /b/ is voiced in English while in the same category /p/ is unaspirated and /p^h/ is aspirated in Mandarin[2].

[2] Although US English /b, d, g/ are categorized as voiced consonants by convention, studies (e.g., C. B. Chang et al., 2011) show that /b, d, g/ in US English are almost identical to the /p, t, k/ in Mandarin in terms of voice onset time (VOT).

Table 2.3 Mandarin and American English vowels

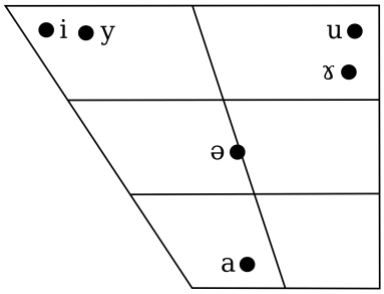
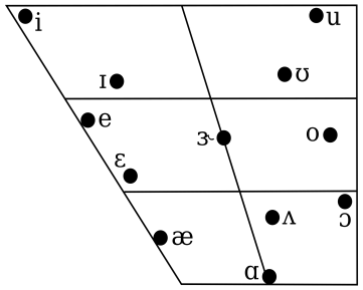
	Mandarin Chinese (W.-S. Lee & Zee, 2003)	**General American English** (Wells, 1982)
Monophthong	/i, y, u, ɤ, ə, a/	/ i, u, ɪ, ʊ, e, ɛ, ɜ, o, æ, ɑ, ʌ, ɔ /
Diphthong	Offglides /ai, ei, au, ou/ Onglides /ia, ie, ua, uo, ye/	/ei, ai, aʊ, oʊ, ɔɪ/
Triphthong	/iua, uai, iou, uei/	
Vowel diagram	 (Lee & Zee, 2003, p. 110)	 (Wells, 1982, p. 486)

Table 2.4 Mandarin and American English consonants

General American English (Wells, 1982)							
	Labial	Dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Nasal	m		n			ŋ	
Stop	p b		t d			k g	
Affricate				tʃ dʒ			
Fricative	f v	θ ð	s z	ʃ ʒ			h
Approximant			l	ɹ	j	w	
Mandarin Chinese (Lee & Zee, 2003)							
	Bilabial	Labiodental	Dental/Alveolar	Post-alveolar	Palatal	Velar	
Nasal	m		n			ŋ	
Stop	p p^h		t t^h			k k^h	
Affricate			ts ts^h	tʂ $tʂ^h$	tɕ $tɕ^h$		
Fricative		f	s	ʂ	ɕ	x	
Approximant	w		l	ɹ	j		

Previous studies have examined the production of consonants and vowels by English-Mandarin/Mandarin-English bilingual speakers, but few measured their bilingual perception. For instance, Charles Chang et al. (2011) investigated the vowel quality, plosive voicing, and fricative place in the production by three groups of English-Mandarin bilingual speakers (aged 18-40): 1) Mandarin-speaking English late-learners; 2) CHL heritage speakers with English as the dominant language; and 3) English-speaking Mandarin late-learners. Via read-aloud tasks, the study measured acoustic parameters including formant resonances, voice onset time (VOT), and spectral features in the production in both languages. Results showed that CHL speakers

outperformed the later learners, which suggests they maintained not only language-internal function contrast, but also cross-linguistic non-functional contrast (C. Chang et al., 2011, p. 32-33). Because of their early exposure to both languages, there exists a more fined-grained, less language-specific perceptual capability which allows some of the CHL speakers dissimilate similar categories resulting in a polarized phonetic space for the two languages.

Yang et al. (2015) profiled the vowel development in an emergent Mandarin-English bilingual child in a longitudinal study. They profiled the English learning process by a Mandarin monolingual boy who started to enroll in an all-English preschool at 3;7. Their observation lasted for more than a year and recorded the initial L2 vowel space, the process of L1-L2 separation, and L1 vowel space in relation to L2 during this process via picture-naming tasks. Results revealed that there were three stages in vowel acquisition: 1) initiation, 2) reorganization, and 3) stabilization. At the beginning of the learning process, English categories were clustered near the Mandarin corner vowels. In the reorganization phrase, the child started to produce exaggerated contrasts between L1 and L2 similar vowels. At the stage, most English vowels were more variable than Mandarin vowels. In the last phrase, the production of English vowels was stabilized with reduced within-category variation. The finding suggests that 1) the establishment of the L2 vowel space is based on L1 vowel system; 2) L1-L2 separation started from a drastic restructuring of the working vowel space to create maximal contrast; and 3) the transfer effect from L1 to L2 was observed. Yang & Fox (2017) examined the vowel systems in bilingual Mandarin-English children aged five to six. They divided the children into two groups according to their language proficiency and compared the formant frequencies in their vowel production with those of monolingual children in both languages. Their measurement not only focused on the static acoustic properties in the formant frequencies, but also included the dynamic acoustic

elements such as formant movement patterns and trajectory length. Findings showed that both static and dynamic acoustic properties were affected by L1-L2 interactions. English vowels produced by children with low English proficiency demonstrated strong L1 effects while the production by children with high proficiency was similar to that by native speakers. On the other hand, it seems that the bilingual children with high English proficiency tended to transfer some L2 features into their Mandarin production and moved Mandarin vowels closer to English vowels.

2.5.2 The development of bilingual phonological awareness

Scholars have also investigated the development of phonological awareness in English-Mandarin/Mandarin-English bilingual children as it can predict reading achievement in elementary school (Barac et al., 2014). Most tasks used to measure phonological awareness in current studies are adjusted from the *Comprehensive Test of Phonological Processing* (CTOPP, Wagner et al., 1999) with tasks such as segment elision, segment blending, sound matching, phoneme isolation, and object naming. For example, McBride-Chang et al. (2004) examined the phonological awareness by kindergarteners and first graders in Xi'an (China), Hong Kong, and Toronto. Via tasks including English word recognition, Chinese character recognition, syllable deletion, and phoneme onset deletion, the study showed that the performance of Chinese-learning children was as good as or even better than that among English speakers in English syllable awareness. Also, Hong Kong children recognized more words in both languages, but performed poorly in phoneme onset deletion tasks. These findings underscore the importance of phonological awareness across languages and orthographies, and pinyin training for Xi'an children may promote their phonological awareness at the syllable level. Marinova-Todd et al. (2010) investigated the effect of bilingual exposure on phonological awareness in both languages

of Mandarin-English bilingual children from Vancouver, Canada. They compared the performance of monolinguals from Shanghai, China and bilingual children aged 5-6 on phonological awareness tasks including syllable deletion, onset-rime combination, initial sound identification, thyme detection, and tone discrimination. Results showed that bilingual children outperformed their monolingual peers in most tasks and their phonological awareness skills, but they were not as good as the monolinguals in language proficiency in either English or Mandarin. This study suggests there exists a bilingual advantage in phonological awareness, especially in the stronger language, and that phonological awareness in one language is associated with awareness in the other. In their longitudinal study, Yeong & Liow (2012) explored the development of phonological awareness in English-Mandarin bilingual children from Singapore. Children's phonological awareness was measured across three 6-month intervals via tasks including vocabulary test, word reading, syllable deletion, phoneme isolation, and phoneme deletion. Results showed that English-L1 children applied their phonological skills in Mandarin processing starting in the middle of the process while Mandarin-L1 children seemed to require exposure to English before they developed phoneme awareness in either language. In general, evidence suggests that there exists cross-linguistic interaction between phonological awareness skills in each language and that bilingual children may perform better than monolingual children if they have sufficient and balanced bilingual input.

2.6 The acquisition of variation

So far, this review of child language and bilingual/CHL development has mainly focused on the acquisition of obligatory structures while how language variation is learned remains unrevealed. As is true of any language learners, children need to understand 1) the obligatory structures and units in the language(s); 2) the optional elements in the envelopes of variation; and

3) where and how to use these variables appropriately in different contexts (Roberts, 2005, 2013; Smith & Durham, 2019). That is, they need to acquire sociolinguistic competence. Current variationist work has examined the use of sociolinguistic variables by adult speakers; nevertheless, research has indicated that young children actively engage as learners of variation and play a key role in driving language change (Foulkes et al., 2005; Senghas & Coppola, 2001). In early sociolinguistic studies, it was believed that the acquisition of variables came after the mastery of the basic grammar (Labov, 1964; Smith & Durham, 2019). Subsequently, scholars' understanding of the time when systematic variable patterns may emerge has been updated (Labov, 1989). Findings have shown that the acquisition of variation can occur in early childhood. Moreover, there is evidence to suggest that standard and vernacular variants may be learned in a sequential fashion (Payne, 1980; Roberts, 1994). Studies show that children are sensitive to the variables used in CDS and factors including *age, gender, and stylistic elements* may constrain the use of the variables (Smith & Durham, 2019). First, as the child grows older, caregivers use less modifications in CDS, but more non-standard variants. Second, the gender of the adults and the children affects the occurrences of the variables in their speech. According to the current studies, it seems that mothers tend to use more standard variants and they use them more often with girls than boys. Variants are also used differently in different settings: formal variants are often associated with instruction and punishment, while informal ones usually come with intimacy and fun (Labov, 2001).

Current studies have examined the use of several variables by English-speaking children. For example, Roberts (2002) explored the replacement of diphthong [ai] by [a] in the southern dialects in Tennessee in CDS and child language. Foulkes et al. (2005) investigated the use of word-medial inter-sonorant /t/ and word-final prevocalic /t/ by caregivers and children in

Tyneside, English. Only a few have focused on sociolinguistic variation in bilingual and heritage language learning children. Starr (2016) investigated the acquisition of sociolinguistic knowledge by first and second graders in a Mandarin-English two-way immersion program in the US. Teachers used both standard and non-standard phonological features (e.g., the dentalization of Mandarin syllable-initial palatal sibilants /tʂ, tʂ^{h}, ʂ/) in classroom speech and the language use by students differ according to their language backgrounds: the speech of native-speaker students is primarily shaped by their home varieties while non-native-speaker students tended to avoid acquiring the non-standard features that used by teachers. More studies are needed to explore the role of young bilingual/heritage speakers in language change by investigating their sociolinguistic competence in various contexts.

2.7 Summary

This chapter reviews previous research on language development of English-Mandarin/Mandarin-English bilingual children in various social and educational environments. Among different types of language learners, CHL children differ from their monolingual counterparts and those who acquire an additional language at a young age in many respects. To what extent a child can master a particular feature in a language depends on the language input they have been exposed to. For CHL children, the input is usually limited and early language shift from CHL to English has been observed in preschool age. As a crucial part of language input, CDS is usually modified for infants and children at a very young age. The use of dialectal variables in CDS have also been identified. Therefore, it is not surprising to see that children as young as three-year-old demonstrate sensitivity to language variation. The acquisition of variation, as the use of variant patterns by native adults, is constrained by gender, age, and stylistic elements. With current evidence, it is believed that children begin to learn the use of

sociolinguistic variables as early as age three with the acquisition of grammatical structures as an integral process.

3. Research method

3.1 Methodology

Based on Vygotskian and Bahktian sociocultural perspectives, language acquisition, like any other type of learning, can be interpreted as a dynamic process through which learners, as novice members in a community, acquire knowledge by engaging in activities with more expert others. The interactions between the newcomers and the more experienced members can be highly contextual. For bilingual child learners, this task will be more challenging as they are learning not only two language systems but also social norms in two cultures. Ethnography, a research approach widely adopted in anthropology, sociolinguistics, and education, often serves as an effective tool to capture how language learning and development are situated in sociocultural contexts and discover what meanings the linguistic variability has for its users (Harklau, 2005; Horvath, 2013). In anthropological studies from where it originated, ethnography has provided extended accounts of a community's social organization, activities, and beliefs (Athanases & Heath, 1995; Levon, 2013). In the 1960s and 1970s, ethnographic studies emerged to investigate disadvantaged and academically unsuccessful students and their interactions with others in school (Athanases & Heath, 1995). Around the same time, the first wave of variationist sociolinguistics began to explore the orderly heterogeneity in language change and the extent to which social structure and language interact (Bayley, 2013; Eckert, 2012). As novice speech community members, children's behaviors were also interpreted with ethnographic descriptions of child language socialization (Duranti et al., 2011; Schieffelin & Ochs, 1986). Ethnography has also served as a significant qualitative approach to illustrate classroom interactions during language teaching and learning (Athanases & Heath, 1995; Harklau, 2005).

This chapter first introduces the interdisciplinary background of sociolinguistics where the current study is rooted. Then ethnographic methodology is discussed regarding its history, implementation, strengths, and weaknesses. The research method adopted for the current study is explained at the end, with reflections on challenges and solutions.

3.2 Theoretical framework

3.2.1 Sociolinguistics as an interdisciplinary field

Generally speaking, sociolinguistics investigates the relationship between language and society (Holmes & Wilson, 2017; Hymes, 1971; Wardhaugh, 2006). This statement can be interpreted from two perspectives. On the one hand, it is concerned with the effect of society, including cultural norms, policies, and ideologies, on the way that language is used and perceived. On the other hand, sociolinguists also explore how language is used for meaning-making, identity (re)construction, and power negotiation in a speech community. Topics that are often discussed in this field include language and language varieties used in particular speech communities, language change and variation, bilingualism and multilingualism, language attitudes and ideology, language contact, social networks and communities of practice, social stratification (e.g., social class and gender) on language use among others (Chambers, 2015; Holmes & Wilson, 2017; Meyerhoff, 2018; Wardhaugh, 2006).

The interdisciplinary nature of sociolinguistics lies in the scientific inquiry of the social meaning through community interactions it shares with other disciplines, such as anthropology, sociology, and education (Bucholtz & Hall, 2016; Ferguson, 2020). Sociolinguistics and anthropology, at least linguistic anthropology, are historically interrelated research approaches (Gumperz & Cook-Gumperz, 2008). And sociolinguistics and sociology have established a broad history of collaboration of their shared interest in social stratification and methodological

similarity (Mallinson, 2009). Thus, it is not surprising that anthropologists, sociologists, and sociolinguists have adopted similar fieldwork methodologies, including ethnography, to understand the behaviors and norms of the members of a community (Levon, 2013).

3.2.2 Linguistic variation and social meaning

As a major branch of sociolinguistics, the variationist tradition focuses on the inherent variability of language and how it changes over time. It has revealed the social meaning behind language change in that synchronic language variation is often a reflection of diachronic language change (Bayley, 2013). Early variationist studies (e.g., Labov, 1963, 1966; Shuy et al., 1968; Wolfram, 1969) examined the effects of social constraints, such as social class, style, and gender, on patterns of variation. This paradigm has been extended to other areas, including studies on creole languages, second and heritage language development, and sign languages (Bayley, 2013).

Regarding the relationship between the individual and the group in the discussion of language variation and change, Eckert (2012) proposed a three-wave model to illustrate how social meanings had been interpreted in variationist studies. In the first wave, scholars focused on broad correlations between linguistic variables and macro-sociological categories such as class, gender, ethnicity, and age. Representative studies include Labov's study in Martha's Vineyard, his later study in Lower East Side in New York City, and the study by Wolfram in Detroit (Labov, 1963, 1964, 1966; Shuy et al., 1968; Wolfram, 1969). These studies have demonstrated the close relationship between social stratification in particular forms and the use of variation patterns. However, individual variation was not paid much attention to because of the homogeneity assumption (Walker & Meyerhoff, 2013). With the methodology of ethnography, studies in the second wave narrowed down to local communities and explored how

speakers used the vernacular forms to express their local or class identity (Eckert, 2012). Examples are Trudgill's study (1972) on the intertwining effect of social stratification and sex differentiation in urban British English, Labov's study (1972) of African American Vernacular English in New York City, and the introduction of social networking by Milroy (1987) in her study of phonological variation in Belfast. In research during the second wave, speakers were often grouped within a static social network where their individual identity was not distinguished from categorical affiliation. From the stylistic perspective, variationists in the third wave now place more emphasis on speaker agency and therefore are reexamining the relationship between language variation and its social meaning (Eckert, 2012). The social meanings behind the linguistic variables are no longer static and fixed. Instead, they are viewed as underspecified and dynamic with the central property of indexical mutability, which is achieved through stylistic practice. Speakers play an active role in the meaning-making process, as shown in the use of Cosmopolitan Mandarin as a post-socialist regime to valorize differentiation among individuals and groups (Q. Zhang, 2018). The role of children, especially children of preschool age, in language change and variation has been investigated early but has yet to be paid much attention to until recently, as discussed in Chapter 2.

3.2.3 Ethnographic methodology in sociolinguistics

The implementation of ethnography as a fieldwork approach in sociolinguistics can be dated to Hymes' disciplinary foundations for the ethnographic study of language use (Bauman & Sherzer, 1975; Farr, 2013; Horvath, 2013; Hymes, 1971, 2013; Lawson, 2014). Back then, the sequential prominence of ethnolinguistics in the late 1940s, psycholinguistics from the early 1950s, and sociolinguistics from the early 1960s reflect the successive impact of anthropology, psychology, and sociology on linguistics (Bauman & Sherzer, 1975). In the ethnography of

speaking, Hymes (1971) integrated linguistic structure as abstract and self-contained codes and ethnographies as the patterns and structure of sociocultural life to understand that speaking is patterned in culture-specific, cross-cultural variable ways (Bauman & Sherzer, 1975). As a research methodology, ethnographic fieldwork is based on two assumptions: first, all social events, including speech events, are necessarily contextualized and multivalent; and second, knowledge of these events is always situated within the speakers and contexts where the event occurred and is therefore subjective (Levon, 2013). Thus, the knowledge revealed by ethnographic fieldwork is always interpretive (Levon, 2013).

Ethnographic fieldwork, especially when it is adopted for language research, is often conducted through participant observation, field notes, interviews, questionnaires, audio or video recordings, and direct participation in community life (Harklau, 2005; Lawson, 2014; Levon, 2013; Long, 1980; Trechter, 2013; Tusting & Maybin, 2007). Among these, participant observation is considered as the key to pursuing ethnographic knowledge in the target community (Harklau, 2005; Lawson, 2014; Long, 1980). In participant observation, the researcher invests a significant amount of time engaging with individuals in her research settings, takes extensive field notes while observing their interactions, and conducts interviews and conversations to gain insight into their viewpoints, beliefs, attitudes, and values (Harklau, 2005). Ethnography is also used as a qualitative research approach, combining other quantitative methods. For instance, in variationist studies, ethnography may be adopted to investigate how speakers perceive the use of sociolinguistic variables during meaning-making, how language-related identity and ideology are shaped or reformed regarding the target variables, and how the linguistic variability is affected by the interaction between members of the speech community (Horvath, 2013). At the same time, quantitative methods, such as statistical analysis, are often

used to capture the ongoing language change, how linguistic constraints accommodate language variability and change, and what kind of social factors can provide the variability required to be observed in the community (Horvath, 2013).

So why ethnography? From a top-to-down perspective, the categories in which researchers are interested are often pre-determined, causing participants to be grouped into specific analytical categories (Lawson, 2014). For example, in gender studies, the dichotomy between males and females excludes numerous ways individuals understand and approach their biological sex. Ethnography does not contain preconceived categories but explores ways of being from an emic perspective rather than an etic one (Lawson, 2014). As a bottom-up inquiry approach, it views categories or specific social interpretations of the target individuals as products of variation patterns instead of their explanations (Lawson, 2014).

The ethnographic method has its own strengths and limitations. The value of this approach lies in its capability to collect materials about speech events produced in natural circumstances, which is the ideal data for studying the social uses of language (Mallinson, 2009). As a hypothesis-generating approach, it holds the possibility of uncovering significant factors rather than adopting pre-established variables and presenting their perceived significance in specific contexts and from the participants' viewpoint instead of from an outsider's perspective (Long, 1980). Ethnography also comes with several disadvantages. First, there are several requirements for the researcher regarding social ethics and interpersonal communication (Long, 1980; Trechter, 2013; Tusting & Maybin, 2007). In several ways, the researcher can access the target community, including snowball sampling or the friend-of-a-friend method, contacting the community's official brokers, or gaining access to the community independently (Levon, 2013). The researcher should also be prepared to develop her knowledge about the community, be

adaptable to unexpected changes, to mindful to identify meaningful patterns of interactions, and be respectful of participants' time and feelings (Levon, 2013). During the interaction with local participants, the researcher has to balance her role as both an insider of the community to understand the internal mechanism of the community and an outsider to conduct the research project (Levon, 2013; Tusting & Maybin, 2007). The researcher's involvement will inevitably have some impact on the practices being researched (Chambers, 2015; Labov, 1972; Mallinson, 2009; Trechter, 2013; Tusting & Maybin, 2007). However, the effect of the observer's paradox may be minimized with the increasing amount of time the researcher investigates in the community. Other strategies consist of using naturalistic observation, building rapport with the subjects, adopting multiple data collection methods, and keeping critical reflections in the field notes (Horvath, 2013; Mallinson, 2009; Meyerhoff, 2018; Trechter, 2013). At the same time, as Cameron et al. (1992) proposed, the researcher should not just *do* research on subjects but also research *on* and *for* subjects (p. 15). Precisely, three programmatic statements were specified:

> (a) Persons are not objects and should not be treated as objects.
> (b) Subjects have their own agendas, and research should try to address them.
> (c) If knowledge is worth having, it is worth sharing.
>
> (pp. 22-24)

The knowledge learned from the community should also be used, with the researcher's knowledge of linguistic rules and social context, to advocate for the speakers of a vernacular (Trechter, 2013).

3.3 Research methods in the current study

The sociolinguistic analysis in the current study interprets the language practices in two dual immersion preschool classrooms as two similar speech communities. They are not combined in the analysis as an integrated speech community as they differ in several aspects, including participants' characteristics, the settings, and the interactions among each speaker.

3.3.1 Local community

The first preschool that I successfully reached out to, Lily Valley (a pseudonym), is located in a coastal city near San Francisco. Many early Chinese immigrants from the southern parts of China have resided in San Francisco for generations (Hall-Lew, 2010). The first wave of Chinese immigration to the U.S. took place around the 1850s, with many Chinese workers coming to work on the transcontinental railroad (G. H. Chang, 2020; Y. Chen, 2002; Xiao, 2010). Around the mid-19th century, driven by economic and political factors in China and the California Gold Rush in the U.S., Chinese immigrants from Eastern Guangdong province moved to San Francisco (Hall-Lew, 2010; Xiao, 2010). Say Yup or Siyi (四邑, sì yì, 'four counties') was a widely adopted term then to refer to Chinese immigrants from the four counties in Guangzhou: Taishan, Kaiping, Xinhui, and Enping. Siyi used to be a well-known place of origin for overseas Chinese. Siyi dialects are usually categorized under Cantonese (or 粤语, yuè yǔ as it is called in Mandarin) and Toishanese is one of the Siyi dialects that has been widely used and well-known (Yue, 2003). Later waves of Chinese immigrants in San Francisco came from other regions, such as Fujian, Hong Kong, Taiwan, Shandong, Hunan, and other mainland areas. This group consisted of speakers of Yue, Hakka, Min Nan, and other Chinese dialects. Now more residents in the San Francisco Bay Area are recent immigrants from elsewhere in the US. Among them, there are many descendants of highly educated Taiwanese Americans who moved to the US in the late 20th century.

Language shift and change in San Francisco Chinese immigrant communities have been observed in previous studies (Hall-Lew, 2010; Staicov, 2020). Moreover, it is not surprising that language use and speakers' perceptions of their ethnic identities are often closely related. Among Chinese immigrants in San Francisco Chinatown, the first generation or those who were foreign-

born tended to refer to themselves as "Chinese." Among the second generation, the older cohort showed higher frequencies for "Chinese American," and the younger group preferred to name themselves "Asian American" (Staicov, 2020). This transition echoes many Chinese communities' language shift from Chinese to English (He & Xiao, 2008; D. Zhang, 2010). As observed in many other immigrant languages, language shift occurs through several generations (Veltman, 1983). This is always related to various reasons, including historical backgrounds of the two languages, language contact, behavior and attitude, and other psychological, sociocultural, and cognitive factors (Fishman, 1965, 2012; Veltman, 1983). Intergroup language change from Cantonese to Mandarin among oversea Chinese communities has also been identified (W. Li & Zhu, 2010, 2013; Staicov, 2020). This can be explained by (1) the status of Mandarin as the official language in China and its wide adoption in education as the instructional language; and (2) the interaction between the Chinese diaspora and China as the home country supported by recent transportation and technologies (W. Li & Zhu, 2010).

The close relationship between language identity and language use may be attributed to the ways speakers interpret their own roles via language practice. For Chinese immigrants, it is often believed that the ability to use the Chinese language is an integral part of being “Chinese” (Hall-Lew & Starr, 2010; He, 2004; K. Wong & Xiao, 2010). However, which Chinese varieties are related to Chinese identity may differ in different communities. For Chinese in San Francisco, it was believed that Cantonese, or Toishanese specifically, was a significant factor in Chinese identification and Chinese community connection (Staicov, 2020). The younger generations predominantly used Chinese (maybe one or more of the varieties as mentioned above) at home with their Chinese-speaking parents or grandparents. At the same time, many younger generation speakers expected that their own children could continue to use Chinese for

several reasons: to enhance their connection to Chinese culture and ethnicity, to communicate with family members, and for instrumental advantages (Staicov, 2020).

The second preschool, Sunflower Garden, is located in South San Jose, which also has a long history of hosting Chinese immigrants and has attracted more newcomers from mainland China with higher educational levels and socioeconomic statuses in recent years. The earliest Chinese immigrants in Santa Clara Valley were part of the San Jose - San Francisco Railroad workers during the Civil War (S. Chan, 1989; M. S. Chang, 1997). In the 1860s, San Jose Chinatown was formed as the center for cultural events, business, recreation, employment, and temporary shelter for Chinese immigrants from nearby areas, including Gilroy, Milpitas, Alviso, Campbell, Cupertino, Mountain View, and Palo Alto (M. S. Chang, 1997). The exclusion of Chinese immigrants in 1882 caused countless consequences, including the burning down of Chinatown in San Jose in 1887. Decades later, a Chinese American middle class began to emerge in Santa Clara County, with the 1882 Chinese Exclusion Act repealed in 1943 and the improved social acceptance of Chinese after World War II (M. S. Chang, 1997). A new generation of researchers and intellectuals from mainland China, Taiwan, and Hong Kong were able to relocate themselves to U.S. universities. Between the 1950s and 1960s, the Stanford area served as the center for the Chinese American community in Santa Clara County (M. S. Chang, 1997). With the approval of the Civil Rights Act in 1964 and the Immigration Reform Act in 1965, an unprecedented number of highly educated Chinese professionals participated in the development of Silicon Valley. Many of them were international students who obtained advanced degrees in STEM fields at U.S. universities and had been recruited by high-tech companies, which started to grow explosively since then. Around the 1990s, Chinese American entrepreneurs in computer science, semiconductors, software, multimedia, biotechnology, and

networking began to develop rapidly. Today, Silicon Valley still stands as an attractive center with its outstanding educational resources, technology companies, and business network.

As observed in San Francisco and its neighboring areas, the Chinese language is widely used in Santa Clara County. Because of the composition of Chinese immigrants in Silicon Valley, three varieties, namely Mandarin or Putonghua, Cantonese, and Taiwan Mandarin, are mainly spoken among Chinese communities in Silicon Valley. Among these three Chinese varieties, Putonghua and Taiwan Mandarin differ in several variable features (e.g., the mixed-use of word-initial sibilants, the full realization of neutral tones, and variation in particular lexical items and syntactic features), they do share the same linguistic structure in general. In contrast, Cantonese and Mandarin are not mutually intelligible due to their distinctive phonetic inventories, vocabularies, and grammatical structures. Other Chinese dialects, such as Toishanese, Hakka, Shanghainese, Sichuanese, and Northeastern Mandarin, are also used. Nevertheless, most of the time, these dialects are only used among speakers from the same place of origin (e.g., the same city or the same province in China). At the same time, Mandarin (in different dialectical versions) serves as the lingua franca in most Chinese communities in Santa Clara.

A large number of Chinese immigrant families in the area leads to the expansion of childcare services and language programs for children. As seen in other Chinese immigrant communities, Chinese language programs are often provided for preschool-aged children and elementary students, though there are some Advanced Placement (A.P.) or International Baccalaureate (I.B.) programs for high school students. Many of the language programs for young children are combined with childcare or extended afterschool services in family daycare centers, preschools, afterschool programs, weekend programs, and summer camps, among

others. Mandarin is usually selected as the instructional language or one of the instructional languages. Cantonese is also used in classrooms, depending on the language curriculum design in the program.

3.3.2 Lily Valley

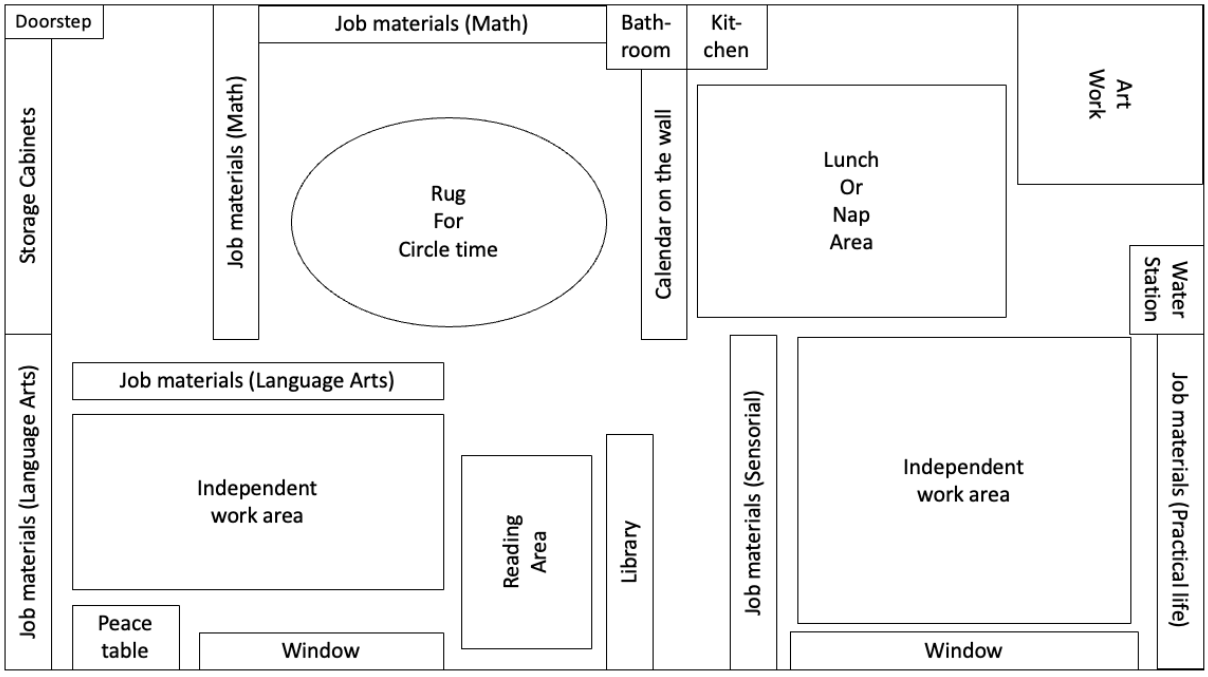
Many Chinese language programs and schools exist in San Francisco and nearby cities. Many of these programs have a long history and used to provide Cantonese language instruction. Now more schools prefer to adopt Mandarin as the instructional language. Lily Valley is one of these schools. It is a family-based English-Mandarin dual immersion Montessori preschool established by Ms. Olivia[3] in 2017. Lily Valley is in the San Francisco Peninsula and serves children aged three to six from local neighborhoods. Due to the demographic characteristics of local households, children enrolled in Lily Valley can mainly be categorized into two groups: children from Caucasian families whose parents believe in the benefits of being bilingual at a young age and children from Chinese immigrant families (first and second generations) whose parents expect the maintenance of their heritage language. Supported by Montessori pedagogy (see more details in Montessori, 2014), the school provides an age-appropriate long-term curriculum for each of the children in subjects including practical life, sensorial exploration, math, language arts, botany, zoology, and geography. Solid learning materials are also available for children to practice. By taking the dual immersion model, Lily Valley encourages children to learn English and Mandarin from the teachers at school and use both languages for daily activities with peers. Chinese characters are also introduced to children through learning materials, blackboards, posters, and storybooks. Simplified and traditional scripts are mixed and

[3] All participants names and school names are pseudonyms.

used. Thanks to the small student size, teachers can often work with individual children after group instruction and adjust their teaching plans when necessary.

The classroom arrangement in Lily Valley is demonstrated in Figure 3.1, and the daily schedule is listed in Table 3.1. From Monday to Friday, school starts around 8:30 am, and students have a quiet working period from 9:00 to 11:00 to do some hands-on practice with solid materials. Around 11:05, one of the teachers leads the circle time to talk about the calendar, weather, and seasonal events. At the beginning of circle time, the children learn nursery rhymes, sing songs and poems, or play movement games in small groups. Then based on the current theme, the teacher demonstrates a related job by showing children the keywords about the theme, how to work on the materials, and routines to follow. Children are supposed to remember the steps and work on the materials during individual work time by themselves. The teachers would also read one short story after lunch, and the children have one more working period in the afternoon. According to the curriculum design, all instruction should be in both English and

Figure 3.1 Classroom arrangement _ Lily Valley



Mandarin in a 50%-50% ratio. However, considering most children only speak English at home and are emergent English-dominant bilingual speakers, the teachers add more English to facilitate their teaching and classroom management. Mandarin is mainly used in work time, circle time, and story time.

Table 3.1 School daily schedule _ Lily Valley (2021-2022)

Time	Events
8:00 – 8:30	Student drop-off
8:30 – 9:00	Morning play (outdoor)
9:00 – 11:05	Work period
11:05 – 11:15	Small group
11:15 – 11:30	Circle time
11:30 – 12:00	Enrichment classes
12:00 – 12:30	Lunch
12:30 – 1:15	Outdoor recess
1:15 – 3:00	Naptime/ quiet work time
3:00 – 3:30	Afternoon snack
3:30 – 4:15	Hands-on enrichment
4:15 – 4:30	Clean-up
4:30 – 5:00	Outdoor recess
5:00	School closed

3.3.2.1 Lily Valley: teachers, children, families, and language practice

Several teachers worked at Lily Valley during the academic year of 2021-2022 when the data were collected, including the school director Ms. Olivia; the head teacher Ms. Daisy; the

teaching assistant Ms. Megan; the music teacher Ms. Lucia; the substitute teacher Ms. Marianna, and the soccer coach Mr. Peter. Only three of the teachers used the Chinese language with children. Ms. Olivia used English and Mandarin when leading classroom instruction, story time, and cultural events (see Table 3.2). Ms. Daisy had a particular circle time for Mandarin learning once a week, where she introduced Mandarin words, songs, and stories to the children. Ms. Marianna occasionally came when a substitute teacher was needed and worked with children on art crafts. She spoke Mandarin when the theme was about Chinese culture and Cantonese with children exposed to Cantonese at home. Among staff, English was usually the language for both work discussion and casual conversation. Mandarin-speaking teachers also used Mandarin among themselves. School official files, documents, and paper works were all printed in English.

Table 3.2 Language use by teachers _ Lily Valley

Teacher	**Role**	**Language in classroom**
Ms. Olivia	School director	English, Mandarin
Ms. Daisy	Head teacher	Mandarin, English
Ms. Megan	Teaching assistant	English
Ms. Lucia	Music teacher	English
Ms. Marianna	Substitute teacher	English, Mandarin
Mr. Peter	Soccer coach	English
Note: All names are pseudonyms.		

Eight children aged 3;2-5;0 enrolled in Lily Valley during the 2021-2022 academic year; and one child who could not be identified as a CHL learner was excluded from the research. The

children’s demographic information is listed in Table 3.3. All were from nearby neighborhoods, and seven could be identified as CHL learners. That means they had at least one parent or grandparent as a native Chinese (Mandarin, Cantonese, or other Chinese varieties) speaker. Most children spoke English as the dominant language at home. This may be attributed to several factors, including the parents' Chinese proficiency, family structure, and the language policy adopted in the family. For example, Joseph, Jenny, and Evelin's parents were second-generation and had limited Chinese proficiency. Although they preferred to maintain Chinese as their heritage language, English was still their dominant language at home. For some children, such as Noah and Jenny, English served as a lingua franca for parents and, therefore, the primary language at home. The one-parent one-language policy was not adopted in their families (Baker, 2011; De Houwer, 2007, 2018). Emma was the only one who demonstrated a high level of Mandarin proficiency and could interact with teachers fluently in Mandarin. Mandarin was the family language not only for parents but also for siblings.

Table 3.3 Demographic information of the target children _ Lily Valley

Child[1]	Age[2]	Gender	Home language	Family background
Evelin	3;02	F	English	The father was a second-generation Chinese American who could speak some basic Mandarin. The mother was a native speaker of English. Evelin had an older brother who was a former student in Lily Valley. The family occasionally got together with the grandparents, who spoke some Mandarin.
Emma	4;00	F	English, Mandarin	The father was a native speaker of Mandarin, and the mother was a native speaker of English and a Mandarin-L2 learner. Emma had an older sister who was six or seven-year-old and was also learning Mandarin in a Chinese language program.
Jenny	4;02	F	English	The father was a second-generation Chinese American who could speak some basic Mandarin. The mother was a second-generation Vietnamese American. English was their home language. Jenny had a younger sister who was one year old.
Isabella	4;03	F	Mostly English	The parents were second-generation Chinese immigrants and spoke some Cantonese at home. Isabella had a younger brother who was about one year old.
Joseph	4;06	M	English	Both parents were second-generation Chinese immigrants. They understood some basic Chinese. The family also had other extended family members who spoke Mandarin at family get-togethers. Joseph had a younger brother who was one year old.
Noah	4;08	M	Mostly English, sometimes Mandarin	The home language was mainly English. The mother was a native speaker of Mandarin, and the father was a native speaker of English. Grandparents spoke Mandarin. No siblings.
Mia	5;00	F	English, Cantonese	Parents used English at home. Grandmother spoke Cantonese with the child. No siblings.

Notes:
1. All names are pseudonyms.
2. Child age was calculated by 2021/09 at the beginning of the academic year.

Considering the English dominance among the children, the teachers usually needed to include more English to facilitate their teaching and classroom management. During circle time, when teachers were giving formal instruction, they often tried to provide the same information by saying one sentence in English and the next one in Mandarin or vice versa. Due to her language skills, Emma was often identified as a language broker between the teachers and the children in group activities. Children addressed their teachers in an American English norm for preschool teachers with Ms. as the title and the teachers' first names followed. For instance, Ms. Olivia was called "Ms. Olivia" instead of "[Olivia's last name] + 老师 (lǎoshī, teacher)," which is a classical way to address teachers in Chinese culture.

As mentioned, English, and simplified and traditional Chinese scripts were all presented in the classroom. English was used in various teaching and learning materials, including calendars, nomenclature cards (shown in Figure 3.2 (a)), posters, story books, and worksheets. Simplified Chinese script (which is characterized by reduced stroke count and simplified shaped of traditional Chinese characters and is primarily used as the standard writing system in mainland China) could be found in many areas, such as labels in learning materials (shown in Figure 3.2 (b)), nomenclature cards, posters, worksheets, and Chinese character screens (shown in Figure 3.2 (c)). Traditional Chinese script (which retains the intricate and complex forms of Chinese characters and is commonly used in Hong Kong, Macau, Taiwan, and many overseas Chinese communities) was used occasionally, usually by teachers from areas where the traditional writing was adopted (e.g., Hong Kong and Taiwan). As shown in Figure 3.2 (d), traditional Chinese characters were often seen during cultural celebrations such as Chinese New Year.

Figure 3.2 Print scripts in classroom _ Lily Valley

	
(a) English script (types of landscapes)	(b) Simplified Chinese script (Chinese numerals 0-10)
	
(c) Simplified Chinese character screen (one-character verbs and two-character verbs)	(d) Traditional Chinese script (New Year wishes: may you be happy and prosperous)

3.3.3 Sunflower Garden

Sunflower Garden was established in 2017 by Ms. Lillian, an experienced early childhood educator from Guizhou, China, and Ms. Georgia, a preschool administrator from Taiwan. As a Mandarin-English bilingual Montessori preschool, Sunflower Garden runs several programs for infants, toddlers, and children of different ages. The bilingual curriculum provides children with various language experiences in both English and Mandarin in listening, speaking, reading, and writing. Following the Montessori pedagogy, the school supports the enrolled

children in growing into independent learners. Individualized lessons and group activities are designed for fine motor skills, language, math, science, geography, and culture.

Among five classrooms in Sunflower Garden, the PreK classroom was selected as the target research setting because the children in the PreK class were most comparable to those in Lily Valley in age and language proficiency. The classroom arrangement is demonstrated in Figure 3.3, and the daily schedule is listed in Table 3.4. Around 9 am, children arrive at the classroom and start their day quietly, working on worksheets or Montessori learning materials. If they skipped their breakfast, they might also choose to have some snacks on the snack table. Then the Chinese teacher would begin the Chinese circle time by organizing all the children on the big rug in the center of the classroom, greeting each of the children with a Chinese song, then demonstrating the materials for the day's lecture. After a short break, the English teacher would lead the English circle time in a similar way. During circle time, which serves as the primary resource of formal instruction in the program, children were supposed to learn keywords introduced by the teachers, remember the procedures to operate the learning materials and answer questions proposed by the teachers. The teachers used the two languages differently than in Lily Valley. Similar to the one-parent one-language approach adopted by some mixed-ethnic families, the school used the one-teacher one-language strategy in classrooms - the Chinese teachers used Mandarin, and the English teachers used English.

Figure 3.3 Classroom arrangement _ Sunflower Garden

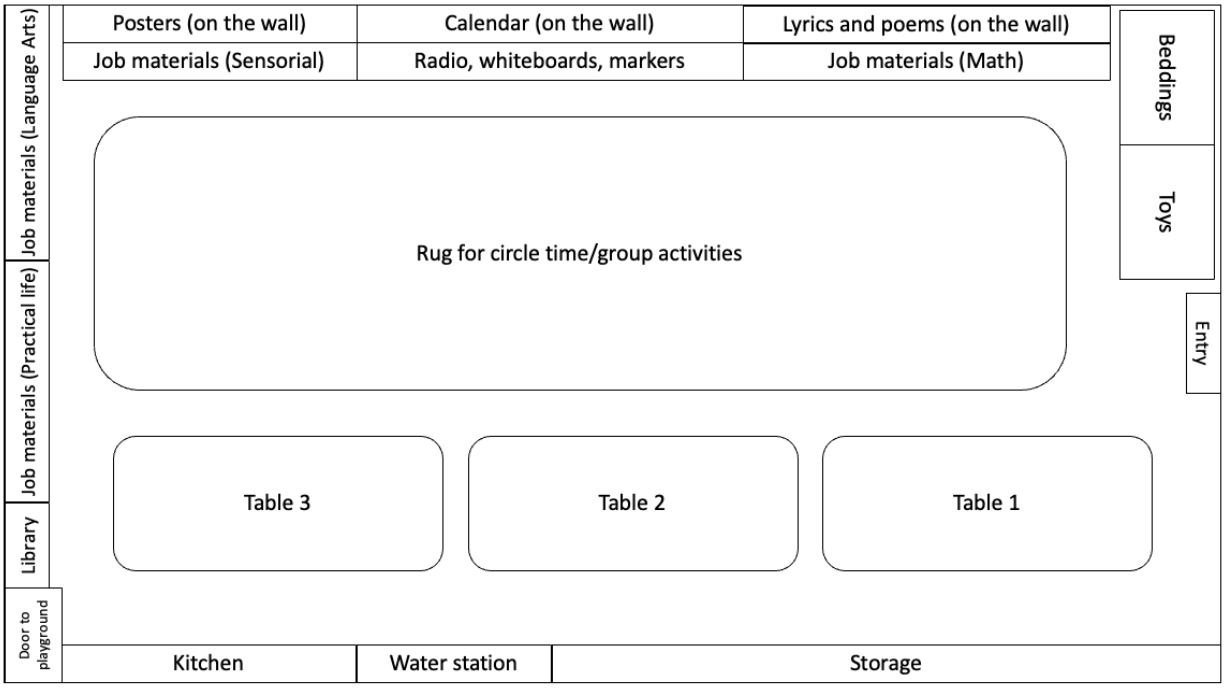


Table 3.4 School daily schedule _ Sunflower Garden (2021-2022)

Time	Events
8:45-9:00	Drop off time
9:00-9:10	Bathroom break
9:10-10:00	Worksheet/Montessori work/Snack
10:00-10:30	Chinese circle time
10:30-10:40	Bathroom break
10:40-11:10	English circle time
11:10-11:50	Playground recess
11:50-12:30	Lunch
12:30-12:50	Storytime
12:50-1:00	Bathroom break
1:00-3:00	Nap
3:00-3:10	Bathroom break
3:10-3:15	Clean up
3:15-3:30	Afternoon snack
3:30-4:00	Math circle time
4:00-4:35	Playground recess
4:35-4:45	Bathroom break
4:45-5:10	English circle time
5:10-6:00	Montessori work period/parent pick up

3.3.3.1 Sunflower garden: teachers, children, families, and language practice

Two head teachers were in charge of the PreK classroom - the Chinese teacher Ms. Lucy and the English teacher Ms. Rose. Other teachers were also involved in classroom activities, including the school directors, Ms. Lilian and Ms. Georgia, the substitute teacher Ms. Gianna;

the gymnastics coach Ms. Perry; and the soccer coach Mr. John (see details in Table 3.5). About half of the staff communicated with children in Mandarin. Ms. Lucy used Mandarin in her instruction, classroom management, private interaction with small groups or individual children, and other school chores. She also spoke Cantonese with children who were Cantonese speakers. Ms. Lilian and Ms. Georgia came into the classroom once or twice a day for routines and announcements. Both of them used Mandarin with children and Chinese teachers. The substitute teacher Ms. Gianna was also a native Mandarin speaker and would replace either the Chinese teacher or the English teacher in the classroom in their absence. As in Lily Valley, all the official announcements, documents, and paper works in Sunflower Garden were also printed in English so that staff and parents who could not read Chinese could understand them.

Table 3.5 Language use by teachers _ Sunflower Garden

Teacher	**Role**	**Language in classroom**
Ms. Lillian	School director	Mandarin, English
Ms. Georgia	School administrator	Mandarin, English
Ms. Lucy	Chinese teacher	Mandarin
Ms. Rose	English teacher	English
Ms. Gianna	Substitute teacher	Mandarin, English
Mr. Perry	Gymnastics coach	Mandarin, English
Mr. John	Soccer coach	English, Mandarin
Note: All names are pseudonyms.		

Among all the 48 children (aged 3;01 to 5;04) in the PreK classroom in Sunflower Garden in school year 2021 and 2022, 36 were identified as CHL learners with at least one parent or grandparent as a native speaker of one or more Chinese varieties (i.e., Mandarin, Taiwan Mandarin, or Cantonese). Their demographic backgrounds are shown in Table 3.6 below. Compared to their Lily Valley peers, Sunflower Garden children were generally more Mandarin-dominant. Many parents were first-generation immigrants from mainland China or Taiwan, where Mandarin was predominantly used as the official language. Some families (e.g., Andrew's and Sheldon's family, Peyton's, Tessa's, and Natalie's family) had a close relationship and often spent weekends or holidays together. This kind of social network where Mandarin could be shared among adults and children outside their families greatly supported improving the language status in local communities. Some children, such as Emily, Kevin, and Andrew, could not use Mandarin for daily conversations. They might be identified as CHL learners with some receptive Mandarin skills. These children often used English for interactions with teachers and peers at school.

Table 3.6 Demographic information of the target children _ Sunflower Garden

	Child name	Age	Gender	Home language	Family background
1	Naomi	3;01	F	Mandarin-dominant	Naomi came from a new immigrant family from mainland China. Mandarin was the only language used at home.
2	Scott	3;02	M	Equally bilingual	Both parents were immigrants from mainland China. Mandarin and English were both used at home.
3	Lola	3;08	F	Mandarin-dominant	Lola's parents were new immigrants from mainland China. Mandarin was the dominant language at home.
4	Owen	3;07	M	Equally bilingual	The mother was a recent immigrant from Taiwan, and the father was a second generation. Mandarin and English were both used in the family.
5	Kristina	3;08	F	Mandarin-dominant	Mandarin was primarily used at home. Both parents were recent immigrants from Taiwan. The mother often needed to fly between Taiwan and California for work.
6	Michael	3;08	M	Mandarin-dominant	A new immigrant family from mainland China. Mandarin was the dominant language spoken at home, while English was occasionally used for literacy activities.
7	Alice	3;10	F	Equally bilingual	Both parents were immigrants from Taiwan. Mandarin and English were mixed at home.
8	Elena	3;10	F	Equally bilingual	One parent was a recent immigrant from mainland China, the other was a second generation from Canada. Mandarin and English were mixed at home.
9	Steven	3;11	M	Mandarin-dominant	Both parents were immigrants from Shanghai. Shanghainese and Mandarin were mainly used in the family.
10	Brandon	4;00	M	Mandarin-dominant	Both parents were immigrants from Taiwan. Mandarin was the primary language at home, while English was occasionally used.
11	Catherine	4;00	F	English-dominant	One parent was Caucasian and English native speaker, and the other was a second generation from China. English was the primary language for the family.
12	Elsa	4;00	F	Mandarin-dominant	Both parents were recent immigrants from mainland China. Mandarin was used as their main home language.

13	Lucas	4;01	M	Equally bilingual	Both parents were immigrants from Taiwan. Mandarin and English were mix-used at home.
14	Jackson	4;02	M	English-dominant	The father was a Caucasian and English native speaker, the mother was a recent immigrant from mainland China. English was the primary language used at home.
15	Andrew	4;04	M	Equally bilingual	Both parents were immigrants from Guangzhou. English and Cantonese were mixed at home.
16	Albert	4;04	M	Equally bilingual	Both parents were immigrants from Hong Kong. Mandarin, English and Cantonese were mix-used in the family.
17	Patrick	4;04	M	Mandarin-dominant	Both parents were new immigrants from Taiwan. Mandarin was primarily spoken at home.
18	Abigail	4;05	F	Equally bilingual	One parent was from Taiwan, and the other was a second-generation Californian. English and Mandarin were both used in the family.
19	Sheldon	4;06	M	Equally bilingual	One parent was from Taiwan, and the other was a second-generation immigrant from China. They spoke both English and Mandarin at home.
20	Harry	4;07	M	Equally bilingual	The father was a Caucasian and English native speaker, and the mother was a native speaker of Mandarin from mainland China. The family followed the one-parent one-language policy at home.
21	Peyton	4;07	F	Mandarin-dominant	Both parents were new immigrants from mainland China. Mandarin was the dominant language at home, while English was occasionally used.
22	Tessa	4;07	F	Mandarin-dominant	Both parents were new immigrants from Taiwan. Mandarin was used primarily in the family.
23	Eva	4;07	F	English-dominant	The father was a recent immigrant from mainland China. The mother was a second generation Chinese American. English was the primary language at home.
24	Dylan	4;08	M	Mandarin-dominant	Dylan came from a Chinese immigrant family from Taiwan. Both of his parents were Taiwan Mandarin speakers.
25	Lia	4;08	F	Equally bilingual	Both parents were second-generation immigrants from Taiwan. Their Mandarin was

					maintained relatively well so that both English and Mandarin were spoken at home.
26	Ophelia	4;08	F	Mandarin-dominant	Ophelia lived with her parents and grandparents, who were all native speakers of Mandarin from mainland China.
27	Emily	4;09	F	English-dominant	The father was a native Mandarin speaker from mainland China. The mother was a second-generation Chinese immigrant. The family chose to use English only at home.
28	Kevin	4;09	M	Equally bilingual	Kevin's family immigrated from Hong Kong and mostly used Cantonese at home.
29	George	4;09	M	Mandarin-dominant	Both parents were new immigrants from mainland China. Mandarin was the only language in the family.
30	Matthew	4;09	M	Equally bilingual	The mother was a new immigrant from mainland China. The father was Caucasian but had learned Mandarin for eight years in Beijing. Mandarin and English were both used at home.
31	Jay	4;10	M	Mandarin-dominant	Mandarin was primarily used at home. Both parents were recent immigrants from Taiwan. The mother often needed to fly between Taiwan and California for work.
32	Cameron	4;11	M	Mandarin-dominant	Cameron also came from a Chinese immigrant family from Taiwan. Parents were native Taiwan Mandarin speakers.
33	Edward	4;11	M	Mandarin-dominant	Both parents were new immigrants from mainland China. Mandarin was the only language in the family.
34	Natalie	5;00	F	Mandarin-dominant	Natalie came from a new immigrant family from mainland China. Both parents spoke Mandarin at home.
35	Julian	5;04	M	Equally bilingual	Both Julian’s parents could speak Mandarin. The mother was a native speaker, and the father was a second-generation immigrant from China.
36	John	5;04	M	Mandarin-dominant	John’s parents were new immigrants from mainland China. The mother was also a teacher in the same preschool.

For print scripts, English, simplified Chinese, and traditional Chinese were often presented together in the classroom. Many teaching materials were printed in two or three

scripts. For instance, in Figure 3.4 (a), the calendar on the left contains simplified Chinese numerals for dates and words for days of the week. The calendar on the right presents the same information in the same structure in English. The poster of the rainforest shown in Figure 3.4 (b) contains all three scripts in different colors. All keywords, including theme, animals, and names of the rainforest layers, were all written in English, simplified Chinese, and traditional Chinese. The color-coding system was used systematically in all classroom posters so that children could differentiate different orthographies according to the colors. Traditional Chinese scripts were also found in culture-related items, such as the Chinese New Year decoration in Figure 3.4 (c.1). Classroom rules were also demonstrated with pictures, English, and simplified Chinese in the classroom (as shown in Figure 3.4 (c.2)). Parents also helped provide knowledge about Chinese writing systems. For example, in an "all-about-me" poster (see Figure 3.4 (d)), the mother wrote down two sentences about the language ability of the child: "I am bilingual!" in English and "我會講中文!" (wǒ huì jiǎng zhōngwén, I can speak Chinese) in traditional Chinese. The mismatch between the information in the two sentences may reveal the sociocultural values the parent identified in English and Chinese. In English, the bilingual competence of the child was emphasized, whereas, in Chinese, the ability to use Chinese was specified.

Figure 3.4 Print scripts in classroom _ Sunflower Garden

<table>
<tr>
<td> 
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<tr>
<td>(a) English and simplified Chinese scripts on calendars (months, dates, and days of the week)</td>
<td>(b) English, simplified Chinese, and traditional Chinese scripts for words on posters (rainforest and animals: English in black, simplified Chinese in read, and traditional Chinese in blue)</td>
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<tr>
<td> 
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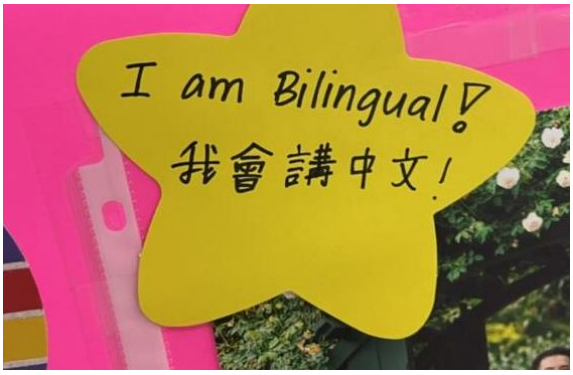
<td> 
</td>
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<tr>
<td>(c.1) Traditional Chinese scripts in Chinese New Year Decoration (traditional Chinese scripts: Happy New Year)
(c.2) English and simplified Chinese scripts for classroom rules</td>
<td>(d) Parent’s handwriting in English and traditional Chinese on an “all-about-me” poster (traditional Chinese scripts: I can speak Chinese!)</td>
</tr>
</table>

3.4 Fieldwork method

3.4.1 Ethnographic study

As mentioned in Chapter 1, with the ethnographic approach, this study aims to explore the language practices between teachers and children in the two preschool classrooms as two multilingual speech communities. Access to these two communities was obtained through my personal connections. In the spring of 2020, I started to reach out for potential research settings through the connections I had obtained in my previous early childhood education program. With this networking, I came to know Ms. Olivia and her preschool, Lily Valley. I joined the school as a teaching assistant during the summer and became familiar with the children and classroom routines. My formal ethnographic study in Lily Valley began in September 2020, with all consent forms collected from teachers and parents. From then on, I visited the school once or twice a week to collect fieldwork data until June 2021, when all the five-year-olds graduated. In most of these visits, I was able to observe the entire school day and all sorts of school activities.

After a few months of classroom observation in Lily Valley, I was concerned about the generalizability of the study if it only contained seven children, many of whom were English-dominant. In other words, I doubted whether these children would be representative of the "CHL learners in the San Francisco Bay Area," defined as my research subjects. The generalizability concern of ethnographic research may not be completely erased from a theoretical perspective. However, the increase in sampling size could contribute to the diversity of research subjects and, therefore, reduce the potential bias that may exist in participant selection. In October 2021, through a friend of a friend, I connected with Ms. Lilian, the program director of Sunflower Garden. She introduced me to the PreK classroom, where I collected data from a larger group of children. With all the paperwork completed around the beginning of November, I started my

fieldwork in the classroom as a volunteer. From then on, I visited the teachers and children once or twice a week until August 2022, when two cohorts of children graduated from the program. In most of my visits, I covered the entire school day from morning drop-off to afternoon pick-up and was able to observe many school activities.

3.4.2 Data collection

Data were collected via family background questionnaires, classroom observations, language tasks for the children, and sociolinguist interviews with the teachers in both classrooms (see detailed interview structure and questions in Appendix A). In the family background questionnaires, parents shared their children's demographic information, home language use, and literacy activities at home (see detailed questionnaire structure and questions in Appendix B). In classroom observations, classroom activities, including circle time, story time, cultural events, and birthday celebrations, were all recorded with audio files and field notes. To collect language data from the target children, three types of language tasks were conducted: an English oral language proficiency task, a Chinese receptive vocabulary proficiency task, and a story retelling task. Most children completed the three tasks at the beginning and the end of the school year. Details about the instrumental tools are explained in Chapter 5 and Chapter 6. Children's language use during the tasks was also audio recorded in the same way. At the end of the school year, all Chinese teachers in the two classrooms had a sociolinguistic interview with me. In the interviews, the teachers talked about their educational and language backgrounds, professional training, and teaching experiences in the school. The interviews were also audio recorded. All speakers, including teachers and children, were recorded with a Sony ICD-UX570 Digital Voice recorder and a lavalier lapel microphone placed on their collars. A Zoom H1n portable digital

audio recorder was placed next to the speaker at the same time as a backup solution. All audio files were recorded with a 44.1 kHz sampling rate, and field notes were kept for each event.

3.4.3 Fieldwork challenges and solutions

There are several challenges I encountered during my fieldwork in these two programs. The first was the coronavirus pandemic, which led to various restrictions and concerns. Due to its high infectiousness and fatality rate, especially when vaccination was unavailable at the beginning of the pandemic, many public institutions moved their services online, including schools. However, this did not apply to early childhood centers, and many had to shut down their business. For those who were still trying to keep their programs running, they had to follow several guidelines provided by the Centers for Disease Control and Prevention (CDC), as close interactions with infants, toddlers, and young children who might be more vulnerable to the disease were inevitable. To ensure that my visits to the two preschools would not increase the risks of exposing the children to outside sources of infection, I needed to provide a negative test result before I entered the classrooms every week. I also carefully followed all the guidelines for childcare providers, including disinfection, social distancing, vaccination, and wearing facial masks in the preschools. During the school year, cases occasionally occurred among individual teachers or children but did not cause large-scale infection in the programs.

Another problem I had to deal with in my research during the pandemic is that all individuals, including children at a very young age, needed to wear a facial mask to reduce the possibility of spreading disease. This practice affected the quality of audio recordings, which was the essential data of my fieldwork. Recording with a lavalier lapel microphone is an effective way to improve voice quality, so it was used for data collection in the current study.

Another challenge I had to solve was the participation of children aged three to five. Due to their young age, some had difficulties maintaining their attention or understanding the instructions during the tasks. To support children's engagement in the activities, I separated the tasks into short activities, which could be completed in 20-30 minutes. At the beginning of each task, I usually explained to the children the overall schedule of the activities and guaranteed that they would be rewarded with stickers or toys for their full participation in each activity. This strategy worked for most children. For others who had difficulties focusing on the activities for some particular reason (e.g., illness or emotional issues), I would conduct the tasks on another day. Sometimes children could not understand what they were expected to do with the tasks. One of the reasons lies in their limited language skills. I provided explanations and examples in English for English-dominant children and instructions in Mandarin for Mandarin-dominant children. Sometimes, children did not understand the tasks because, cognitively, they could not capture the abstract rules set within the linguistic stimuli. This only occurred in one or two children. When this happened, instructions and examples were explained using other words. If the child still could not understand, the particular task was skipped.

The last challenge in the fieldwork involved my multiple roles and the corresponding expectations in the research settings. As an ethnographic researcher, I expected myself to be viewed as an insider of the local community so that natural language practices would be accessible to me. To be an insider in a preschool classroom means I was expected to perform as a reliable childcare provider, responding to children's various needs. Children sometimes asked me to help them with their wounds, clothes, or conflicts with others. Through these interactions, I came to learn the characteristics of each child and their own ways of language use. At the beginning of the school year, I introduced myself and my purpose of joining the classroom to all

the teachers. They showed enthusiasm about theories and suggestions for language acquisition. It is also these teachers from whom I learned about children's family backgrounds, classroom performance, and daily language practices. I shared with the teachers my experiences and challenges teaching Chinese in the U.S., but not the specific language practices that I expected to observe in the fieldwork. In this way, teachers' self-consciousness about or attempt to alter their language use in the classroom was avoided. A close relationship between me and the research subjects was established through my participation in these school chores. However, I needed to remind myself now and then about my own role as a researcher who is expected to capture the patterns of subjects' language practices in a systematic way. The observer's paradox did not bother me for a long time. Teachers and children got used to my presence in the classrooms after a few weeks. However, balancing my roles as both an insider and an outsider working with the teachers and children was challenging. To keep this on track, I conducted weekly critical reflections in my field notes about the tasks I had managed as an insider and research goals I had achieved as an outsider. Based on these reflections, I was able to adjust my fieldwork in the following weeks accordingly.

3.5 Summary

In sum, this chapter first reviewed sociolinguistics as an interdisciplinary field. This was followed by an overview of the history, development, and implementation of ethnography as a research method in language research. The demographic backgrounds of the research subjects and the multilingual language practices in the two research settings were introduced. The research method adopted in the current study mainly relies on the ethnographic approach, with other data collection methods, including questionnaires, classroom observations, language tasks,

and sociolinguistic interviews. Challenges in the fieldwork and solutions were discussed at the end.

4. Variation in Teacher Speech

4.1 Introduction

In Hyper and Hypo-articulation theory, Lindblom (1990) proposed that "speech production is adaptive" (p. 403) and speakers can have their own choices "to vary their output along a continuum of hyper- and hypospeech" (p. 404) according to the context. Child-Directed Speech (CDS) is such a fine-tuning register which is modified phonetically, phonologically, morphologically, and syntactically (Snow, 1995). Studies (e.g., Foulkes et al., 2005; Grieser & Kuhl, 1988; Han et al., 2018; Kuhl et al., 1997; Tang et al., 2017) have identified some universal characteristics in CDS, such as shorter utterances, slower speaking rate, longer durations, a large number of repetitions, higher pitch, larger pitch range, and simplified vocabulary and syntactic structures across tested languages. Two possibilities are proposed to explain the observed modifications: the hyperarticulation hypothesis claims that the contrasts between different phonetic categories will be enhanced for learnability (Kempe et al., 2001; Kuhl et al., 1997; Tare et al., 2008) while the prosodic hypothesis states that the observed modifications are just due to the emotional expressions in CDS and adults expect to facilitate adult-child interaction by attracting the child's attention (Dominey & Dodane, 2004; Gauthier & Shi, 2011; Matychuk, 2005; Papoušek & Hwang, 1991; Trainor & Desjardins, 2002; P. Wong, 2018; P. Wong & Ng, 2018).

However, most current CDS studies mainly focus on input provided by caregivers, mothers most of the time, at home, while input in other settings, such as preschool, is often understudied for its linguistic role. As a critical setting where a child intensively develops their linguistic, cognitive, and socio-emotional skills, preschool serves as the first transitional step from home to the broader social environment where the child starts independent socialization

(Schwartz & Palviainen, 2016). Through interaction with teachers, preschoolers learn the group norms and how they are expected to express their needs in different contexts. In addition, compared with exposure to the dominant language in a community, linguistic input in a heritage language for young children is limited, and the primary language resource often comes from core family members (Cychosz, 2022; De Houwer, 2018; Duff et al., 2017; Montrul, 2010; Xiao, 2006). Whether and how heritage language children learn and use their home language outside the family is still unknown. Viewing teacher speech as another crucial part of CDS, this chapter investigates the characteristics of language input in the two English-Mandarin dual immersion preschools. Specifically, it examines the variation of syllable-initial sibilants /s/ and /ʂ/ in Mandarin classroom instruction for CHL children with various language backgrounds. Findings show that several linguistic constraints condition sibilant variation, including lexical tone, preceding and following sounds, word type, and sentence type. In addition, teachers tended to extend sibilant duration and emphasize the phonetic distinction between /s/ and /ʂ/ in classroom instruction for English-dominant children. Moreover, the mixed use of /s/ and /ʂ/, a typical dialectal feature in several Mandarin varieties, was identified in teacher speech to Mandarin-dominant children. This suggests that teachers adjust their use of sociolinguistic variants according to the context and that differences in children's language backgrounds may serve as one of the reasons for their choice of variants. Consequently, CHL children in the class had been exposed to various sociolinguistic variables outside their families. This would further affect their acquisition of variation and the development of sociolinguistic competence.

4.2 Literature review

4.2.1 Preschool teacher speech

Previous research on preschool teachers' speech has mainly explored language use in different classroom activities (Cabell et al., 2013; Dickinson et al., 2014; Dickinson & Keebler, 1989; Price et al., 2012). For example, Dickinson and Keebler (1989) demonstrated that by using different book-reading styles, daycare teachers constructed different speech events for 3- and 4-year-old children. Dickinson and colleagues (2014) further examined preschool teachers' language in Head Start programs in three settings: book reading, group content instruction, and small group instruction. Focusing on the use of vocabulary and syntactic complexity, the study revealed that (1) differences in teacher speech are primarily associated with settings; (2) book reading could foster an academic register by using analytical language; and (3) rich vocabulary input but not syntactic complexity was found to be significantly higher in the narrative text (Dickinson et al., 2014). Similarly, Price et al. (2012) compared teacher talk during storybook and information book read-aloud. Results showed that teachers tended to use more extratextual utterances during information book reading and favored reading storybooks more. Teachers' educational backgrounds and the age of the children in the class were related to the language teachers used during the read-aloud (Price et al., 2012). Lastly, the effectiveness of instructional interactions among different classroom settings was examined based on a large-scale data collection consisting of instructional interactions by 314 preschool teachers and children primarily from low-income families in eight states (Cabell et al., 2013). Statistical analysis showed that teachers demonstrated the most effective instruction in science activities and literacy-focused events during large group activities.

Language input in preschool may also function as a reliable predictor of various aspects of children's language development in the long term (Dickinson & Porche, 2011; Hadley et al., 2022; Huttenlocher et al., 2002; Piasta et al., 2012). For example, based on teacher speech collected from 40 preschool classrooms, Huttenlocher et al. (2002) found that the syntactic complexity in the classroom linguistic input was positively associated with children's performance in the syntax comprehension text after a year. In a longitudinal study, Dickinson and Porche (2011) revealed that (1) the use of low-frequency words by preschool teachers significantly predicted the children's reading comprehension in fourth grade; and (2) teachers' correction in preschool classes was also associated with children's receptive vocabulary in the fourth grade. In addition, Piasta et al. (2012) investigated the relationship among professional development, preschool teachers' conversational responsivity, and children's language outcomes. Findings showed that trained teachers adopted significantly more communication-facilitating strategies to promote children's participation in class. Consequently, children with trained teachers demonstrated greater linguistic productivity and complexity in the assessments (Piasta et al., 2012). In a recent systematic review, Hadley et al. (2022) interpreted 54 related studies to examine the relationship between teacher language use and children's oral language outcomes. The most typical methodology adopted to investigate teacher language is recording segments of classroom activities, transcribing the interactions between teachers and children in the class, and coding the utterances by teachers. Four critical strands of teacher language practice were identified: conceptual talk, interactive talk, linguistic features, and management and literal talk. Generally, preschool teachers can support children's oral language development by using various communicative strategies tailored to specific contexts. And children's oral language in early childhood can predict their later reading comprehension (Hadley et al., 2022).

4.2.2 Child-directed speech

In contrast to the language teachers use in class, caregivers' linguistic input at home is often explicitly modified according to the child's needs. This language genre is also known as parental speech, maternal speech, motherse, or child-directed speech (CDS) (Grieser & Kuhl, 1988; Liu et al., 2009; Tare et al., 2008; Zellou & Scarborough, 2015). Universal characteristics of CDS have been identified across languages, including short utterances, longer duration, repetition, parental addition, phonetic clarification and enhancement, simplified structures, and salient prosodic patterns (e.g., Foulkes et al., 2005; Grieser & Kuhl, 1988; Han et al., 2018; Kempe et al., 2001; Kuhl et al., 1997; Lahey & Ernestus, 2014; Liu et al., 2009; Tang et al., 2017). As a fine-tuning speech register, CDS has been examined in terms of its unique modifications compared with other registers (e.g., Adult-directed speech or ADS, Foreigner-Directed-Speech or FDS, and Lombard Speech or speech in a noisy environment), the possible functions of these adjustments, and the effects on child language development (Snow, 1995, 2019).

CDS can be modified for phonetic distinction. For example, Kuhl et al. (1997) compared the realization of three corner vowels /i, a, u/ in English, Russian, and Swedish Infant-Directed Speech (IDS) and found that the vowels were hyperarticulated with stretching of the vowel space area. Studies also demonstrated that rich vocabulary input in CDS contributes to children's later vocabulary knowledge (e.g., Rowe, 2012). In addition, CDS may also be adjusted for the social meanings behind the linguistic variation. For example, in the use of British English /t/ in word-medial and word-final prevocalic contexts, adults tended to use more standard variants with girls and more vernacular versions with boys. This differentiation by gender was most apparent for the youngest children aged 2;0 (Foulkes et al., 2005). Moreover, the extent CDS that is modified

is associated with parents' socioeconomic status. Rowe (2008) reported that parents with better educational backgrounds and higher family income tended to talk more, use more diverse vocabulary, and produce longer utterances with their young children. However, the differentiation caused by socioeconomic status could be mediated by parental knowledge of child development (Rowe, 2008). Similarly, in Hebrew and English CDS, caregivers with high socioeconomic backgrounds provided more successive utterances with partial self-repetitions to support children's language learning in both languages (Tal & Arnon, 2018). Schwab and Lew-Williams (2016) reviewed recent research on language input for children from different socioeconomic groups. Parental socioeconomic status was found to be a significant predictor of the quantity and quality of linguistic input in perspectives of vocabulary, grammar, and pragmatic functions. This is further associated with children's language development longitudinally. Differences in input and learning also exist within socioeconomic-status groups (Schwab & Lew-Williams, 2016).

4.2.3 Language input for bilingual and heritage children

An increasing number of children are growing up in linguistically diverse environments (De Houwer, 2018). Both the linguistic input for these children and the extent to which they can acquire the language(s) they have been exposed to in the environment are highly variable. However, with current evidence in hand, recent studies on preschool teacher speech for bilingual children have demonstrated convergent conclusions regarding the relationship between language input and children's learning outcomes across languages (Aukrust, 2007; Bowers & Vasilyeva, 2011; K. C. J. Chan et al., 2022; Sawyer et al., 2018). To illustrate the role of preschool instruction in L2 vocabulary acquisition, Aukrust (2007) investigated the amount, diversity, and complexity of teacher speech addressing Turkish-speaking children who were learning

Norwegian as a second language. Findings showed that the quantity and quality of preschool teacher speech predicted children's subsequent Norwegian L2 vocabulary in the second grade (Aukrust, 2007). Bowers and Vasilyeva (2011) compared language input provided for monolingual children and preschoolers who were learning English as an additional language (EAL). Teacher speech was measured by input quantity, lexical diversity, and syntactic complexity. Results demonstrated that different factors contributed to the progress of vocabulary in the two groups: lexical diversity in the input predicted vocabulary gain in monolingual children, whereas syntactic complexity in the input significantly affected vocabulary progress in EAL children (Bowers & Vasilyeva, 2011). Similarly, Kin Chung Chan et al. (2022) reported that when preschool teachers talked to monolingual children who demonstrated higher proficiency in English, they tended to use more diverse vocabulary and more complex syntactic structures. This suggests that teachers were sensitive to children's distinctive language capabilities and would adapt their language use accordingly (K. C. J. Chan et al., 2022). Lastly, Sawyer et al. (2018) examined the preschool language input for Spanish-English dual-language learners from low-income families. Results indicated that teachers, including lead teachers and assistant teachers, predominantly used English in class. Variation for children with various language proficiency levels was not identified. This may imply the necessity of professional development for teachers in low-income communities.

Only a few recent studies have begun to investigate the language input provided for heritage language children in local communities (Cychosz, 2022; Daskalaki et al., 2019, 2020; Serratrice, 2020; Starr, 2016; Unsworth, 2019). For example, Daskalaki et al. (2019, 2020) illustrated the role of parental input on the acquisition of subject realization by Greek-English bilingual children who were learning Greek as a heritage language in North America. By

comparing different groups of children with monolingual backgrounds and various exposure to the heritage language, the studies demonstrated that the language input that heritage children received at home may be qualitatively different from that for monolingual children in terms of the distribution of subject placement, and this may contribute to the high rate of preverbal subjects used by Greek heritage children (Daskalaki et al., 2019, 2020). At the same time, language shift has not only been identified in heritage language speakers themselves but also in the communities. To investigate how rapid language shift in the environment may affect language input for heritage children and their language learning outcomes, Cychosz (2022) examined the phonetic development by Quechua heritage children in a Quechua-Spanish bilingual community in southern Bolivia. Results showed that language input at home was Spanish-dominant, and the language shift in the community resulted in different learning outcomes in the children. Specifically, children's expressive language experience is closely related to their coarticulation-morphological skills, while children's receptive experience predicted their vowel variation (Cychosz, 2022). In the investigation of variation acquisition by Chinese Mandarin heritage children in a two-way English-Mandarin immersion program in California, Starr (2016) explicitly analyzed the language input provided by teachers in class. The study focused on the variation of Mandarin syllable-initial sibilants /t͡s, t͡sʰ, s/ and /t͡ʂ, t͡ʂʰ, ʂ/, and revealed the mixed use of the variables in teacher speech. However, teachers' dialectal backgrounds and the types of classroom events also affected the variable patterns (Starr, 2016). In sum, heritage children are often exposed to a variety of language input, including input with various dialectal features and input from native speakers, first-, second-, and even third-generation heritage speakers (Serratrice, 2020). This is qualitatively and quantitatively different

from the input for monolingual learners and could result in divergence in their learning outcomes (Polinsky & Scontras, 2020; Unsworth, 2019).

4.3 The current study

This chapter focused on the language input provided for CHL children in two dual English-Mandarin dual immersion preschools. Children who have been exposed to Chinese languages at home consist of a crucial part of the student population in the United States (McFarland et al., 2018). However, CHL education for young children primarily relies on families and language programs in local communities (Duff et al., 2017; Xiao, 2016). Recent studies have begun to explore the construction and reconstruction of learners' identities during the teaching and learning of CHL (Fang & Duff, 2018; He, 2001; W. Li, 2011, 2014; W. Li & Zhu, 2013; K. Wong & Xiao, 2010), the acquisition of particular linguistic features by CHL learners discourse patterns (C. B. Chang & Yao, 2016; J. Hao & Chondrogianni, 2023; L. Jia & Bayley, 2008; R. Jia & Paradis, 2020; Mai et al., 2018; X. Zhang, 2021), and CHL language practice in class and family (S. H. Chen et al., 2021; Curdt-Christiansen, 2006; He, 2001; M. Li, 2005; Xiao, 2006). Few studies have examined the variability of language input for young CHL children outside the family. To fill this gap, the current study investigated the variation in Mandarin syllable-initial sibilants /s/ and /ʂ/ in teacher speech as an understudied type of CDS addressing CHL preschoolers. The mixed use of alveolar and retroflex sibilants, including /s/ and /ʂ/, is common in several Mandarin dialects, such as Taiwan Mandarin (Y. S. Chang & Shih, 2015; Chiu et al., 2020; F. Li, 2017). This research aims to answer the following questions:

1. Do teachers change their ways of using this sociolinguistic variable when talking to CHL children in class, and if so, how?
2. What kind of social and linguistic factors constrain sibilant variation in the CHL input?

4.3.1 Research settings

Teacher speech data were collected in the 2021-2022 academic year from three teachers in two preschools. With the increase of Chinese immigrants in recent years, various early childhood centers that provide Chinese learning programs have burgeoned in local communities. One of the preschools, Lily Valley, is located in the San Francisco Peninsula, where many early Chinese immigrants from the southern parts of China have resided for generations. As a family-based preschool, Lily Valley serves eight to ten children every academic year in a mixed-age classroom and adopts English and Mandarin at a 50/50 ratio for classroom instruction. Most children speak English as the dominant language at home. Considering this, teachers usually include more English to facilitate their teaching and classroom management. During circle time, when teachers are giving formal instructions, they often try to provide the same information by saying one sentence in English and the next one in Mandarin or vice versa. The other preschool, Sunflower Garden, is located in South Bay, which also has a long history of hosting Chinese immigrants and attracts more newcomers from mainland China with higher educational levels and socioeconomic status. In contrast to Lily Valley, Sunflower Garden runs several programs for infants, toddlers, and children of different ages. Each classroom has at least two teachers: an English teacher who only speaks English and a Chinese teacher who mainly speaks Mandarin with the children. As the two languages are spoken by different teachers, English and Mandarin are used in a 50/50 ratio. Teachers host circle time for instruction separately for different languages, although code-switching occasionally occurs during Mandarin instruction. Among 36 children in the PreK classroom in Sunflower Garden, more than half have at least one native Mandarin-speaking parent, while some parents are heritage speakers themselves. However,

compared to their peers in Lily Valley, children in Sunflower Garden are more Mandarin-dominant in general.

The background information of the three teachers who participated in this study is shown in Table 4.1. Ms. Daisy comes from Wuhan, China. Ms. Daisy has been the lead teacher in Lily Valley for four years and is responsible for curriculum design, classroom management, and all instructional activities. She uses both English and Mandarin in her class. Ms. Olivia is the director of Lily Valley and is in charge of the whole program's operation. She is from a Chinese immigrant family from Taiwan. In the classroom, Ms. Olivia speaks in English with the children most of the time and introduces some Mandarin expressions during circle time and story time. Lastly, Ms. Cindy is the Chinese teacher in the PreK class in Sunflower Garden. As mentioned earlier, another English teacher is responsible for English instruction in class, so Ms. Cindy mainly uses Mandarin to address children in her class. All the teachers are experienced early childhood educators and have more than five years of experience working with CHL children in California.

Table 4.1 Background information of the participants

Teacher	Gender	Age	School	Place of origin
Ms. Daisy	F	43	Lily Valley	Wuhan
Ms. Olivia	F	41	Lily Valley	Taipei
Ms. Cindy	F	45	Sunflower Garden	Guangzhou

4.3.2 Data collection

Data were collected via weekly classroom observations, family background questionnaires, and teacher interviews. For the entire school year, I visited each classroom once a week to observe and audio-record various school activities, including circle time, story time, cultural events, and birthday celebrations in both programs. To better understand the language backgrounds of the children in the two classrooms, I also invited parents to fill out the family background questionnaires in which they shared their children's demographic information, home language use, and literacy activities at home. In the interviews, the teachers talked about their educational and language backgrounds, professional training, and teaching experiences in the school (see detailed interview structure and questions in Appendix A). All audio recordings were collected with a Sony ICD-UX570 Digital Voice recorder with a lavalier lapel microphone at a 44.1 kHz sampling rate. Field notes were kept for each observation. In total, I completed more than 500 hours of classroom observation with about 52 hours of audio recordings. For data analysis in this study, I randomly selected eight classroom events for each teacher. Classroom recordings and interview recordings were transcribed in text.

4.3.3 Sibilant variation

To examine sibilant variation in teacher speech, I focused on the realization of Mandarin syllable-initial sibilants /s/ and /ʂ/ as the target tokens. As discussed earlier, /s/ and /ʂ/ are often mixed in several Mandarin varieties, such as Taiwan Mandarin and some Southern and Northern Mandarin dialects (Brubaker, 2012; Y. S. Chang & Shih, 2015; Chiu et al., 2020; F. Li, 2017; Starr, 2016; Wen-Chao Li, 2004). As two voiceless fricatives in Mandarin, alveolar /s/ and postalveolar /ʂ/ mainly contrast in their places of articulation (W.-S. Lee & Zee, 2018; F. Li & Munson, 2016). In the merger of /s/ and /ʂ/, it is more common to find sibilant dentalization in

which retroflex sibilants such as /ʂ/ are realized as alveolar sibilants such as /s/. For example, in Table 4.2 sentence 1, the second character "***shān***" in the word volcano "huǒ ***shān***" was realized as "***sān***". On the contrary, alveolar sibilants may also be hypercorrected as the corresponding retroflexes. As shown in sentence 2, the first character "***suǒ***" on the determiner all "***suǒ*** yǒu" was hypercorrected as "***shuǒ***". Both phonetic environment and social factors of the speakers constrain the differentiation of the sibilants. For linguistic constraints, Starr (2016) noted that preceding rounded vowels might lead to a retroflex realization. For social factors, Fangfang Li (2017) revealed that female adult speakers' production of the palatal fricative /ɕ/ was more anterior than that of males. This finding echoes recent findings in /s/ vs. /ʃ/ gender variation in English (Stuart-Smith, 2020). Starr (2016) illustrated that standard sibilants were used more by Chinese teachers in formal settings such as reading and instruction, whereas dentalized sibilants tended to be used in non-instructional events and behavior management. For Mandarin monolingual children, /ɕ/ is acquired first, followed by /ʂ/, then /s/ (F. Li & Munson, 2016). However, the gender-related differentiation of sibilants occurs around four-year-old and becomes more robust at the age of five (F. Li, 2017).

Table 4.2 Linguistic examples _ teacher speech

(1) sibilant dentalization: **retroflex sibilant /ʂ/ 'sh' is dentalized as alveolar sibilant /s/ 's'**						
原来	美国	有	那么	多	火山。	
Yuán lái	měi guó	yǒu	nà me	duō	huǒ **sān**	
It turns out	the United States	have	so	many	volcano	
'It turns out that there are so many volcanoes in the United States.'						
(2) sibilant hypercorrection: **alveolar sibilant /s/ 's' is produced as post alveolar sibilant /ʂ/ 'sh'**						
所有	的	庄稼	都	被	烧焦	了。
Shuǒ yǒu	de	zhuāngjia	dōu	bèi	shāo jiāo	le
All	DE	crop	all	PASS	scorch	LE
'All the crops were scorched.'						

4.3.4 Data analysis

The realization of sibilants was measured by several acoustic parameters, including sibilant duration, F2 value at the onset of the following vowel, and spectral moments analysis of the target sibilant (F. Li, 2009). Although /s/ and /ʂ/ can be identified as categorical phonetic contrasts, many previous acoustic studies have pointed out that the sibilant space or the space between the constriction points of /s/ and /ʂ/ is continuous in the same axis of front-back articulation (Gunter et al., 2021; F. Li, 2009; F. Li & Munson, 2016). Acoustically, /s/ is produced with higher resonant frequencies than /ʂ/ or /ʃ/ in English, Japanese, and Mandarin (Reidy, 2016). Recent studies showed that the phonetic distinction between /s/ and /ʂ/ can be captured by spectral moments analysis which consists of the first spectral moment (M1) or the centroid frequency, the second spectral moment (M2) or the standard deviation of the fricative

spectrum, the third spectral moment (M3) or the skewness of the spectral shape, and the fourth spectral moment (M4) or the kurtosis of the spectral shape (F. Li, 2009; Reidy, 2016). As M2 and M4 only distinguish sibilants from non-sibilant consonants, these two parameters were not involved in the analysis. In addition, Fangfang Li (2009) pointed out that F2 frequency at the onset of the following vowel may better reflect the contrasts among /s, ʂ, ɕ/ in Mandarin. Based on the explanations given in Fangfang Li (2009), Table 2 presents all the acoustic parameters tested in the target sibilants in the current research. Acoustic parameters were measured in Praat with a spectral moments analysis script with 15-ms window size, 6 window number, and high-pass filter at 300 Hz (Boersma & Weenink, 1992; DiCanio, 2021).

Table 4.3 Acoustic parameter of the target sibilant

Parameter	**Definition**	**Tentative articulatory interpretation**
Sibilant duration	The temporal interval between the beginning and end of the target sibilant	Sibilant duration may vary in different contexts
Centroid frequency (M1)	The weighted mean frequency in the fricative spectrum	M1 negatively correlates with the length of the front resonating cavity
Skewness (M3)	The extent the spectral shape is skewed by subtracting the frequency range of the spectrum below the centroid from that above the centroid	M3 indicates the energy concentration in the frequencies; /ʂ/ should have a positive value while /s/ should have a negative value
Onset F2	The F2 value at the onset of the following vowel	Onset F2 negatively correlates with the length of the back resonating cavity

The linguistic environment and contextual types of the target sibilants were also coded. Linguistic constraints were measured as preceding sound, following vowel, lexical tone, word type, and sentence type. Preceding sounds consist of vowels (unrounded /i, e, a/ and rounded /y, u, o/), nasals (/n, ŋ/), retroflex /ɻ/, and pause. Following vowels are unrounded /i, e, a/ and rounded /y, u, o/. Five lexical tones were coded, including T1, T2, T3, T4, and T0 or neutral tone. Word type is categorized as noun, verb, determiner, classifier, numeral, adjective, adverb, conjunction, complement, and wh word. Sentence types consist of declarative, imperative, exclamation, and question. Three types of contexts were coded, including classroom informational instruction, classroom management rule, and sociolinguistic interview. However, /s/ in classroom management speech only occurred at a rate of 2.11%, so the two classroom contexts were combined. In total, 1896 tokens were coded, including 583 /s/ and 1313 /ʂ/ from three teachers.

Linear mixed-effect models and multiple logistic regression analyses were conducted in R to examine the functions of linguistic environment and context on sibilant variation (D. E. Johnson, 2009; Kuznetsova et al., 2017). In the four rounds of analyses, variation in all target sibilants was measured first, followed by variation in /s/ and /ʂ/ separately, then sibilant realization by individual speakers. In the analyses, each acoustic parameter was set as the dependent variable, while independent variables consisted of factors in the linguistic environment and context type. Factors were excluded in each analysis when the number of tokens in a particular factor was lower than 1% of the total amount. Factors were combined when the combination was linguistically eligible. The individual speaker was set as the intercept.

4.4 Findings

4.4.1 In all target sibilants

Table 4.4 and Table 4.5 show the statistical results of sibilant variation in terms of sibilant duration with both categories: alveolar /s/ and post-alveolar /ʂ/. The effect of the initial sibilant did not reach significance in neither model, which indicates that the realizations of /s/ and /ʂ/ did not vary significantly from each other in terms of sibilant duration. The duration variation in these two sibilants combined as an entire variable group is constrained by context, word type, sentence type, preceding sound, and lexical tone. For contextual effect, teachers tended to extend the sibilant duration in classroom speech and produced sibilants with shorter duration in the interviews. Sibilant duration is significantly longer in class speech than in interviews as a genre of ADS. This resembles the universal modification in CDS, as previous studies illustrated (Snow, 1995). For word type effect, sibilants tended to be produced longer when they occurred in nouns, numerals, classifiers, which were often emphasized as key information in the speech, compared with those in wh words and other components. In addition, although imperatives and questions were involved in both registers, sibilants were mainly prolonged in declarative sentences. Also, when there were pauses or /ɻ/ occurred before the sibilants, they tended to be realized longer. Lastly, sibilants that occurred in T3 and T4 were longer than those in T2 and T1.

Table 4.4 Multiple regression result _ sibilant duration (s)

Factor group	Factor	Coefficient	N	Mean
Context	Class	0.017	892	0.108
	Interview	-0.017	970	0.084
Word	NP	0.021	965	0.110
	VP	0.002	569	0.082
	W	-0.007	143	0.066
	Other	-0.015	185	0.083
Sentence	Declarative	0.018	1561	0.099
	Imperative	-0.004	66	0.093
	Question	-0.014	235	0.076
Preceding	Pause	0.015	322	0.123
	/ɻ/	0.004	42	0.123
	Vowel	-0.009	1153	0.008
	Nasal	-0.010	345	0.092
Tone	T3	0.008	205	0.103
	T4	0.003	812	0.098
	T2	-0.003	328	0.087
	T1	-0.008	517	0.094
N = 1862, df = 15, log-likelihood = 3348.03, intercept = 0.084, overall mean = 0.096				

Table 4.5 Mixed-effect result _ sibilant duration (s)

Effect	Estimated coefficient	Std. error	P value
Intercept	1.208e-01	1.501e-02	0.012
Word_O	-3.559e-02	3.796e-03	< 2e-16
Word_VP	-1.889e-02	2.359e-03	2.04e-15
Word_W	-2.755e-02	4.947e-03	2.93e-08
Context_interview	-3.376e-02	2.287e-03	< 2e-16
Preceding_r	1.366e-02	6.713e-03	0.042
Preceding_V	5.341e-04	2.577e-03	0.836
Preceding_pause	2.494e-02	3.269e-03	3.70e-14
Sentence_imperative	-2.184e-02	5.313e-03	4.13e-05
Sentence_question	-3.145e-02	3.629e-03	< 2e-16
Tone_2	5.590e-03	3.435e-03	0.104
Tone_3	1.623e-02	3.735e-03	1.46e-05
Tone_4	1.105e-02	2.410e-03	4.86e-06

Although the two sibilants were combined in this section to examine the variation in sibilant duration, they still serve as two contrastive categories in Mandarin phonology. Therefore, in the following analyses, /s/ and /ʂ/ were interpreted separately. If /s/ and /ʂ/ were mixed in certain contexts, most or at least some acoustic parameters would demonstrate similar

patterns. If /s/ and /ʂ/ were mostly used as two distinctive categories, then their acoustic parameters should be distinguishable in most contexts.

4.4.2 In each phonetic category

In the second round of multiple regression analyses, alveolar sibilant /s/ and postalveolar sibilant /ʂ/ were examined separately to identify the specific variation in each phonetic category. The contextual variation in the two sibilants was reflected in different acoustic parameters.

The contextual and linguistic constraints on /s/ are demonstrated in Table 4.6. Centroid frequency is significantly constrained by rhyme, sentence type, lexical tone, and preceding sounds. /s/ tended to be realized with higher centroid frequency or more like an /s/ sound when the sibilant occurred before an unrounded vowel, in a declarative sentence, in T3 and T1, and after /ɻ/. The onset F2 value was only affected by context and tone. The sibilant tended to be produced with higher onset F2 or more like a /ʂ/ sound in the interview and in T1. Lastly, the skewness of the sibilant was significantly constrained by rhyme, sentence type, and tone. Specifically, a positive skewness, which is a typical feature of /ʂ/, tended to occur when the sibilant was followed by a rounded vowel, in a non-declarative sentence, and in T4 or T1. In sum, the effect of context is only identified in onset F2, whereas other linguistic constraints, especially the effect of lexical tone, demonstrate systematic patterns in general.

Table 4.6 Multiple regression result _ variation in /s/

Factor group	factor	Coefficient	N	Mean
Centroid frequency				
Rhyme	Unrouded vowel	643.163	371	6796.219
	Rounded vowel	-643.163	190	5791.157
Sentence	Declarative	805.331	520	6608.205
	Non-declarative	-805.331	41	4523.179
Tone	T3	504.336	98	6399.945
	T1	-32.827	229	7112.235
	T4	-471.509	234	5836.841
Preceding	/ɻ/	843.589	30	8068.211
	Pause	-93.139	163	6625.949
	Vowel	-274.128	239	6467.931
	Nasal	-476.322	129	5843.454
N = 562, df = 10, log-likelihood = -5112.51, intercept = 5937.43, overall mean = 6455.82				
Onset F2				
Context	Interview	32.968	296	1834.802
	Class	-32.968	265	1781.727
Tone	T1	34.355	229	1840.842

	T4	-13.785	234	1782.119
	T3	-20.570	98	1802.961
N = 561, df = 6, log-likelihood = -3783.767, intercept = 1799.236, overall mean = 1809.731				
Skewness				
Rhyme	Rounded vowel	0.331	190	0.207
	Unrounded vowel	-0.331	371	-0.296
Sentence	Non-declarative	0.359	41	0.701
	Declarative	-0.359	520	-0.191
Tone	T4	0.236	234	0.106
	T1	0.016	229	-0.397
	T3	-0.252	98	-0.048
N = 561, df = 7, log-likelihood = -832.051, intercept = 0.193, overall mean = -0.126				

Table 4.7 shows the results of multiple regression analysis of variation in /ʂ/. Similarly, the effect of context is only identified in onset F2, while other linguistic constraints are largely systematic. Centroid frequency is only affected by lexical tones. The sibilant tended to be realized with higher centroid frequency or more like an /s/ sound in T3 and T4 syllables. However, the onset F2 value is constrained by more factors, including rhyme, context, word type, tone, and preceding sound. The sibilant tended to be realized with higher onset F2 or more like a /ʂ/ sound when it occurred before an unrounded vowel, in classroom speech, in nouns, numerals, classifiers, and verbs, in T3 and T4, and after a pause. Lastly, the skewness of the

sibilant tended to be positive, which means the sibilant sounded more like a /ʂ/ sound when it occurred in T3 and T4. Again, linguistic constraints are systematic, and the effect of context is only significant in onset F2.

Table 4.7 Multiple regression result _ variation in /ʂ/

Factor group	factor	Coefficient	N	Mean
Centroid frequency				
Tone	T3	119.823	106	4525.750
	T4	82.030	578	4633.566
	T2	-71.233	323	4529.515
	T1	-130.619	288	4597.024
N = 1295, df = 6, log-likelihood = -10910.67, intercept = 4544.354, overall mean = 4590.662				
Onset F2				
Rhyme	Unrounded vowel	137.174	973	2014.382
	Rounded vowel	-137.174	311	1835.790
Context	Class	49.209	617	2007.005
	Interview	-49.209	667	1937.935
Word	NP	66.346	537	2008.609
	VP	51.230	530	1952.999
	O	-39.660	74	1941.223
	W	-77.916	143	1913.021
Tone	T3	88.793	106	1991.486
	T4	1.530	578	2007.111
	T2	-19.755	312	1988.867

	T1	-70.568	288	1872.188
Preceding	Pause	47.751	158	2049.428
	Nasal	-12.959	214	1973.438
	Vowel	-34.792	912	1957.017
N = 1284, df = 13, log-likelihood = -9038.093, intercept = 1893.029, overall mean = 1971.125				
Skewness				
Tone	T3	0.170	106	0.769
	T4	0.063	578	0.619
	T1	-0.061	288	0.446
	T2	-0.172	312	0.379
N = 1284, df = 6, log-likelihood = -1824.978, intercept = 0/556, overall mean = 0.535				

In conclusion, linguistic constraints including preceding, rhyme, tone, word type, and sentence type affect sibilant variation systematically, whereas the effect of context is only revealed by the significant difference in onset F2. By comparing the onset F2 differences in the two registers, the patterns indicate that /s/ was modified less than /ʂ/ for their phonetic distinction in CDS (class speech) and ADS (interview). In other words, /ʂ/ tended to be realized as its standard form in CDS and dentalized as an /s/-like sibilant in ADS, whereas the articulatory position of /s/ tended to be closer to that of /ʂ/ in ADS.

4.4.3 By programs and teachers

As shown in Table 4.8, individual variation plays an important part in the results. That is to say, when talking to CHL children with different Mandarin backgrounds, different teachers adopted different strategies to modify linguistic input in their classroom speech. Both Ms. Daisy and Ms. Olivia were from Lily Valley, where English-dominant children were involved in classroom activities. And their patterns of sibilant variables show similarities. Sibilants were produced with a longer duration in class speech. /s/ and /ʂ/ were distinguished by centroid frequency, skewness, and onset F2. The phonetic distinction between /s/ and /ʂ/ was enhanced in CDS. In contrast, for Ms. Cindy from Sunflower Garden, where the student population mainly consisted of Mandarin-dominant CHL children, the contextual effect on sibilant variation is reversed. The two sibilants were not distinguished in terms of duration, and the contextual effect was not identified in sibilant duration as well. At the same time, /s/ and /ʂ/ were distinguished by centroid frequency, skewness, and onset F2. For contextual effect, sibilants were produced with higher centroid frequency, higher skewness, and higher onset F2 in interviews. In sum, Lily Valley teachers tended to emphasize the phonetic distinction of the sibilants in CDS and ADS when talking to English-dominant children, while the Sunflower Garden teacher did not extend sibilant duration in CDS. The phonetic distinction between /s/ and /ʂ/ was enhanced slightly as measured by skewness and onset F2 in ADS instead of CDS.

Table 4.8 Contextual effect grouped by teachers

Teacher	Acoustic parameter	Effect	Estimated coefficient	Std. error	t-Value
Ms. Daisy (Lily Valley)	Duration	(intercept)	0.100165	0.025533	3.923 ***
		sibilant_ʂ	0.003422	0.003850	0.889
		context_interview	-0.034991	0.002573	-13.597 ***
	Centroid frequency	(intercept)	8097.83	1138.47	7.113 ***
		sibilant_ʂ	-1293.53	171.65	-7.536 ***
		context_interview	-91.76	114.75	-0.800
	Skewness	(intercept)	-0.873403	0.761575	-1.147
		sibilant_ʂ	0.553566	0.114823	4.821 ***
		context_interview	-0.271716	0.076760	-3.540 ***
	Onset F2	(intercept)	2199.803	206.788	10.638 ***
		sibilant_ʂ	271.577	31.177	8.711 ***
		context_interview	-102.880	20.842	-4.936 ***
Ms. Olivia (Lily Valley)	Duration	(intercept)	0.118096	0.032768	3.604 ***
		sibilant_ʂ	0.015602	0.008140	1.917. .
		context_interview	-0.051370	0.006835	-7.515 ***
	Centroid frequency	(intercept)	6815.82	862.46	7.903 ***
		sibilant_ʂ	-3378.95	214.24	-15.772 ***

		context_interview	-763.65	179.91	-4.245 ***
	Skewness	(intercept)	-0.375478	0.611144	-0.614
		sibilant_ʂ	1.434024	0.151811	9.446 ***
		context_interview	-0.491233	0.127482	-3.853 ***
	Onset F2	(intercept)	1973.64	207.22	9.524 ***
		sibilant_ʂ	295.88	51.47	5.748 ***
		context_interview	-202.24	43.22	-4.679 ***
Ms. Cindy (Sunflower Garden)	Duration	(intercept)	0.0449506	0.0334498	1.344
		sibilant_ʂ	0.0008187	0.0047331	0.173
		context_interview	-0.0027873	0.0036812	-0.757
	Centroid frequency	(intercept)	4471.93	1506.55	2.968 **
		sibilant_ʂ	-918.18	213.17	-4.307 ***
		context_interview	599.23	165.80	3.614 ***
	Skewness	(intercept)	-0.1940063	0.9335414	-0.208
		sibilant_ʂ	0.2865006	0.1320936	2.169 *
		context_interview	0.7485165	0.1027373	7.286 ***
	Onset F2	(intercept)	1496.041	183.534	8.151 ***
		sibilant_ʂ	43.979	25.970	1.694 .
		context_interview	68.928	20.198	3.413 ***
Significance levels = 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’					

4.5 Discussion

4.5.1 Linguistic environments and discourse contexts

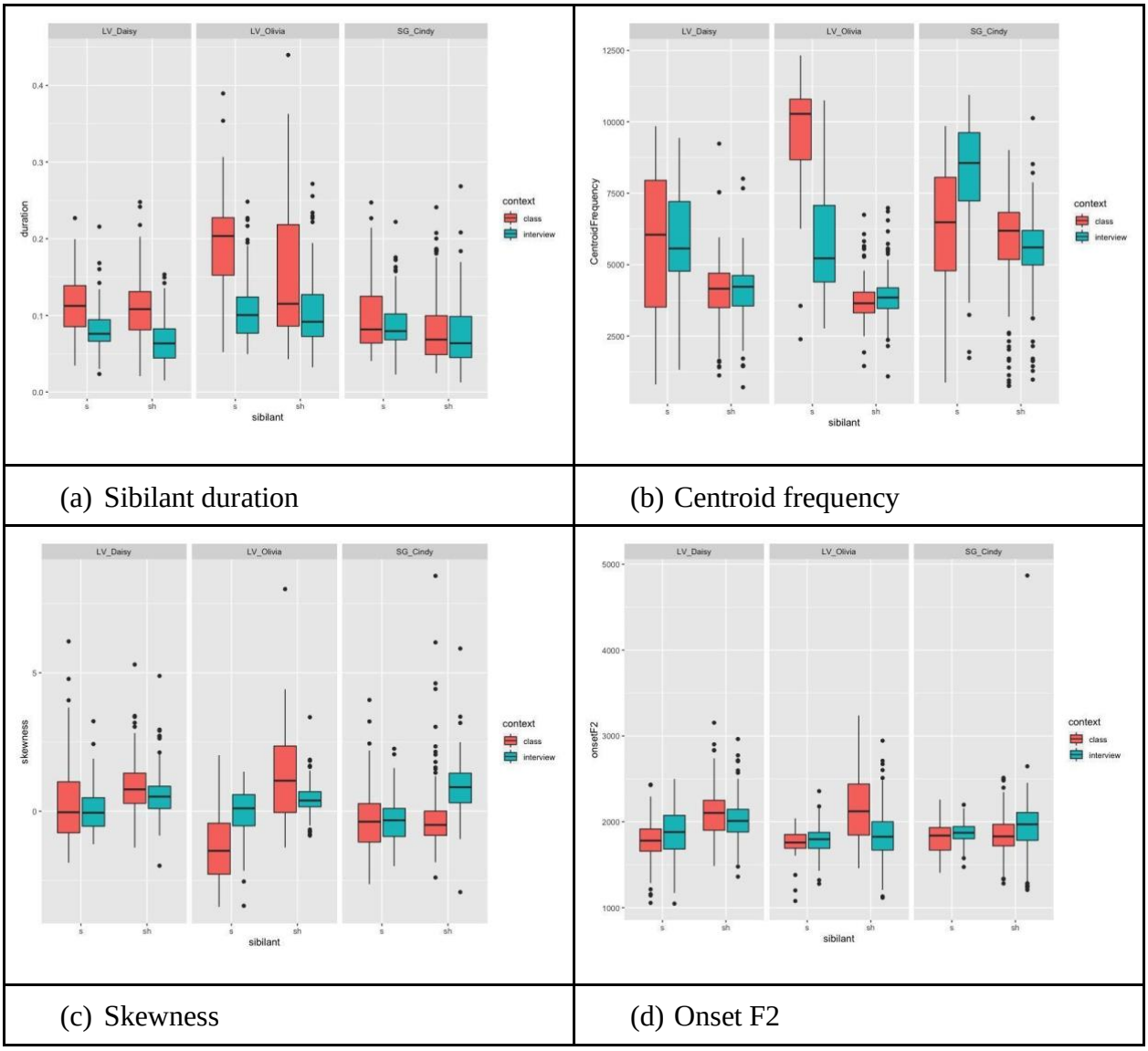
Previous studies have indicated /s/ vs. /ʂ/ or /ʃ/ variation in various linguistic environments and genres across languages (Ahlers & Meer, 2019; Y. S. Chang & Shih, 2015; Chiu et al., 2020; Gunter et al., 2021; Kallay & Holliday, 2012; F. Li, 2009, 2017; F. Li & Munson, 2016; Reidy, 2016; Stuart-Smith, 2020). Among those, most data were spontaneous speech collected from native adult speakers, and particular parameters of sibilant realization were measured. For instance, /s/ in English varieties is often found to retract before consonants, in consonant clusters, and in /str/ cluster particularly (Ahlers & Meer, 2019; Gunter et al., 2021), whereas /ʃ/ variation is more stable and less variable than /s/ in English (Gunter et al., 2021). In Mandarin, sibilants only occur at the beginning of syllables that end with either nasals or vowels. Therefore, the articulatory position of preceding and following sounds significantly affects the sibilant variation in most contexts, as coarticulation would facilitate the production of juxtaposed sounds in continuous speech. Moreover, few previous studies included pragmatic functions the lexicon carried within the phonetic units in a particular context. This is measured by word type and sentence type in this study. Some critical information, such as new vocabulary, numbers, and wh words, was often emphasized in the sibilant variation by enhancing the phonetic distinction between /s/ and /ʂ/ in class speech. Similarly, sibilant realization in imperative sentences and questions was also distinguished by teachers in their instruction. Lastly, the sibilant variation is asymmetric in Mandarin as in some English varieties, but in a contradictory way. Previous studies pointed out that in English voiceless sibilant variation, /s/ is often observed to retract to /ʃ/, while /ʃ/ does not appear to front to /s/ (Gunter et al., 2021). However, data in the current study demonstrate that in the sibilant variation in Mandarin, the realization of s is less variable,

while /ʂ/ is often dentalized in causal contexts. This also echoes to previous findings in teacher speech for CHL elementary students (Starr, 2016). The phonetic environment allowed by English and Mandarin grammar may explain part of the observed differences. /s/ and /ʃ/ in English can occur after consonant, vowel, nasal, and pause, and before consonant, vowel, nasal, and pause. While the phonetic environment for Mandarin /s/ and /ʂ/ is much more restricted. Mandarin sibilants can only occur after vowel, nasal, and pause, and before vowel. But this cannot account for the asymmetric Mandarin sibilant variation: why /ʂ/ often fronts to /s/ whereas /s/ rarely retracts to /ʂ/? Future research may need to explore some historical and empirical evidence to reveal the sibilant merge in Chinese dialects.

4.5.2 Speakers and their audience

This study aims to not only identify the linguistic constraints but also explore the social factors that affect the observed sibilant variation in CDS (preschool classroom instruction) and ADS (sociolinguistic interview with an adult). As mentioned previously, teachers varied their production of sibilants in class instruction and in the sociolinguistic interviews. And the variation is affected by their understanding of the audience. As Table 4.8 and Figure 4.1 show, the three teachers differed in their strategies to produce sibilants with children in the class with different Mandarin proficiency.

Figure 4.1 Sibilant variation by context and individual



(a) Sibilant duration

(b) Centroid frequency

(c) Skewness

(d) Onset F2

Addressing English-dominant CHL children, Ms. Daisy and Ms. Olivia in Lily Valley tended to extend the sibilant duration and enhance the phonetic distinction between /s/ and /ʂ/ in their classroom speech. These typical CDS modifications have been identified in previous findings in language input provided by caregivers across languages (Cristià, 2010; Han et al., 2018; Kuhl et al., 1997; Liu et al., 2009; Tang et al., 2017). In general, it is believed that IDS/CDS serves two basic functions – social and analytical (Garnica, 1977). On one hand,

language units are simplified, enhanced, or even exaggerated so that the language input for the young learner is easier to process. For instance, Kuhl et al. (1997) proposed that vowels were hyperarticulated in IDS to "provide exceptionally well-specified information about the linguistic units that form the building blocks for words" (p. 684). On the other hand, these adjustments in CDS were believed to support the social and emotional interaction between the child and the adult. With increased pitch and exaggerated prosodic patterns, CDS is modified to better facilitate the commutation and maintain the infant's attention during this process (Soderstrom, 2007; Trainor & Desjardins, 2002; P. Wong & Ng, 2018). But most previous studies illustrated that adjustments in linguistic input are often observed in linguistic input to infants, and as children grow older, the way that parents talk with them will become similar to ADS (Snow, 2019; P. Wong, 2018). That is to say, for older children, parents believe that the basic mastery of language has been achieved and the modifications of the analytic units in linguistic input are no longer needed. Similar findings were also reported in FDS to adult foreign-language learners (Hazan et al., 2015; Jian & Konopka, 2012; Knoll et al., 2011). To explain the identified phonetic enhancements of Mandarin sibilants, the children's limited Mandarin proficiency may be accounted for the main reason.

In Sunflower Garden, however, /s/ and /ʂ/ were mixed in class instruction, and sibilant duration was not extended. As mentioned, many children in Ms. Cindy's class were Mandarin-dominant, and nearly half of them came from Chinese immigrant families from Taiwan. The merger of /s/ and /ʂ/ is a typical dialectal feature in Taiwan Mandarin (Brubaker, 2012; Chiu et al., 2020; Lee-Kim & Yun-Chieh, 2022). So children had been exposed to similar sibilant variation at home. On the other hand, Ms. Cindy herself was a multilingual speaker of Mandarin, Cantonese, and English. She used Mandarin most of the time with children in the class,

Cantonese with Cantonese-speaking children occasionally, and English when it was necessary for communication. Although English distinguishes /s/ and /ʂ/ as two distinctive categories, Cantonese does not contain any retroflex sound (Bauer & Benedict, 1997). So Ms. Cindy's sibilant variation may be attributed to the influence of her L1 or Cantonese. However, this is not to say that she could not distinguish /s/ and /ʂ/ in her Mandarin. As the analysis of her ADS shows, she tended to emphasize the phonetic difference between /s/ and /ʂ/ when talking to me, a native Mandarin speaker who differentiated sibilants clearly. In Hyper and Hypo-articulation theory (H&H theory), Lindblom (1990) proposed that "speech production is adaptive" (p. 403) and speakers can have their own choices "to vary their output along a continuum of hyper- and hypospeech" (p. 404) according to the context. This may be able to explain the reversed modifications in sibilants by Ms. Cindy. As the audience distinguished /s/ and /ʂ/ in the conversation, she tried to enhance the difference between the two sibilants in the interview as well. While in the classroom, through the daily interaction with the CHL children, she came to understand the way they talked and the language proficiency they had. Therefore, she was comfortable using some sociolinguistic variables in the class. Ms. Cindy also acknowledged the differences among Chinese dialects and addressed some of these in class. For instance, she explained to the children that pineapple was called "鳳梨 fèng lí" in Taiwan and "菠萝 bō luó" in mainland China.

In sum, teachers tended to extend the sibilant duration and emphasize the phonetic distinction between /s/ and /ʂ/ in classroom instruction for English-dominant children. On the contrary, the mixed use of /s/ and /ʂ/ was identified in teacher speech for Mandarin-dominant children. This suggests that teachers have their own adjustments regarding the use of sociolinguistic variants in different contexts, and children's language backgrounds may serve as

one of the reasons. According to the particular language learning stages of the children in the class, preschool teachers modified their linguistic input to further facilitate the learning of Mandarin as a heritage language.

4.6 Conclusion and implications

This chapter investigated the use of sociolinguistic variables in linguistic input for CHL children in two dual-immersion preschools. Specifically, it compared the Mandarin sibilant variation by three teachers in classroom instruction as a CDS genre and in sociolinguistic interviews as an ADS genre. Statistical analysis shows that phonetic environment, pragmatic function, and discourse context all significantly affected the realization of sibilants. The particular language learning needs of CHL children from different language backgrounds were well acknowledged and addressed by the teachers in classroom interaction. In the instruction for English-dominant children, the analytic information in linguistic input was emphasized. While for Mandarin-dominant children, sociolinguistic variables were used in the input. The linguistic input in the two classrooms matched the CHL children's different developmental stages. This study extends the current understanding of language input for bilingual and multilingual children outside the family by illustrating the role of preschool instruction as a crucial part of CDS. It also contributes to the literature on CHL development in early childhood. By exposing CHL children to heterogeneous contexts where Chinese varieties can be used flexibly, the preschool class serves as an interactive setting where children can explore the available resources to expand the linguistic repertoire in their heritage language.

The current findings also lead to several pedagogical implications for the teaching of the heritage language in early childhood. First, the language backgrounds and learning needs of heritage children need to be well explained in professional development. Most of the time,

teachers establish their own teaching strategies according to classroom observation and their understanding of the children in the class. Pedagogical suggestions based on language acquisition theories will be helpful to new teachers who may not be familiar with the complex situation in the classroom. Second, the differences in language development between heritage language learners and L2 students should be taken into account in curriculum planning. Also, when young children are exposed to heterogeneous linguistic environments, their speaking may be delayed to the complexity of language input. This should be carefully differentiated from language dysfunction. Lastly, using sociolinguistic variables in classroom activities may support children's development of sociolinguistic competence or the ability to use sociolinguistic variables appropriately in different contexts (Bayley & Regan, 2004; X. Zhang, 2021). Linguistic input in heritage language is often limited not only in amount but also in types of varieties. By introducing language varieties and sociolinguistic variables to heritage language children, teachers can further facilitate the development of heritage language in early childhood, especially the learning of underrepresented varieties.

5. CHL children's longitudinal bilingual development

5.1 Introduction

With the promotion of heritage language maintenance and the increasing opportunities for additive bilingual education, language development, especially the proficiency of minority languages in bilingual children, has received more attention in recent years. Among the efforts to develop CHL in English-speaking countries (e.g., United States, Canada, United Kingdom, and Australia), both family and community play a crucial role to support language education for the next generations (Duff et al., 2017; He & Xiao, 2008; Mu & Dooley, 2015). Previous CHL studies have explored attitudes toward CHL maintenance (M. Li, 2005; Lindholm-Leary, 2011; Xiao & Wong, 2014; L. Yang et al., 2018; D. Zhang & Slaughter-Defoe, 2009), motivation for CHL learning (D. Li & Duff, 2008; X. Lu & Li, 2008; Wen, 2011), how CHL speakers reconstruct their identities in and out of classrooms (He, 2004; W. Li, 2014; Shen & Jiang, 2021; K. Wong & Xiao, 2010), and political and institutional influences on CHL development (Duff et al., 2017; D. Li & Duff, 2008; McGinnis, 2008). Other scholars have been exploring the differences in language acquisition by native, heritage, and foreign language learners (C. B. Chang & Yao, 2016; Taguchi et al., 2017; Wen, 2018; S.-L. Wu & Ortega, 2013; D. Zhang & Koda, 2012; H. Zhang & Koda, 2018b). However, most previous research focused on CHL adult speakers, while only a few have explored the language proficiency of CHL children who are exposed to various Chinese varieties in and out of their families at an early age (S. H. Chen et al., 2021; Lindholm-Leary, 2011; Lü & Koda, 2011). In fact, many CHL children attend bilingual or dual immersion programs beginning at three-years-old or younger, which is a critical period when children intensively develop their linguistic, cognitive, and socio-emotional skills. These programs serve as the first transitional step from home to the wider social environment where

children start their independent socialization (Schwartz & Palviainen, 2016). Previous studies have demonstrated that early dual immersion not only supports the acquisition of both majority and minority languages but also facilitates the development of social-emotional skills in multicultural and multiethnic children (Barnett et al., 2007; Hickey & de Mejía, 2014; Schwartz & Gorbatt, 2016; H. Sun et al., 2021).

To investigate the language proficiency of both English and Mandarin in CHL children and how this is affected by children's home language and the bilingual programs they attend, this chapter examines the bilingual development of 43 children (20 girls, 23 boys, aged 3;01-5;04) from the two dual immersion preschools. Children's language proficiency and phonological skills were measured with standardized assessments and language tasks at the beginning and the end of the school year with a six-month interval. Mixed-effect regression analysis shows that children's performance in the initial tests is significantly affected by home language, age, and language-specific skills. Their performance in the final tests is predicted by home language, age, language-specific skills, enrollment length, and gender. Children's progress in Mandarin vocabulary is constrained by gender and home language. These results suggest that how languages are used in families plays a key role to explain the diverse language proficiency among CHL children. In addition, children's oral language and vocabulary size correlate with their phonological skills, but this is limited within a language. From a long-term perspective, the enrollment length in dual immersion programs and gender affect CHL children's English and Mandarin development.

In the following sections, previous CHL studies and how dual immersion support bilingual development in the US are reviewed first. Then the methods adopted for data collection and data analysis are illustrated. Detailed findings are unfolded in the discussion section, and pedagogical implications are discussed at the end.

5.2 Literature Review

5.2.1 CHL background and development

Chinese immigrants have established a long history in the United States, beginning from the first wave in the mid-nineteenth century with dreams of gold (Xiao, 2010). After that, Chinese immigrants experienced ups and downs regarding their social and political status in the States. CHL speakers differ in their places of origin, languages, social economic status, and educational levels. The first-wave pioneers were mostly Cantonese speakers who were peasants or fishermen by origin, while many recent Chinese immigrants are Mandarin speakers and some have achieved promising positions in academia, commercial activities, and high-tech industries (Xiao, 2010, 2011).

More attention has been paid to CHL lately, and scholars have explored topics such as attitudes toward CHL maintenance (M. Li, 2005; Lindholm-Leary, 2011; Xiao & Wong, 2014; L. Yang et al., 2018; D. Zhang & Slaughter-Defoe, 2009), motivation for CHL learning (D. Li & Duff, 2008; X. Lu & Li, 2008; Wen, 2011), how CHL speakers reconstruct their identities in and out of classrooms (He, 2004; W. Li, 2014; Shen & Jiang, 2021; K. Wong & Xiao, 2010), and political and institutional influences on CHL development (Duff et al., 2017; D. Li & Duff, 2008; McGinnis, 2008). For language development, CHL learners differ from native speakers due to their limited exposure to the target structures, but they also differ from foreign language learners because of their early exposure to Chinese languages at home. Findings show that CHL students often outperformed their counterparts who were learning Chinese as a foreign language (CFL) in oral language skills (S.-L. Wu & Ortega, 2013), the production and perception of lexical tones (C. B. Chang & Yao, 2016), grammar and lexicon accuracy (Wen, 2018), pragmatic competence (Taguchi et al., 2017), and some word-level subskills such as oral vocabulary

knowledge, morphological awareness, and lexical inferencing ability (H. Zhang & Koda, 2018a, 2018b). Sometimes, CHL learners demonstrated similar interlanguage patterns as found in CFL students, such as underproduction and overproduction of some pragmatical markers in requests (Wen, 2018). In other cases, because of the limited Chinese literacy input, CHL learners even could not achieve the same print vocabulary knowledge as their CFL peers (H. Zhang & Koda, 2018a).

As identified in other heritage languages, CHL development is challenging and language shift to English may occur quite early (Y. Hao et al., 2019; Polinsky, 2018; Polinsky & Scontras, 2020; Sheng, 2014; Sheng et al., 2011; Unsworth, 2019). It seems that language input, including both home language and languages used at school, contributes to the development of children's language skills. For example, Sheng and colleagues conducted a series of longitudinal studies (Sheng, 2014; Sheng et al., 2006, 2011) to examine the lexical-semantic skills in CHL children aged 3;01 to 8;05 in Austin, Texas. Parents were native Mandarin speakers and children's English exposure began in daycare or preschool around two or three years old. On average, children had 41%~43% Mandarin input because parents mixed Mandarin with English at home and English appeared to be the only instruction language at school. Results revealed age-related growth in English, but not Mandarin vocabulary after 16 months. Statistical analysis demonstrates the effect of age and initial language proficiency. But in general, the CHL children were becoming English-dominant. Early language shift is also tested in CHL children's narrative skills. Ying Hao et al. (2019) examined the narrative skills in CHL children's (age 4;06 – 9;07) English and Mandarin by measuring the macro-structure and the micro-structure in story-telling. Results show that children had better narrative performance in English than in Mandarin with the increased cumulative English experience. However, at the same time, they might experience a

plateau in Mandarin due to insufficient language input. The input effect, especially the influence of home language, has been observed in other heritage languages, such as Spanish (Cha & Goldenberg, 2015) and Cantonese (Cheung et al., 2019). And the stabilization of home language after English exposure at school is also reported in Hmong heritage children (Kan & Kohnert, 2005).

5.2.2 Dual immersion and bilingual development

As a strong form of bilingual education, dual immersion aims to have an approximately equal number of language minority and language majority students in the same classroom and uses both languages for instruction (Baker, 2011; Lyster & Genesee, 2019). By exposing students to two languages used by peers, dual immersion can contribute to social cohesion and increase tolerance for cultural diversity, support heritage language maintenance and revitalization, and prevent marginalization of minority groups by facilitating the formation of peer-group networks through the minority language (Hickey & de Mejía, 2014). Dual immersion has been shown to effectively close the achievement gap in English and support home-language development (Collier & Thomas, 2004).

Empirical or experimental research on early dual immersion is still rare. For example, Barnett et al. (2007) compared the effects of English-Spanish dual language and monolingual English immersion preschool on children's learning outcomes. Three to four-year-old children in the two programs were measured for their oral language, emergent literacy, and math. Findings showed that children in both programs experienced substantial gains in all tested aspects, and no significant differences were identified in children's English proficiency. In addition, the dual immersion program improved Spanish in both ELLs and native English children (Barnett et al., 2007). Similarly, Partika et al. (2021) demonstrated that instructional support in a Spanish dual

immersion preschool classroom was positively correlated with children's progress in Spanish expressive vocabulary skills and quantitative reasoning skills in English. Schwartz and Gorbatt (2016) interpreted the interactions in an Arabic-Hebrew dual immersion preschool in Israel and revealed that through children's metalinguistic skills, especially discourse management skills, they tried to establish their social networks and enhance their ethnic identities.

Studies on English-Mandarin or Mandarin-English bilingual children have revealed their early bilingual advantages and cross-linguistic influences in their production and perception. For example, Marinova-Todd et al. (2010) tested the phonological awareness in both languages by Mandarin-English bilingual children in Vancouver, Canada, and compared that with the skills of monolingual Mandarin-speaking children in Shanghai, China, and monolingual English-speaking children in Vancouver. Results demonstrate that bilinguals outperformed monolinguals in both languages, and the bilingual advantages are attributed to early exposure to different languages. In addition, for cross-linguistic influences, studies revealed a strong cross-language phonological transfer from Mandarin to English, but the phonological transfer from English to Mandarin did not occur in eight-year-old Mandarin-English bilingual children (M. Wang et al., 2005, 2009). Their studies suggest that there is a joint function of shared phonological processes in the biliteracy acquisition, and the asymmetry in the transfer may be attributed to the different morphophonological systems in the two languages. However, few of the studies investigate the internal diversity of the English-Mandarin or Mandarin-English bilingual children and how different language inputs from both family and school may affect their bilingual development longitudinally.

To address the research gaps discussed above, this chapter focuses on CHL children's language development in English and Mandarin and aims to answer the following questions:

(1) What is the profile of CHL children's oral language skills and phonological skills in English and Mandarin at the beginning and the end of the school year?

(2) What factors, among age, gender, home language, and enrollment in dual immersion, are related to children's language skills in English and Mandarin?

5.3 The current study

Forty three CHL children (20 girls, 23 boys with the initial age of 3;01-5;04) from two dual immersion preschools in northern California were recruited in the 2021-2023 academic year (see detailed demographic information in Appendix C). These children were identified as CHL learners because they had at least one parent who was a native Mandarin speaker or a heritage Mandarin speaker. Data were collected via classroom observation, family background questionnaires, teacher interviews, and language assessments. English and Mandarin were used in classroom interaction in a 50-50 ratio. After completing the consent forms, parents shared their children's demographic information, home language use, and literacy activities at home in the background questionnaire (see detailed questionnaire structure and questions in Appendix B). Based on the amount of English and Mandarin used at home, children were categorized into three groups for their home language: English-dominant if English was used more than 90%, equally bilingual if English and Mandarin were used in a 50-50 or 40-60 ratio, and Mandarin-dominant if Mandarin was used more than 90%[4]. Children's language skills were measured with several standardized assessments and language tasks. Following previous methods, Mandarin receptive vocabulary was measured with a Mandarin version of the *Peabody Picture Vocabulary*

[4] According to parents, Mandarin and/or English were used at home in three different levels: English only or English-dominant where English was used more than 90% of the time; Mandarin only or Mandarin-dominant where Mandarin was used more than 90%; and equally bilingual where the two languages were used in a relatively equal amount in a 50%-50% or 40%-60% ratio. Families in which either language was used between 60%-90% or 0%-40% were not reported in the background questionnaires.

Test 5 (Chow & McBride-Chang, 2003; Dunn, 2019; Ji et al., 2022; L. Lu & Liu, 1998; McBride-Chang et al., 2006; D. Zhang, 2017). Children's Mandarin phonological skills were measured with a series of phoneme identification and discrimination tasks (see examples in Appendix D). In the Mandarin phonological awareness tasks, phoneme identification was designed with 12 items of word-initial sibilants and 12 items of lexical tones. Children were shown pictures and asked to match one of the two pictures with the target words. Phoneme discrimination consisted of 22 items of sibilants and 22 items of tones. Children heard three words and were asked to pick out the one which had a different initial sibilant or tone. Such phonological identification tasks and discrimination tasks are often adopted to measure children's metalinguistic skills (F. Chen et al., 2017; Marinova-Todd et al., 2010). And English oral language and phonological skills were measured with *Woodcock-Johnson IV Oral Language* for their oral communication skills and phonological skills (Schrank & Wendling, 2018). All tests except the Mandarin phonological tasks were conducted twice at the beginning and the end of the school year with a six-month interval. Due to time limitations, Mandarin phonological awareness was only tested once at the beginning of the school year.

Mixed-effect linear models were adopted to interpret children's performance in the tests (Bates et al., 2015). Test scores in each task were calculated according to the assessment norms in terms of standard scores. Children's performance in the Mandarin phonological tasks was quantified according to the overall accuracy rate. Three rounds of analysis were conducted. First, children's performance in the initial tests was examined by the effect of age, gender, home language, and enrollment length in the program. Second, children's performance in the final tests was examined by the effect of age, gender, home language, and enrollment in the same way. Lastly, with the same model, the differences between the initial results and the final results were examined.

5.4 Findings

5.4.1 Initial test results

The four initial tests measured at the beginning of the school year consist of the Mandarin receptive vocabulary test, the Mandarin phonological skill tasks, the English oral skills assessment, and the English phonological skills assessment. For Mandarin vocabulary, 17 out of 43 children reached the average level, 8 demonstrated better performance, while 18 were categorized as below average levels. The average standard score was 93.63, with a 22.84 standard deviation. In Mandarin phonological tasks, CHL children demonstrated 76.69% accuracy on average. However, as these tasks are not standardized tools, children's performance could not be categorized. For English oral skills, 16 children reached the average level, 8 demonstrated higher proficiency, while 19 were identified with lower oral skills. The average standard score of oral English was 89.93 with a 19.20 standard deviation. While many children showed early advantages in English phonological skills: 17 reached the average level, 21 demonstrated better performance, and only 5 were categorized into lower levels. The average standard score of English phonological skills was 112.40 with a 16.78 standard deviation.

As shown in Table 5.1, each of the test results was analyzed as a dependent variable with independent variables including age, gender, home language, enrollment length, and other initial test results. Linear regression analyses show that children's performance in English and Mandarin tests at the beginning of the school year is significantly affected by their home language, age, and language-specific skills. Specifically, children who primarily used English at home did not perform as well as their bilingual and Mandarin-dominant counterparts. In addition, children with better Mandarin phonological skills demonstrated better Mandarin vocabulary knowledge. On the other hand, children's Mandarin phonological skills were also

positively correlated to their exposure to Mandarin at home and their Mandarin vocabulary knowledge. Meanwhile, children in the younger age group, exposed to more English at home, and with high English phonological skills demonstrated higher English oral proficiency. And children's English phonological skills were affected by their age and English oral skills.

Table 5.1 Initial test results

Mandarin vocabulary (mean = 93.63, std = 22.84, multiple R-squared = 0.75, p = 2.357e-08)				
	Estimate	Std. error	t-value	Pr (> |z|)
Intercept	58.40408	28.48711	2.050	0.04812
Home language_English	-36.57353	5.83810	-6.265	3.91e-07
Mandarin phonological skills	61.28044	19.03701	3.219	0.00283
Mandarin phonological skills (mean = 0.7669, std = 0.1273, multiple R-squared = 0.51, p = 0.0009077)				
Intercept	0.1070659	0.2384539	0.449	0.65628
Mandarin vocabulary	0.0036959	0.0011731	3.150	0.00339
Homelanguage_Mandarin	0.1441588	0.0627256	2.298	0.02782
English oral (mean = 89.93, std = 19.19, multiple R-squared = 0.67, p = 1.725e-06)				
Intercept	102.2100	23.5201	4.346	0.000119
Test age	-1.2410	0.3845	-3.227	0.002765
English phonological skills	0.3815	0.1218	3.131	0.003566
Homelanguage_Mandarin	-18.3041	5.0845	-3.600	0.001002
English phonological skills (mean = 112.39, std = 16.78, multiple R-squared = 0.35, p = 0.04458)				
Intercept	-23.65778	36.15025	-0.654	0.51724
Test age	1.27616	0.49916	2.557	0.01521
English oral skills	0.58673	0.18737	3.131	0.00357

5.4.2 Final test results

Three standardized language assessments were given again before the end of the school year with a six-month interval. In general, children showed different degrees of progress in English and Mandarin. In the final Mandarin vocabulary test, children reached a 96.35 average standard score with a 29.07 standard deviation. 17 children out of 43 were categorized as average, and 11 children were identified as above average. For English oral skills, 10 children demonstrated higher than average proficiency, and 18 reached the average level. Lastly, for

English phonological skills, 19 children scored higher than average and 13 reached the average level.

As shown in Table 5.2, compared with the initial results, the final results were constrained by more factors, including home language, age, gender, enrollment length, and language-specific skills. Specifically, girls, children who used both languages or Mandarin primarily at home and children with better Mandarin phonological skills demonstrated better Mandarin vocabulary knowledge. At the same time, children in the older age group who were enrolled in the program for a longer time had better English phonological skills, and exposure to more English at home performed better in the English oral tasks. Lastly, children achieved higher scores in the final English phonological tests if they were enrolled in the program longer, at an older age, and showed better English oral proficiency.

Table 5.2 Final test results

Mandarin vocabulary (mean = 96.35, std = 29.07, multiple R-squared = 0.77, p = 6.871e-09)				
	Estimate	Std. error	t-value	Pr (> |z|)
Intercept	74.926215	37.482722	1.999	0.0537
Gender_boy	-13.003104	5.366421	-2.423	0.0209
Home language_English	-45.489912	7.056251	-6.447	2.28e-07
Mandarin phonological skills	60.212823	23.964614	2.513	0.0169
English oral (mean = 93.30, std = 20.09, multiple R-squared = 0.76, p = 1.511e-08)				
Intercept	111.609033	18.160403	6.146	5.57e-07
Enrollment length	0.003549	0.001014	3.501	0.001317
Test age	0.963230	0.247572	3.891	0.000442
English phonological skills	0.609254	0.119384	5.103	1.26e-05
Home language_Mandarin	-12.512604	4.692585	-2.666	0.011649
English phonological skills (mean = 115.28, std = 16.90, multiple R-squared = 0.60, p = 4.042e-05)				
Intercept	-59.522890	26.632513	-2.235	0.032097
Enrollment length	0.003321	0.001144	2.902	0.006459
Test age	1.112048	0.259108	4.292	0.000139
English oral	0.711932	0.139504	5.103	1.26e-05

5.4.3 Progress in six months

Children's progress in six months was calculated by the differences in standard scores between the initial and the final tests. In general, CHL children demonstrated subtle progress in their language skills in both languages. However, the progress in English oral and phonological skills is not significantly affected by any tested factors, whereas children's improvement in Mandarin vocabulary knowledge is predicted by gender and home language. As shown in Figure 5.1, compared with their equally bilingual and Mandarin-dominant peers, English-dominant children made slightly more progress in English oral tests. The three groups did not differ

significantly in their performance in English phonological tasks. But for Mandarin vocabulary tests, Mandarin-dominant children demonstrated a significant advantage, followed by their equally bilingual peers. While English-dominant children exhibited a 5.8 attrition by the end of the school year, which means they did not perform as well as in the initial tests for Mandarin vocabulary knowledge. In addition, results in Table 5.3 show that gender is another significant factor that affected the progress of Mandarin vocabulary. The model reveals that compared with boys, girls demonstrated greater improvement in their Mandarin vocabulary knowledge.

Figure 5.1 Progress in six months

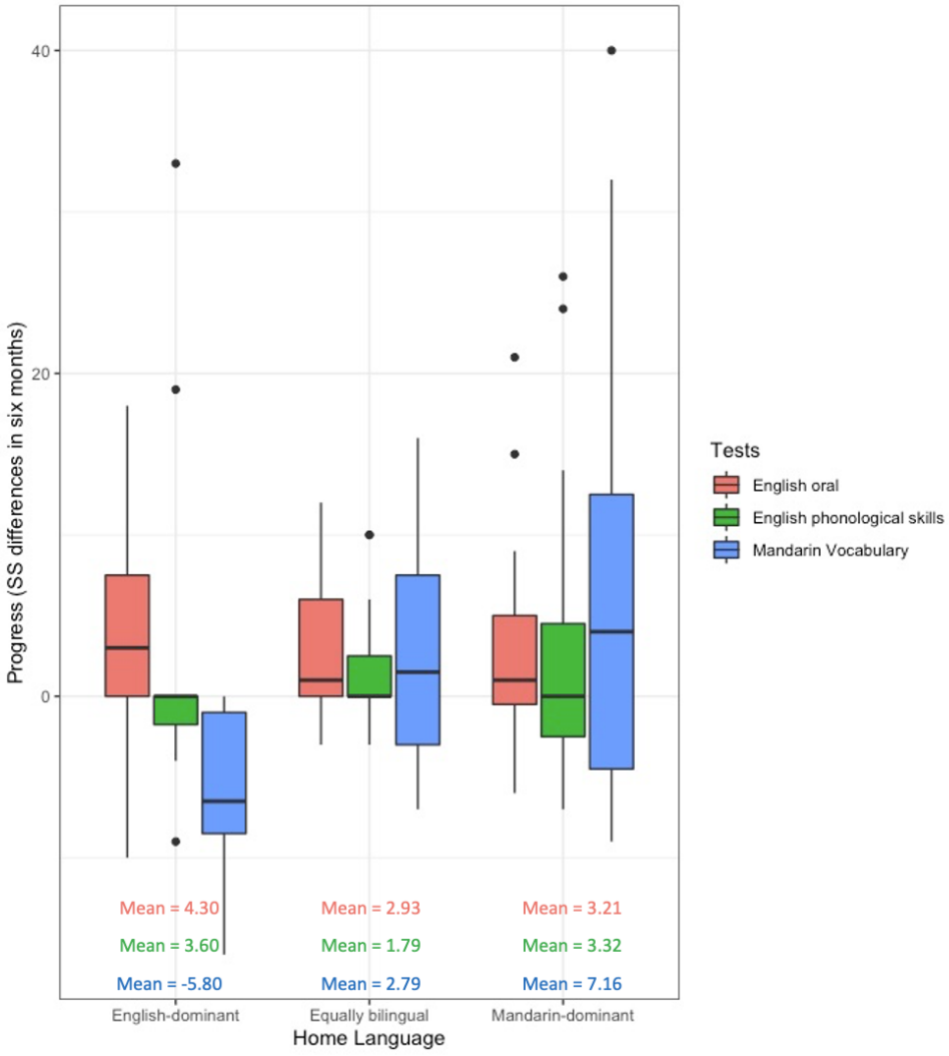


Table 5.3 Progress of Mandarin vocabulary knowledge in six months

	Estimate	Std. error	t-value	Pr (> |z|)
Intercept	-2.022e+01	2.546e+01	-0.794	0.43247
Home language_English	-1.494e+01	5.588e+00	-2.674	0.01144
Gender_boy	-1.123e+01	3.310e+00	-3.391	0.00178
Multiple R-squared = 0.47, p = 0.002592				

5.5 Discussion

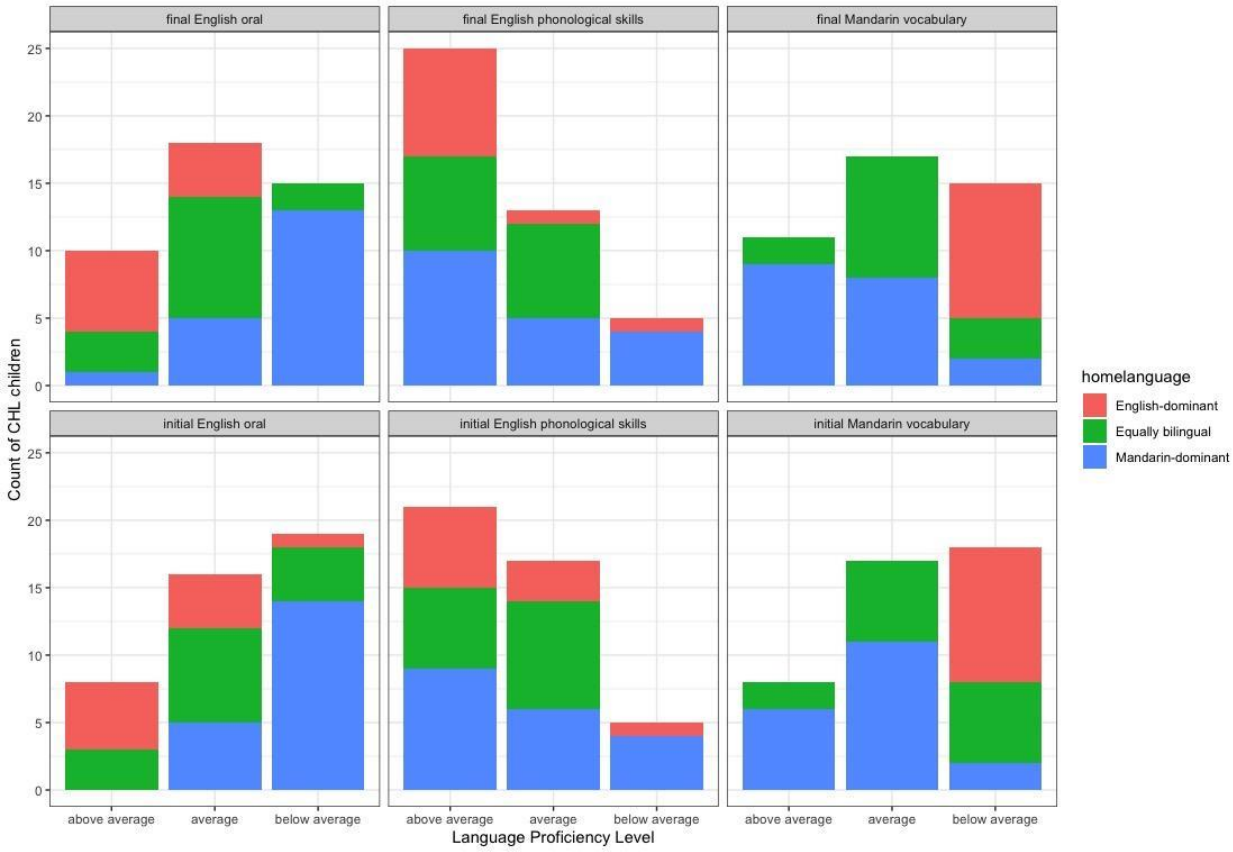
According to the above analyses, the two research questions are addressed as follows. First, what is the profile of CHL children's oral language skills and phonological skills in English and Mandarin at the beginning and the end of the school year? At the beginning of the school year, 41.86% of the children were identified as below average levels for their Mandarin vocabulary knowledge, and 44.19% were below average for English oral skills. However, children demonstrated some early bilingual advantages as shown in their English and Mandarin phonological performance. After six months of enrollment in the dual immersion programs, children exhibited subtle improvement in both languages. By the end of the school year, the percentage of children with below-average Mandarin vocabulary knowledge was reduced to 34.88%, and the percentage of children with below-average English oral skills was reduced to 34.88%. In addition, more children showed higher English phonological skills. Second, what factors, among age, gender, home language, and enrollment in dual immersion, are related to children's language skills in English and Mandarin? Children's initial language proficiency in general is significantly affected by age, gender, home language, enrollment length, and other initial test results. Children's final language performance is predicted by more influential factors,

including home language, age, gender, enrollment length, and language-specific skills. The progress in six months is only significant in Mandarin vocabulary knowledge which is constrained by home language and gender.

5.5.1 Home language and school language

In the results, home language appears to be a strong predictor of children's performance in both English and Mandarin tasks. As shown in Figure 5.2, home language is closely associated with children's proficiency levels in each test. English-dominant children demonstrated advantages in English oral and phonological skills, while Mandarin-dominant children performed better in Mandarin vocabulary knowledge tasks. Equally bilingual children had achieved some progress in both English and Mandarin skills, and they had demonstrated average or better English phonological knowledge since the beginning of the school year. This echoes the early bilingual advantages as reported in previous studies (Marinova-Todd et al., 2010; Padilla et al., 2013).

Figure 5.2 Result summary _ language proficiency level



The effect of home language, as interpreted as a crucial part of language input, has been illustrated in other languages as well. For instance, Cheung et al. (2019) revealed that the amount of English used in unconstrained contexts significantly predicted the English vocabulary knowledge of Cantonese-English sequential bilingual preschool children in a U.S. Head Start program. Similarly, for Moroccan- and Turkish-speaking children who were learning Dutch as a second language in the Netherlands, home language use during storytelling and conversations was related to children's vocabulary knowledge in their L1s (Scheele et al., 2010). Among emergent Spanish-English bilingual kindergartners in California and Texas, it was found that high levels of Spanish use at home were associated with additive bilingualism whereas English-

dominant home language predicted subtractive bilingualism (Cha & Goldenberg, 2015). The effect of home language is not only limited to vocabulary or oral language but also identified in metalinguistic awareness and literacy competence in English-Chinese bilingual children (B. Sun et al., 2018; D. Zhang & Koda, 2011).

On the other hand, the effect of dual immersion as measured by enrollment length is only statistically significant in the final results. In short, the longer CHL children enrolled in the dual immersion program, the better English oral and phonological skills they demonstrated. However, children's Mandarin vocabulary knowledge is not significantly affected by their enrollment length. Given the fact that both languages were adopted in a 50-50 ratio in classroom interactions, it seems that dual immersion may support CHL children's bilingual development as a mild mediator, while how the two languages were used at home serves as a strong predictor of children's language proficiency, especially the proficiency in CHL. This illustrates the importance of family involvement and cooperation between school and family, especially for English-dominant children, to support CHL development longitudinally. At the same time, preschool teachers may also need to adjust their pedagogical strategies to adjust the language input for CHL with different backgrounds.

5.5.2 Within- and cross-linguistic influences

Cross-linguistic influences from L1 to L2 or the other way around are often observed in bilingual children. Previous studies have shown the impact from one language to another as reflected in bilingual children's oral language, reading and writing, and vocabulary knowledge (e.g., Bialystok et al., 2005; Proctor et al., 2010; Sparks et al., 2008; van der Leij et al., 2010). The cross-linguistic effect has also been discussed regarding its contribution to the acquisition of language-specific structures that are different in L1 and L2, such as possessive constructions in

French and English (Nicoladis, 2012), subject placement in Greek and English (Daskalaki et al., 2019), object omissions in Dutch-French German-French, and German-Italian bilingual children (Müller & Hulk, 2001), word order in relative clauses in Cantonese and English (X. Sun et al., 2022; V. Yip & Matthews, 2007a) among others.

However, the results of the current CHL data only demonstrated within-language interactions between vocabulary or oral language knowledge and phonological skills. As shown above, children's Mandarin vocabulary knowledge was positively correlated with their Mandarin phonological skills. And children's English oral language proficiency was also positively related to their English phonological skills. These correlations appeared early in children's performance at the beginning of the school year. And the same correlations remained in their performance in the final tests. On the other hand, cross-linguistic influences were not identified in the test scores. However, this is not to say that cross-linguistic influences do not exist in CHL children's language system. And this is often reflected in forms of code-switching, word order, and morphosyntactic functions. Overall, this suggests that classroom instruction for bilingual children may be expanded into various within- and cross-linguistic areas so that children can become more aware of their bilingual skills and how to relate them to language learning.

5.5.3 Age, gender, and language socialization

Age and gender are the other two significant influential factors as shown in the models. Age is closely related to children's English proficiency, while gender is significantly associated with their Mandarin proficiency. For the age effect, bilingual children demonstrate different developmental trajectories compared to typically developing monolingual children, and this is usually attributed to the quality and quantity of language input provided in each language and the age of acquisition of the second language (De Houwer, 2007, 2021; Genesee, 2010; Genesee et

al., 1995; Genesee & Nicoladis, 2007; Lauro et al., 2020). In addition, as children grow, they become more cognitively competent to process bilingual input strategically and are more likely to achieve prominent progress (Barac et al., 2014; S. Chen et al., 2022; Clark, 2004, 2016).

Instead of age, gender significantly affected children's Mandarin vocabulary knowledge. Compared with boys, girls made more progress after six months in general. Gender difference in child language development has been interpreted among monolingual children, and girls demonstrate early advantages in language acquisition than boys in many cases (Holtgraves & Leaper, 2014; Leaper & Smith, 2004; Rinaldi et al., 2023). The differences have been explained by several reasons, including biology, neuropsychology, socioeconomic status, and culture (Rinaldi et al., 2023). As all the CHL children shared similar socioeconomic status and cultural backgrounds, the gender difference identified in Mandarin vocabulary may be largely attributed to how they socialized with their peers in the programs. Language socialization or the process by which speakers acquire the knowledge and practices that enable them to effectively engage in their community explains how children established their linguistic networks by choosing friends from potential candidates (Duranti et al., 2011; González, 2008). A gender preference was observed among the CHL children. Boys were more involved in sport-like activities, such as scooters, cars, and balls with other boys in the same class. Many of them had relatively equal language proficiency in Mandarin and English, therefore they often switched from one language to another in the playground. When a language was used depends on the interlocuters, the topics, and the contexts. On the other hand, most girls preferred to chat in doll houses, draw pictures with chalk, and collect leaves and seeds around the garden. Many of the girls are Mandarin-dominant, which made it possible to share secrets, tell jokes, and schedule weekend plans in

Mandarin. Such a sociolinguistic network among peers, to some extent, may explain the gender differentiation in children's Mandarin vocabulary progress.

5.6 Conclusion and implications

In conclusion, this study investigated the language proficiency of both English and Mandarin in CHL children and how this is affected by age, gender, home language, and enrollment length in dual immersion programs. Results show that children's performance in the initial tests is significantly affected by home language, age, and language-specific skills. Their performance in the final tests is predicted by home language, age, language-specific skills, enrollment length, and gender. And children's progress in Mandarin vocabulary is constrained by gender and home language. These results suggest that how languages are used in families plays a key role to explain the diverse language proficiency among CHL children. In addition, children's oral language and vocabulary size correlate to their phonological skills, but this is limited within a language. From a long-term perspective, the enrollment length in dual immersion programs and gender affect CHL children's English and Mandarin development.

By identifying the effect of home language on the language proficiency of CHL children, the study revealed CHL attrition in English-dominant children may occur as early as four-year-old. It also illustrated the potential of dual immersion to support early childhood development in both CHL and English. Considering the diversity among CHL children, preschool teachers need to include different pedagogical strategies addressing the different learning needs of English-dominant, equally bilingual, and Mandarin-dominant children. Simultaneously, teachers may also think about what kind of language resources should be provided in a dual immersion classroom. By combining children from diverse linguistic backgrounds in the same class, dual immersion provides miscellaneous language input and contexts to practice the use of different

language varieties and styles. It also offers children opportunities to actively establish their own sociolinguistic network with peers with whom they may creatively use their full linguistic repertoire in different languages and varieties.

Within the burgeoning research in early childhood education, more studies are needed to further explore the role of dual immersion for a more effective, inclusive, and balanced bilingual model. For example, regarding the linguistic diversity within the group, what kind of pedagogical strategies may be adopted to address the particular learning needs of the language minority children, such as Cantonese-speaking children? In addition, the peer interaction through which young bilingual children establish their own sociolinguistic networks with various linguistic practices needs to be examined with a new methodology. This interaction is always dynamic, multimodal, and context-based, therefore its unique nature may be not accurately captured by the static model based on quantified characteristics measured in social network analysis (Chamberlain et al., 2007; J. Chen et al., 2019; Raghavendra et al., 2012). Moreover, it is still unknown how the diverse linguistic environment in dual immersion would affect children's socio-emotional development and their sociolinguistic competence (Bayley & Regan, 2004; H. Sun et al., 2021). Comparisons across different language and age groups may provide insight into the relationship between early bilingual experience and the development of socio-emotional skills. Lastly, more empirical and experimental studies are needed to explore the association between early dual immersion, literacy development, and reading achievement in both majority and minority languages from a longitudinal perspective. Early bilingual advantages fostered in dual immersion programs often reduce soon after children enter mainstream elementary schools. To fully support the next generation's bilingual, bicultural, and biliterate development, the transition from preschool to elementary level needs to be adjusted for a sustainable, balanced, and inclusive bilingual education.

6. Acquisition of Variation by CHL Children

6.1 Introduction

The acquisition of adult-like patterns of variation is an integral part of language learning (Labov, 2013; Roberts, 1997a; Smith & Durham, 2019). It reveals the full complexity of language learning in two ways: first, acquiring a language means not only learning the obligatory structures and features of the target language but also becoming a member of the speech community by learning their norms of language performance and behaviors. Second, there are two possible sequences regarding the learning of the standard and local variants in the target language (Smith & Durham, 2019). That is, both categories may be acquired simultaneously or one after another in a sequence. To explore how variable patterns are passed from more experienced speakers to new members of the community, previous studies have examined the effect of input or if the different patterns of variation in child language can be attributed to the language input they receive from the caregivers (e.g., Payne, 1980; Roberts, 2002; Smith et al., 2007; Smith & Durham, 2019; Stanford, 2008). Recent studies also investigated whether the social factors that are often found as significant predictors of variation in adult speech affect children's use of the variables in the same way (see more in Johnson & White, 2020; Nardy et al., 2013; Smith & Durham, 2019). These factors include children's age, gender, the socioeconomic status of their family, and discourse context.

Current findings are inconsistent regarding different linguistic variables used in different communities, languages, and contexts. But in general, most studies are on the same page for the following claims. First, as has been found in adult speech, variation in child language is systematic and follows linguistic rules, although sometimes children's variable patterns differ from what their caregivers or other adults in the same community present. Second, the systematic

use of sociolinguistic variables can occur quite early, as early as 2;10 or even younger (Labov, 1989; Smith & Durham, 2019). In addition, as adults, children from higher social classes also tend to use standard variants more frequently. As for the effect of gender, it is not always tested or identified, but some studies pointed out how the variants were selected were effected by both the gender of the caregivers and the child (Nardy et al., 2013; Smith & Durham, 2019). Lastly, although it was believed that style shifting occurred relatively late in preadolescence, findings show that children as young as three-years-old were able to vary their use of specific variables according to their interlocutors or contexts (E. S. Andersen, 1990; Roberts, 1997a; Smith et al., 2007; Smith & Durham, 2019).

The discussion above, including the learning process of variation and the factors influencing speaker choices, is mainly based on empirical evidence from monolingual children and monolingual communities. If a child is learning two or more languages simultaneously or has been exposed to several languages at a young age, can they still develop a native-like sociolinguistic competence or the ability to use sociolinguistic variables appropriately? How would language input, age, gender, language proficiency, and discourse context affect the ways that multilingual children use these sociolinguistic variables? This chapter aims to explore these questions by investigating the use of Mandarin syllable-initial sibilants by CHL children in two dual immersion preschools. Data were collected with standardized language proficiency assessments, a sentence repetition task, story-retelling, and sociolinguistic interviews with 12 children (4;01-5;02, six boys and six girls) at the beginning and the end of 2021-2022 school year with a 6-month interval. Statistical results show that linguistic factors such as preceding sound, word type, sentence type, and sibilant type significantly affect the duration and the centroid frequency of the sibilant. The mix of dental and post-alveolar sibilants is identified in

child language. As children's age increases, they tend to distinguish /s/ and /ʂ/ better. They also tended to enhance the difference between the two categories in formal settings, in contrast to casual speech. Other factors, including children's English and Mandarin proficiency, language input, and gender, also significantly affected the ways they chose to use the sibilants.

6.2 Literature review

6.2.1 Acquisition of variation and input effect

An attractive explanation for the differences between language variation in adult speech and child language is that children, at least in the beginning years of their language acquisition, tend to reproduce variable patterns in language input from their caregivers. When addressing young children, parents often prefer to switch from the way they talk to adults to an approach in which many typical CDS modifications and standard variants are applied. This is how input may affect the acquisition of variation by children (E. K. Johnson & White, 2020; Nardy et al., 2013; Romaine, 2003; Smith et al., 2007; Smith & Durham, 2019).

Language input forms important stimuli or examples for children's language development. But it also contains varieties of languages and the use of local dialectal features. For instance, in an early study, Payne (1980) investigated the learning of Philadelphia vowels by children who moved to the Philadelphia area after their early language acquisition period. Findings show that to what extent the variables could be fully acquired closely associated with speakers' age of arrival in Philadelphia. In addition, only children who were native Philadelphians or the children of native Philadelphians had acquired the variable patterns completely. Sometimes, unfamiliar accents may be challenging for young children. For example, Schmale et al. (2010) found that nine-month-old infants failed to recognize newly learned words in Southern Ontario Canadian English instead of North Midland-American English as their own

dialect. Van Heugten et al. (2015) revealed that 15 to 20-month-old Canadian-English-learning toddlers struggled to recognize familiar words in unfamiliar Australian English. However, the difficulties in dealing with unfamiliar language varieties will disappear gradually, and the ability to retrieve meaningful messages from accented speech increases with age, especially when their vocabulary expands (Cristia et al., 2012; van Heugten et al., 2015). During early childhood, the emergence of segmental awareness indicates the locations of systematic variation in the input for children (Roberts, 2002). And early exposure to different language varieties also supports children's language processing abilities (E. K. Johnson & White, 2020).

At the same time, consciously or unconsciously, parents often adjust their language when talking to their young children, and this may affect the variation patterns children acquire. For instance, Smith et al. (2007) investigated the alternation between /ʌʉ/ and /u:/ in words such as "house" and the use of third person plural -s (e.g., "my trousers is fa'in down.") in a Scottish dialect. With data from 11 children (2;10 - 3;06), their primary caregivers, and other adults in the same community, the study demonstrated that for vowel variables, compared with community norms, caregivers used more standard forms in their CDS, and children followed this pattern in general. For the -s variable, caregivers used the community norms, but children did not or had not yet started to show a similar pattern at the age of 3;06. It is possible that the -s variable carries more grammatical functions and is constrained by relatively more complex factors so that the children had not mastered its norms at this age. Similarly, Roberts (2002) compared the replacement of diphthong [ai] by [a] in the southern dialects in Tennessee in CDS and child language. Results demonstrate that the mothers adjusted their diphthongs in CDS differently than in ADS, and children were still developing their vowel variation patterns. In the illustration of the language learning settings for bilingual children, De Houwer (2021) also noted that children

may acquire different varieties of the same language or varieties of different languages, and caregivers often tend to use more standard language with young bilingual children.

Sometimes the preference for standard forms in CDS by parents is to enhance the success of their children in school. Bull (1992) found that in northern Norway, Sami-speaking women would try to raise their children in Norwegian because it is the language of instruction used at school. Similarly, in both upper-working and lower-middle classes in the Netherlands, parents also preferred to use the standard forms in Dutch (Romaine, 2003). Another reason behind the preference for standard language in CDS is that caregivers often mean mothers of the children. And female speakers, as revealed in adult variation patterns, tend to use standard variants more than their male counterparts in general. In the study about the acquisition of some ongoing sound changes in Philadelphia, Roberts (1997b) mentioned that females were both early childcare providers and sound change leaders, and this may contribute to the early acquisition of variation by children.

Besides the effect of input, children's acquisition of variation from the environment is also affected by other social factors, including their age, gender, the socioeconomic status of their families, and the discourse context where the speech occurs.

6.2.2 Age and time

For the effect of age and time, previous studies mainly focused on these two questions. First, when do children begin to demonstrate systematic variation patterns? Second, are the standard and vernacular forms are acquired simultaneously or sequentially? Current findings show that children may start to use sociolinguistic variables by the end of the third year. For instance, Roberts (1997a) found that Philadelphia children as young as three had mastered the phonological constraints on /t, d/ deletion in English word final consonant clusters. In Smith et

al.'s (2007) study, children aged 2;10 demonstrated systematic vowel variation in Scottish English. Similarly, Foulkes et al. (2001) found that children aged 2-4 in Newcastle upon Tyne had structured variation in the production of intervocalic /t/ in British English. Studies also show that the acquisition of variation may start around the age of 2;04 in other languages, including Syrian, Spanish, and French (Barbu et al., 2015; Díaz-Campos, 2005; Habib, 2017). Although adult-like variation patterns may be acquired quite early, young children, in general, tend to produce more standard forms than vernacular ones due to the input effect (Smith & Durham, 2019). As both scope and depth of the socialization with individuals out of the family increase, children are gradually exposed to more heterogeneous sociolinguistic variables and become familiar with their social meanings. However, regarding the -ing vs. -in variation and /t, d/ deletion by children aged 6-9 in Philadelphia, Labov (1989) suggested that the social and stylistic constraints on variation may emerge first, followed by language-specific grammatical and articulatory constraints. Some variables may be learned earlier than others, and this may depend on the characteristics of the variable under study: whether it carries any salient features linguistically or culturally or whether its constraint is complex (E. K. Johnson & White, 2020; N. L. Shin, 2016; Smith & Durham, 2019).

As mentioned, standard and vernacular variants may be acquired simultaneously or sequentially. In the sequential view, Labov (1964) first proposed that young children appear to be initially mono-stylistic. It was believed then that the obligatory structural features were acquired as the foundation of the target language, and sociolinguistic variables were learned after the mastery of the basic grammar (E. K. Johnson & White, 2020; Smith & Durham, 2019). Specifically, from birth to age five, children focus on the acquisition of basic grammatical units. From five to twelve, they begin to learn some particular vernacular features with the influence of

their peers. In early adolescence, the awareness of the social significance of a dialect starts to show up. And stylistic variation may appear in late adolescence, with greater use of standard forms. Later, the time point when systematic variable patterns may emerge has been updated (Labov, 1989), and findings showing that the acquisition of variation can occur in early childhood, there are evidence to suggest that standard and vernacular variants may be learned in a sequential fashion (Payne, 1980; Roberts, 1994). For instance, in Smith & Durham's (2019) work, lexical and lexical-phonological variants were learned sequentially, with the standard form learned first by Scottish children (2;10-4;02). However, they also reported that the same group of children acquired some other sociolinguistic variables at the same time, including phonetic variables, glottal replacement, and agreement. The differences identified in the order of how the variables are acquired have been attributed to the characteristics of the variable under study.

6.2.3 Adults' and children's gender

Among adult speakers, women usually prefer standard forms compared to their male counterparts, and they are often found to be the leaders in some ongoing language changes (Barbu et al., 2015; Romaine, 2003). However, in variation by young children, although gender may affect the language input in CDS, the effect of gender is not always significant because the distinction between gender roles may not be salient enough for children younger than age five (Nardy et al., 2013).

In general, in CDS, caregivers tend to use more standard variants when addressing girls than boys. For instance, Foulkes et al. (2005) found that for the phonetic variants for /t/ in word-medial and word-final prevocalic contexts in British English, mothers from Tyneside working-class families used more standard variants in their speech to girls than boys (both aged 2;00-4;00). Similar patterns have even been identified in CDS addressing opposite-sex twins aged

2;05 to 3;09 (J. Johnson, 2003). These findings suggest that heterogeneous variable patterns are available in CDS, which provides children as young as 2;00 with differential opportunities to learn the gender values behind the sociolinguistic variables. On the other hand, the gender of the caregivers may also affect the ways they talk to their young children. For example, Warren-Leubecker and Bohannon (1984) investigated English intonation patterns by both fathers and mothers addressing their children. Results show that compared with mothers, fathers actually increased their pitch and ranges more when addressing two-year-olds, but they did not differentiate between five-year-olds and adult listeners.

A gender effect has only been occasionally identified in child language. In the deletion of word-final post-consonantal /r/ in French, Chevrot (1991) found that girls aged six to seven deleted /r/ more in formal contexts. Similarly, Roberts (1997a) revealed that girls aged 3;02 to 4;11 from Philadelphia working and lower-middle class families deleted more word-final /t/ than their male peers. However, other studies did not demonstrate the effect of gender in child language. No gender effect was identified in the /t,d/ deletion in Philadelphia children aged 3;02 - 4;11 (Roberts, 1994). Children's gender also did not reach significance in the investigations of several variable patterns in British English (Foulkes et al., 2001; Smith et al., 2007). In the realization of liquid /r/ and /l/ in word-final post-consonantal positions in French by children aged 6, the gender effect was still not identified (Chabanal, 2001). This suggests that although children become conscious of the physical differences in different gender groups at age two and develop an impressive constellation of stereotypes about gender by age five, they may not relate these social messages to variation norms in language input in early childhood (Martin & Ruble, 2004).

6.2.4 Social class and family background

Social class was one of the first social factors investigated in variationist studies. Labov (1964) has illustrated the correlation between variation patterns and social stratification. Specifically, speakers from lower social classes tend to use more vernacular forms, while those from upper classes prefer to use more standard features. Similar patterns have been observed in children (Labov, 2013; Nardy et al., 2013; Smith & Durham, 2019). For example, Macaulay (1977) found that among 32 children aged ten to fifteen from Glasgow, the higher social classes they came from, the more frequent the production of standard variants. Similarly, Díaz-Campos (2005) found that Venezuelan Spanish-speaking children aged 3;06 to 5;11 from higher social classes tended to produce the intervocalic /d/ more often than those from lower social classes. Chevrot et al. (2011) also reported that the effect of class differences on phonological variation in French children increased through the age groups (2;03- 6;00), with the biggest difference found among the six-year-old group. In general, the effect of socioeconomic status has been paid relatively less attention than other social influences in child language research. Current studies mainly focused on Caucasian children from the middle and upper classes, leaving children from other social backgrounds understudied (E. K. Johnson & White, 2020).

6.2.5 Style-shifting and context

For style-shifting, Labov (2013) proposed that the emergence of adult-like patterns is in place at least in preadolescence or the first year of high school. However, current findings about style-shifting in child language regarding its inception are inconsistent (Smith & Durham, 2019). Some studies found children only demonstrated stylistic adaptation in their teens. For instance, in the alternation of post-consonantal /r/ in French, children did not omit the /r/ in different contexts until age ten (Chevrot et al., 2000). Similarly, systematic style-shifting patterns were only

observed in twelve-year-olds but not in eight- or four-year-olds from the new town of Milton Keynes (Kerswill & Williams, 2000). However, other scholars reported early effects of discourse contexts. For example, children aged 3;02 to 4;11 in Philadelphia began to vary their use of -ing according to their interlocutors, selecting the standard variant more frequently when talking to an adult than when addressing another child (Roberts, 1994). Similar findings also revealed that systematic style-shifting in some particular sociolinguistic variables might come quite early, around age three or four (E. S. Andersen, 1990; Díaz-Campos, 2001, 2005; Smith & Durham, 2019). The inconsistency of previous findings may be explained by several reasons. First, the types of discourse contexts that have been examined vary from one study to another. For example, the discourse contexts investigated in the studies discussed above contain dialogue and exercises, words to adults and young children, careful speech and less careful speech, conservation and storytelling, and routine, play, teaching, and talks about discipline and intimacy (Chevrot et al., 2000; Díaz-Campos, 2005; Roberts, 1994; Smith & Durham, 2019). In addition, as mentioned earlier, children's exposure to sociolinguistic variables changes as their social network expands. In the early stage of variation acquisition, children mainly develop their primary variable patterns based on the input in CDS at home. And the style-shifting norms as part of the variation acquired from home will be further evaluated by their intersection with patterns of social stratification in adolescence (Labov, 2013). Thus, hypothetically, if a child has been exposed to a sociolinguistic variable with all its variants applied in different contexts, they may be able to demonstrate the adult-like capacity to use this variable appropriately for style-shifting as early as age three.

6.3 The current study

Since the beginning of the study of language variation and change in the 1960s, scholars have investigated linguistic and social constraints on variation patterns and how these constraints are passed on from one generation to the next. However, current findings may not be representative enough to cover all types of speakers because they were mainly recruited from monolingual environments. It is still unknown whether bilingual children who may be exposed to different varieties in their L1 and L2 can internalize the variation patterns in the language input and if they can acquire these patterns in the same way as their monolingual peers. To fill in these research gaps, this chapter focuses on the acquisition of Mandarin syllable-initial sibilants /s/ and /ʂ/ as a sociolinguistic variable by children and aims to answer the following research questions.

1) How do children who are learning Mandarin as a heritage language use the dental sibilant /s/ and post-alveolar sibilant /ʂ/ in their language production?
2) What kind of linguistic constraints, including phonological environment and grammatical function, affect the use of sibilants in child language?
3) What kind of social factors, including age, gender, language background, and discourse context, affect the use of sibilants in child language?
4) According to findings in Chapter 4, is there any evidence to suggest an input effect on variation patterns in child language?

6.3.1 Data collection

For two academic years from 2021 to 2023, spontaneous data have been collected from 43 children (20 girls, 23 boys) aged 3;01 to 5;04 from two English-Mandarin dual immersion preschools in the San Francisco Bay Area. All children are CHL learners with at least one parent or grandparent who is a native speaker of a Chinese language. All families belonged to the

middle class, and all parents had received bachelor's or higher degrees. The preschools adopt both English and Mandarin as the language of instruction in a 50:50 ratio. Among the 43 children, 14 predominantly use English at home and therefore, cannot speak in Mandarin effectively with others. Of the remaining 29 children, 12 completed all the tasks for data collection by the beginning of 2023. One child's data has been excluded because they have a dental implant in their mouth, which caused significant deformation of most consonantal articulation. Thus, the language production of 11 CHL children (five girls, six boys with initial age of 4;01 - 5;00) serves as the main resource for data analysis in this chapter. Table 6.1 summarizes their demographic and language backgrounds.

Table 6.1 Background information of the target children

Name	Gender	Age (months)	Home language	English oral level	English phonetic skill level	Mandarin vocabulary level
Emma	F	49	Mandarin (S)	Time 1: average Time 2: high	Time 1: high Time 2: high	Time 1: average Time 2: high
Cameron	M	59	Mandarin (S)	Time 1: low Time 2: low	Time 1: high Time 2: high	Time 1: average Time 2: high
Dylan	M	56	Mandarin (S)	Time 1: low Time 2: low	Time 1: low Time 2: low	Time 1: low Time 2: low
Julian	M	59	Mandarin (N)	Time 1: average Time 2: average	Time 1: high Time 2: high	Time 1: high Time 2: high
Jay	M	58	Mandarin (S)	Time 1: low Time 2: low	Time 1: high Time 2: average	Time 1: average Time 2: average
John	M	59	Mandarin (N)	Time 1: low Time 2: low	Time 1: low Time 2: low	Time 1: average Time 2: average
Lia	F	56	English, Mandarin (S)	Time 1: average Time 2: average	Time 1: high Time 2: high	Time 1: low Time 2: average
Natalie	F	60	Mandarin (N)	Time 1: low Time 2: low	Time 1: high Time 2: high	Time 1: high Time 2: high
Ophelia	F	56	Mandarin (N)	Time 1: low	Time 1: high	Time 1: high

				Time 2: low	Time 2: high	Time 2: high
Sheldon	M	54	English, Mandarin (S)	Time 1: low Time 2: low	Time 1: high Time 2: high	Time 1: low Time 2: low
Tessa	F	55	Mandarin (S)	Time 1: low Time 2: low	Time 1: high Time 2: high	Time 1: average Time 2: high

Notes

1. All children's names are pseudonyms.
2. Children's age was calculated by the beginning of 2021 school year when the first language tasks were completed.
3. S in Mandarin means the mixed use of sibilants in the Mandarin variety spoken at home is a common norm, while N means this variable is infrequently used in the home variety. English means English and Mandarin were both used at home, in a roughly 50-50 ratio.

Family information about the target children, including demographic background, home language, interpersonal relationships, and language education, was collected via a family background questionnaire. At the beginning (time 1) and the end (time 2) of each academic year, children completed several language tasks, including English and Mandarin language assessments (see details in Chapter 5), a sentence repetition task, a story retelling task, and sociolinguistic interviews. Children were encouraged to talk as much as they could during the tasks, and all tasks were audio-recorded. All audio recordings were collected with a Sony ICD-UX570 Digital Voice recorder with a Lavalier lapel microphone at a 44.1 kHz sampling rate. Field notes were kept for each observation. In total, three to four hours of recordings were elicited from each child in all types of tasks.

6.3.2 Data analysis

In a similar method as introduced in Chapter 4, the realization of Mandarin word-initial dental sibilant /s/ and post-alveolar sibilant /ʂ/ was measured by several acoustic parameters, linguistic factors, and social constraints. Specifically, the two acoustic parameters that were measured in the target tokens were sibilant duration (ms) and centroid frequency (Hz). /s/ is often realized with a higher centroid frequency, while /ʂ/ usually occurs with a lower centroid frequency due to their distinctive articulatory positions (F. Li, 2009; Reidy, 2016). Linguistic factors consist of preceding sound, following sound, lexical tone, word type, and sentence type. Social constraints include children's age, gender, home language, English oral language level, English phonetic coding skill level, and Mandarin receptive vocabulary level. The Chinese varieties, including Taiwan Mandarin and Guangzhou Mandarin, where sibilants are often mixed, are categorized as Mandarin (S), while other varieties, where dental and post-alveolar sibilants are used separately, are grouped as Mandarin (N). In sum, 2363 tokens, including 696 /s/ and 1667 /ʂ/, were collected, with sibilants in noisy backgrounds, interrupted sentences, and invalid acoustic parameters excluded.

To examine the effect of linguistic and social constraints on the realization of sibilants, four rounds of mixed effect linear regression models in R (Bates et al., 2015; Kuznetsova et al., 2017). In the first round, sibilant duration was set as the dependent variable, while independent variables consisted of all linguistic factors and social constraints as explained above. In the second round, sibilant centroid frequency served as the dependent variable, while other independent variables remained the same. Then dental sibilant /s/ and post-alveolar sibilant /ʂ/ were separated as two independent categories, and the effect of linguistic and social factors were tested again in each data sample. In all models, the individual and target word were set as

random intercepts. Factors that contain fewer than 1% of the total number of tokens have been excluded.

6.4 Findings

6.4.1 Sibilant duration

As shown in Table 6.2, statistical results demonstrate that among all sibilant tokens, duration is significantly affected by both linguistic factors and social constraints. Specifically, for linguistic constraints, both preceding sound and word type contributed to the form of a particular phonological environment where longer sibilants were produced. In general, when the sibilant occurred after a pause and in a noun, a verb or their modifiers (i.e., determiner, classifier, adjective or adverb), children tended to produce it with a longer duration. For social factors, results reveal that children's proficiency as reflected in Mandarin receptive vocabulary, test time, gender, and home language are significant influences. In particular, children with larger Mandarin vocabulary size tended to extend their sibilants in Mandarin. In addition, boys tended to talk faster and produced shorter sibilants than girls. At time 2, children also tended to produce sibilants with longer duration. And children from families where dental and post-alveolar sibilants were distinguished preferred to use sibilants with longer duration in their speech.

Table 6.2 Statistical results: sibilant duration (ms)

	Estimate	Std. error	df	t-value	Pr (> |z|)	N	Mean
Intercept	216.5428	38.2919	8.1084	5.655	0.000456		
Preceding_pause	47.1117	5.5574	2301.6432	8.477	< 2e-16	472	191.2513
Mandarin_vocabulary (standard score)	-0.9802	0.1797	87.1643	-5.454	4.54e-07	2354	142.250
Word type_other	-19.3845	7.5411	668.1257	-2.571	0.010370	289	114.285
Test time_time2	12.4065	5.1477	305.0683	2.410	0.016540	1206	136.424
Gender_male	-20.3793	6.0799	5.5424	-3.352	0.017344	929	147.269
Home language_Mandarin(N)	36.8527	13.7248	10.9066	2.685	0.021356	1223	132.445
Notes: N = 2354, factor groups are listed based on p values in ascending order							

6.4.2 Centroid frequency

Centroid frequency, or center of gravity in another form, often serves as a key acoustic parameter to distinguish dental sibilants from post-alveolar sibilants (F. Li, 2009; Reidy, 2016). Acoustically, as /s/ is produced before the alveolar ridge, its centroid frequency is higher than that in post-alveolar sibilant /ʂ/ (F. Li, 2009). In the current study, centroid frequency is measured as another dependent variable to quantify the sibilant variation in child language.

In the first model, /s/ and /ʂ/ were combined as a whole sibilant group. As shown in Table 6.3, it seems that children treated the sibilants as two distinctive categories as the sibilant type is the most significant factor of the variation in centroid frequency. And, as predicted, /s/ is realized with a higher centroid frequency while /ʂ/ occurs with a lower value. The remaining linguistic

constraints include preceding segment, sentence type, and word type. In general, sibilants preceded by unrounded vowels, in declarative sentences, and in verbs, verbal modifiers, and other elements tend to be realized with a higher centroid frequency. The effect of vowel roundedness echoes previous findings about the phonological environment on Mandarin sibilant realization (Starr, 2016). Dental /s/ is more likely to occur if it is surrounded by unrounded vowels, while the retroflexion of /ʂ/ is often better supported if the tongue is already retracted in preceding and following rounded vowels. On the other hand, more social constraints reached significance in this model, including children's language proficiency, age, and test time. In short, children aged 5;00 or older were tested at the beginning of the school year, and with higher language proficiency in both English oral skills, English phonetic coding skills, and Mandarin receptive vocabulary tended to produce sibilants with higher centroid frequency or more like the /s/ sound. Among all three language assessments, English oral skills appear to be the strongest influential factor on Mandarin sibilant realization regarding its centroid frequency.

Table 6.3 Statistical results: Centroid frequency (Hz) in both sibilant groups

	Estimate	Std. error	df	t-value	Pr (> |z|)	N	Mean
Intercept	-19576.065	4413.822	28.934	-4.435	0.000122		
English oral (standard score)	94.968	10.956	1600.373	8.668	< 2e-16	2354	4639.269
Age_under 5	-1243.390	169.113	2326.556	-7.352	2.68e-13	1213	4271.324
Time time_time2	-1113.172	151.497	1948.320	-7.348	2.95e-13	1206	4648.349
English phonetics (standard score)	83.417	14.517	764.804	5.746	1.32e-08	2354	4639.269
Mandarin vocabulary (standard score)	18.047	6.362	1724.127	2.837	0.004610	2354	4639.269
Preceding_unrounded vowel	403.975	113.150	2312.247	3.570	0.000364	1012	4925.025
Sentence type_ Interrogative	-490.104	128.080	2318.622	-3.827	0.000133	286	4076.556
Sibilant_/ʂ/	-895.345	255.759	54.375	-3.501	0.000935	1661	4387.775
Word type_other	475.788	187.633	620.388	2.536	0.011466	289	4469.836
Word type_verbal	498.321	201.740	197.982	2.470	0.014353	869	4907.234
Notes: N = 2354, factor groups are listed based on their p values in ascending order							

As mentioned, children basically treated /s/ and /ʂ/ as two distinctive categories as early as four years old. Thus, in the following analysis, these two sibilants were separated into two different models where their centroid frequencies still serve as the dependent variable. Independent variables remain the same.

Table 6.4 shows the significant constraints on the centroid frequency of dental sibilant /s/. None of the linguistic influences reached significance in this model. Part of this may be attributed to the small sample size. While social factors that significantly affect sibilant realization are English oral skills, children's age, and test time. Results demonstrate that children with higher English oral communication skills tended to produce sibilants with higher centroid frequency. In addition, compared with their younger peers, children older than age five also preferred to produce /s/ with higher frequency. Lastly, at the beginning of the academic year, children preferred to emphasize the realization of /s/ with higher frequency.

Table 6.4 Statistical results: Centroid frequency in dental sibilant /s/

	Estimate	Std. error	df	t-value	Pr (> |z|)	N	Mean
Intercept	-6409.262	4808.681	11.025	-1.333	0.2095		
English oral (standard score)	114.842	23.952	24.624	4.795	6.58e-05	693	5242.057
Age_under5	-891.539	347.315	296.680	-2.567	0.0108	439	4434.605
Test time_time2	-678.939	316.489	140.761	-2.145	0.0337	265	5295.487
Notes: N = 693, factor groups are listed based on their p values in ascending order							

For the realization of post-alveolar sibilant /ʂ/, as shown in Table 6.5, significant constraints are English oral skills, children's age, discourse context, preceding sound, test time, and sentence type. For linguistic factors, /ʂ/ tended to be produced with higher frequency or more like an /s/ sound when it occurs after an unrounded vowel or pause, or in a declarative sentence. Significant social factors in this model include children's English oral proficiency, age, discourse

context, and test time. Specifically, children with higher English oral skills preferred to produce /ʂ/ with higher frequency. Children aged five and above also tended to produce /ʂ/ like /s/. /ʂ/ was more mixed with /s/ in informal contexts, such as spontaneous speech. At the end of the school year, children also tended to produce /ʂ/ with lower centroid frequency.

Table 6.5 Statistical results: Centroid frequency in post-alveolar sibilant /ʂ/

	Estimate	Std. error	df	t-value	Pr (> |z|)	N	Mean
Intercept	-4353.0713	2927.9272	51.8683	-1.487	0.143137		
English oral (standard score)	53.6965	10.0218	169.3230	5.358	2.72e-07	1661	4387.775
Age_under5	-628.5735	186.4748	1543.4036	-3.371	0.000768	774	4178.713
Context_repetition	-677.6779	211.0056	1054.4277	-3.212	0.001360	66	4036.135
Preceding_unrounded vowel	287.8971	114.5320	1304.6780	2.514	0.012067	777	4571.803
Test time_time2	-325.3927	159.1505	732.4711	-2.045	0.041255	941	4466.105
Sentence type_interrogative	-238.1258	118.1891	865.0761	-2.015	0.044236	260	3987.677
Notes: N = 1661, factor groups are listed based on their p values in ascending order							

6.5 Discussion

6.5.1 Linguistic constraints

As discussed in previous chapters, among Mandarin sibilants /ɕ/ is acquired first by monolingual children, followed by the mastery of /s/, then /ʂ/ (F. Li & Munson, 2016). Specifically, 90% monolingual children in Beijing can produce /ɕ/ clearly at around 2;07 to 3;00, then the production of /s/ is mastered around 4;01-4;06, followed by the use of /ʂ/ after 4;06 with the acquisition of several other affricates such as /tʂ, tʂ^{h}, ts, and ts^{h} / (Zhu & Dodd, 2000). Based on this observation, most monolingual children have established the basic phonological knowledge about /s/ and /ʂ/ as two distinctive categories by age four. CHL data in the current study, especially the effect of sibilant type on the centroid frequency of all target tokens, demonstrate that the same knowledge has also been acquired by CHL children in the dual immersion programs. In their Mandarin production, children differentiated /s/ and /ʂ/ by realizing /s/ with significantly longer duration and higher centroid frequency.

For linguistic constraints on the alternation between /s/ and /ʂ/, Starr (2016) noted that the roundedness of the following vowels might lead to a retroflex realization. Specifically, dental /s/ is more likely to be hypercorrected or realized as the retroflex /ʂ/ before rounded vowels in words such as /ʂù/ (shù, 树, ‘tree’). The findings in the current study not only echo the impact of the roundedness in the following vowels but also show that preceding sounds significantly affect the production of the sibilants. In particular, dental /s/ is more likely to occur if it is surrounded by unrounded vowels, while the retroflexion of /ʂ/ is often better supported if the tongue is already retracted in preceding and following rounded vowels.

Another linguistic factor that consistently reaches significance in all models is sentence type. In all language tasks, children often address questions or describe events with declarative

sentences. But they also asked many questions about the pictures that they saw during the tasks. The examples below in Table 6.6 demonstrate some frequently asked questions. For example, they were wondering about some unfamiliar objects shown in the pictures, trying to figure out why something happened in the story, or just curious if the same situation occurred to the researcher or their friends. In general, children realized sibilants with longer duration and higher centroid frequency values in declarative sentences. But the two groups of sibilants were well distinguished in different sentence types. The mean centroid frequency of /s/ is 5252.84 Hz in declarative sentences and 4965.34 Hz in questions, while the mean centroid frequency of /ʂ/ is much lower (4462.03 Hz) in declarative sentences and reaches the lowest level (3987.68 Hz) in questions. The variation pattern identified in sentence type may suggest that the difference between declarative and interrogatory sentences is part of the CHL children's sociolinguistic knowledge, and this is reflected in the duration and centroid frequency of the sibilant variation.

Table 6.6 Linguistic examples _ sibilant variation in child language

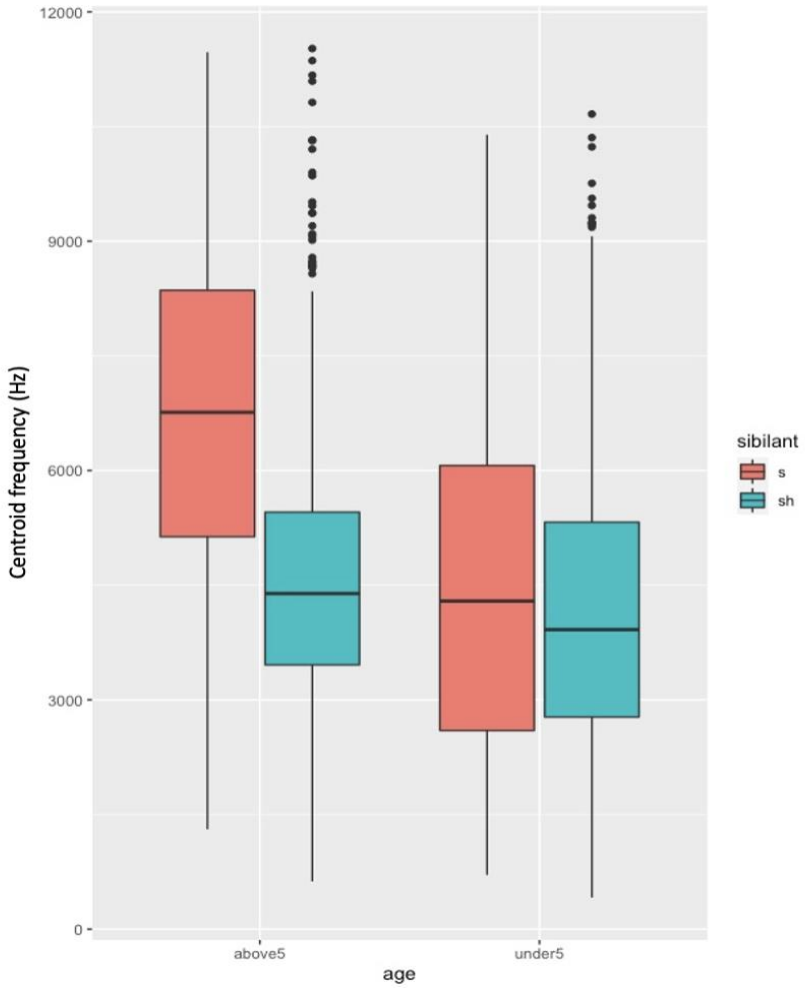
(1)	Julian (5;04)	Olivia	也	是	这样	的	吗？			
		Olivia	yě	**shì**	zhèyàng	de	ma?			
		Olivia	also	COP	this way	DE	Q			
		'Is it the same for Olivia?'								
(2)	Dylan (5;01)	是不是	你	开车	经常	在	马路	上	看	到？
		Sìbù**sì**	nǐ	kāicē	jīngcáng	zài	mǎlù	**sàng**	kàn	dào?
		COP-not-COP	2SG	drive	often	on	road	COMP	see	COMP
		'Do you often see it on the road when you are driving?'								
(3)	Emma (4;01)	这	个	是	什么？					
		Zhè	ge	**sì**	**sén**me?					
		This	CLF	COP	what					

		‘What is this?’			
(4)	Natalie (5;05)	为什么	有	个	狗？
		Wèi**shén**me	yǒu	gè	gǒu?
		Why	have	CLF	dog
		‘Why is there a dog?’			

6.5.2 Age and the sequence of acquisition

As discussed earlier, monolingual children may begin to demonstrate adult-like variation patterns as early as the second year. The CHL children in the current study show systematic patterns of sibilant use in Mandarin as their heritage language, and age turns out to be a significant factor that constrains the centroid frequency in sibilant variation. For both categories, when children were older than five, they tended to produce the sibilants with higher centroid frequency. However, results show that after five, children greatly increased the centroid frequency in /s/ so that the acoustic distinction between /s/ and /ʂ/ has been clarified. For children younger than five, /s/ was produced with a mean centroid frequency value of 4434.61 Hz and /ʂ/ at 4178.71 Hz. Children older than five produced /s/ with a mean centroid frequency value of 6637.61 Hz with about a 1200 Hz increase and /ʂ/ at 4570.20 Hz. Figure 6.1 shows the differences in centroid frequency values by the two age groups. These findings suggest that as children’s age increases, they are more capable of distinguishing the two categories of sibilants with better articulatory skills and metalinguistic awareness. It is also possible that younger children tended to follow the sibilant patterns of adults while older children tended to imitate their peers’ style. This will be further discussed in the association between input and output.

Figure 6.1 Children's age and sibilant realization



On the other hand, current findings cannot provide enough evidence to reveal the acquisition sequence of the sibilant variation in CHL children. Specifically, they do not clarify whether the standard and vernacular variants are acquired simultaneously or sequentially. This can only be answered after two prerequisite questions have been addressed. First, what are the standard and vernacular variants for Mandarin sibilant variation in the CHL community? As previous studies reveal, dental and post-alveolar sibilants often vary in vernacular Mandarin (Y.

S. Chang & Shih, 2015; Chiu et al., 2020; S.-W. Liao, 2010; Starr, 2016). And it is possible that a similar language ideology or prestige hierarchy has also been established in the Chinese diaspora. However, whether standard Mandarin, instead of other Chinese varieties, is positioned at the top of the linguistic prestige structure in the local speech community is a topic for future research. Second, does the acquisition of variation differ from or intertwine with the acquisition of categorical units, and if so, how does it differ? For the acquisition of Mandarin sibilants specifically, if children follow the dialectal patterns and merge /s/ and /ʂ/ in their production, do they still perceive these sibilants as two distinctive categories?

6.5.3 Context and style shifting

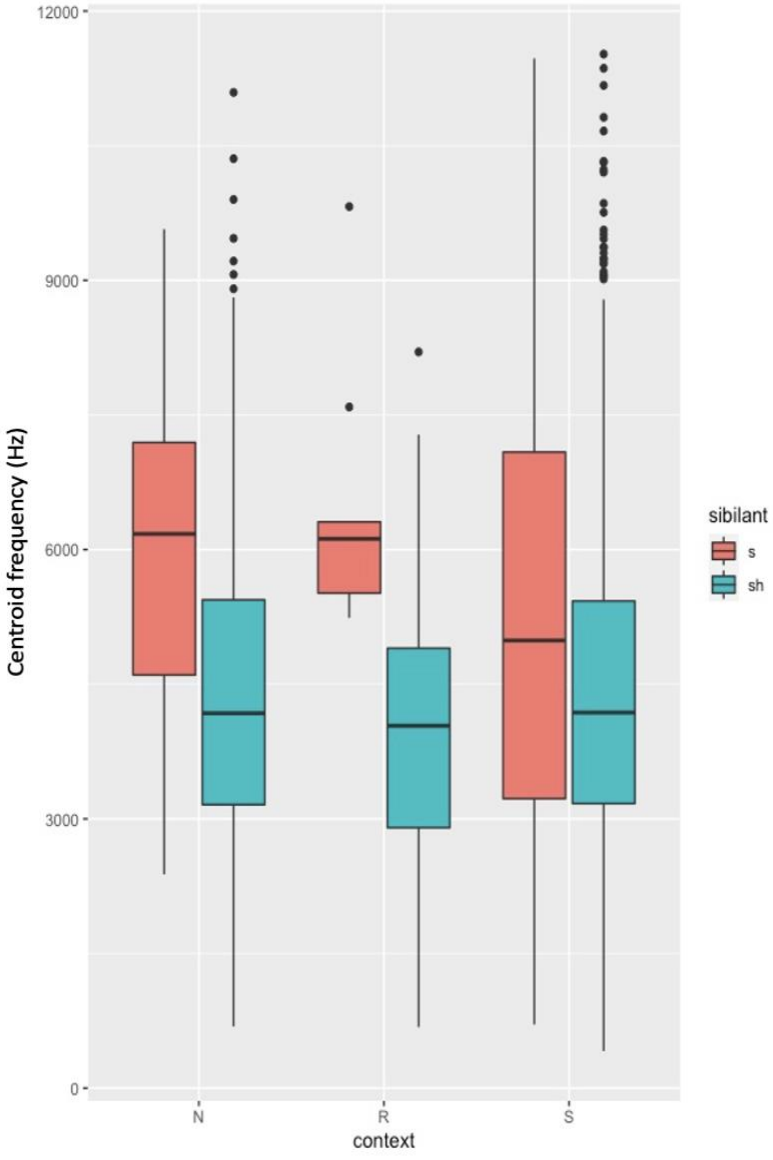
Acoustic analyses of the centroid frequency in both dental and post-alveolar sibilants have demonstrated the effect of context. As mentioned, previous findings about the emergence of style-shifting in variation by young children are inconsistent. Some studies suggest that this may begin as early as age three (E. S. Andersen, 1990; Díaz-Campos, 2001, 2005; Roberts, 1994; Smith & Durham, 2019). This may depend on the particular linguistic variable under study. For sibilant variation by CHL children, results suggest that style-shifting may also start quite early, around the age of four or even earlier. As shown in Figure 6.2, children tended to merge /s/ and /ʂ/ in spontaneous speech [S] when they were having casual conversations with the researcher. While in narratives [N] during the story retelling task and sentence repetition [R], children seemed to emphasize the acoustic distinction between the two categories more by increasing the centroid frequency of /s/ and keeping /ʂ/ as where it was in the spontaneous speech. These

findings imply that even for CHL children who have been exposed to limited language input, sociolinguistic competence for style-shifting has been established at age four.

6.5.4 Language background and language proficiency

Starr (2016) investigated the acquisition of sociolinguistic knowledge by first and second-graders in a Mandarin-English two-way immersion program in California. Teachers used both standard and non-standard sibilants in classroom speech, and the language use by students

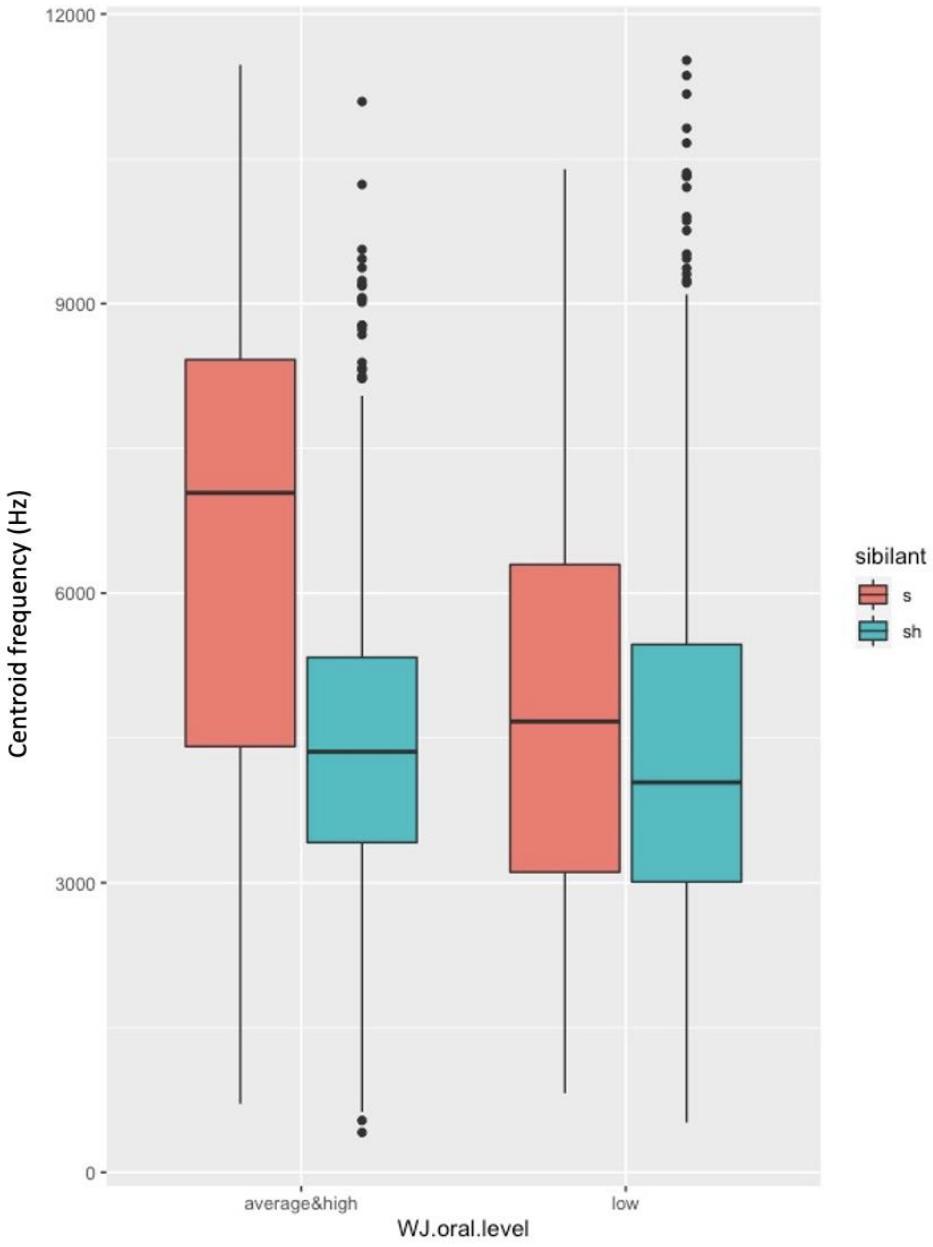
Figure 6.2 Discourse context and sibilant realization



differed according to their language backgrounds: the speech of native-speaker students is primarily shaped by their home varieties, while non-native-speaker students tended to avoid acquiring the non-standard features that were used by teachers. However, the effect of home language is not identified in the current study. Among the 11 CHL children, seven had been exposed to sibilant dentalization at home, four had experienced the use of dental and post-alveolar sibilants as two categories by their parents, and two were using both English and Mandarin with their family members. These three types of home language environments seemed not to affect the sibilant variation in children's language production.

Yet, on the other hand, children's language proficiency in both English and Mandarin significantly affected their realization of the sibilants, which may be indirectly influenced by their home language. In general, children with a larger Mandarin vocabulary size and lower English oral proficiency tended to produce sibilants longer. Children with better English oral skills also realized sibilants with higher centroid frequencies. By increasing the mean centroid frequency of /s/ to 6384.56 Hz, which is about 2000 Hz higher than the mean centroid frequency of /ʂ/ at 4420.46 Hz, children with average and higher English oral proficiency emphasized the phonological distinction between the two sibilant categories. It is interesting to note that children's Mandarin vocabulary size did not reach significance in most of the models. This may imply that bilingual children's metalinguistic awareness and sociolinguistic knowledge are more related to their linguistic experiences from different languages rather than the vocabulary size in the target language.

Figure 6.3 Children's English oral proficiency and sibilant realization



6.5.5 Input, outcome, and gender

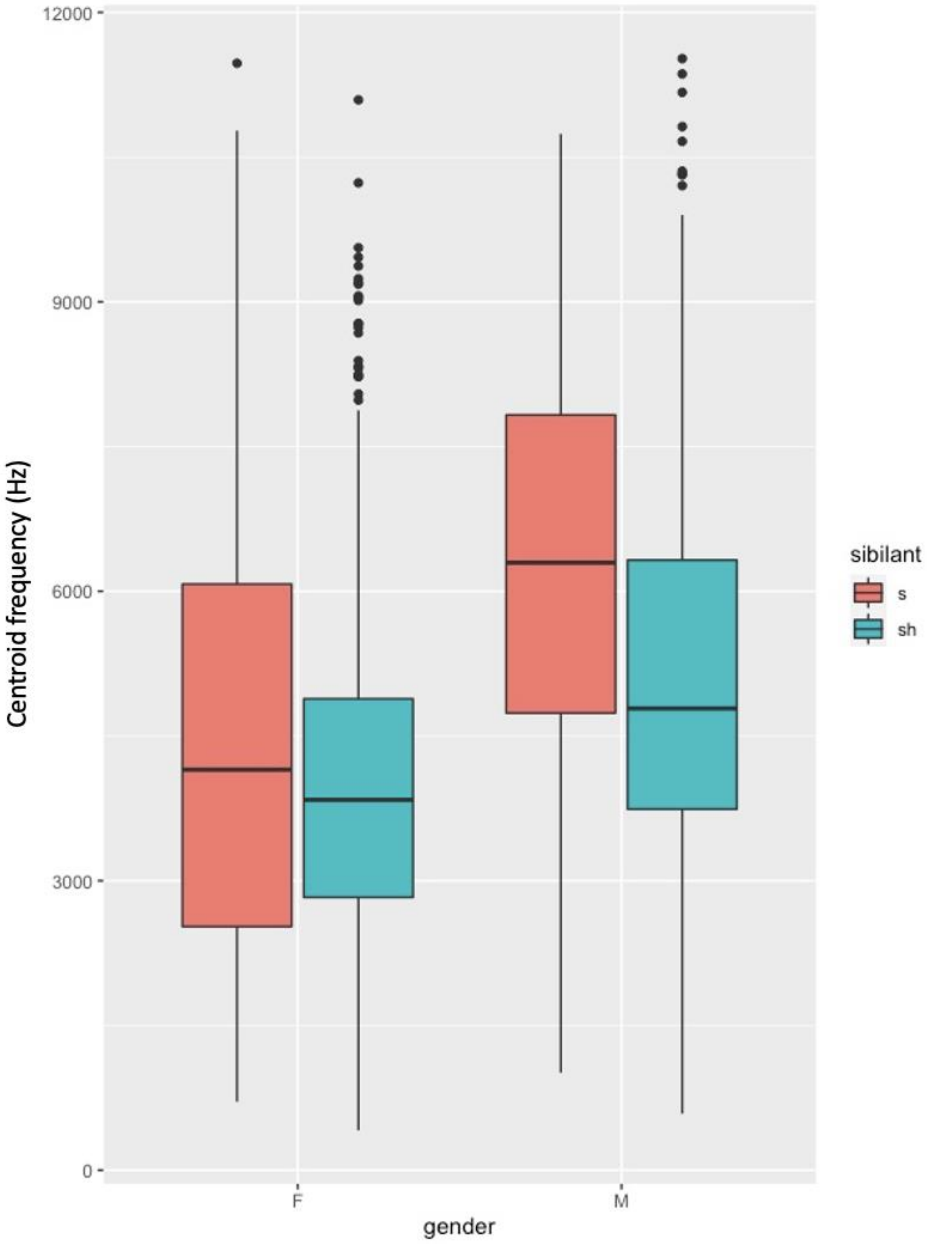
Chapter 4 revealed that for Mandarin-dominant children, teachers provided language input that consisted of both standard and vernacular forms of Mandarin sibilants. Among the 11 children, only Emma was from Lily Valley and interacted with Ms. Daisy and Ms. Olivia, who tended to use more standard sibilants in class. The other ten children were all in Ms. Cindy's class, and they had been exposed to the mixed use of /s/ and /ʂ/ not only by the teacher but also from the daily interaction with their peers. To interpret the potential effect of language input, the following discussion focuses on sibilant variation by three girls: Emma, Lia, and Ophelia (Table 6.7). For Emma, home language contained sibilant merger, while teachers at school tended to distinguish /s/ and /ʂ/. As the only student who could speak Mandarin fluently in class, Emma had to switch to English when playing with her peers. With this kind of input, Emma demonstrated typical sibilant merger patterns in her Mandarin production. The language input regarding sibilant variation is more consistent for Lia. /s/ and /ʂ/ were mixed in both home language and school input. Consequently, the two categories in Lia's Mandarin production are merged more than that in Emma's speech. However, for Ophelia from the same program, /s/ and /ʂ/ were acoustically separated with a 2000 Hz difference in the centroid frequency. Although Ms. Cindy provided some sibilant dentalization patterns in class, Ophelia maintained her sibilants as two distinctive categories. This probably is because /s/ and /ʂ/ were clearly differentiated by her family members and the friends who she talked to most frequently at school. Similar findings were also identified in boys. In sum, the findings suggest that there exists a close association between language input and children's variation patterns. And the language input not only contains CDS from caregivers at home but also language patterns children may be exposed to at school.

Table 6.7 Examples of sibilant variation in children from different programs

Child	School	Home language	Sibilant	Intercept	N	Mean (Hz)
Emma	L (N)	Mandarin (S)	/s/	-2676.2	45	2891.93
			/ʂ/	-949.141	96	3203.364
Lia	S (S)	English, Mandarin (S)	/s/	-1224.307	45	5868.315
			/ʂ/	1263.038	157	5602.659
Ophelia	S (S)	Mandarin (N)	/s/	894.613	39	5252.087
			/ʂ/	-442.603	163	3206.782

Lastly, boys and girls seemed to treat the sibilants differently, although gender did not reach significance in the above statistical models. As shown in Figure 6.4, in general, girls tended to mix the two sibilants more than boys. This result differs from previous findings about the effect of gender on the acquisition of variation. As mentioned before, although caregivers may alter their language patterns according to the gender of the children, the effect of gender was only occasionally identified in child language (Chevrot et al., 2000; Foulkes et al., 2005; J. Johnson, 2003; Roberts, 1994, 1997a). It is possible that monolingual children are not sensitive to gender differentiation in language patterns by age five or six, while the bilingual exposure of the CHL children in the current study may boost the children's metalinguistic awareness, as reflected in their high English phonological coding skills. And this may lead them to interpret the variation patterns at an early age. And girls may prefer to follow the sibilant patterns demonstrated by their teacher, who served as a model of a female Mandarin speaker in formal contexts.

Figure 6.4 Children's gender and sibilant realization



6.6 Conclusion

This chapter illustrated the use of Mandarin syllable-initial sibilants by 11 CHL children aged 4;01 to 5;02. Statistical results show that linguistic factors such as preceding sound, word type, sentence type, and sibilant type significantly affect the duration and the centroid frequency of the sibilant. The mix of dental and post-alveolar sibilants is identified in child language. As children's age increases, they tend to distinguish /s/ and /ʂ/ better. They also preferred to enhance the difference between the two categories in formal settings instead of casual speech. Other factors, including children's English and Mandarin proficiency, language input, and gender, also significantly affected the ways they chose to use the sibilants.

The study contributes to the current understanding of variation acquisition by expanding the research context to CHL communities where heterogeneous language resources are available for children to explore. It also reveals the potential connection between language input and child language production to illustrate the acquisition process where different variation patterns may compete for salience. In this age group, children start exploring and experimenting with various language features and styles with adults and peers. The observed variation patterns in their language production may also be changed according to the dynamics in their social network.

7. Other developmental and variation patterns in CHL children

7.1 Introduction

Typical developing monolingual children often demonstrate consistent language acquisition trajectories. For example, Mandarin monolingual children usually have mastered lexical tones and can produce some one-word utterances by age two (Erbaugh, 1992; Zhu & Dodd, 2000). Around three or four years old, children become fluent in Mandarin speech with clear pronunciation of most vowels and consonants (Zhu & Dodd, 2000). And English monolingual children generally have established a 50-word vocabulary size by age two (Clark, 2016). Some vowels are acquired before age three, while most consonants are not mastered before age five when most children are able to manipulate a variety of complex syntactic constructions with a vocabulary of 6,000 words (Clark, 2016; Crowe & McLeod, 2020; Otomo & Stoel-Gammon, 1992).

However, bilingual and heritage language children often demonstrate various language developmental trajectories. Factors including the age of onset bilingualism, the quality and quantity of input in both languages, children's cognitive abilities, and sociocultural influences all contribute to the diverse language proficiencies in bilingual children (Baker, 2011; De Houwer, 2018; Genesee & Nicoladis, 2007; Paradis et al., 2017). More studies have begun to investigate the acquisition of language-specific structures by bilingual children, as such phonological processes and lexical development (e.g., Lin & Johnson, 2010; Marinova-Todd et al., 2010; Sheng, 2014; Yang & Liu, 2012). For example, Jia et al. (2006) highlighted the age differences in the perception and production of English vowels by Mandarin-speaking children in China. By comparing Mandarin monolinguals, English-Mandarin bilinguals, and English monolinguals (aged six to eight), Jie Yang and Liu (2012) revealed the potential effects of language

backgrounds on children's perception of Mandarin lexical tones. Language backgrounds and language dominance also effected Mandarin-English children's achievement in lexical-semantic skills (Sheng, 2014).

As explained in chapter 3, although CHL children in this study were grouped in the same classroom, they may be sequential bilingual learners or simultaneous bilingual learners with limited input in one of the languages. Previous chapters illustrate the variation patterns in teacher speech (Chapter 4), CHL children's English and Mandarin language proficiency (Chapter 5), and the variation patterns in CHL children's Mandarin production (Chapter 6). This chapter aims to address other developmental and variation patterns observed in children's Mandarin and English. The following sections summarize children's phonological processes, morphosyntactic patterns, and the mix of English and Mandarin with examples and offer potential explanations.

7.2 Developmental patterns

7.2.1 Mandarin developmental patterns

7.2.1.1 Stopping

Stopping is a typical phonological process in both monolingual and bilingual children (X. X. Li & To, 2017; Zhu & Dodd, 2000). Stopping was also found in CHL children's Mandarin production. As shown in Table 7.1, many affricates were realized as the corresponding stops, but the rest of the features, including place and aspiration, were preserved in the stops. Previous findings based on monolingual data show that stopping of affricates was more common than stopping of fricatives (Cohen & Anderson, 2011). As a typical pattern of consonant simplification, stopping has been explained as a substitution for the complex fricatives and affricates (Jeng, 2011; Zhu & Dodd, 2000). Stops are also one of the first mastered consonants, earlier than fricatives and affricates. Thus, it is not surprising to find that CHL children,

including English-dominant and Mandarin-dominant children, also demonstrated this phonological process.

Table 7.1 Mandarin stopping examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Isabella	4;04	F	English dominant	花丛 'clumps of flowers'	/xua1 ts^{h}ʊŋ2/	[xua1 t^{h}ʊŋ2]
2	Emma	4;01	F	Mandarin (S)	超人 'Superman'	/$tʂ^{h}$ao1 ɹən2/	[t^{h}ao1 ɹən2]
3	George	4;09	M	Mandarin (N)	在找 'be searching	/tsai4 tʂao3/	[tai4 tʂao3]
4	Steven	3;11	M	Mandarin (S)	这里 'here'	/tʂə4 li3/	[tə4 li3]
5	Michael	3;08	M	Mandarin (N)	出租车 'taxi'	/$tʂ^{h}$u1 tsu1 $tʂ^{h}$ə1/	[k^{h}u1 ku1 $tʂ^{h}$ə1]

Notes:
1. All children's names are pseudonyms.
2. S in Mandarin means the mixed use of sibilants in the Mandarin variety spoken at home is a common norm, while N in Mandarin means this variable is infrequently used in the home variety. English means English and Mandarin were both used at home, in a roughly 50-50 ratio.
3. If the target word was produced in continuous speech, then the whole utterance was presented. If not, then only the target word was presented.

7.2.1.2 Deaspiration and aspiration

Aspiration may be one of the most apparent distinctions between Mandarin and English consonantal inventories (C. B. Chang et al., 2011). Voicing distinguishes English consonants such as /b/ and /p/, while aspiration only serves as an allophonic but not as a distinctive feature. However, there are no voiced stops in Mandarin. On the other hand, aspiration serves as a crucial feature to distinguish /t^{h}/ from /t/ as two different phonemes. Thus, it is often found that Chinese adult learners of English would neglect the differences between voiced and voiceless sounds in English (F. Zhang & Yin, 2009). The acoustic differences in Mandarin aspiration and English

voicing have been measured by voice onset time (VOT) (C. B. Chang et al., 2011; Hui & Oh, 2015). Based on this, (C. B. Chang et al., 2011) Chang et al. (2011) revealed that thanks to their early bilingual exposure, CHL adult speakers successfully maintained both language-internal and cross-linguistic contrasts in Mandarin and English stops and affricates. However, according to the data in the current study, it seems that CHL children were still working on Mandarin aspirated consonants. As examples in Table 7.2 show, aspirated and unaspirated consonants were mixed sometimes. Moreover, this occurred more frequently in young and English-dominant children, which may suggest an English influence on their Mandarin phonology.

Table 7.2 Mandarin aspirated and unaspirated stop examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Evelin	3;03	F	English dominant	探望 'visit'	/tʰan4 waŋ4/	[tan4 waŋ4]
2	Noah	4;09	M	English dominant	腰带 'belt'	/jao1 tai4/	[jao1 tʰai4]
3	Mia	5;01	F	English dominant	太空人 'astronaut'	/tʰai4 kʰʊŋ1 ɹən2/	[tʰai4 kʊŋ1 ɹən2]
4	Joseph	4;07	M	English dominant	我**跟**太空人 'the astronaut **and** I'	/kən1/	[kʰən1]
5	Sheldon	4;11	M	Equally bilingual	飘扬 'float'	/pʰiao1 jaŋ2/	[piao1 jaŋ2]

7.2.1.3 Syllable-initial consonant deletion

In children's CHL, some syllable-initial consonants were omitted, including fricatives, affricates, approximants, and syllable-initial nasals. Most of the reduced consonants are often acquired relatively later than other consonants by monolingual children (Zhu & Dodd, 2000).

Zhu and Dodd (2000) also noted that syllable-initial consonant deletion most frequently happened before high vowels /i, y, u/ among young Mandarin monolingual children. Similar patterns were also observed in CHL children's Mandarin production (as shown in Table 7.3).

Table 7.3 Mandarin consonant omission examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Isabella	4;04	F	English dominant	花 'flower'	/xua1/	[ua1]
2	Scot	3;02	M	Equally bilingual	这是**水族箱**,是装鱼的。 'This is an **aquarium**. It's for fish.'	/ʂuei3 tsu2 ɕiaŋ1/	[ʂuei3 u2 ɕiaŋ1]
3	Lola	3;08	F	Mandarin (N)	狗在弄**蜜蜂**。 'The dog is playing with the **bees**.'	/mi4 fəŋ1/	[i4 fəŋ1]
4	Albert	4;07	M	Equally bilingual	日历 'calendar'	/ɹi4 li4/	[i4 li4]
5	Noah	5;04	M	English dominant	鞋子 'shoe'	/ɕie2 tsɨ/	[ie2 tsɨ]
6	Tessa	4;07	F	Mandarin (S)	一个**倒过来**的章鱼 'an **upside-down** octopus'	/tao4 kuo4 lai2/	[tao4 kuo4 ai2]

7.2.1.4 Simplification of diphthongs and triphthongs

Compared with the diphthongs in English, Mandarin has more complex structures for vowel combinations. Previous research shows that the acquisition of single vowels was often completed by monolingual children pretty early, before age 1;06 (X. X. Li & To, 2017). However, the stabilization of diphthongs and triphthongs occurred much later, and some were not even fully acquired by age 6;00. Because of the complicated structure of Mandarin

diphthongs and triphthongs, CHL children tended to simplify them by deleting one of the vowels. However, this rarely occurred in older Mandarin-dominant children. This suggests that the heterogeneous linguistic environment that the CHL children had been exposed to may accelerate their mastery of some complex syllable structures.

Table 7.4 Mandarin diphthong and triphthong simplification examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Emily	4;09	F	English dominant	转动 'spin'	/tʂuan4 tʊŋ4/	[tʂan4 tʊŋ4]
2	Jenny	4;03	F	English dominant	蝙蝠侠 'Batman'	/pian1 fu2 ɕia2/	[pian1 fu2 ɕi2]
3	Steven	3;11	M	Mandarin (S)	脚踏车 'bicycle'	/tɕiao3 tʰa4 tʂʰə1/	[tɕio3 tʰa4 tʂʰə1]
4	Lia	4;08	F	Equally bilingual	那个男生就把他的东西**丢掉**了 'the boy just **threw away** his stuff'	/tiu1 tiao4/	[tiu1 tao4]

7.2.1.5 Tone errors

Although Mandarin lexical tones are notoriously difficult for noon-tonal language speakers to acquire, they are actually one of the first acquired phonological features by Mandarin monolingual children (C. N. Li & Thompson, 1977; X. X. Li & To, 2017). So & Zhou (2000) demonstrated that monolingual children often acquired T1 and T2 around 2;0, T4 at 2;06, then T3 around 3;0. However, Zhu & Dodd (2000) noted that tone errors were rare even for children as young as 1;06. In the CHL data, tone errors were frequently observed in English-dominant children, which implies the English influence on the acquisition of Mandarin lexical tones. As shown in Table 7.5, errors in T3 were the more frequent. Other types of tone errors also existed.

The most apparent error patterns are: (1) T1 was substituted for T4; (2) T2 was realized as T1; (3) T3 was produced as T2; and (4) T4 was pronounced as T1. And this echoes previous challenges identified in Mandarin L2 learners (Y.-C. Hao, 2012).

Table 7.5 Mandarin tone error examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Isabella	4;04	F	English dominant	冰箱 ‘refrigerator ’	/piŋ1 ɕiaŋ1/	[piŋ1 ɕiaŋ14]
2	Noah	4;09	M	English dominant	滑雪 ‘ski’	/xua2 ɕye3/	[xua1 ɕye3]
3	Jackson	4;02	M	English dominant	昨晚 ‘last night’	/tsuo2 wan3/	[tsuo2 wan2]
4	Owen	3;07	M	Equally bilingual	**鼹鼠**先生 ‘Mr. **mole**’	/ian4 ʂu3/	[ian1 ʂu3]

7.2.1.6 Omission of verb complement

Mandarin verb complements serve two grammatical functions: they expand the meaning of the head verb compound and reflect the different stresses on markedness (Yong, 1997). Mandarin verb complements can be categorized as quantitative, resultative, directional, temporal, degree, and potential (Huang & Liao, 2007). Table 7.6 shows CHL children’s errors in verb complements. In general, children did not realize the verb complements as expected, resulting in ungrammatical utterances.

Table 7.6 Mandarin verb complement examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Lola	3;08	F	Mandarin (N)	他们掉河里了。 Tamen diao he li le 'They fall into the river.'	*他们掉河了。 Tamen diao he le 'They fall the river.'
2	Peyton	4;07	F	Mandarin (S)	小青蛙跳进了这个 baby 的车。 Xiao qingwa tiao jin le zhege baby de che 'The little frog jumped into the baby's cart.'	*小青蛙跳了这个 baby 的车。 Xiao qingwa tiao le zhege baby de che 'The little frog jumped the baby's cart.'
3	Jay	4;10	M	Mandarin (S)	他看到了一只虫。 Ta kan dao le yizhi chong 'He saw a bug.'	*他看了一只虫。 Ta kan le yizhi chong 'He saw a bug.'

7.2.1.7 Word order

CHL children demonstrated different types of speech errors in Mandarin word order. As shown in Table 7.7 in example 1, Mandarin often has the locative adverbial phrase preceding the main verb, but CHL children tended to position the locative phrase at the end of the sentence, which is often observed and implies a possible English influence, as demonstrated in example 4 where the child had the adverb at the end of the sentence. Examples 5 and 6 show some typical errors in the construction of BA and BEI structures. This is not only challenging for L2 learners but also for monolingual young children. Example 2 demonstrated the child's developmental pattern in the combination of the negation word "not" and the universal quantifier "every". To say "the camel does not need to have water every day (it still needs water, but only in a few days)", the child had "every day" preceded the negation so that the meaning had been changed into "every day, the camel does not need to have water (it does not need water at all)." The reordering of the negation and the quantifier caused misunderstandings for the need of water and

how often it is needed. In example 3, the child positioned the adjective before the classifier. And in example 8, if the negation “no” is placed between the verb compound “come out”, the sentence is interpreted as “the tyrannosaurus could not come out”. However, the child placed the negation before the whole verb compound turning the sentence into “the tyrannosaurus did not come out anymore.” Examples 2, 3, and 8 were not frequently identified in CHL children.

Table 7.7 Mandarin word order examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Matthew	4;09	M	Equally bilingual	Locative adverbial phrase 但我**在奶奶家**看过一个动物。 Dan wo zai nainai jia kanguo yige dongwu 'But I at grandma's house saw an animal.'	*但我看过一个动物**在奶奶家**。 Dan wo kanguo yige dongwu zai nainai jia 'But I saw an animal at grandma's house.'
2	Matthew	4;09	M	Equally bilingual	Negation and universal quantifier 它**不需要每天都**喝水。 Ta bu xuyao meitian dou heshui 'It (the camel) does not need to have water every day.'	*它**每天都不需要**喝水。 Ta meitian dou bu xuyao heshui 'Every day, it (the camel) does not need to have water.'
3	Steven	3;11	M	Mandarin (S)	Classifier and adjective 是**一个大的**熊猫。 Shi yige da de xiongmao 'Is a big panda.'	*是**大的一个**熊猫。 Shi da de yige xiongmao 'Is big a panda.'
4	Michael	3;08	M	Mandarin (S)	Verb and adverb 然后它又**偷偷地出来**。 Ranhou ta you toutou de chulai 'Then it secretly came out again.'	*然后它又**出来偷偷地**。 Ranhou ta you chulai toutou de 'Then it came out again secretly'
6	Tessa	4;07	F	Mandarin (S)	BA structure 因为**这个树枝把他绊倒了**。 Yinwei zhege shuzhi BA ta bandao le 'Because this brach trapped him.'	*因为**他绊倒了这个树枝**。 Yinwei ta bandao le zhege shuzhi 'Because he trapped this branch'
7	Cameron	5;11	M	Mandarin (S)	BEI structure 然后他**被一朵花吓到**。 Ranhou ta BEI yiduo hua xiadao 'Then he was scared by a flower.'	*然后他**被吓到一朵花**。 Ranhou ta BEI xiadao yiduo hua 'Then he was scared a flower.'
8	Emma	4;01	F	Mandarin (S)	Negation	

					霸王龙出不来了。 Bawanglong chu bu lai le ‘The tyrannosaurus could not get out.’	*霸王龙不出来了。 Bawanglong bu chu lai le 'The tyrannosaurus did not come out anymore.'

7.2.2 English developmental patterns

7.2.2.1 Word-final consonant deletion

English consonants that occurred at the end of the words were often deleted by CHL children, as noted in Mandarin-English bilingual children in Taiwan (Lin & Johnson, 2010). This did not happen frequently in English-dominant children and thus may be interpreted as one of the Mandarin influences because only nasals are allowed in word-final positions in Mandarin phonology. In CHL data, most deleted word-final consonants were voiceless consonants, as shown in Table 7.8. However, some of the consonants were part of the root and the deletion of the consonants may cause misunderstandings of the meanings.

Table 7.8 English word-final consonant deletion examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Abigail	4;05	F	Equally bilingual	brush	/brʌʃ/	[brʌ]
2	Michael	3;08	M	Mandarin (S)	tooth	/tuθ/	[tu]
3	Sheldon	4;02	M	Equally bilingual	yard	/jɑrd/	[jɑr]

7.2.2.2 Epenthesis

Sometimes sounds were inserted in the middle of the word by CHL children. Previous studies on the acquisition of English as a second language revealed vowel epenthesis as a typical interlanguage pattern by L2 learners (Carlisle, 1988; Yazawa et al., 2015), while consonant epenthesis, such as stop epenthesis, was also identified in some English dialects (Fourakis & Port, 1986). The sounds that were inserted in English words by CHL children did not contain any vowels but were mainly sonorants and glides (see details in Table 7.9). And epenthesis was mainly found in Equally bilingual and Mandarin-dominant children.

Table 7.9 English epenthesis examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Harry	4;07	M	Equally bilingual	forget	/fərgɛt/	[fərgwɛt]
2	Elsa	4;00	F	Mandarin (N)	going	/goʊɪŋ/	[goʊɹɪŋ]
3	Harry	5;01	M	Equally bilingual	marker	/mɑrkər/	[mɑrktər]

7.2.2.3 Voicing and devoicing

Errors in English voicing can be associated with the Mandarin aspiration problem as mentioned above. As shown in Table 7.10, children with relatively high Mandarin proficiency and English phonological skills tended to mix the voiced and voiceless stops and fricatives in English. And this may suggest the Mandarin influence on their English phonology.

Table 7.10 English voicing and devoicing examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Lia	4;08	F	Equally bilingual	So you don't need a mama anymore.	/doʊnt/	[toʊnt]
2	Harry	5;01	M	Equally bilingual	toothpaste	/tuθpeɪst/	[duθpeɪst]
3	Elsa	4;00	F	Mandarin (N)	Why is it so cold?	/koʊld/	[goʊld]
4	Dylan	4;08	M	Mandarin (S)	我吃很多 **vegetable**。 'I eat a lot of **vegetables**.'	/vɛdʒtəbəl/	[fɛdʒtəbəl]

7.2.2.4 Syllable reduction

For multiple-syllable words, CHL children may remove one consonant in the middle or the end of the word for simplification. This echoes the findings in Mandarin-English bilingual children in Taiwan (Lin & Johnson, 2010). Among the deleted consonants, as shown in Table 7.11, /ɹ/ was the one that children omitted most frequently, followed by /l/ and other consonants. The deletion of inflectional markers, such as the plural marker -s, was mainly observed in English-dominant children. The absence of plural -s resembles the previous discussion about the /t, d/ deletion in past tense markers that the inflections may be deleted at a later stage of the derivation (Bayley, 1996). In the investigation of plural inflections in the English interlanguage by adult Chinese learners, Young (1991) revealed that learners did not always mark the plural nouns.

Table 7.11 English syllable reduction examples

	Child	Age	Gender	Home language	Target word	Expected realization	Child realization
1	Albert	4;04	M	Equally bilingual	umbrella	/əmbɹɛlə/	[əmbɛlə]
2	Peyton	4;07	F	Mandarin (S)	flashlight	/flæʃlaɪt/	[flæʃaɪt]
3	Jenny	4;03	F	English dominant	forgets	/fəɹgɛts/	[fəɹgɛt]
4	Joseph	4;07	M	English dominant	pumpkin	/pʌmpkɪn/	[pʌmpɪn]

7.2.2.5 Subject-verb agreement

Since Mandarin lacks inflectional markers, Mandarin-speaking English learners often have trouble with the subject-verb agreement (e.g., Armstrong et al., 2018; Chen et al., 2007; Jackson et al., 2018; Wei et al., 2015). This difficulty is also identified in CHL children, as shown in examples in Table 7.12. There exist three main types of errors: (1) singular forms of subjects were followed by plural verbs (examples 1 & 2); (2) first person singular subject was matched with an inappropriate verb form (example 3); and (3) plural subjects were combined with singular forms of verbs (examples 4 & 5). Moreover, these errors were identified not only in Mandarin-dominant children but also in equally bilingual and English-dominant ones. The errors of verb inflections may partially be attributed to the multifunction of the morpheme -s in English. According to Roger Brown's five stages of syntactic and morphological development, free morphemes are usually used exclusively in one-word and two-word phrases (Brown, 1973). Since the two-word phrase, children begin to acquire inflections in an orderly fashion which will take several years (Clark, 2016). A typical developing English monolingual child often starts to form plural -s, possessive 's, and inflections of copular first and third person verbal inflections after three-year-old (Brown, 1973).

Table 7.12 English verb agreement examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Isabella	4;04	F	English dominant	Submarine goes down the ocean.	*Submarine go down the ocean.
2	Dylan	4;08	M	Mandarin (N)	Water is freezing.	*Water are freezing.
3	Mia	5;01	F	English dominant	Am I get the right shape?	*Is I get the right shape?
4	Lia	4;08	F	Equally bilingual	My mom and my dad were helping me and my sister make popcorn.	*My mom and my dad was helping me and my sister make popcorn.
5	Lia	5;02	F	Equally bilingual	My eyes don't make tears.	*My eyes doesn't make tears.

7.2.2.6 Wh questions

When children were forming WH questions, the auxiliary verbs were sometimes omitted, as shown in examples 1 and 2 in Table 7.13. This was only occasionally observed in English monolingual children (Bloom et al., 1982; Brown, 1968; Rowland et al., 2003). More often, monolingual children generate normal questions from occasional questions from the base form of "John will read what?", to the preposing form of "What John will read?", then to the transposing form of "What will John read?" (Brown, 1968). The omission of auxiliaries by CHL children could be a result of the influence of Mandarin syntax because auxiliaries are not required for questions in Mandarin. The child's realization of "*Why he fall down here?" may be an adjustment of the English question "Why did he fall down here?" and the Mandarin question "ta weishenme shuaidao le? (He why fall down here?)." In example 3, the child had the auxiliary in the correct form and position, but the negation was left behind the subject as that in a declarative sentence. The phrase "you don't have" may also be interpreted as a parallel realization of the

Mandarin expression “ni meiyou (you don’t have).” Occasionally, as shown in example 5, the auxiliary the child had in the question did match the main verb. But this type of error occurred rarely.

Table 7.13 English Wh question examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Emily	4;09	F	English dominant	Why did he fall down here?	*Why he fall down here?
2	Joseph	4;07	M	English dominant	What is that word?	*What that word?
3	Emma	4;01	F	Mandarin (S)	Why don’t you have yellow stamps?	*Why do you don’t have yellow stamps?
4	Joseph	4;07	M	English dominant	Does that go in the dark?	* Is that goes in the dark?

7.2.2.7 Past tense marker and past participle

English past tense errors in both regular and irregular verbs have been identified not only in monolingual children but also in adults (J. L. Bybee & Slobin, 1982). But the overall frequency of errors decreases with age (J. L. Bybee & Slobin, 1982; Marchman, 1997). Previous studies suggested that the development of English past tense was affected by input frequency and some other linguistic internal features, such as the phonological environment of the past tense markers (J. L. Bybee & Slobin, 1982; Marchman, 1997). English past tense errors are typical in Mandarin-speaking learners (Y. Yang & Lyster, 2010). Mandarin-English bilingual children are found to acquire the correct forms later than monolingual children but were more accurate with irregular forms than regular forms (Nicoladis, 2012; Nicoladis et al., 2020). CHL children sometimes did not mark the verbs for past tense, as shown in examples 1 and 3 in Table 7.14.

However, typical monolingual developmental patterns such as "standed" in example 2 were also identified. In addition, CHL children also substituted past tense participles for past tense forms as presented in examples 4 and 5.

Table 7.14 English past tense marker and past particle examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Emily	4;09	F	English dominant	I went to different zoos.	*I go to different zoos.
2	Harry	4;07	M	Equally bilingual	He stood up.	*He standed up.
3	Lia	4;08	F	Equally bilingual	She gave you the stickers and she stuck them on the box.	*She gave you the stickers and she stick them on the box.
4	Andrew	4;04	M	English dominant	The trees are getting broken.	*The trees are getting broke.
5	Lia	5;02	F	Equally bilingual	I've seen one before.	*I've saw one before.

7.2.2.8 One or more

Another indication of possible Mandarin influence on CHL children's English morphology is the expression of singular and plural nouns. As shown in the examples below in Table 7.15, children may choose an irregular plural form instead of a singular form (example 1), omit the plural -s for count nouns (example 2), add an unnecessary -s for singular nouns (example 3), or mismatch the determiners with the nouns (example 4). Studies illustrated that monolingual children usually start with singular forms of nouns, regardless of context of the actual number of the referred items (Clark, 2016). They fully acquire plural forms around age three, while L2 learners tended to master this structure later after five years of English exposure

(G. Jia, 2003). The CHL data shows that the stabilization of English singularity and plurality may be completed later than in monolingual children. Typical errors still can be found in four- and five-year-old children.

Table 7.15 English plural marker examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Isabella	4;04	F	English dominant	A tooth	*A teeth
2	Jay	4;10	M	Mandarin (S)	Cars always have four wheels.	*Car always have four wheel.
3	Joseph	4;07	M	English dominant	That's a different side.	*That's a different sides.
4	Lia	5;02	F	Equally bilingual	You know how many hours it took for me to get to the desert from California?	*You know how much hours it took for me to get to the desert from California?

7.2.2.9 He or she or "ta"

Mandarin only distinguishes third personal pronouns in writing: "他" is for 'he', "她" is for 'she', and "它" is for 'it'. All these three pronouns are pronounced as "ta"; thus listeners need to rely on contextual clues to figure out who or what the subject is. However, English distinguishes "he" and "she" for different genders of the subjects. And errors in gender agreement of pronouns in English oral speech are prevalent in Chinese L2 learners (Dong et al., 2015; Qin, 2019). As demonstrated in the examples in Table 7.16, both English-dominant and Mandarin-dominant CHL children occasionally selected the opposite pronouns for their referents. However, cross-linguistic influence may not be persuasive enough to explain the typological gender errors. Gender errors in L2 English were also identified in speakers of Spanish, Italian and Dutch, especially in possessive pronouns (Antón-Méndez, 2011). Other

linguistic internal constraints, such as animacy and local agreement may also contribute to this developmental pattern (Antón-Méndez, 2011; Pozzan & Antón-Méndez, 2017).

Table 7.16 English pronoun examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Mia	5;01	F	English dominant	He (a boy) turns to the evil Superman.	*She turns to the evil Superman.
2	Jay	4;10	M	Mandarin (S)	He (a boy) is gonna catch the frog.	*She is gonna catch the frog.
3	Andrew	4;10	M	English dominant	She (a girl) is reading the book.	*He is reading the book.

7.3 Variation patterns

7.3.1 Mandarin variation patterns

7.3.1.1 Sibilant substitution

Mandarin has three groups of sibilants, namely dental-alveolar sibilants /ts, ts^h, s/, post alveolar or retroflex sibilants /tʂ, $tʂ^h$, ʂ/, and alveolo-palatal sibilants /tɕ, $tɕ^h$, ɕ/. Because the sibilants demonstrate similar acoustic properties and differ only slightly in production, children often replace one sibilant with another. The following examples in Table 7.17 present some of the identical sibilant substitutions. Example 1 shows the replacement of /ɕ/ by /s/, but the opposite substitution was not identified. Meanwhile, /ʂ/ and /ɕ/ were often mixed by children in fricatives and affricates, as shown in examples 2–7. The replacement of a sibilant with another is found in children of different ages, genders, and home language backgrounds. The sibilant substitution demonstrated here may be correlated with the sibilant variation that has been interpreted in Chapter 6. Fangfang Li (2009) showed that two and three-year-old Mandarin monolingual children had not established clear categorical distinctions between the sibilant

fricatives. Thus, their sibilant production was often intermediate and variable. However, Lin and Johnson (2010) found that there were no group differences in Mandarin deretroflexion and deaffrication by 5-year-old monolingual and English-Mandarin bilingual children. For the CHL children in the current study, when language input contained heterogeneous sibilant variable patterns, children demonstrated more flexible but systematical use of the sibilants.

Table 7.17 Mandarin sibilant substitution examples

	Child	Age	Gender	Home language	Target word	Standard realization	Child realization
1	Scot	3;02	M	Equally bilingual	海星 'sea star'	/xai3 ɕiŋ1/	[xai3 siŋ1]
2	Dylan	4;08	M	Mandarin (S)	因为它吓到它了。 'because it was **scared** by it.'	/ɕia4 tao4/	[ʂia4 tao4]
3	Emma	4;01	F	Mandarin (S)	不是 'be not'	/pu2 ʂɨ4/	[pu2 ɕɨ4]
4	Lola	3;08	F	Mandarin (N)	蜘蛛网 'spider web'	/tʂɨ1 tʂu1 waŋ3/	[tɕi1 tʂu1 waŋ3]
5	Kristina	3;08	F	Mandarin (S)	我自己 'myself'	/wo3 tsɨ4 tɕi3/	[wo3 tɕi4 tɕi3]
6	Noah	4;09	M	English dominant	蜻蜓 'dragonfly'	/tɕʰiŋ1 tʰiŋ2/	[tʂʰiŋ1 tʰiŋ2]
7	Andrew	4;04	M	English dominant	超人 'Superman'	/tʂʰao1 ɹən2/	[tɕʰao1 ɹən2]

7.3.1.2 /l/ and /n/ variation

The mixed use of /l/ and /n/ is often treated as a typical dialectal feature in many Chinese varieties, such as Sichuan dialect, Taiwanese, Taiwan Mandarin, Cantonese, Nanjing dialect, Xiangxiang dialect among others (L.-S. L. Cheng et al., 1997; B. Li et al., 2012; C. N. Li & Thompson, 2009; S.-W. Liao, 2010; M.-Y. Wu & Tzeng, 2019; W. Zhang, 2007). And the

alternation between /l/ and /n/ in Mandarin dialects may also affect the perception of these two sounds in English as a foreign language as well (Levis & Levis, 2021; B. Li & Wayland, 2006). The examples below in Table 7.18 show that CHL children, especially the children who had been exposed to southern Mandarin varieties at home, alternated the /l/ and /n/ sounds in their Mandarin speech. This variation has only been explored in adult speech and was rarely included as a phonologic process in monolingual or bilingual children.

Table 7.18 Mandarin /l/ and /n/ variation examples

	Child	Age	Gender	Home language	Target word	Standard realization	Child realization
1	Emma	4;01	F	Mandarin (S)	我不知道在**哪里** 'I don't know **where** it is'	/na3 li3/	[na3 ni3]
2	Dylan	4;08	M	Mandarin (S)	火烈鸟 'flamingo'	/xuo3 lie4 niao3/	[xuo3 nie4 niao3]
3	Sheldon	4;06	M	Mandarin (S)	在里面**那个** '**that one** inside'	/nei4 kə/	[lei4 kə]
4	Albert	4;04	M	Equally bilingual	南瓜 'pumpkin'	/nan2 kua1/	[lan2 kua1]

7.3.1.3 /l/ and /ɹ/ variation

The substitution of lateral /l/ for alveolar approximant rhotic /ɹ/ is a typical variation pattern that has been well-documented in Taiwan Mandarin (Kubler, 1985; S.-W. Liao, 2010; Starr, 2016). As shown in Table 7.19, /ɹ/ was more frequently replaced with /l/ by Mandarin (S) children, while the substitution of /l/ for /ɹ/ occurred rarely. This asymmetrical variation pattern may be attributed to the deretroflexion in typical child phonological process and the dialectal home language input as the substitution of /l/ for /ɹ/ was only found in Mandarin (S) children.

Table 7.19 Mandarin /l/ and /ɹ/ variation examples

	Child	Age	Gender	Home language	Target word	Standard realization	Child realization
1	Cameron	4;11	M	Mandarin (S)	无人机 'drone'	/wu2 ɹən2 tɕi1/	[wu2 lən2 tɕi1]
2	Kristina	3;08	F	Mandarin (S)	**然后**还可以喷水 '**and then** (it) can spray (water)'	/ɹan2 xou4/	[lan2 xou4]
3	Patrick	4;04	M	Mandarin (S)	两个 'two CLA'	/liaŋ3 kə/	[ɹiaŋ3 kə]
4	Steven	3;11	M	Mandarin (S)	轮胎 'wheel'	/lən2 t^hai1/	[ɹən2 t^hai1]

7.3.1.4 Nasal variation

The emergence of final nasal /n/ by monolingual children occurred at around age two, with /an/ emerging at 2;06 and no final nasals were found before 1;08 (X. X. Li & To, 2017). Early nasals may be absent or replaced by nasalized vowels. Final nasal /ŋ/ occurred relatively late, especially when it is combined with diphthongs in syllables such as /uəŋ/ and /iʊŋ/ which emerged at 3;00. In addition, denasalization was identified as a common phonological process among monolingual children (X. X. Li & To, 2017; Lin & Johnson, 2010). In the CHL data, Mandarin (S) children often realized velar nasal /ŋ/ as the alveolar nasal /n/ which is acquired earlier and is easier to produce. However, this may also be attributed to the syllable-final nasal merger in many Chinese southern dialects, including Taiwan Mandarin and Sichuan dialect (Fon et al., 2011; S. Liao et al., 2022; Xu, 2015). On the other hand, /n/ sometimes was hypercorrected as /ŋ/ by younger equally bilingual children. This may be interpreted as a strategy for equally bilingual CHL children to emphasize the distinction between the two nasals with their advanced phonological skills.

Table 7.20 Mandarin nasal variation examples

	Child	Age	Gender	Home language	Target word	Standard realization	Child realization
1	Cameron	4;11	M	Mandarin (S)	鲸鱼 'whale'	/tɕiŋ1 y2/	[tɕin1 y2]
2	Natalie	5;00	F	Mandarin (S)	那我用**橙色**涂 'Then I will use **orange** to color'	/tʂʰəŋ2 sə4/	[tʂʰən2 sə4]
3	Scott	3;02	M	Equally bilingual	因为他不**开心** 'because he is not **happy**'	/kʰai1 ɕin1/	[kʰai1 ɕiŋ1]
4	Owen	3;07	M	Equally bilingual	这个**人** 'this **person**'	/ɹən2/	[ɹəŋ2]

7.3.1.5 Subject pronoun omission

The contextual omission of subject pronouns, especially subject personal pronouns in prodrop languages (e.g., Chinese Mandarin, Spanish, Italian, and Portuguese) is a native-like variation pattern as demonstrated in native speakers, L2 learners, and heritage learners (Flores-Ferrán, 2007; X. Li & Bayley, 2018; Paredes Silva, 1993; X. Zhang, 2021). However, the null subject seems to be a typical feature in child language cross-linguistically (Hyams, 1989; N. L. Shin, 2016; Valian, 1990; Q. Wang et al., 1992). Wang et al. (1992) have shown that children acquiring English as an L1 also exhibit null subjects, the rate of null subject use was not nearly as high as it is among Mandarin acquiring children and Mandarin speaking adults. Shin and Erker (2015) also demonstrated that monolingual Spanish-speaking Mexican children, especially boys, used fewer pronouns than adults. Similarly, CHL children tended to omit subject pronouns, especially when the pronoun had been mentioned previously in the context. As in the examples in Table 7.21, subject pronouns were omitted for both human and animal subjects. Inanimate subjects were involved in child speech less frequently but when they appeared, sometimes children did not overtly express the pronouns as well, as shown in example 5. To account the

pervasive subject omission in child language, in both pro-drop languages (e.g., Mandarin, Spanish, and Portuguese) and non-pro-drop languages (e.g., English, Dutch, and French), Clark (2009) summarized several explanations that have been proposed: (1) it is possible that overt subject is not a part of the initial parameters in early grammar, and children tend to treat all languages as pro-drop structures; (2) some propose that young children with their limited abilities cannot access and produce overt subjects in complex contexts (Valian, 1990); (3) and phonological structure may also be involved because children often omit unstressed syllables including subject pronouns in initial positions in a sentence (Gerken, 1991). In sum, subject omission in child language as a cross-linguistic feature has been attributed to language type, discourse, and phonological structure (Clark, 2009). Future research on null subject in heritage and bilingual child language may provide a different perspective to interpret the internal mechanism in early language acquisition.

Table 7.21 Mandarin subject pronoun omission examples

	Child	Age	Gender	Home language	Overt realization	Child realization
1	Kristina	3;08	F	Mandarin (S)	INV: 青蛙跳到哪里了？ Qingwa tiaodao nali le? 'Where did the frog jump to?' CHI: 它跳到了狗狗的头上。 Ta tiaodao le gougou de toushang 'It jumped onto the head of the dog.'	INV: 青蛙跳到哪里了？ Qingwa tiaodao nali le? 'Where did the frog jump to?' CHI: 跳到了狗狗的头上。 Tiaodao le gougou de toushang 'Jumped onto the head of the dog.'
2	Mathew	4;09	M	Equally bilingual	CHI: 因为有火的话，我们可以用那个东西… Yinwei you huo de hua, women keyi yong nage dongxi 'Because if there is fire, we can use that' CHI: 我们可以用那个水来灭火。 Women keyi yong nage shui lai miehuo 'We can use the water to put out the fire.'	CHI: 因为有火的话，可以用那个东西… Yinwei you huo de hua, keyi yong nage dongxi 'Because if there is fire, can use that' CHI: 可以用那个水来灭火。 Keyi yong nage shui lai miehuo 'Can use the water to put out the fire.'
3	Lola	3;08	F	Mandarin (N)	INV: 还有人跟它玩吗？ Haiyou ren gen ta wan ma? 'Was there anyone still playing with it?' CHI:他不跟它玩了。 Ta bu gen ta wan le 'He did not play with it anymore.'	INV: 还有人跟它玩吗？ Haiyou ren gen ta wan ma? 'Was there anyone still playing with it?' CHI:不跟它玩了。 Bu gen ta wan le 'Did not play with it anymore.'
4	George	4;09	M	Mandarin (N)	INV: 它头上是什么东西啊？ Ta toushang shi shenme dongxi a? 'What was that on its head?' CHI: 它的头上是罐子。 Ta de toushang shi guanzi 'It was a jar on his head.'	INV: 它头上是什么东西啊？ Ta toushang shi shenme dongxi a? 'What was that on its head?' CHI: 头上是罐子。 Toushang shi guanzi 'was a jar on head.'

5	Natalie	5;06	F	Mandarin (N)	INV: 紫色的这一块是什么？ Zise de zhe yikuai shi shenme? 'What is this purple piece?' CHI: 这是天空的色彩。 Zhe shi tiankong de secai. 'This/It is the color of the sky.'	INV: 紫色的这一块是什么？ Zise de zhe yikuai shi shenme? 'What is this purple piece?' CHI: 是天空的色彩。 Shi tiankong de secai. 'Is the color of the sky.'

7.3.1.6 The use of morphosyntactic particle -le ("了")

The Mandarin morphosyntactic particle -le marks either the perfectivity of an action or event or a currently relevant state as a sentence-final particle (C. N. Li & Thompson, 1981). It is one of the greatest challenges for L2 learners due to its multifunctionality: it is obligatory in some contexts but not in others (Bredeche, 2011; X. Li et al., 2022). And L2 learners often used -*le* at a lower rate than native adult speakers (X. Li et al., 2022). As shown in Table 7.22, some CHL children, even the Mandarin-dominant ones, sometimes demonstrated incorrect use of the particle. For example, -*le* was absent when it was required in examples 1 and 2 to indicate the completion of the action "fell down" and the implication of the currently relevant state of "having a rabbit". However, children also added -*le* when it was not needed, as demonstrated in example 3. But this type of error occurred rarely. In addition, as example 4 shows, when the use of -*le* was optional, children sometimes omitted it, especially in narratives.

Table 7.22 Mandarin -le examples

	Child	Age	Gender	Home language	Standard realization	Child realization
1	Matthew	4;09	M	Equally bilingual	他摔倒了。 Ta shuaidao le 'He fell down -le.'	*他摔倒。 Ta shuaidao 'He fell down.'
2	Ophelia	4;08	F	Mandarin (N)	养了一只黑白的兔子。 Yang le yizhi heibai de tuzi 'Had -le a black-white rabbit.'	*养一只黑白的兔子。 Yang yizhi heibai de tuzi 'Had a black-white rabbit.'
3	Scott	3;02	M	Equally bilingual	没有抓到狗狗。 Meiyou zhuadao gougou 'Did not catch the doggy.'	*没有抓到了狗狗。 Meiyou zhuadao -le gougou 'Did not catch the doggy.'
4	Tessa	4;07	F	Mandarin (S)	青蛙就跳到树枝上。 Qingwa jiu diaodao shuzhi shang 'The frog just jumped to the branch.' 青蛙就跳到了树枝上。 Qingwa jiu diaodao shuzhi shang 'The frog just jumped -le to the branch.'	青蛙就跳到树枝上。 Qingwa jiu diaodao shuzhi shang 'The frog just jumped to the branch.'

7.3.1.7 The omission of morphosyntactic particle DE ("的")

In general, *DE* in Mandarin has three major functions: genitive marker, attributive marker, and nominalization marker (C. N. Li & Thompson, 1981; P.-C. Yip & Rimmington, 2004). *DE* may be omitted when it serves as a genitive marker or an attributive marker after an adjective, a noun, or between a head noun phrase and a modifier (X. Li, 2010). In other contexts, the omission of *DE* is not allowed in standard grammar. As shown in Table 7.23, CHL children sometimes omitted *DE* in eligible contexts, but other times deleted it when deletion was not allowed (e.g., examples 2 and 4).

Table 7.23 Mandarin DE omission examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Naomi	3;01	F	Mandarin (N)	丁丁是姐姐的朋友。 Dingding shi jiejie de pengyou 'Dingding is my sister's friend.'	丁丁是姐姐朋友。 Dingding shi jiejie pengyou 'Dingding is my sister friend.'
2	Michael	3;08	M	Mandarin (S)	我要大个的鱼。 Wo yao dage de yu 'I want big fish.'	*我要大个鱼。 Wo yao dage yu 'I want big fish.'
3	Tessa	4;07	F	Mandarin (S)	我觉得是老鹰的爪子。 Wo juede shi laoying de zhuazi 'I think that is an eagle's claw.'	我觉得是老鹰爪子。 Wo juede shi laoying zhuazi 'I think that is an eagle claw.'
4	Mathew	4;09	M	Equally bilingual	一个是海边的家。 Yige shi haibian de jia 'One is a house by the sea.'	*一个是海边家。 Yige shi haibian jia 'One is a house the sea.'

7.3.1.8 Classifier variation

Classifiers in Mandarin, as in some other East Asian languages such as Vietnamese, Thai, Korean, and Japanese, serve as a system of noun categorization and can be categorized into measure classifiers, collective classifiers, kind classifiers, event classifiers, and sortal classifiers (Erbaugh, 2006). The absence of a classifier or the mismatch between the classifier and the noun in some contexts can cause ungrammaticality. CHL children sometimes could not select the appropriate classifiers for the nouns in their sentences, as shown in examples 2-4 in Table 7.24. However, in some other contexts, the selection of a classifier is flexible (Zheng & Liu, 2023). For example, as example 1 shows, to illustrate the number of frogs, the general classifier *GE* and the specific classifier *ZHI* are both eligible. The child chose to use the default general classifier. This may be explained by the "one-to-one" principle that learners will tend to choose the one

with most general application when where is a choice between different forms (R. W. Andersen, 1984). In addition, this also resembles the preference of the general classifier over the specific classifier by native adult speakers and L2 learners (Zheng & Liu, 2023). However, studies showed cross-dialect and cross-context differences regarding the use of classifiers. For example, Beijing Mandarin colloquial speech often omits a classifier, whereas Cantonese narratives have five times more sortal classifiers per noun than Mandarin narratives (Erbaugh, 2006). For the acquisition of classifiers by Mandarin monolingual children, the embedded semantic complexities are challenging. Infants usually start from general classifiers such as *GE*, but may tend to overgeneralize it around age three (Erbaugh, 2006; Hu, 1993). While the acquisition of specific classifiers such as *ZHI* may not be completed by age ten, and animacy plays a key role in this process (Erbaugh, 2006; Hu, 1993). For CHL children, the limited and heterogeneous input may have the acquisition of Mandarin classifiers more discommoded.

Table 7.24 Mandarin classifier examples

	Child	Age	Gender	Home language	Expected realization	Child realization
1	Albert	4;04	M	Equally bilingual	两只青蛙 Liang zhi qingwa 'Two frogs' 两个青蛙 Liang ge qingwa 'Two frogs'	两个青蛙 Liang ge qingwa 'Two frogs'
2	Natalie	5;0	F	Mandarin (N)	小狗有个屁股 Xiaogou you ge pigu 'The doggy has a butt.'	*小狗有只屁股 Xiaogou you zhi pigu 'The doggy has a butt.'
3	Scott	3;02	M	Equally bilingual	一根树枝 Yi gen shuzhi 'A branch' 一个树枝 Yi ge shuzhi 'A branch'	*一颗树枝 Yi ke shuzhi 'A branch'
4	Tessa	4;07	F	Mandarin (S)	我每天晚上都会认字。 Wo meitian wanshang dou hui renzi 'I learn Chinese characters every night.'	*我每次晚上都会认字。 Wo meitian wanshang dou hui renzi 'I learn Chinese characters every time night.'

7.3.2 English variation patterns

7.3.2.1 Word-final /t, d/ deletion

Among studies of word-final /t, d/ deletion as a native-like sociolinguistic pattern, Bayley (1996) pointed out that this may result in the loss of obligatory past tense inflections that "had been affixed to the base at an earlier stage of the derivation" (p. 97). And Chinese learners of English exhibited greater rate of /t, d/ absence than native speakers (Bayley, 1996). Roberts and Labov (1995) revealed that English monolingual children began to acquire the contraptions on /t, d/ deletion very early. For the /t, d/ deletion in past tense forms in CHL data, it seems that English dominant children (see examples in Table 7.25) tended to omit the /t, d/ sounds more

than their equally bilingual peers, while utterances that contain past tense forms were rarely used by Mandarin-dominant children.

Table 7.25 English word-final /t, d/ deletion examples

	Child	Age	Gender	Home language	Target word	Standard realization	Child realization
1	Joseph	5;01	M	English dominant	He **lost** the froggy.	/lɔst/	[lɔs]
2	Lia	5;02	F	English dominant	My mum **told** me that.	/toʊld/	[toʊl]
3	Scott	3;02	M	Equally bilingual	Armchair can be **helped**.	/hɛlpt/	[hɛlp]

7.3.2.2 /s/ and /ʃ/ variation

The sibilant variation in CHL children's English differs from the patterns in Mandarin sibilant variation. As shown in Table 7.26, the syllable-initial /s/ was replaced by /ʃ/, but the substitution of /ʃ/ for /s/ was not identified. And this type of phonological process occurred much less frequently than the sibilant variation in Mandarin.

Table 7.26 English /s/ and /ʃ/ variation examples

	Child	Age	Gender	Home language	Target word	Standard realization	Child realization
1	Abigail	4;05	F	Equally bilingual	super	/supər/	[ʃupər]
2	Noah	5;03	M	English dominant	The wind is **strong**.	/strɔŋ/	[ʃtrɔŋ]

In sum, several developmental processes and variation patterns have been identified in CHL children's Mandarin and English. Mandarin developmental patterns include stopping, deaspiration and aspiration, syllable-initial consonant deletion, simplification of diphthongs and triphthongs, tone errors, the reduction of verb complement, and errors in word order. English developmental patterns contain word-final consonant deletion, epenthesis, voicing and devoicing, syllable reduction, subject-verb agreement, the formation of Wh questions, the marking of past tense and past participles, the use of plural and singular morphemes, and the mixed-use of gendered third personal pronouns. At the same time, CHL children also exhibited the use of several dialectal variables in Mandarin, including sibilant substitution, /l/ and /ɹ/ variation, /l/ and /n/ variation, nasal variation, null subject pronouns, the use/misuse of -*le*, the omission of *DE*, and classifier variation. In English, they also varied the realization of word-final /t, d/ and the contrast between sibilants /s/ and /ʃ/. As illustrated in each section, some of these patterns, resemble previous findings in monolingual children, English-Mandarin/Mandarin-English bilingual children, or adult L2 learners. Some of the patterns were typical to identify in monolingual children, while others are even challenging for adult L2 learners to fully acquire. Part of these patterns may be attributed to cross-linguistic influences. Other linguistic (i.e., phonology, morphology, or syntax) and social factors (i.e., age, gender, proficiency, input) may also contribute to the CHL children's language practice. Many of the variation patterns as observed in the CHL children lack systematic linguistic investigation. This leads to some future directions in research on the acquisition of variation in bilingual and multilingual contexts.

7.4 Language mixing

Language mixing is often observed in bilingual speakers (Cantone, 2007). By definition, it refers to "the co-occurrence of elements from two or more languages in a single utterance" (Genesee, 1989, p. 162). Although some scholars may use it as a synonym for code-switching, the latter is more about the mixes of languages that occur either within or across boundaries within a single constituent when children have been proficient in both languages (Cantone, 2007). Language mixing in bilingual children has been identified across languages and in early childhood (Arnberg & Arnberg, 1985; Lindholm & Padilla, 1978; Redlinger & Park, 1980). Some believed that bilingual children develop their two languages based on one language system initially, thus early language mixing may reflect their incompetence to separate the two languages (Köppe & Meisel, 1995; Redlinger & Park, 1980). However, language differentiation or the ability to differentiate the two languages as two different systems in the brain should be distinguished from language separation, or the capacity to choose the better language to use according to the interlocutors and the contexts (Cantone, 2007). Numerous studies have shown that bilingual children were actually able to mix two languages grammatically and strategically (Bosma & Blom, 2019; De Houwer, 2021; Genesee et al., 1995; Meisel, 1994; S. J. Shin & Milroy, 2000; Yow et al., 2018). Besides the one-system vs. two-system interpretations, language mixing has been attributed to several environmental factors. Some proposed that language mixing in bilingual children may derive from language input, especially from parents who mix the two languages at home (Byers-Heinlein, 2013; Byers-Heinlein et al., 2022; Goodz, 1989). For example, Goodz (1989) revealed that a large proportion of parents modeled mixed utterances for their children. As Chapter 4 demonstrated, preschool teachers also mixed English and Mandarin in their classroom speech, although standard forms were preferred in their CDS.

However, not all CHL children mixed English and Mandarin in their speech. It was only identified in 12 out of 43 emergent bilingual children. The analyses of CHL children's language mixing focused on four children who exhibited English and Mandarin mixes most frequently in their speech. As shown in Table 7.27, the majority of their language mixes occurred within sentence boundaries. Most of the time, children inserted English lexical entries into Mandarin clauses. And this is more observed in spontaneous context, while in the narratives for the frog stories, children tended to complete the story in one language. Nearly all the inserted mixes were not function words but were nouns, verbs, and adjectives. Examples in Table 7.28 show that all the inserted mixes were in general grammatical. The English mixes in examples 2-4 were not marked for tense, and it seem that children followed the morphosyntactic rules in the matrix language or Mandarin. For examples 5 and 6, although the mixed sentences were still grammatical, the Mandarin-dominant children ordered the words in English syntax. For "how about this," a Mandarin monolingual child would form a sentence like "zheyangzi zenme yang (this how)." The child placed "zheyangzi (this)" after "how about" to substitute for "this" in English. And in example 6, "daxiang baobao" or "baby elephant" was realized as "baby daxiang" where the roots of the compound had been switched to match the word order in English. This may imply the English influence on Mandarin syntax structure.

Table 7.27 CHL children language mixing summary

Child	Age	Gender	Home language	N of mixes	LM range	Matrix language	Context	Type
Dylan	4;08-5;04	M	Mandarin (S)	210	Intrasentential = 87.14% Inter sentential = 12.86%	Mandarin = 97.62% English = 2.38%	Spontaneous = 81.43% Narrative = 18.57%	Content = 99.05% Function = 0.95%%
Emma	4;01-4;07	F	Mandarin (S)	210	Intrasentential = 70.48% Intersentential = 29.52%	Mandarin = 92.86% English = 7.14%	Spontaneous = 97.62% Narrative = 2.38%	Content = 100.00% Function = 0.00%
Sheldon	4;05-4;11	M	Equally bilingual	101	Intrasentential = 84.16% Intersentential = 15.84%	Mandarin = 97.03% English =2.97%	Spontaneous = 84.16% Narrative = 15.84%	Content = 100.00% Function = 0.00%
Lia	4;07-5;01	F	Equally bilingual	216	Intrasentential = 71.30% Intersentential = 28.70%	Mandarin = 99.07% English = 0.93%	Spontaneous = 91.20% Narrative = 8.80%	Content = 98.61% Function = 1.39%

Table 7.28 CHL language mixing examples

	Child	Age	Gender	Home language	Language mix
1	Lia	5;01	F	Equally bilingual	大家要 keep 那个，那个，嗯，猫咪 busy。 Dajia yao keep that, that, em, kitten busy. 'People need to keep that kitten busy.'
2	Sheldon	4;05	M	Equally bilingual	还有刚才那个企鹅 jump，还有 jump。 Haiyou gangcai nage qie jump, haiyou jump. 'Also just now that penguin jumped, and jumped.'
3	Sheldon	4;11	M	Equally bilingual	它刚才 relax 了。 Ta gangcai relax le. 'It (the frog) just relaxed.'
4	Lia	4;08	F	Equally bilingual	Owl 也在 chase 它。 Owl ye zai chase ta. 'The owl was charing it (the frog).'
5	Dylan	4;08	M	Mandarin (S)	How about 这样子? How about zhe yangzi? 'How about this?'
6	Emma	4;00	F	Mandarin (S)	小的 baby 大象。 Xiaode baby daxiang 'Small baby elephant.'

7.5 Summary

The discussion above has touched on several developmental and variation patterns in CHL children and how they mixed English and Mandarin for bilingual practices. As mentioned, the cross-linguistic influences, along with other possible linguistic and social factors, may contribute to the patterns that observed in CHL children. Again, the heterogeneous language environment that the CHL children had been exposed to has provided them with enriched linguistic repertoires which they consistently compared, experimented, and played with. Further investigations of the variation patterns in CHL children may also shed light on the interpretation of the bilingual mechanism from a different perspective. For example, a possible direction could focus on the use of subject personal pronouns by CHL children and whether it differs in CHL

speakers, monolingual children, native adults, and L2 learners. This variation pattern may also be interpreted typologically to identify the general sequence of variation acquisition and factors that constrain the variation in pro-drop and non-pro-drop languages. Such investigation will contribute to the current understanding of the dynamics within language variation and change. It shall facilitate the theoretical models of language acquisition by exploring the roles of input and context at the same time.

8. Summary and conclusion

8.1 Summary of key findings

This study has drawn upon qualitative and quantitative methodologies to investigate the linguistic practices in two dual immersion preschools in California. CHL children have been interpreted as novice members in local speech communities who actively explored the linguistic repertoire in the multilingual environment and used their languages or language varieties strategically. As mentioned in Chapter 1, the current research focused on Mandarin variation patterns by both teachers and children in two preschools and explored the use of sociolinguistic variables in language input and child production. Specifically, it has addressed the following questions:

(1) How do teachers use Mandarin dental sibilant /s/ and post-alveolar sibilant /ʂ/ as a sociolinguistic variable when talking to CHL children in class?

Findings show that teachers varied their realization of the sibilants in their Mandarin speech in CDS and ADS significantly. On one hand, several linguistic factors, including lexical tone, preceding and following sounds, word type, and sentence type, constrain the sibilant variation by teachers. On the other hand, teachers tended to extend the sibilant duration and emphasize the phonetic distinction between /s/ and /ʂ/ in classroom instruction for English-dominant children. While the mixed use of /s/ and /ʂ/, a typical dialectal feature in several Mandarin varieties, was identified in teacher speech to Mandarin-dominant children.

(2) How will CHL children's English and Mandarin language proficiency be affected during their enrollment in the dual immersion programs?

By measuring CHL children's language proficiency and phonological skills with standardized assessments and language tasks at the beginning and the end of the school year, the

study has demonstrated that children's performance in the initial tests is significantly affected by home language, age, and language-specific skills. Their performance in the final tests is predicted by home language, age, language-specific skills, enrollment length, and gender. Children's progress in Mandarin vocabulary is constrained by gender and home language. In addition, children's oral language and vocabulary size correlate with their phonological skills, but this is limited within a language. From a long-term perspective, the enrollment length in dual immersion programs and gender affect CHL children's English and Mandarin development.

(3) How do CHL children use the two Mandarin sibilants /s/ and /ʂ/ as a sociolinguistic variable in their heritage language? And if this is influenced by their enrollment in the dual immersion programs and other linguistic and social factors?

The mix of dental and post-alveolar sibilants has been identified in child language. Many linguistic constraints found in sibilant variation by teachers have also been found in child language, including preceding sound, word type, sentence type, and sibilant type. Moreover, as children's age increases (after age five), they tend to distinguish /s/ and /ʃ/ better. They also tended to enhance the difference between the two categories in formal settings, in contrast to casual speech. Other factors, including children's English and Mandarin proficiency, language input, and gender, also significantly affected the ways they chose to use the sibilants. Specifically, children with a larger Mandarin vocabulary size and lower English oral proficiency tended to produce sibilants longer. Children with better English oral skills realized sibilants with higher centroid frequencies. Findings also suggest that children's variation patterns may be closely related to language input, including both home language and input from teachers at school. Lastly, girls seemed to mix the two sibilants more than boys, which may partly be

attributed to the sibilant patterns demonstrated by their teachers, who served as a model of a female Mandarin speaker in different contexts.

In sum, teachers adjusted their use of variants according to the contexts and children's language backgrounds may serve as one of the reasons for their choice of variants. Consequently, CHL children in the classroom had been exposed to various sociolinguistic variables outside their families. In addition, how languages are used in families plays a key role to explain the diverse language proficiency among CHL children. The differences in language proficiency, along with other factors such as age, discourse context, input, and gender significantly affected the ways CHL children chose to use the sibilants in their heritage language. Besides sibilant variation, other developmental and variation patterns have also been identified, as discussed briefly in Chapter 7.

These findings lead to several pedagogical implications for language teaching and learning. First, by identifying the effect of home language on the language proficiency of CHL children, the study revealed CHL attrition in English-dominant children may occur as early as four-years-old. It also illustrated the potential of dual immersion to support early childhood development in both CHL and English. Second, considering the diversity among CHL children, preschool teachers may need to include different pedagogical strategies addressing the different learning needs of English-dominant, equally bilingual, and Mandarin-dominant children. In addition, teachers may also think about what kind of language resources should be provided in a dual immersion classroom. By combining children from diverse linguistic backgrounds in the same class, dual immersion provides miscellaneous language input and contexts to practice the use of different language varieties and styles. It also offers children opportunities to actively

establish their own sociolinguistic network with peers with whom they may creatively use their full linguistic repertoire in different languages and varieties.

8.2 Limitations and future directions

This research is one of the first studies to investigate the early acquisition of variation in bilingual/multilingual contexts. On one hand, it contributes to the current understanding of variation acquisition by expanding the research context to CHL communities where heterogeneous language resources are available for children to explore. On the other hand, it also reveals the potential connection between language input and child language production to illustrate the acquisition process where different variation patterns may compete for salience. In this age group, children start exploring and experimenting with various language features and styles with adults and peers. The observed variation patterns in their language production may also be changed according to the dynamics of their social interactions.

The limitations of this project are related to the research method that I adopted, the approaches used for data collection and analysis, the limited number of research subjects, and the long-term acquisition process the project did not manage to cover. First, as explained in Chapter 3, from the perspective of sociolinguistics, this study adopts the ethnographic method to interpret the language practices of teachers and children in the two preschools. Besides the advantages and disadvantages of this approach mentioned previously, this also means that the way that I explain the local language practices would more or less be influenced by the fact that I am also a part of the speech community and a Mandarin native speaker. This concern is mainly addressed by data triangulation. As quantitative analyses have been combined as part of the research method, the statistical results provide solid evidence to support the conclusions about sibilant variation observed in teachers and children. Furthermore, I kept in touch with as many research subjects as

I could to update information such as home language, attitudes toward CHL learning, and expectations of being bilingual or multilingual. Second, to obtain the natural speech from the research settings, all data were recorded in the preschool classrooms. Thus, the quality of the audio files is not comparable to that from a phonetic lab. Additionally, the acoustic analyses of sibilant variation adopted in this study mainly rely on sibilant duration and centroid frequency, which have been identified as the key acoustic parameters to distinguish different sibilant across languages (Gunter et al., 2021; F. Li, 2009; Reidy, 2016). Reidy (2016) proposed a new approach to measure the spectral dynamics of English and Japanese word-initial sibilants through a psychoacoustic measure of the peak frequency "peak ERB_N number". This approach was not adopted to examine the sibilant variation in this study because this has not been tested on tonal languages. Lastly, due to the limited time and resources that I had obtained for this project, CHL data were collected from a limited number of research subjects within a school year. Thus, the current findings may not be powerful enough to be generalized. Future studies may expand this scale in the following directions.

First, as Chapter 7 mentioned, besides sibilant variation, there are several other variation patterns identified in CHL children's language production. For example, the contextual omission of subject pronouns is a native-like variation pattern as exhibited in native speakers, L2 learners, and heritage learners (Flores-Ferrán, 2007; X. Li & Bayley, 2018; Paredes Silva, 1993; X. Zhang, 2021). The absence of subject pronouns by young children in both pro-drop languages and non-pro-drop languages stands as a cross-linguistic feature and has been attributed to language type, discourse, and phonological structure (Clark, 2009). The investigation of null subject pronoun in early bilingual and multilingual child language will expand the current knowledge of variation acquisition. Moreover, as Smith & Durham (2019) demonstrated, the

acquisition sequence of different variables by the same group of children could be different. Studies on how different phonological and morphosyntactic variables are acquired by the same learners may refine the current theoretical explanations of the acquisition sequence and the hierarchy among competing features. Furthermore, current findings demonstrate the need to explore the use of sociolinguistic variables and how children perceive and (re)produce the variables in their early years. CHL children as young as 3;01 exhibited systematical patterns of Mandarin sibilant variation. It implies that the emergency of variable use may start earlier. In addition, to what extent children can relate the social meanings to the corresponding variables as adults? Recent perception studies (e.g., Evans & Tomé-Lourido, 2019) have begun to investigate this question but more is still needed to present the big picture. In addition, the comparison between different groups of language users or learners, such as children, adults, native speakers, L2 learners, and heritage learners have effectively illustrated the differences in their language development trajectories (e.g., C. B. Chang & Yao, 2016; Díaz-Campos, 2005; X. Li, 2017). The differences revealed in different learners not only contribute to pedagogical practices in class but also facilitate the construction of a more refined acquisition model. Lastly, the investigation of the same sociolinguistic variable (e.g., null subject pronoun) in different varieties and languages may shed light on the potential typological pattern in language variation and change.

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Appendix A: Sociolinguistic interview with teachers

1) **Introduction: purposes, benefits, and risks**

   Explain to the interviewees the purposes of the interview, how they are expected to respond to the questions, what kind of benefits they have as a participant joining the research, how they personal information will be protected, and any potential risks this may bring.

2) **Personal background**

   a. Where (which city) were you born?

   b. Is it the same city where you were raised? (if no) why did you move to another city?

   c. Do you have any siblings at home?

   d. How would you describe your childhood? How was your relationship with your family members?

   e. What languages or dialects did you speak with your family members? Are these still the languages you use with them now?

3) **Educational background**

   a. What is your highest degree?

   b. What is your major in college?

   c. Why did you choose this major?

   d. What kind of professional training courses on education have you taken?

   e. Do you think these courses are helpful for your current work?

   f. When and how did you learn English/Chinese?

   g. Have you ever taken any language tests before? How was your performance?

4) **Working/teaching experiences**

   a. When did you start to work as a preschool teacher?

   b. Was this your first job? What else did you try?

   c. What kind of children/students/parents/families you have been working with?

   d. According to your knowledge, what are the differences between preschools in the US and China/ publish preschools and private preschools?

   e. Can you share the most joyful moment you have experienced as a preschool teacher?

   f. Can you share the most stressful moment you have experienced as a preschool teacher?

5) **Teaching and learning CHL in the US**

   a. To what extent do you agree that CHL children should learn Chinese/Mandarin at school?

   b. According to your knowledge, what would parents say about this?

   c. What are the benefits and problems of teaching/learning Chinese/Mandarin in the U.S.?

   d. How would you evaluate the effectiveness of teaching a language to preschool children via online platforms?

   e. To what extent do you agree that Chinese literacy is an important part of being Chinese?

6) **Closing: questions, concerns, and follow-up**

   Remind the interviewees how to express their questions, concerns, or add-on comments after the interview. Explain steps to follow-up.

Appendix B: Family background questionnaire

Family Background Questionnaire

Confidential - Confidential - Confidential - Confidential

The following is a questionnaire about the family background and language use at home. This information will be integrated with the observation data to provide a better understanding of the bilingual learning of your child. Please fill out this questionnaire as completely as you can.

About the Child

Name		Gender	
Date of Birth (MM/DD/YY)		Place of Birth (city)	
Ethnic background		Siblings	
The dominant language(s) and dialect(s) spoken at home			
How often the dominant language(s) and dialect(s) are used at home?			
1) 50-60% 2) 60-70% 3) 70-80% 4) 80-90% 5) 90% and above			
The dominant language(s) and dialect(s) are used for…? (dinner talk, home routine, story time, etc.)			
Other language(s) and dialect(s) spoken at home			
How often other language(s) and dialect(s) are used at home?			
1) Lower than 10% 2) 10-20% 3) 20-30% 4) 30-40% 5) 40-50%			
Other language(s) and dialect(s) are used for…? (dinner talk, home routine, story time, etc.)			

About the family

The family members the child often sees (including siblings and grandparents)

Family members	Age	Education	Occupation	Live with the child (Yes/No)	Languages spoken with the child

A few more questions…

1. What do you do at home with your child for languages and cultures? (for example, read story books, celebrate traditional holidays, practice writing letters/characters, etc.) please give a detailed description

2. Why is your child now enrolled in the English-Chinese bilingual program?

3. What kind of expectations do you have about your child learning Chinese in the United States?

4. Have you ever experienced any difficulties helping your child learn Chinese in the U.S.? If so, please explain.

*This is the end of this questionnaire. For any questions or concerns, please contact the project principal investigator via the following contact information.

Thank you for your time!

Appendix C: Demographic information of the target children (Chapter 5)

Demographic information of the target children				
Child name	Age	Gender	Home language	Enrollment length (month)
Naomi	3;01	F	Mandarin-dominant	19.20
Scott	3;02	M	Equally bilingual	7.30
Eveline	3;03	F	English-dominant	1.33
Lola	3;08	F	Mandarin-dominant	4.20
Owen	3;07	M	Equally bilingual	17.27
Kristina	3;08	F	Mandarin-dominant	17.77
Michael	3;08	M	Mandarin-dominant	19.23
Alice	3;10	F	Equally bilingual	17.53
Elena	3;10	F	Equally bilingual	29.37
Steven	3;11	M	Mandarin-dominant	2.37
Brandon	4;00	M	Mandarin-dominant	14.27
Catherine	4;00	F	English-dominant	20.13
Elsa	4;00	F	Mandarin-dominant	13.07
Emma	4;01	F	Mandarin-dominant	13.4
Lucas	4;01	M	Equally bilingual	6.60
Jackson	4;02	M	English-dominant	4.97
Jenny	4;03	F	English-dominant	13.40
Isabella	4;04	F	English-dominant	21.47
Andrew	4;04	M	Equally bilingual	23.3
Albert	4;04	M	Equally bilingual	2.87
Patrick	4;04	M	Mandarin-dominant	7.07
Abigail	4;05	F	Equally bilingual	35.73
Sheldon	4;06	M	Equally bilingual	27.57
Joseph	4;07	M	English-dominant	14.37
Harry	4;07	M	Equally bilingual	35.50
Peyton	4;07	F	Mandarin-dominant	6.13
Tessa	4;07	F	Mandarin-dominant	27.37
Eva	4;07	F	English-dominant	9.53
Dylan	4;08	M	Mandarin-dominant	35.47
Lia	4;08	F	Equally bilingual	37.67
Ophelia	4;08	F	Mandarin-dominant	17.33
Noah	4;09	M	English-dominant	22.53
Emily	4;09	F	English-dominant	39.23
Kevin	4;09	M	Equally bilingual	40.37
George	4;09	M	Mandarin-dominant	7.03
Matthew	4;09	M	Equally bilingual	0.13
Jay	4;10	M	Mandarin-dominant	35.47
Cameron	4;11	M	Mandarin-dominant	1.93

Edward	4;11	M	Mandarin-dominant	14.37
Natalie	5;00	F	Mandarin-dominant	25.43
Mia	5;01	F	English-dominant	36.87
Julian	5;04	M	Equally bilingual	28.50
John	5;04	M	Mandarin-dominant	40.77
Notes: All children's names are pseudonyms. Children's age was calculated by the initial test time. Home language was reported in family background questionnaires by parents. Enrollment length was calculated by the initial test time.				

Appendix D: Language tasks example questions (Chapter 5)

(1) Mandarin phoneme identification tasks

Which of the following item is called “shu3” (mouse)?

shu1 (book)

shu3 (mouse)

(2) Mandarin phoneme discrimination tasks

Who made a different sound than the other two cartoon characters?

Mickey Mouse: ma2

Donald Duck: ma2

Nemo: ma4