Phonological Development of Mandarin-English Bilingual Children in New Zealand

Taiying Lee
PhD in Speech Science

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Acknowledgments

Someone once told me that life was like a train ride. You meet many people, some take the same train for a short time and others come along for the whole journey.

For the train ride that has been my PhD, I have met many people, travelled to many places, eaten some very unusual food combinations and had countless unexpected adventures. My sincere gratitude and thanks to the following people without whom I could not have thought to embark on this PhD.

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PhD sufferers Boon and Joan. Thank you all for reminding me to stretch my legs, switch seats and “look out the window and enjoy the passing scenery”.

It has certainly been an interesting journey.

Abstract

Aims: Aims of this doctoral thesis were to: 1) develop linguistic and cultural guidelines when working with Mandarin-English bilingual children and families in a clinical setting, 2) investigate typical phonological development (phonetic inventories, phonological accuracy, speech error patterns) of Mandarin-English bilinguals aged 5;0-7;11 years in New Zealand (NZ) and 3) explore potential factors (age, gender, socio-economic status (SES), language background and exposure, time in NZ) impacting on development.

Methods: This is a cross sectional study on 326 typically developing Mandarin-English bilingual children aged 5;0 to 7;11 years. Children's phonological skills were assessed using the Diagnostic Evaluation of Articulation and Phonology assessment (Dodd, Zhu, Crosbie, Holm, & Ozanne, 2002) and an adapted Mandarin word test (Zhu & Dodd, 2000a). Consonant and vowel inventories were established for each child in both languages. English and Mandarin phonological accuracy was measured through: percent consonants correct (PCC), percent vowels correct (PVC) and percent phonemes correct (PPC). Additionally, Mandarin tonal percentage was examined. Speech error patterns were identified and further categorised into segmental and syllable error patterns. Multiple linear regression was then performed to examine possible links between demographic factors and phonological accuracy measures.

Results: Findings show that while phonetic inventories were similar to that found previously for monolinguals in both languages, there are differences in accuracy measures and speech error patterns between the bilingual children and their monolingual peers in both Mandarin and English. Bilinguals had lower accuracy across all measures for English and Mandarin with the exception of Mandarin PVC and tone accuracy, which showed a ceiling effect. Key factors that had significant impacts on accuracy measures included age, time in NZ, language background and exposure. Bilinguals had error patterns that would be classified as delayed

(e.g. gliding, cluster reduction) and atypical (e.g. backing, epenthesis) in monolingual populations.

Conclusions: Phonological development of Mandarin-English bilinguals is quantitatively and qualitatively different in comparison to monolingual peers. Phonological development is still a dynamic process for these bilinguals, even at 7;11 years. The descriptive results reported here for Mandarin-English bilinguals aged 5;0-7;11 years in NZ will be valuable when distinguishing language difference from disorder in this population. Findings will support clinical decision making and enable better differential diagnosis for Mandarin-English speaking children with suspected speech sound difficulties and will facilitate the development of guidelines for therapeutic intervention.

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List of Abbreviations

DEAP = Diagnostic Evaluation of Articulation and Phonology

NZ = New Zealand

PCC = Percent Consonants Correct

PPC = Percent Phoneme Correct

PVC = Percent Vowels Correct

SES = Socioeconomic Status

SSD = Speech Sound Disorders

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Building 721, Tamaki Campus
261 Morrin Road, Glen Innes
Auckland, New Zealand
Telephone 64 9 373 7599 ext. 84778
Facsimile 64 9 373 7902
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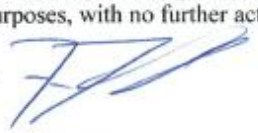
Signed:  Date: 06/04/16

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CO-AUTHORS

Name	Nature of Contribution
Elaine Ballard	Advised on literature search, edited text of article

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Name	Signature	Date
Elaine Ballard	Elaine Young Ballard	12 April 2016

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CO-AUTHORS

Name	Nature of Contribution
Elaine Ballard	Advised on data interpretation and presentation, edited text of article
Suzanne Purdy	Advised on data analysis and interpretation, edited text of article

Certification by Co-Authors

The undersigned hereby certify that:

- the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and
- that the candidate wrote all or the majority of the text.

Name	Signature	Date
Elaine Ballard	Elaine Young Ballard	12 April 2016
Suzanne C Purdy	SCPurdy	12 April 2016

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CO-AUTHORS

Name	Nature of Contribution
Elaine Ballard	Advised on data interpretation, edited text of article
Suzanne Purdy	Advise on data analysis and interpretation, edited text of article

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- that the candidate wrote all or the majority of the text.

Name	Signature	Date
Elaine Ballard	Elaine Young Ballard	12 April 2016
Suzanne C Purdy	SCPurdy	12 April 2016

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Chapter 1: Introduction

Introduction

Demographic changes in recent years have seen significant increases in the cultural and linguistic diversity in predominantly English speaking countries such as the US, UK, Australia and New Zealand. There are more children and families who speak a different language or languages, and who have a background in a different culture (Australian Bureau of Statistics, 2006; Statistics New Zealand, 2014; United States Census Bureau, 2012). This increased diversity is reflected in the work of speech-language therapists and there is an increasing demand on clinicians to assess, diagnose and provide therapy for children who speak a language other than English (Skahan, Watson & Lof, 2007; Stow & Dodd, 2005; Winter, 2001; McLeod, 2011; McLeod, 2014; McLeod, Verdon & Bowen, 2013). This is particularly pertinent for children with speech sound disorders (SSD) as these disorders tend to comprise a considerable portion of the clinician's caseload (Broomfield & Dodd, 2004; Law, Boyle, Harris, Harkness, & Nye, 2000; McLeod & Verdon, 2014). Providing equitable services for these culturally and linguistically diverse populations are a challenge with a number of difficulties of growing significance for clinicians (McLeod, 2014; McLeod, Verdon, & Bowen, 2013). It is a challenging and complex process to extrapolate the possibility of disorder from language difference and interaction and to determine whether intervention is warranted (Baker, 2006; Hemsley, Holm, & Dodd, 2014; Zhu, 2002; Zhu & Dodd, 2006). One of the core challenges underlying these difficulties is the lack of normative data on typical bilingual development (Caesar & Kohler, 2007; Hemsley, Holm, & Dodd, 2014; Jordaan, 2008; Kritikos, 2003; Williams & McLeod, 2012). While the development and progression of English speech sound acquisition are well established, there is comparatively little information on typical development and developmental norms for languages other than English (Caesar & Kohler, 2007; Hoff et al., 2012; McLeod, 2011, 2014; Zhu, 2002). Of particular relevance is Mandarin, the most widely spoken language in

the global context (Lewis, 2009). With large numbers of Mandarin speakers in overseas Chinese communities (Australian Bureauof Statistics, 2006; Statistics New Zealand, 2014; United States Census Bureau, 2012), this population is of increasing clinical significance.

There is consequently a real clinical drive for information on the typical phonological development of Mandarin-English bilingual children. This doctoral thesis aims to provide a detailed description of typical phonological development, in terms of phonetic inventory, phonological accuracy and speech error patterns of Mandarin-English bilingual school age children, 5;0 to 7;11 years.

This introductory chapter will outline the issues facing clinicians working with bilingual children and the considerable need for developmental information on bilingual populations.

Speech sound disorders

Speech sound disorders (SSD) are the most common developmental communication disorder in children with prevalence estimates ranging from 2.3% among children who were 7;0 years to 24.6% among children who were 5;0 years (Law et al., 2000). Children with SSD constitute a significant portion of clinical work (Broomfield & Dodd, 2004; Law et al, 2000; McLeod & Verdon, 2014). SSD is an umbrella term which encompasses a heterogeneous group of speech sound difficulties children experience that are not attributable to sensory, motor or structural causes (Flipsen, Bankson, & Bernthal, 2013; Dodd, 2005; Shriberg, 1980; Stackhouse & Wells, 1997; Shriberg et al., 2010). Children with SSD can have difficulties with the perception of speech sounds, physical articulation and/or the organisation and phonological representation of speech sounds (Bowen, 2015). Despite the prevalence of SSD, there is no universal classification system and a number of different classification systems have been proposed to account for the heterogeneity observed in SSD, these include the Psycholinguistic framework (Stackhouse & Wells, 1997), Speech Disorders Classification

System (Shriberg, Austin, Lewis, McSweeny, & Wilson, 1997; Shriberg et al., 2010) , and the Differential Diagnosis System (Dodd, 2005). Clinically, the most commonly utilised classification system is the Differential Diagnosis System (Dodd, 2005) as its categories are the most clinically practical. This classification system has also been applied to children who speak other languages, including Cantonese (So & Dodd, 1994) and Mandarin (Zhu & Dodd, 2000b), and has been shown to be applicable cross-linguistically (Waring & Knight, 2013). As such, this classification system, its associated terminology and analysis framework is also the approach taken in this thesis.

The Differential Diagnosis System, based on Dodd (2005), defines SSD as four subgroups; articulation disorder, phonological delay, consistent phonological disorder, and inconsistent phonological disorder. It utilises linguistic profiling to distinguish whether a child's phonological development is typical, delayed or disordered, and to determine which subgroup of SSD and its associated underlying difficulty a child is likely to have. Three central measures are used in this process; these are consonant and vowel inventories, phonological accuracy measures and speech sound pattern analysis.

These measures form the basis of independent and relational phonological analyses commonly used by clinicians (Bernthal, Bankson, & Flipsen, 2013; Bowen, 2014; Skahan, Watson, & Lof, 2007). Consonant and vowel inventories are a part of independent phonological analysis, where a child's speech sound productions are analysed independent of the target phonemes (Bowen, 2015; Goldstein, 2001). These inventories are established and then compared to normative data to determine whether the sounds produced are comparable to children in the same age group. Phonological accuracy measures and speech error pattern analysis are a part of relational phonological analysis, where a child's productions are analysed in comparison to target phonemes (Bowen, 2015; Goldstein, 2001). Phonological accuracy measures typically encompass three measures; percent consonants correct (PCC),

the number of consonants produced correctly divided by the number of total consonants elicited in the phonological assessment as a percentage; percent vowels correct (PVC), the number of vowels produced correctly divided by the number of total vowels elicited in the assessment as a percentage; percent phonemes correct (PPC), the number of phonemes (consonants and vowels) produced correctly divided by the total number of phonemes elicited in the assessment as a percentage (Shriberg & Kwiatkowski, 1982; Shriberg, 1993). Speech error patterns, also known as phonological processes or phonological errors, are systematic differences between a child's productions of a given phoneme and the adult target (Peña-Brooks & Hegde, 2000; Zhu & Dodd, 2006a). The surface errors produced by children are representative of the underlying difficulties that may be present. In speech error pattern analysis (also known as error pattern analysis, phonological process analysis), a child's errors are analysed and the types of error produced are compared with normative data to determine whether those errors are age appropriate and a part of typical development. It should be noted that although this is a common clinical analysis of phonological development, there are no set criteria on how error types are classified (Miccio & Scarpino, 2008). Phonological accuracy measures, speech error pattern analysis and classification methods used in this doctoral thesis have paralleled methodology set out in existing monolingual studies (Dodd, Holm, Zhu, & Crosbie, 2003; Zhu & Dodd, 2000a), for comparative purposes.

Bilingualism

Bilingualism is a complex phenomenon. The definition of bilingualism is a fluid and contentious issue in the literature; there are debates on what constitutes bilingualism and the type of bilingualism (Zhu & Dodd 2006b; McLeod, 2014; Grech & McLeod, 2012; Grosjean, 2010). These debates are centred around the variations in age or length of exposure, combination and number of languages exposed to, language learning environment and degree of proficiency in the languages being acquired. As Hambly, Wren, McLeod and Roulstone

(2013) stated, "children described as bilingual are a more heterogeneous group than those described as monolingual" (Hambly et al., 2013, p. 3). In general, bilingual children can be broadly categorised into two groups, simultaneous bilinguals or sequential bilinguals, based on the age of acquisition of their languages. However, there is much discussion, and varying criteria are used in the literature as there is little consensus on a specific age of exposure at which a child would be considered sequential as opposed to simultaneous bilingual (McLeod, 2014; Meisel, 2006; Zhu & Dodd, 2006b; McLaughlin, 1978). For many authors, the term simultaneous bilinguals refers to children who acquire two languages from birth or during the first two years. For others, the definition is broader and encompasses children who acquire their two languages in the first three or four years of life (Meisel, 2006).

This categorisation has potential impacts on the interpretation and clinical applications of research findings. Evidence in the literature suggests that sequential bilinguals may have more variation in their phonological acquisition compared to simultaneous bilinguals. That skills and knowledge from the first phonological system are utilised in the acquisition of the second system (Watson, 1991; Goldstein & Gildersleeve-Neumann, 2007). The complexities of bilingualism arise as bilingual children vary in the number of languages they are exposed to, the age and timing of exposure, language learning environments and the degree of proficiency across their languages. Zhu and Dodd (2006b) suggested that "what is important, then, is for researchers to provide precise information about their populations' language skills, and to use that information to interpret their findings" (Zhu & Dodd, 2006b, p. 9). Thus, a conservative approach was taken with the methodology in this study; precise information on age of acquisition was gathered for each child and children were considered sequential bilinguals if their age of acquisition was beyond 30 months (Zhu & Dodd, 2006b).

Bilingual phonological development

Children learning two phonological systems are a heterogeneous group that differ in terms of their age of acquisition, degree of similarity between the phonological systems and the language learning environment. This heterogeneity has led to debates in the literature on theoretical frameworks encapsulating phonological development for bilingual populations. There are two main theories: the Unitary Systems model which state that bilingual children begin with a single underlying phonological system that separates into two autonomous systems over time (schnitzer & Krasinski, 1994; Volterra & Taescher, 1978; Vogel, 1975), and the Dual Systems model which advocate for the presence of two separate phonological systems (Keshavarz & Ingram, 2002; Paradis & Genesee, 1996; Ball, Muller & Munro, 2001; Law & So, 2006). There are two hypotheses under the Dual Systems model regarding the extent of the interactions between the two phonological systems (Keshavarz & Ingram, 2002; Paradis & Genesee, 1996). The two systems may be completely autonomous or have some level of interaction and mutual influence (also known as the Interactional Dual Systems model). According to proponents of the Unitary Systems model (Schnitzer & Krasinski, 1994; Volterra & Taeschner, 1978; Vogel, 1975), there is one undifferentiated phonological system that separates into two over time and with exposure. Vogel (1975) reported on a case study of a Romanian-English bilingual two year old with similar error patterns in both languages, indicating a single underlying system. Similarly, Schnitzer and Krasinski (1994) presented data from a longitudinal case study of a Spanish-English bilingual child with a single mixed consonant system that later developed into two separate systems. Schnitzer and Krasinski (1996) then presented a second Spanish-English longitudinal case study which argued for two separate phonological systems. Since then, most research results have provided support for the Dual Systems model, and specifically the Interactional Dual Systems model, from a variety of language pairings such as Welsh-English, Spanish-English,

Cantonese-Mandarin, Samoan-English (Ball, Muller, & Munro, 2001; Ballard & Farao, 2008; Bortolini & Leonard, 1991; Brulard & Carr, 2003; Castilla, Restrepo, & Perez-Leroux, 2009; Law & So, 2006).

The current consensus is that bilingual children's phonological development is a dynamic process, it is quantitatively and qualitatively different from that of their monolingual peers, following along differing developmental trajectories and can seem protracted in comparison to monolingual development, extending past 5;0 years (Goldstein & McLeod, 2012; Hambly, Wren, McLeod, & Roulstone, 2013; Hemsley et al., 2014; Holm & Dodd, 1999; Holm, Dodd, Stow, & Pert, 1999; Kohnert, 2008; Paradis & Genesee, 1996). This can be attributed to the interaction or transfer between the phonological systems being acquired, and recent research focus has shifted to examining these interactions between the two phonological systems to explain bilingual acquisition and factors influencing these interactions (Hambly, Wren, McLeod, & Roulstone, 2013). Paradis and Genesee (1996) hypothesized that these interaction or transfer effects could be further categorised into two groups; positive transfer or acceleration, and negative transfer or deceleration. Positive transfer is where bilingual children are more 'advanced' in their phonological development in comparison to their monolingual peers, and negative transfer is where the reverse applies (Goldstein & Bunta, 2010, 2012; Goldstein & McLeod, 2012; Paradis & Genesee, 1996). Negative transfer also encompasses interference, where consonants and vowels specific to one language are used in the other (Goldstein & Bunta, 2010; Paradis & Genesee, 1996), resulting in more speech error patterns and error patterns not typically found with monolingual peers.

Goldstein and Washington (2001) assessed the phonological skills of 12 typically developing 4 year old bilinguals on a single word production task in Spanish and English. Their results indicated the presence of interference, with the bilingual children exhibiting

some error patterns that differed from those of the monolingual children. However, they also noted that bilingual phonological patterns were more similar than not to monolingual ones. These results were mirrored in Brice, Carson and O'Brien (2009)'s study on 16 Spanish-English bilinguals aged 4-5 years old. Analysis of phoneme repertoires and speech error patterns showed that bilinguals were more similar to monolinguals than expected with only two of the seven observed error patterns, stopping and velar fronting, differing from monolingual comparisons. Other studies with comparable language pairings also found similar results, where there was clearly more variation with the bilinguals on phonetic inventories, PCC and error patterns but not at a significant level (Anderson, 2004; Burrows & Goldstein, 2010; Fabiano-Smith & Barlow, 2010; Goldstein, Fabiano, & Washington, 2005).

In contrast Dodd, So and Li (1996) examined the speech error patterns of 16 Cantonese-English bilinguals aged 2-4 years old in the UK and found that while there were error patterns comparable to monolinguals in either language, there were also error patterns that were clearly atypical. These included backing and initial consonant deletion. Likewise, in other studies of Cantonese-English bilinguals, the presence of delayed or atypical error patterns was noticeably evident (Holm & Dodd, 1999; Holm & Dodd, 2006). This is also similar to findings from Lin and Johnson (2010)'s study of 25 Mandarin-English bilinguals aged 5 years in an English immersion preschool in Taiwan. Bilinguals made speech errors such as palatalization, final consonant devoicing and vowel errors that were not found in monolingual peers. Russian-English bilinguals aged 3-5 years in Gildersleeve-Neumann and Wright (2010)'s study also demonstrated vowel errors and a greater number of speech error patterns than monolingual English peers. Additionally, findings from studies on other language pairings such as Punjabi-English, Korean-English and Samoan-English also highlight this trend (Anderson, 2004; Ballard & Farao, 2008; Holm, Dodd, Stow, & Pert, 1999; Stow & Pert, 1998).

These varying degrees of interaction or transfer effects across different language pairings indicate that the extent of the interactions may be dependent on the phonological characteristics of the language pairing, on differences of the two phonological systems being acquired. That is, the degree of dissimilarity between the two phonological systems being acquired has direct implications for the scale and scope of interactions between the phonologies being acquired (Hemsley et al., 2014; Law & So, 2006). There may be more variation and interactions evident in the developmental acquisition of typologically different language pairings than those that are more similar like Spanish-English (Fabiano-Smith & Barlow, 2010; Fabiano-Smith & Goldstein, 2010).

Mandarin

These issues have particular relevance to Mandarin, also commonly known as standard Mandarin, Chinese Mandarin, Putonghua, Zhongwen, Huayu and Guoyu. Mandarin is the most widely spoken language in the global context (Lewis, 2009). In addition to being an official language of countries like China, Taiwan, Singapore, Hong Kong and Malaysia there are also significant overseas Mandarin communities in English speaking countries such as the US, UK, Canada, Australia and New Zealand (Australian Bureau of Statistics, 2006; Statistics NewZealand, 2014; United States Census Bureau, 2012).

Mandarin in NZ context

In recent years, New Zealand has experienced significant growth in the number of ethnic Chinese immigrants and Mandarin speakers. The ethnic Chinese are one of the largest and fastest growing ethnicities. This ethnic group has grown from 2.81% of the total population in 2001 (total of 104, 934) to 4.3% of the total population in 2013 (total of 170, 664). Parallel to the growth of this ethnic group, the Chinese languages and in particular Mandarin has become one of the most common languages spoken. This is clearly evident

from the increases in the Mandarin speaking population by 56% from the 2001 to 2006 census (to 41, 391 speakers), and a further 26% increase from the 2006 to the 2013 census (to 52, 263 speakers) (Statistics New Zealand, 2014). Not only are there increases in the total number of Mandarin speakers, there are also increases in the proportion of Mandarin speakers within this ethnic group with 25.27% of the ethnic Chinese group speaking Mandarin in 2001 growing to 30.62% in 2013. The Mandarin speaking population in New Zealand is a large, vibrant and close-knit community. Mandarin speakers are clustered in specific areas across New Zealand, and form local and national community groups (Statistics New Zealand, 2014). The majority of the Mandarin speaking population, 72.61%, resides in the Auckland region. The community actively promote cultural events and programmes that endeavour to maintain the use of Mandarin. With such a large clustered population, the Mandarin speaking community have developed business and services where the common language used is Mandarin. There are also institutional supports with Mandarin books and DVDs readily available in public libraries, and New Zealanders can access Mandarin television and radio programs, newspapers, magazines, Mandarin services in banks, religious services and bilingual preschools. This is reflected in the 2014 census data which indicated that the most common language spoken by non-English speakers in New Zealand was Mandarin (Statistics New Zealand, 2014).

Given the widespread use of Mandarin in numerous English speaking countries and in particular in New Zealand, there is a considerable need for information on the phonological development of bilingual children speaking it as their native language.

Purpose and rationale for present research

This research was motivated by the increases in cultural and linguistic diversity in English speaking countries and SSD being the most common type of developmental communication disorder in childhood, with SSD being a common cause for referral to

speech-language therapy services. Providing equitable services for SSD in bilingual populations is an issue of growing concern and significance in the clinical setting (McLeod, 2014; McLeod et al., 2013). This is of particular importance given the evidence for long term negative impacts and consequences of SSD, such as academic and literacy difficulties throughout school, as well as the impact on resources that occurs with misdiagnosis (Leitao & Fletcher, 2004; Lewis, Freebairn, & Taylor, 2000, 2002; McCormack, McLeod, McAllister, & Harrison, 2009).

Working with bilingual children with suspected SSD is an immense challenge. SSD differential diagnosis, in accordance with the Differential Diagnosis Model from Dodd (2005), is based on linguistic symptomology from common clinical measures of independent and relational analysis (Bowen, 2015). These involve establishing consonant and vowel inventories, phonological accuracy measures (PCC, PVC and PPC), and speech error pattern analysis. Normative comparisons are then needed to determine whether development is typical, delayed or disordered as well as which subgroup of SSD the presenting characteristics are likely to fall under. It is a complex process to extrapolate the possibility of disorder from language difference and interaction and to determine whether intervention is warranted (Hemsley et al., 2014; Zhu, 2002; Baker, 2006; Zhu & Dodd, 2006b). The use of monolingual norms for bilingual children with suspected SSD is not adequate and likely to lead to misdiagnosis (Goldstein & Gildersleeve-Neumann, 2007). This is especially evident since the literature on bilingual phonological development consistently shows that it is a dynamic process, extending past the typical phonological development age range of monolinguals. Additionally, there are qualitative and quantitative differences between monolingual and bilingual development due to interactions between the phonologies being acquired. This causes more variation in phonemic inventory, phonological accuracy and speech error patterns than occurs in typical monolingual development. Additionally, there is

growing evidence that the extent of the interactions may be reliant on the phonological characteristics of the language pairing, specifically the differences between the two phonological systems being acquired. Compounding the complexity is the lack of normative comparisons available for most bilingual populations. This is one of the core issues consistently identified by clinicians, and constitutes a significant clinical challenge as it impacts on all aspects of clinical work from differential diagnosis through to therapeutic intervention (Guiberson & Atkins, 2012; Williams & McLeod, 2012). Without normative comparisons, clinicians are unable to determine the presence of SSD or differentially diagnosis the relevant subtype of SSD. Accurate differential diagnosis is crucial with effective therapeutic intervention as there is increasing evidence that children in different subgroups of SSD respond best to different types of treatment (Broomfield & Dodd, 2011; Crosbie, Holm, & Dodd, 2005; Dodd & Bradford, 2000).

In combination with these issues and the influx of Mandarin speaking population in NZ as well as the continued growth in these communities with Mandarin one of the most common languages used in NZ (Statistics New Zealand, 2014), there is a critical need for normative information on typical phonological development in Mandarin-English bilinguals. Additionally, it is important to investigate age groups that are older than typically investigated for monolingual phonological development. Bilingual phonological development appears protracted in comparison to monolingual development due to variables such as age of exposure to the second language, degree and amount of exposure, and children over 5;0 years are likely to be still developing their phonological systems. Currently there is no existing research or information on Mandarin-English bilingual phonological development in NZ. Internationally, there is only one study by Lin and Johnson (2010) on 25 Mandarin-English bilingual 5 year olds in Taiwan, where the ambient language is Mandarin rather than English as is the case for most immigrant populations.

Overview of thesis

This thesis has been structured as a 'thesis with publications' in accordance with the University of Auckland guidelines for theses with publication where the body of the thesis is comprised of published or unpublished research papers, with introductory and concluding discussion chapters. The core of the thesis contains three research papers, along with an introductory chapter (Chapter 1) and a concluding discussion (Chapter 5). Chapter 2 details the methodological considerations in conducting the cross sectional study and outlines specific linguistic and cultural considerations in working with a Mandarin-English speaking population. This chapter is a published article and is included, with permission, as it appeared in the ACQuring Knowledge in Speech, Language and Hearing journal (Lee & Ballard, 2011). Chapter 3 investigates the phonetic inventory and phonological accuracy of Mandarin-English bilinguals aged 5;0 to 7;11 years as well as exploring potential factors impacting on phonological accuracy. Chapter 4 is a close examination of the discrepancies observed between monolingual and bilingual accuracy measures through speech sound error patterns. These two chapters are papers in preparation for submission to a peer reviewed journal.

The current research is the first of its kind on the typical phonological development of Mandarin-English bilingual children aged 5;0 to 7;11 years. Emerging evidence in the bilingual literature illustrates that bilingual phonological development is both quantitatively and qualitatively different from monolingual development, following along differing developmental trajectories. Bilingual children often have comparable phonetic inventories to their monolingual peers but more speech error patterns, and error patterns that are not typically found in monolingual peers (Fabiano-Smith & Barlow, 2010; Gildersleeve-Neumann, Kester, Davis, & Pena, 2008; Gildersleeve-Neumann & Wright, 2010; Goldstein & McLeod, 2012; Hambly et al., 2013; Holm & Dodd, 1999; Holm, Dodd, Stow, & Pert, 1999; Law & So, 2006). From previous research we know that differential diagnosis for

bilingual populations is a complex issue and bilingual children are consistently over-, under- or misdiagnosed with SSD (Winter, 1999, 2001; Stow & Dodd, 2003). With Mandarin being the most widely spoken language globally, with significant overseas Chinese communities in the US, UK, Canada, Australia and in particular New Zealand, there is a real clinical impetus for research on Mandarin and English as a language pairing.

The overall aim of this doctoral thesis is to provide a detailed description of typical phonological development, in terms of phonetic inventory, phonological accuracy and speech error patterns of Mandarin-English bilingual school age children, 5;0 to 7;11 years. It will also provide practical considerations for clinicians working with the Mandarin-English bilingual population in a clinical setting. Results and findings from this thesis will add to the growing literature and further understanding of bilingual phonological development.

Aims of thesis

Specific aims of the study were:

1. Provide information on specific linguistic and cultural considerations when working with Mandarin-English bilingual population around assessment and interactions with children and families in a clinical setting.
2. Provide descriptive data on typical phonological development in the form of phonetic inventories, phonological accuracy measures (in terms of percent consonants correct, percent vowels correct, percent phonemes correct) and explore potential factors impacting on phonological accuracy.
3. Identify age appropriate speech sound errors for Mandarin-English bilingual school-aged children in both of the languages being acquired.

Chapter 2: Working with Mandarin Speaking Clients: Linguistic and Cultural Considerations

Lee, T., & Ballard, E. (2011). Working with Mandarin speaking clients: Linguistic and cultural considerations *ACQuiring Knowledge in Speech, Language and Hearing, 13*(3), 132-136.

This publication is inserted as published, with the exception of minor edits and formatting changes to maintain consistency throughout the thesis. It is included in the thesis with permission from the *ACQuiring Knowledge in Speech, Language and Hearing*

Abstract

Immigration patterns in both NZ and Australia have changed significantly in the last 20 years with an increase of clients from a Mandarin-speaking background in clinical practice. Working with this population as a clinicians can be both challenging and frustrating. In this paper we outline some issues speech pathologists should be aware of in order to make their practice with clients from this background more effective. Our discussion will cover both linguistic and cultural cconsiderations. We conclude with some thoughts on how best to work with this population.

Introduction

Immigration patterns in both New Zealand and Australia have changed significantly in the last 20 years (Australian Bureau of Statistics 2006; Statistics New Zealand 2006). As a result, speech pathologists in these countries are now working with an increasingly multilingual and multicultural population.

Of particular note is the increase of clients from a Mandarin-speaking background in clinical practice. The ethnic Chinese are one of the largest and fastest growing immigrant groups in New Zealand with a 40% increase from the 2001 to the 2006 Census. This is also reflected in the Australian statistics where there has been a 57% increase from 2001 to 2005. From the census as well as our experience of working with families, both clinically and through research, we are aware that most of these families speak Mandarin as their first language, and have a strong commitment to encouraging the maintenance of that language by their children. The children are primarily exposed to Mandarin in the home environment, and have their first exposure to English in early childhood centres and can thus be considered as growing up bilingual.

Clinicians face linguistic and cultural challenges when working with this bilingual

population. In this paper, we outline some of the issues speech pathologists should be aware of in order to make their practice with clients from a Chinese-English background more effective. Our discussion will be divided into two sections: 1) linguistic issues, and 2) cultural considerations. As our experience of this population is primarily in the area of phonological acquisition, the linguistic section will focus on phonology. The discussion of cultural considerations will, however, have a wider applicability and is not restricted to any particular type of assessment or intervention. These considerations are furthermore not restricted to Mandarin-speaking immigrants, as they are relevant to any immigrants from a Chinese background. We conclude the paper with some thoughts on how best to work with this population.

Linguistic considerations

When diagnosing bilingual children for a possible speech sound disorder or delay it is a given that they be assessed in both their languages (Genesee, Paradis, & Crago, 2004; Kohnert, 2007; Zhu & Dodd, 2006b). In working with the Mandarin-speaking population, clinicians need some basic background knowledge of Mandarin, in particular its phonology and its differences to English phonology so that they can make informed clinical decisions around assessment, analysis, and therapy.

Mandarin

Mandarin is the most widely spoken language in the world with 1,023 million speakers globally (Lewis, 2009) and is the native language of approximately 70% of the population in mainland China. In China, Mandarin is commonly known as Putonghua. As the official language of the country it has widespread uses in the mass media and is the language of instruction in schools. Mandarin is also the official language of Taiwan where it is known as Guoyu, and in Hong Kong it shares official language status with English and Cantonese, a southern variety of

Chinese. Mandarin is also widely spoken in Brunei, Indonesia, Malaysia, Mongolia, Philippines, Singapore, and Thailand as well as in overseas Chinese communities in the US, UK, Canada, Australia, and New Zealand.

In assessing children's ability in Mandarin we have used the Putonghua speech sound assessment developed by Zhu (2002). This assessment is not the only one available (see Putonghua Segmental Phonology Test, So & Zhou, 2000) but it is readily accessible. The Zhu (2002) assessment is a picture-naming task that targets all of the consonants, vowels, and tones of modern standard Chinese as spoken in China. Below we give a description of Mandarin phonology based on the version used in the assessment.

Consonants.

Mandarin has 22 consonant phonemes (see table 1). Unlike English, Mandarin does not have a voicing contrast with its obstruents. This is generally not critical for the stops and affricates, as there is a contrast based on aspiration/ non-aspiration which is perceptually similar to that found with the English stops and affricates. However, this is more problematic with the fricatives as the lack of contrasting pairs of fricatives in Mandarin makes it difficult for children acquiring English to perceive the difference between /f/ and /v/, /θ/, and /ð/, /ʃ/ and /ʒ/. It is to be further noted that Mandarin /ɹ/ bears little resemblance phonetically to its English counterpart. References such as Norman (1988) describe this phone as a voiced retroflex continuant which suggests that its pronunciation varies from a fricative through to an approximant.

Table 1. *Mandarin consonants*

	Bilabial	Labiodental	Alveolar	Retroflex	Alveolopalatal	Velar
Stop	p p^h		t t^h			k k^h
Nasal	m		n			ŋ
Affricate			ts ts^h	tʂ $tʂ^h$	tɕ $tɕ^h$	
Fricative		f	s	ʂ	ɕ	x
Approximant			ɹ			
Lateral approximant			l			

Vowels.

According to Zhu (2002) and Zhu & Dodd (2006a), the vowels can be classified into three groups with nine monophthongs, nine diphthongs and four triphthongs. The nine monophthongs are /i, y, u, ɤ, o, a, ə, ɛ, ɚ/ (see chart 1). The diphthongs can be divided further into offglides and onglides; /ae/, /ei/, /ɑo/ and /ou/ are offglides with the first vowel sound being longer and having more intensity; /ia/, /iɛ/, /ua/, /uo/, and /yɛ/ are onglides with the second element being sonorous. The four triphthongs are /iao/, /iou/, /uae/ and /uei/, with the middle element having the most intensity and of the longest duration. There is however a lack of consensus within the literature as to the actual number of monophthongs as some researchers classify the mid vowels [ɛ ɤ o] as allophones of the phoneme /ə/, since these vowels occur in predictable phonetic contexts (Duanmu, 2007; Norman, 1988; Wan & Jaeger, 2003). Although there are more diphthongs and triphthongs in Mandarin than in English, there are fewer monophthongs. As a consequence Mandarin speakers who have only recently learned English often have trouble distinguishing between the greater number of phonemic contrasts within the English monophthongs. The tense/lax high vowels /i ɪ u ʊ/ and vowels /e æ ɒ/ provide the most difficulty in their production.

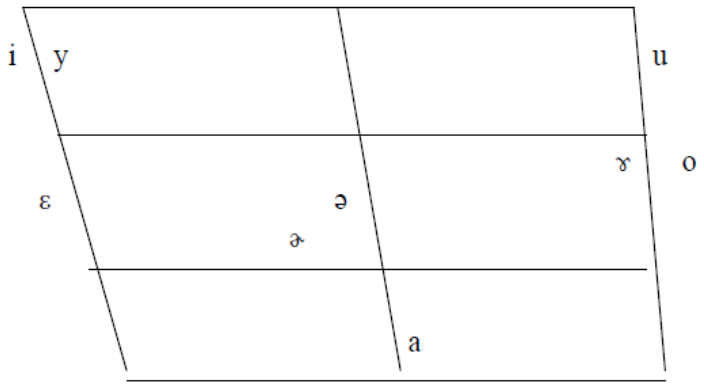

Figure 1. Mandarin vowels

Tone.

While English does utilise pitch changes over the course of an utterance for pragmatic and grammatical reasons in intonation, it does not use them phonemically. Mandarin does, as pitch changes occur at a lexical level and are associated with change in meaning. There are four main phonemic tones in Mandarin, i.e. high level, high rising, falling-rising and high falling, primarily characterized by voice pitch but also by length and intensity (Duanmu, 2007; Norman, 1988). They are referred to as tones 1, 2, 3 and 4 respectively (see table 2).

Table 2. *A description of Mandarin tones using syllable /mA/*

Tone	Tonal indicator	Example
High level	1	媽 Mother
Rising	2	麻 Hemp
Falling-rising	3	馬 Horse
High falling	4	罵 Scold

Syllable structure.

There are only four possible syllable types in Mandarin: V (一 /i:/ "one"), CV (踢 /ti/ "kick"), VC 碗 /uan / "bowl") and CVC (糖 / tʰa ŋ / "sugar"). There are also restrictions on consonants occurring post-vocalically as only the nasals /n/ and /ŋ/ can occur in this position. The range of syllable types is therefore more restricted than in English, where up to three consonants are permitted as a cluster in the onset position of the syllable (e.g., string) and up to four in coda position (e.g., exempts).

Variation in Mandarin.

While some of the children we have encountered under clinical or research conditions have been first language speakers of the standard Mandarin of the assessment (Putonghua), we have found that the majority were not. From our experience most Mandarin speakers in New Zealand communities speak a variant Putonghua or a different Mandarin standard. Many speakers from

China speak Putonghua and one or more other Chinese languages.

These Chinese languages include Wu, Yue, Xiang, Kejia and Min (Yuan, 1960 cited in Norman, 1988). These bear little resemblance phonologically to Putonghua but may impact on a speaker's production when speaking Putonghua.

Speakers we have encountered from other countries such as Taiwan and Singapore use a Mandarin standard distinct from Putonghua. These standard languages are based on the varieties of Chinese spoken in those communities. A crucial difference between Putonghua and the other variet- ies of Mandarin (within and outside of China) is found in the retroflex consonants / tʂ tʂʰʂ / and the alveolar approximant /ɹ/ (Duanmu, 2007; Norman, 1988). None of these varieties have retroflexes, so that target words with retroflexes are consistently rendered with the alveolars [ts tsʰ s]. Addition- ally, some of these varieties (e.g., Yue-based Mandarin, Taiwanese Mandarin) do not have a central approximant and tend to merge target words with this consonant with the lateral /l/.

English

From bilingual research into phonological acquisition (Holm & Dodd, 1999; Lin & Johnson, 2010) and our own initial findings (Lee & Ballard, 2010, May), we know that Chinese- dominant bilingual children growing up in English-speaking countries will lag behind their monolingual peers in terms of their phonological skills in English. We have used the phonology subtest from the Diagnostic Evaluation of Articulation and Phonology DEAP (Dodd et al., 2002) with this population and have found that their phonological accuracy is on average lower than that of the monolinguals. In our research, initial findings from 78 children indicate that the average percent phoneme correct (PPC) score for 5-year-olds in this population is 85%. This mean score is considerably lower than the score of 97.68% found for age-equivalent monolinguals (Dodd et al. 2002). Furthermore, they are more likely to produce speech errors which would be termed atypical for monolinguals. Examples of such errors that we found fairly common among our

participants are the devoicing of voiced obstruents in word final position and the substitution of /s/ for /θ/. We note here that while English monolingual children are more likely to front /θ/ (Dodd et al., 2003), our Mandarin dominant speakers are more likely to back this fricative.

Cultural considerations

Concepts of self, of family, and more pertinently of social interactions, communication styles, and language use are embedded in cultural values and practices (Gudykunst et al., 1996). In outlining the characteristics of the Mandarin-speaking population culture and discussing these issues we have adopted the framework outlined in Hwa-Froelich and Vigil (2004). In the following we discuss three aspects of the framework particularly pertinent to the Mandarin-speaking population and the implications of these characteristics on views on disability. It is important to note that these are general outlines and generalisations across a complex community and will therefore not apply to every family or individual. Within the Mandarin-speaking population, there are also cultural practices and values specific to the families' country of origin, and their rate of acculturation to a new community or country.

Responsibility relationships

According to Hwa-Froelich and Vigil (2004), responsibility relationships refer to a culture's perspective or preference on responsibility roles and how they are managed. Responsibility relationships vary according to the degree of independence/interdependence among its members. Broadly speaking, independence is equated to individualism while interdependence equates to collectivism. While many western cultures may favour individualism, and children are socialised to function independently, many Chinese- speaking populations are collectivist in outlook. In practice, this means that the individual is interdependent and has strong bonds with the group(s) that they identify with. Thus they tend to consider the group well-being over individual wishes when making decisions. Family relations are integral to the collective viewpoint and the core family unit is much larger, incorporating members of the extended family.

We have found the above to be true for many of the families we have encountered. For these families, the grandparents often live together with or in close proximity to the rest of the family and have a significant role in the care and upbringing of children.

Interpersonal relationships

Interpersonal relationships, according to Hwa-Froelich and Vigil (2004), refer more specifically to the social status of individual members and are based on variables such as age, wealth and education. In practice, cultures vary according to a continuum that spans from informality/ equality at one end to formality/inequality at the other.

Generally, Chinese-speaking families are characteristically closer to the formal/unequal end, while many western cultures veer towards the other end of the continuum, where equality and informality are emphasised. In relationships where informality and equality are valued, interactions are more direct and more verbal. In relationships where formality and inequality are predominant, respect is shown to elders and non-verbal behaviour and indirect language is used to avoid conflict. Family structure is hierarchical with the older generation, and male family members having more say in family decision-making. In our clinical and research experience, we have found Hwa-Froehlich and Vigil's observations regarding Chinese families to be true for many Mandarin- speaking families residing in New Zealand.

Risk management

Risk management in the framework outlined by Hwa-Froelich and Vigil (2004) refers to the way different cultures manage uncertainty or ambiguity. Communication varies in the level of implicitness/explicitness and cultures differ in their expectation for rules, guidance and structure. Cultural differences manifest themselves along a continuum that spans the dimensions of weak uncertainty/avoidance and strong uncertainty/avoidance. In many western cultures that favour weak uncertainty, children are encouraged to question, take risks, explore and be creative. In Chinese culture strong uncertainty is generally favoured. Parents are more directive and children

are socialised to obey without question and imitate adult models. This type of parenting style allows for few play-type interactions. Children are expected to obey their parents and avoid making mistakes. In our experience, this is particularly evident in assessment sessions with Mandarin families, where the child is often directed to respond to assessment tasks or look for non-verbal cues to indicate their involvement.

Views on disability

The three areas discussed above have considerable impact on the view of disability espoused by more traditional Chinese families and recent immigrants. The degree of interdependence among family members in terms of responsibility relationships is reflected in the way families rally around to support the member with the disability and in the degree of dedication they demonstrate in caring for and meeting needs of that person. We have found that more traditional families residing in New Zealand seek help and support within the family unit. Seeking support from social welfare or government services, including special education services, can be intimidating.

We have also found that these families can be very inclusive towards and accepting of a family member with disability. However, the importance of social status in interpersonal relationships and the highly hierarchical nature of families lead to a negative view of disability. Consequently, some families will conceal or simply not discuss family members with a disability.

From the above it would seem that Chinese families generally prefer a directive style and favour certainty and structure. This gives them a view of disability as being something that can be cured given clear guidelines as to how to go about fixing the problem. The consequences are that the family can be very diligent and persistent in doing home activities with the "sick" family member but only if they perceive it worthwhile. How clearly activities are presented will influence their perception of the value of therapeutic activities.

Implications for the clinician

The linguistic and cultural characteristics discussed above can come into conflict with aspects of clinical training and best practice. They can even become barriers to service delivery and methods of assessment and therapeutic interventions. In Boxes 1 to 3, we provide practical suggestions and considerations for working with the Chinese community and families as they relate to 1) general interactions with the family and child, 2), assessment practices, and 3) intervention. We are of course aware and note again that these are generalisations, and will therefore not apply to every family or individual. Families acculturate into a new community at different rates. Therefore, it is always beneficial as a first step for clinicians to find out about a family's unique cultural and linguistic background. It is also important for clinicians to consider their own culture and cultural practices and how these may impact on their interactions with the child and family.

Box 1: practical considerations in engaging with the family

Interactions/engagement with family and child
• It is polite to address parents with the title of Mr or Mrs unless specifically told otherwise. • Names and their pronunciation are important. If you are unsure of the pronunciation, ask the family. • Families will arrive at appointments or scheduled meetings on time or slightly early. This indicates their respect and the importance they place on the clinician and service. However, when visiting families at home, it is appropriate to arrive five to ten minutes later than the given time. This gives the family additional time to prepare for your visit. • Personal space is more defined and there is less emphasis on physical displays of affection or physical interaction. On a home visit, follow the family's guide on where to sit and let them find a space and distance that they feel comfortable with. • Hospitality is important. It is polite to accept and try a drink and food when offered. • People from different cultures interpret actions and non-verbal signals differently. When building rapport with a client and family, it is important to keep this in mind and reach a clear understanding through discussion rather than assumptions through nonverbal signals and actions. For example, smiling in Western cultures generally indicates agreement but with Mandarin-speaking populations it may indicate politeness, embarrassment or apology. Similarly nodding in Western cultures indicates agreement but for many Chinese families this only indicates acknowledgement.

Box 2: practical considerations in the assessment process

Assessment
• It is imperative to find out about the child's language history. This includes all the languages that the child has been exposed to and the length of time that they have been exposed to these languages. • Note the variety of Mandarin that your interpreter speaks. It may be pertinent to ask them about the Mandarin the child and family speaks and any general differences between their Mandarin varieties. • Observations of the child in different settings are essential. This is particularly pertinent as there clear scripts and expectations for different communication contexts and communicative partners. • Be careful of pragmatic differences as these can be misinterpreted. Clinicians must view observed behaviours in the light of cultural expectations and appropriate politeness rules. For example, in the classroom children are expected to listen quietly to the teacher rather than ask questions or volunteer information. • It may be difficult to engage with the child in situations where the child is expected to converse with an unfamiliar adult. To increase child engagement and participation, discuss the process with the parents. This gives them the chance to explain it to their child. Clearly explain what you would like the child to do, how you are going to assess, its purpose and how you want the parents to act. • Be aware that children may be reluctant to respond or decline to participate when they are not sure of the 'correct' answer or they may provide several responses to ensure that they have responded 'correctly'. • Parental teaching is generally directive so parents may unintentionally provide hints and answers to tasks that their child finds difficult. It is important to make sure that you go through what you would like the parents to do/not do during the assessment. • Given the variation that exist across the Mandarin standard spoken, allow for alternate scoring within a Mandarin speech assessment. Always compare the child's speech productions to the Mandarin standard of their variety of Mandarin. • Be aware that Mandarin dominant children's score on any English speech assessment will lag behind those of their English monolingual peers. • Mandarin dominant children are likely to produce errors considered atypical for monolingual English speakers in English speech assessments.

Box 3: practical considerations in implementing therapy

Therapy and therapeutic interventions
• Families may view the clinician as a 'specialist' whose role is to 'fix' the child. • Be aware of the differences in the Mandarin and English phonologies. These must be considered if therapy goals are to be appropriate. • After considering family dynamics it may be appropriate to involve the wider family in discussions about interventions. • With home programs, it is important to find out who will be most likely to work with the child and discuss the activities specifically with them. • Clearly explain any home program. Place emphasis on the clinical rationale behind the activities and if possible, the likely outcomes thereof. Go through what you would like the family to do. Be specific and give clear examples. • Negotiate how the family is going to work on the therapy targets. Keep the therapy goals and rationale in mind as opposed to interaction style. For example, praising the child for achieving a target is expressed differently in different cultures. • Take time to discuss how the family can incorporate goals into their everyday life. Discuss how they will undertake and incorporate the activities suggested.

Conclusion

With this paper we hope that clinicians will become more aware of the impact that linguistic and cultural difference can have on clinical practice with their Mandarin-speaking clients. The practical considerations provided are intended to serve as a quick and easy reference so that clinicians may be able to engage more effectively and efficiently with children and families from this background.

Chapter 3: Phonological development of Mandarin-English sequential bilinguals: phonetic inventory and accuracy

Lee, T., Ballard, E. & Purdy, S. C. (In preparation). Phonological development of Mandarin-English sequential bilinguals: phonetic inventory and accuracy

This publication is inserted as it will be submitted for publication, with the exception of minor edits and formatting changes to maintain consistency throughout the thesis.

Introduction

In recent years, there has been a significant increase in the cultural and linguistic diversity in predominantly English speaking countries culture (Australian Bureau of Statistics, 2006; Statistics New Zealand, 2014; United States Census Bureau, 2012). There are more children and families who speak a different language or languages, and who have a background in a different culture (McLeod, 2011, 2014; Stow & Dodd, 2003). These population changes are progressively reflected in the caseload of speech and language therapists. As such there is an increasing demand on clinicians to assess, diagnose and provide therapy for children who speak a language other than English (Skahan, Watson & Lof, 2007; McLeod, 2011; McLeod, 2014; McLeod, Verdon & Bowen, 2013). This is particularly pertinent for children with speech sound disorders (SSD) as these disorders are the most commonly diagnosed developmental communication disorder through childhood, and comprise a considerable portion of therapy caseloads (Broomfield & Dodd, 2004; Law, Boyle, Harris, Harkness, & Nye, 2000; McLeod, 2014).

One of the main initial difficulties clinicians encounter when working with culturally and linguistically diverse populations is determining whether these children have a speech disorder or delay or whether the difficulties in speech development are due to interactions between their languages (Hemsley, Holm & Dodd, 2014; Zhu, 2002; Baker, 2006; Zhu and Dodd, 2006a). It is a challenging and complex task to determine whether there is disorder when language difference and interaction are present. Additionally, clinicians working with bilingual children with SSD face a whole host of challenges and issues that combine to significantly impact on all aspects of clinical practice from assessment and diagnosis to therapeutic interventions and goal setting (McLeod, 2014; McLeod et al., 2013).

One of the core challenges is the lack of normative data on typical bilingual phonological development (Caesar & Kohler, 2007; Jordaan, 2008; Kritikos, 2003; Williams

& McLeod, 2012). A description and understanding of the development and course of speech sound acquisition through childhood is needed for clinicians to interpret assessment results and gauge where a child is at with their speech sound development and whether their phonological development and speech errors are progressing in a typical fashion, are delayed or deviated from the norm. This information is essential for clinicians for purposes of diagnosis, determining the need for and the nature of therapeutic intervention and measurement of change in performance over time (Crais, 2011; Owens, 1999; Parkinson & Pate, 2000; Paul, 2012; McLeans et al., 2004). Detailed information on the phonological development in each of the languages a bilingual child speaks is a requirement. The majority of acquisition studies in the literature are based on the progression of English phonology, and hence the development and progression of English speech sound acquisition as well as descriptions of typical speech error patterns are well established. However this is not the case for languages other than English. There is comparatively little detailed information on typical development and developmental norms for other languages (Caesar & Kohler, 2007; Zhu 2002; Zhu & Dodd, 2006a; McLeod, 2011, 2014; Hoff et al., 2012).

This is problematic as there is growing evidence in the bilingual literature that bilingual phonological development is quantitatively and qualitatively different from that of monolingual phonological development, following differing developmental trajectories, and for sequential bilinguals, phonological development is often protracted (Goldstein & McLeod, 2012; Hambly et al., 2013; Holm & Dodd, 1999; Holm, Dodd, Stow, & Pert, 1999). Differential diagnosis for bilingual populations is a complex issue and consequently bilingual children are frequently over-, under- or mis-diagnosed with SSD (Winter, 1999, 2001; Stow & Dodd, 2003).

The typical development of bilingual populations is a continuously developing field with current research focussed on typologically related languages like Spanish-English and

French-English (Fabiano-Smith & Barlow, 2010; Goldstein & Bunta, 2010; Yavas & Goldstein, 2006; Gildersleeve-Neumann & Wright, 2010; Law & So, 2006). There is little on language pairings that are typologically unrelated. The issues around bilingual speech development have particular relevance to a major language, which is less explored in the literature, Mandarin. This is surprising as Mandarin is the most widely spoken language globally (Lewis, 2009), with the largest native speaking population in the world (Zhu & Dodd, 2000a). Like English, there are in fact several varieties of Mandarin, with differences in pronunciation, vocabulary and to some extent grammar (Duanmu, 2000). The most prevalent variety of Mandarin in most phonological descriptions is based on the pronunciations of the variety spoken in Beijing, China (Norman, 1988; Duanmu, 2000). Mandarin is also commonly known as standard Mandarin, Chinese Mandarin, Putonghua, Zhongwen, Huayu and Guoyu; the terminology used is largely dependent on the country of origin. Mandarin is the official language of mainland China and Taiwan. Mandarin is also one of the official languages of Singapore and Hong Kong. In Hong Kong it shares official language status with English and Cantonese, a southern variety of Chinese. In Singapore it is one of the four official languages. Additionally, Mandarin is also widely spoken in many other countries such as Brunei, Indonesia, Malaysia, Mongolia, Philippines, Singapore, Thailand and in overseas Chinese communities in the US, UK, Canada, Australia and New Zealand (United States Census Bureau, 2012; Statistics New Zealand, 2014; Australian Bureau of Statistics, 2006).

Despite this, the phonological development of Mandarin speaking children, and in particular bilingual Mandarin speaking children remains underexplored. To date, there have been a handful of monolingual Mandarin studies, most of which are longitudinal case studies (Erbaugh, 1992; Li, 1977; Jeng, 1979; Shiu, 1990), with one cross-sectional study by Zhu and Dodd (2000) of 129 monolingual Mandarin speakers in northern China. There have been

even fewer bilingual Mandarin studies, the only one being Lin and Johnson (2010) on 25 Mandarin speaking children aged 4-5 years in Taiwan in English immersion programmes at their early childhood centre. Lin and Johnson (2010) found that Mandarin-English bilinguals did not differ significantly from their monolingual Mandarin speaking peers in either phonological accuracy or error patterns in Mandarin. Additionally they report that their bilingual group also achieved high English phoneme accuracy percentages and although there were error patterns evident in English, these were not present above 10% of the time with the exception of final consonant deletion. Lin and Johnson (2010) conclude that Mandarin-English bilinguals at 5 years old achieve overall phonological competence in both Mandarin and English for their sample. However, they also acknowledge the limitations in their study and the need for further investigation into error patterns exhibited by this population in both English and Mandarin.

The key purpose of this study is to provide descriptive data on the phonological development of Mandarin-English bilingual children growing up in New Zealand. Specifically, the focus is on phonetic inventory and phonological accuracy as these measures are commonly used to examine phonological development in the literature and also in clinical settings. Potential factors such as socioeconomic status (SES), gender, age, language background, and time in New Zealand, which may impact on these aspects of phonological development for this population, are also explored.

NZ context

Within the New Zealand context, the ethnic Chinese are one of the largest and fastest growing ethnicities with a 40% increase from the 2001 to 2006 census and a further 16% increase in the 2013 census (Statistics New Zealand, 2014), taking this ethnic group from 2.81% of the total population in 2001 (total of 104, 934) to 4.3% of the total population in 2013 (total of 170, 664). Parallel to the growth of this ethnic group, the Chinese languages

and in particular Mandarin has become one of the most common languages spoken. This is clearly evident from the increases in the Mandarin speaking population by 56% from the 2001 to 2006 census (to 41, 391 speakers), and a further 26% increase from the 2006 to the 2013 census (to 52, 263 speakers) (Statistics New Zealand, 2014). Not only are there increases in the total number of Mandarin speakers, there are also increases in the proportion of Mandarin speakers within this ethnic group with 25.27% of the ethnic Chinese group speaking Mandarin in 2001 growing to 30.62% in 2013.

This is reflected in the number of children who have Mandarin as their native language or one of their languages in New Zealand classrooms. Subsequently, there are increasing needs for this bilingual population with regards to speech and language therapy, with a significant number of these children being referred to the special education services for support, principally for support from a speech-language therapist (Skahan, Watson & Lof, 2007). This is particularly evident in the area of speech sounds and phonology which is often the most noticeably different in bilingual Mandarin-English speaking children and constitutes the main reason for referrals (Skahan, Watson & Lof, 2007).

Factors affecting sound development

A broad spectrum of factors, both at an individual and societal level, have been examined in relation to phonological development in the literature; of particular note are age, gender and SES (Burt, Holm, & Dodd, 1999; Dodd et al., 2003; Law, 1992; Smit, Hand, Freilinger, Bernthal, & Bird, 1990), alongside language background and exposure (Grech & Dodd, 2008; Hammer et al., 2012; Lin & Johnson, 2010; Vihman, 2002). Research findings indicate that age, gender and SES have broad impacts on speech and language development. In general, older children are significantly more accurate than younger children, girls tend to have better speech sound acquisition and accuracy than boys (Smit, Hand, Freilinger, Bernthal, & Bird, 1990), and low SES backgrounds are generally associated with poorer

performance on speech and language measures (Law, 1992), although different measures of SES have resulted in contentious findings in the literature. Additionally, the bilingual literature shows that language background, usage and exposure are positively associated with better accuracy (Grech & Dodd, 2008; Hammer et al., 2012). Identifying factors that may impact on children's speech sound acquisition is important when considering how norms should be developed and applied to clinical populations. Consequently the above demographic factors were explored in the present study.

Mandarin phonology

The following is an outline of standard Mandarin phonology. The main differences between standard Mandarin and other Mandarin varieties have also been highlighted as the Mandarin speaking population in New Zealand, being an immigrant population, is heterogeneous and speakers originate from a range of different Mandarin speaking countries. It is acknowledged that are numerous in-depth debates regarding both the number and the phonemic representation of Mandarin phonemes among linguists, which is well documented in the literature (Duanmu, 2000, 2007; Sun 2006; Norman 1988). These are beyond the scope of this paper and will not be discussed further here.

Consonants.

Mandarin has 22 consonants with aspiration as a distinctive feature. There are three pairs of stops /p, pʰ/, /t, tʰ/ and /k, kʰ/. In addition to these stops, there are a series of fricatives; labial-dental /f/, the dental /s/, palatal /ɕ/ and the retroflex /ʂ/. There is also a series of affricates; the dental affricates /ts, tsʰ/, palatal affricates /tɕ, tɕʰ/ and retroflex affricates /tʂ, tʂʰ/. The series of sonorants includes the liquid /l/ and a group of nasals: labial nasal /m/, dental nasal /n/ and the velar nasal /ŋ/, which only occurs in final position. Additionally, there is a velar fricative /x/ and a retroflex approximant /ɻ/.

Vowels.

Mandarin has a set of three high vowels, a mid vowel, and a low vowel. The high vowels consist of the high front vowel /i/, the high back vowel /u/ and the high front rounded vowel /y/. The mid vowel has several variants [o, e, ə, ɤ, ɛ] as does the low vowel [ɑ, a, æ, ɐ]; there are many different suggestions regarding their phonemic representation. The general consensus is /ə/ as the mid vowel and /A/ as the low vowel (Norman 1988, Duanmu 2007, Wan and Jaeger 2003). In addition to these five vowels, Mandarin also has a 'retroflex vowel' /ɚ/, where the tongue tip is curled back (Duanmu 2000; Zhu 2002; Sun 2006; Duanmu 2007) (see Appendix 4 for a list of Mandarin IPA symbols).

Tone.

Mandarin is a tonal language so in addition to the consonant and vowels, every syllable in Mandarin has a tone. The tones in Mandarin are lexical tones, they are an integral part of the syllable or word and are as necessary as its consonants and vowels. The tones occur at the phonemic level, and differences in the tones can change the meaning of a word (Norman 1988). There are four distinct tones in Mandarin; the first tone (Tone 1) is a high level, the second tone (Tone 2) is high rising and begins from about the middle of a speakers' pitch range and rises abruptly to the top, the third tone (Tone 3) is a contour tone. It begins low, falls to the lower limits of the pitch range and rises to half way. Tone 3 has the longest duration of all the tones. The fourth tone (Tone 4) is a high falling tone and begins from the top of a speaker's pitch range and falls abruptly to the lower limit.

Table 3. *A description of Mandarin tones using syllable /mA/*

Tone	Tonal indicator	Example
High level	1	媽 Mother
Rising	2	麻 Hemp
Falling-rising	3	馬 Horse
High falling	4	罵 Scold

Tone sandhi.

The four tones in Mandarin are altered when syllables are connected in natural speech; this process is called tone sandhi (Norman, 1988). It is noted that the third tone undergoes tone 3 sandhi, one of the most known tone sandhi processes in Mandarin. This is where tone 3 becomes a tone 2 when it preceded another tone 3 as evidenced in [mai] 'buy' + [ma] 'horse' = [mai. Ma] 'buy horse'. This changed tone 3 is indistinguishable from a naturally occurring tone 2 (Norman 1988; Dunamu, 2000; 2007). Tone 4 also undergoes tone sandhi and a tone 4 followed by another tone 4 will become a low falling tone.

It is acknowledged that the other tones of Mandarin also have variations and undergo changes in varying phonetic situations. Tone sandhi is a convoluted process in Mandarin that occurs not only at the word level but also across syntactic domains, whether it is a word, compound word or phrase. However, this research examines Mandarin speech sounds primarily at the mono- and bi-syllabic word level and hence the complexities of tone sandhi will not be discussed further.

Table 4. *Mandarin phonology*

	Mandarin
Tones	1 high level tone (T1) 2 rising tone (T2) 3 contour tone (T3) 4 falling tone (T4)
Consonants	p, p^h, t, t^h, k, k^h m, n, ŋ ts, ts^h, tʂ, $tʂ^h$, tɕ, $tɕ^h$ f, s, ʂ, ɕ, x l, ɻ
Vowels	i, y, u, ə, A
Syllable structure	[C_{0-1}] V [C_{0-1}]

Key differences between standard Mandarin and other varieties of Mandarin

The core difference between standard Mandarin, and other varieties of Mandarin spoken in countries such as Singapore, Taiwan and Malaysia, is found with the use of retroflex consonants /ʂ, tʂ, $tʂ^h$/ and the approximant /ɻ/ (Duanmu 2000, 2007). The contrast

between the retroflex /ʂ, tʂ, tʂʰ/ and alveolar consonants /s, ts, tsʰ/ tends to disappear and the two series are in actuality indistinguishable. Additionally, many of these Mandarin varieties rarely utilise the approximant /ɻ/ and tend to merge this with the lateral approximant /l/. Linked with this reduction in contrast between the retroflex and alveolar consonants, the contrast between the final consonants /n/ and /ŋ/ also tends to disappear (Duanmu, 2000). There are likewise slight differences between the vowel productions in standard Mandarin and other variants of Mandarin. One of the most noticeable dividing points between standard Mandarin and other varieties of Mandarin is the use of /ɚ/. Other varieties of Mandarin have less rhotacisation and as a consequence the 'retroflex vowel' /ɚ/ that commonly occurs in standard Mandarin is often realised as the unrounded mid back vowel /ɤ/.

Methodology

Participants

Schools across Auckland, New Zealand were invited to participate, 30 schools consented, 6 schools did not have participants who met the inclusion criteria, the remaining 24 schools went on to participate in the current research. Participant information and consent forms were sent to the participating schools. Teachers were asked to identify 5;0 -7;11 year old Mandarin-English bilingual children who were typically developing with no concerns around hearing, communication or learning. Information and consent forms were then sent home for parents to send through if interested to participate. Children (n=326) aged 5;0 to 7;11 years participated from these 24 primary schools. The majority of the children (98.77%) were sequential bilinguals with Mandarin being the primary language spoken consistently at home and in the local community and English being the ambient language in the wider community, with most children exposed to English more consistently once at kindergarten or school, after 30 months of age. As the Mandarin speaking population in New Zealand is an immigrant population, there was also a small group of children that were exposed to an

additional Chinese language in the sample, the most common being Cantonese. Teachers were asked to check school hearing and vision records and parent reports determined all children were typically developing, had normal hearing and that there were no concerns regarding general development, cognitive or speech and language skills.

Semi-structured interviews

Semi-structured interviews were completed with primary caregivers either in their home environment or in a meeting room at the school (see Appendix 5 for interview format). The language used in the interviews was either Mandarin or English or a combination of the two depending on what the primary caregiver felt comfortable with. The majority of interviews were 60 minutes long with some extending to over 90 minutes. Information was obtained on language exposure (as measured in time in New Zealand), families' language use, families' access to language support networks in the community, and SES estimated based on the published school decile ratings. In New Zealand, school decile ratings are a broad measure of the SES of the families and children attending a specified school based on factors such as income and local house prices. It is used to indicate the level of financial support provided by the government to the school. The ratings range from 1, indicating a high proportion of families from a lower socioeconomic area enrolled in the school to 10 indicating a higher socioeconomic area. Participant demographic characteristics are summarised in Tables 5 to 7.

Table 5. *Normative sample by age and gender*

			Gender		
Age group (year; month)	**n**	**Mean age**	**Girl**	**Boy**	**% of participants**
5;0 – 5;5	57	5;2	25	32	17.48
5;6 – 5;11	59	5;7	25	34	18.10
6;0 – 6;5	53	6;2	19	34	16.26
6;6 – 6;11	53	6;7	17	36	16.26
7;0 – 7;5	50	7;2	26	24	15.34
7;6 – 7;11	54	7;8	32	22	16.56

Table 6. *Socio-economic status (SES) of participants through school decile rating*

SES (school decile rating)	n	% of participants
4	1	0.31
6	30	9.20
8	91	27.91
9	140	42.94
10	64	19.63

Table 7. *Language background of participants*

Language background	n	% of participants
Mandarin	283	86.81
Mandarin + other Chinese language*	43	13.19
Language use and exposure		
Family in NZ	286	87.73
Immediate family	40	12.27
Extended family		
Siblings in family	159	48.77
Only child	96	29.45
Older siblings only	45	13.80
Younger siblings only	26	7.98
Older and younger siblings		
Preschool language environment	293	89.88
English speaking	19	5.83
Mandarin speaking	14	4.29
Both English and Mandarin		
Additional language classes	9	2.76
English classes	317	97.24
No English classes	102	31.29
Mandarin classes	224	68.71
No Mandarin classes		
Relatives on extended visits	306	93.87
No	20	6.13
Yes		
Home country visits		
No	234	71.78
Yes	92	28.22

*most common other Chinese language was Cantonese

Assessment

Mandarin phonological acquisition was assessed using the standard Mandarin word list from Zhu (2002) as this was the most readily accessible. The word list comprises 44

items, 39 everyday nouns, 1 colour adjective and 4 common phrases, of which there are 17 monosyllabic and 27 multisyllabic items (26 disyllabic and 1 trisyllabic). It was administered as a picture naming test that targets all the consonants, vowels and tones of standard Mandarin. Seventeen additional test items were included in the word list to adapt the word list to a broader Mandarin speaking population (see Appendix 1 for items). All items were represented as high quality colour drawings on laminated A5 white cards. English phonological acquisition was assessed using the phonology section of the Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd, Zhu, Crosbie, Holm, & Ozanne, 2006). The phonology subtest was selected instead of the articulation subtest as it contains a comparable coverage of English phonemes to the Mandarin wordlist for Mandarin phonemes. There are 50 test items compared with 30 in the articulation subtest. Additionally it samples a wider range of word shapes, including multisyllabic words, initial and final consonant clusters, and vowels in different words, and offers analysis of phonological accuracy (Dodd et al., 2006) (see Appendix 2 and 3 for frequency distribution of phonological features). Although both assessments have normative data associated, they were developed for monolingual populations and as such are not appropriate for use with bilingual populations. Thus, the assessments were used for descriptive analysis purposes.

Procedure

Mandarin and English phonological assessments were completed in two separate sessions. All children were assessed individually in a quiet space at their school by the first author, a trained speech-language therapist and native speaker of Mandarin. The assessment procedures outlined in the DEAP manual were followed (Dodd et al., 2006). Semantic or contextual prompts were provided if the child was unable to produce the target word. If a spontaneous production could not be elicited through prompts, the child was asked to imitate the target word. Imitated responses were then noted on the record form. Children's

productions were evaluated and scored in accordance to the Mandarin standard of their variety of Mandarin. Assessment results were transcribed live on site and all assessment sessions were also recorded on an Olympus WS-100 digital voice recorder. Ten percent of Mandarin and English samples were used to determine inter-judge agreement. One native Mandarin speaking speech language therapy student transcribed the Mandarin samples. Point by point transcription agreement was 98.79% for all phonemes. One native English speaking speech language therapist transcribed the English samples. Point by point transcription agreement was 99.02% for all phonemes.

Data analysis

Phonetic inventory.

Phonetic consonant and vowel inventory was established for each child in both English and Mandarin. Sounds were included in the inventory if they were produced by 90% of the children in a specified age group regardless of whether the sound was the target sound or not. This follows guidelines set in previous studies for comparative purposes (Dodd et al., 2003; Zhu & Dodd, 2000a; Zhu, 2002; So & Dodd, 1994).

Phonological accuracy.

English and Mandarin phonological accuracy was measured through: percent consonants correct (PCC), the number of consonants produced correctly divided by the number of total consonants elicited in the phonological assessment as a percentage; percent vowels correct (PVC), the number of vowels produced correctly divided by the number of total vowels elicited in the assessment as a percentage; percent phonemes correct (PPC), the number of phonemes (consonants and vowels) produced correctly divided by the total number of phonemes elicited in the assessment as a percentage (Shriberg & Kwiatkowski, 1982; Shriberg, 1993). Additionally for Mandarin, a tonal accuracy percentage was determined.

The R statistics program version 2 was used for statistical analysis (R Core Team, 2013). This program is a comprehensive statistical analysis program which provides a wide variety of statistical modelling and analysis, including linear and nonlinear modelling, classical statistics tests, time-series analysis and clustering. Descriptive statistics were calculated for phonological accuracy measures, PCC, PVC, PPC for both English and Mandarin across the age groups, with the addition of tonal accuracy for Mandarin. Since these outcome variables are all continuous, linear regression was performed to examine the possible links between demographic factors (see Tables 5-7) and phonological accuracy measures. Age, gender, SES (based on school decile), exposure to English, L2 (measured as time in NZ in months) and language background were controlled for in all models. To explore language background children were categorised as having only Mandarin exposure, or Mandarin and other Chinese language background. Bidirectional stepwise selection based on Akaike Information Criterion (AIC) was used to select the best model for each speech measure.

Assumptions for multiple regression were tested for normality, linearity, multi-collinearity and homoscedascity. Multi-collinearity was investigated using variance inflation factors. Distribution of the outcome variables were relatively normal with the exception of Mandarin PVC and Mandarin tonal accuracy, as most participants obtained scores of 100% on these measures across age groups.

Multiple linear regression was performed using the lm function in the R statistics program. A bidirectional stepwise selection procedure was performed using the step function in R on all variables added to the model. If the bidirectional stepwise selected model chose three variables in addition to the control variables, then the best fitting model with eight variables was examined. Pairwise comparisons were then made between the levels of the categorical variables that had significant p values ($p<0.05$).

Results

Bilingual phonetic inventory

The English and Mandarin phonetic inventories were established for each child. Sounds were included in the inventory if they produced by 90% of the children in a given age group.

English sound acquisition

By 5;0 90% of the children were able to articulate all the sounds of English with the exception of the post-alveolar fricatives /ʃ, ʒ/, dental fricatives /θ, ð/, voiced affricate /dʒ/ and the approximant /ɹ/ (Table 8). The post alveolar fricatives /ʃ, ʒ/ and voiced affricate /dʒ/ were acquired in the phonetic repertoire shortly after, with ongoing acquisition of the dental fricatives /θ, ð/ and approximant /ɹ/ through to 7;11 years.

Table 8. *English sound acquisition 90% criterion*

Age	90% criterion	Absent
5;0 – 5;5	p, b, t, d, k, g, m, n, ŋ, f, v, s, z, h, tʃ, l, w, j	ʃ, ʒ, θ, ð, dʒ, ɹ
5;6 – 5;11	ʃ, ʒ, dʒ	θ, ð, ɹ
6;0 – 6;5		θ, ð, ɹ
6;6 – 6;11		θ, ð, ɹ
7;0 – 7;5		θ, ð, ɹ
7;6 – 7;11		θ, ð, ɹ

Mandarin sound acquisition

Children in the current study were able to articulate most sounds in Mandarin by 6;5 years with the exception of the alveolo-palatal fricative /ɕ/ and the approximant /ɻ/. At 5;0 years, children were still distinguishing between all the affricates in Mandarin and it is not until 5;6 and 6;0 that 90% of the children were able to produce the all the alveolar /ts, ts^h/ and alveolo-palatal affricates /tɕ, $tɕ^h$/ respectively.

Table 9. *Mandarin sound acquisition 90% criterion*

Age	90% criterion	Absent
5;0 – 5;5	p, p^h, t, t^h, k, k^h, m, n, ŋ*, f, x, s, ʂ, l	ts, ts^h, ɕ, tɕ, $tɕ^h$, tʂ, $tʂ^h$, ɻ**
5;6 – 5;11	ts, ts^h, $tʂ^h$	ɕ, tɕ, $tɕ^h$, tʂ, ɻ
6;0 – 6;5	tɕ, $tɕ^h$, tʂ	ɕ, ɻ
6;6 – 6;11		ɕ, ɻ
7;0 – 7;5		ɕ, ɻ
7;6 – 7;11	ɕ	ɻ

*90% criterion taking into account regional variation and dialectal impacts
**variable presence in different Mandarin dialects

Bilingual phonological accuracy

The descriptive statistics for each of the phonological accuracy measures across the age groups are outlined in Table 10 for English and Table 11 for Mandarin. There was a clear increase in accuracy percentages across all measures as older children perform more accurately than younger children. Children were also more accurate with Mandarin across the age groups for all measures than for English.

Table 10. *Descriptive statistics for phonological accuracy measures for English by age group*

	Age group					
	5;0 – 5;5	**5;6 – 5;11**	**6;0 – 6;5**	**6;6 – 6;11**	**7;0 – 7;5**	**7;6 – 7;11**
			PCC (%)			
Mean	82.28	84.66	85.82	86.95	87.90	89.47
Standard deviation	3.86	4.046	3.94	3.18	3.38	3.17
Minimum	71.63	73.76	76.60	80.85	82.27	83.69
Maximum	90.07	90.78	94.33	94.33	95.75	97.16
			PVC (%)			
Mean	95.93	96.59	96.32	97.29	97.90	98.00
Standard deviation	2.00	1.74	2.35	2.19	1.63	1.55
Minimum	87.18	91.03	89.74	91.03	94.87	93.59
Maximum	100.00	100.00	100.00	100.00	100.00	100.00
			PPC (%)			
Mean	87.14	88.91	89.56	90.63	91.46	92.51
Standard deviation	2.72	2.92	3.08	2.58	2.51	2.34
Minimum	79.00	81.28	83.11	84.93	87.22	88.13
Maximum	93.15	94.06	96.35	95.89	96.80	98.17

Table 11. *Descriptive statistics for phonological accuracy measures for Mandarin by age group*

	Age group					
	5;0 – 5;5	**5;6 – 5;11**	**6;0 – 6;5**	**6;6 – 6;11**	**7;0 – 7;5**	**7;6 – 7;11**
			PCC (%)			
Mean	84.85	87.94	91.38	92.22	93.94	93.70
Standard deviation	6.34	5.61	6.34	5.90	4.97	4.96
Minimum	71.54	77.69	76.15	78.46	80.77	80.00
Maximum	96.15	100.00	100.00	100.00	100.00	100.00
			PVC (%)			
Mean	99.65	99.55	99.70	99.75	99.66	99.89
Standard deviation	0.69	0.67	0.61	0.53	0.66	0.40
Minimum	97.14	97.14	97.14	97.14	97.14	98.10
Maximum	100.00	100.00	100.00	100.00	100.00	100.00
			PPC (%)			
Mean	91.46	93.13	95.09	95.58	96.49	96.47
Standard deviation	3.55	3.12	3.63	3.29	2.91	2.81
Minimum	84.26	87.66	86.38	88.09	88.94	88.94
Maximum	97.45	100.00	100.00	100.00	100.00	100.00
			Tone (%)			
Mean	99.93	99.94	99.98	100.00	99.87	99.93
Standard deviation	0.24	0.24	0.13	0.00	0.46	0.25
Minimum	99.07	99.07	99.07	100.00	97.20	99.07
Maximum	100.00	100.00	100.00	100.00	100.00	100.00

Factors impacting on accuracy measures

Multiple linear regression analysis was used to examine possible links between demographic factors and phonological accuracy measures in both English and Mandarin. Age, gender, SES (based on school decile), language background, language exposure (measured as time in NZ in months) and other demographic factors pertaining to language use and exposure: siblings, preschool language environment, visits back to the home country, wider family networks (Tables 5-7) were included in the regression model to determine the association between these variables and phonological accuracy measures. Table 12 shows the

multiple linear regression model statistical information for the phonological accuracy measures for both English and Mandarin.

Table 12. *Multiple linear regression results for each phonological accuracy measure for English and Mandarin*

	Adjusted R-squared	F-statistic (df)	p value
English PCC	0.3306	14.379 (12)	<0.0001
English PVC	0.1819	6.161 (14)	<0.0001
English PPC	0.3422	13.075 (14)	<0.0001
Mandarin PCC	0.2537	8.893 (14)	<0.0001
Mandarin PVC	0.0456	2.035 (15)	0.0130
Mandarin PPC	0.2580	8.534 (15)	<0.0001
Mandarin Tone	0.0704	2.449 (17)	0.0013

Factors impacting on English phonological accuracy

The multiple linear regression analysis showed that older children were more accurate across all English phonological accuracy measures than younger children; PCC ($p<0.001$), PVC ($p<0.001$) and PPC ($p<0.001$). Children who had spent more time in NZ were also more accurate; PCC ($p=0.0014$), PVC ($p=0.0002$) and PPC ($p=0.0003$). Gender was only a significant factor for PCC ($p=0.0427$); girls (mean=85.77%) were significantly more accurate than boys (mean=84.99%), although the percentage difference was small. SES was not a significant factor for any of the English phonological measures. In contrast, language background was significant for both PCC ($p=0.0076$) and PPC ($p=0.0297$). Pairwise comparisons indicated that children with a Mandarin only background were more accurate than children with a Mandarin and other Chinese language background. Although language background was not a significant factor for PVC, children with extended family networks in NZ were less accurate ($p=0.0044$) than children with immediate family only in NZ.

Factors impacting on Mandarin phonological accuracy

For Mandarin phonological accuracy measures, the analysis revealed that older children were more accurate for both PCC ($p<0.001$) and PPC ($p<0.001$). Language use at home was also a significant factor, with children who used mainly Mandarin at home more accurate than those who used a combination of Mandarin and English or Mandarin, English and another Chinese dialect, for both PCC ($p=0.0136$) and PPC ($p=0.0069$). SES, gender, time in NZ and language background were not significant for any of the Mandarin phonological accuracy measures. For PVC and Mandarin tonal accuracy, ceiling effects meant that there were no significant factors impacting on these two measures.

Discussion

Little is known about typical bilingual phonological development, particularly for typologically different language pairings like Mandarin and English. Such normative data is crucial for clinicians in all aspects of clinical practice from differential diagnosis to intervention when working with bilingual populations. The purpose of the current study was to outline the phonological acquisition of 326 Mandarin-English sequential bilingual children, aged between 5;0 to 7;11 years and provide descriptive data focused on the age of acquisition of sounds and phonological accuracy for both English and Mandarin. Possible links between a range of demographic factors and phonological accuracy measures were also explored. These included age, gender, SES, language background, language exposure (measured in time in NZ in months) as well as other factors that pertain to language use and exposure.

Findings indicate that the sequence of sound acquisition for Mandarin-English bilinguals generally follows previous normative monolingual studies for English and Mandarin. English post alveolar fricatives /ʃ, ʒ/, dental fricatives /θ, ð/ and approximant /ɹ/ (Dodd et al. 2003), along with Mandarin affricates /ts, ts^h, tɕ, $tɕ^h$, tʂ, $tʂ^h$/ were mastered later

(Zhu & Dodd, 2000a; Zhu, 2002) in the current study and in the literature. By 5;0, 90% of the bilingual children in the current study were able to articulate most sounds of English with the exception of the post-alveolar fricatives /ʃ, ʒ/, dental fricatives /θ, ð/, voiced affricate /dʒ/ and central approximant /ɹ/. Although the post-alveolar fricatives and voiced affricate are then acquired shortly after, the dental fricatives and the central approximant are still developing even by 7;11 years. However, there were slight differences in the order of acquisition of the post-alveolar fricatives and voiced affricate in the bilingual children in the current study, compared to monolingual English norms (Table 13) suggesting a different acquisitional trajectory for bilingual Mandarin-English speaking children.

Table 13. *Comparison of bilingual and monolingual English phonetic acquisition 90% criterion*

Age	Language background	90% criterion	Absent
3;0 – 3;5	Monolingual[1]	p, b, t, d, k, g, m, n, ŋ, f, v, s, z, h, l, w, j	ʃ, ʒ, θ, ð, tʃ, dʒ, ɹ
3;6 – 3;11	Monolingual[1]		ʃ, ʒ, θ, ð, dʒ, ɹ
4;0 – 4;5	Monolingual[1]	ʒ, tʃ, dʒ	ʃ, θ, ð, ɹ
4;6 – 4;11	Monolingual[1]		θ, ð, ɹ
5;0 – 5;5	Monolingual[1]	ʃ	θ, ð, ɹ
	Bilingual[2]	p, b, t, d, k, g, m, n, ŋ, f, v, s, z, h, tʃ, l, w, j	ʃ, ʒ, θ, ð, dʒ, ɹ
5;6 – 5;11	Monolingual[1]		θ, ð, ɹ
	Bilingual[2]	ʃ, ʒ, dʒ	θ, ð, ɹ
6;0 – 6;5	Monolingual[1]	ɹ	θ, ð
	Bilingual[2]		θ, ð, ɹ
6;6 – 6;11	Monolingual[1]		θ, ð
	Bilingual[2]		θ, ð, ɹ
>7;0	Monolingual[1]	θ, ð	
	Bilingual[2]		θ, ð, ɹ

[1] English monolingual (Dodd et al.2003)
[2]Mandarin-English bilingual

The same pattern occurred for speech sound mastery for Mandarin (Table 14). The children were still distinguishing between Mandarin affricates at 5;6 years. Again there were slight differences in the sequence for the children in the current study who mastered alveolo-

palatal affricates /tɕ, tɕ^{h}/ later than alveolar affricates /ts, ts^{h}/, which is in contrast to monolingual English speaking children that have the reverse order of development (Dodd et al., 2003). Additionally, for the bilingual children the palatal fricative /ɕ/ and approximant /ɻ/ were the last sounds to be mastered. Thus for the bilingual children in the current study, mastery of English and Mandarin speech sounds was not yet complete at 7;11 years although this is assumed for Mandarin monolinguals by children older than 4;6 (Zhu, 2002; Zhu & Dodd, 2000a) and for English monolinguals by 7;0 years (Dodd et al., 2003).

Table 14. *Comparison of bilingual and monolingual Mandarin phonetic acquisition: syllable initial consonants 90% criterion*

Age	Language background	90% criterion	Absent
>4;6	Monolingual[1]	p, p^{h}, t, t^{h}, k, k^{h}, m, n, ŋ, f, x, s, ts, ts^{h}, ɕ, tɕ, tɕ^{h}, ʂ, tʂ, tʂ^{h}, l, ɻ	
5;0 – 5;5	Bilingual[2]	p, p^{h}, t, t^{h}, k, k^{h}, m, n, ŋ*, f, x, s, ʂ, l	ts, ts^{h}, ɕ, tɕ, tɕ^{h}, tʂ, tʂ^{h}, ɻ**
5;6 – 5;11	Bilingual[2]	ts, ts^{h}, tʂ^{h}	ɕ, tɕ, tɕ^{h}, tʂ, ɻ
6;0 – 6;5	Bilingual[2]	tɕ, tɕ^{h}, tʂ	ɕ, ɻ
6;6 – 6;11	Bilingual[2]		ɕ, ɻ
7;0 – 7;5	Bilingual[2]		ɕ, ɻ
7;6 – 7;11	Bilingual[2]		ɕ, ɻ

[1] Mandarin monolingual (Zhu & Dodd, 2002)
[2]Mandarin-English bilingual
*90% criterion taking into account regional variation and dialectal impacts
**variable presence in different Mandarin dialects

These disparities between monolingual and bilingual sound mastery may be attributable to differences in English and Mandarin phonology as sounds mastered later or still in the process of being mastered in bilinguals are, respectively, unique to English and Mandarin phonologies. Additionally, differences with the order of sound mastery for both English and Mandarin are indicative of interactional effects which are well documented in the bilingual phonological acquisition literature through different language pairings (Dickinson, McCabe, Clark-Chiarelli, & Wolf, 2004; Fabiano-Smith & Barlow, 2010; Gildersleeve-Neumann, Pena, Davis, & Kester, 2009; Goldstein & Bunta, 2012; Kim, 2009; Lopez &

Greenfield, 2004). Mastery of the English affricate before the post alveolar fricatives can be attributed to the fact that Mandarin has significantly more affricates. Likewise, the mastery of Mandarin alveolar affricates before palatal consonants could well be linked to the greater number of consonants in the alveolar region in English.

Mandarin-English bilinguals in this study clearly have an extended period of sound mastery in comparison to the monolingual norms of their respective languages, as phonological acquisition is still a dynamic process even at 7;11 years in the current sample. In comparison with published monolingual norms, both English and Mandarin phonological accuracy measures were comparable to those found in younger age groups. English monolingual accuracy measures as reported in Dodd et al. (2003), show that by 7;0 years children achieved 95.86% for PCC, 99.19% for PVC and 97.03% for PPC. For bilingual English accuracy at the same age, children in the current study achieved 89.47% for PCC, 98.00% for PVC and 92.51% for PPC. Monolingual Mandarin accuracy measures from Lin and Johnson (2010), show that by 5;0 children achieved 97.17% for PCC and 99.02% for PVC. For bilingual Mandarin accuracy at the same age, children in the current study achieved 84.85% for PCC and 99.65% for PVC. Unfortunately there were no phonological accuracy measures reported in the cross sectional study on Mandarin monolinguals by Zhu and Dodd (2000a) and hence no comparisons can be made with this cohort.

Age was a significant factor in phonological accuracy, this is reflected in the clear progression in phonological accuracy measures for both English and Mandarin in the six-month age groups up to 7;11 years. Significant differences were found between age groups across all English phonological measures but only in Mandarin for PCC and PPC, as ceiling effects were evident for Mandarin PVC and tonal accuracy measures. Although Mandarin phonological accuracy measures were consistently higher than English across all phonological accuracy measures and age groups, these measures were still significantly lower

than monolingual Mandarin norms (Zhu & Dodd, 2000a). Thus the ambient language environment does have an impact on the children's first language even when Mandarin is the only language spoken at home.

Age, gender and SES were examined to determine possible influences on phonological accuracy measures. In contrast to findings in the literature that support a gender bias (Law, Boyle, Harris, Harkness, & Nye, 2000; Smit et al., 1990), results from the current study show that gender was only a significant factor for English PCC, where girls were more accurate than boys. The lack of gender effect for Mandarin suggests a bias only for the second language in the current cohort of children. Results for SES were in line with some reports in the literature (Smit et al., 1990) as was not a significant factor for any of English or Mandarin phonological accuracy measures. Most children were from a high SES areas, however, which is a limitation of the current study and an area for future research. Of more interest were factors relating to exposure and language use. In general, as anticipated, more exposure led to better accuracy. Children who spent more time in New Zealand, had higher percentage scores across all English phonological accuracy measures, and those with families that used mainly Mandarin in the home environment were more accurate for Mandarin PCC and PPC percentages compared with those who used a combination of Mandarin, English and other Chinese languages. Additionally, children with a Mandarin-English only background were more accurate in English (PCC and PPC) compared with children with a Mandarin-English and other Chinese language background.

Clinical implications

Results from this study have significant implications for clinicians working with speech sound disorders in Mandarin-English bilingual populations. Speech sound disorders are the most commonly diagnosed developmental communication disorder throughout childhood (Broomfield & Dodd, 2004; Law, Boyle, Harris, Harkness, & Nye, 2000; McLeod

& Verdon, 2014) and constitute the bulk of referrals for support from a speech-language therapist (Skahan, Watson & Lof, 2007). For clinicians to determine whether a Mandarin-English bilingual child's speech sound skills are developing normally, access to normative data specific to the population is essential. Accurate differential diagnosis and therapeutic intervention hinges on comparisons with a relevant normative data set.

The descriptive data reported from this study show that although there are similarities between the phonetic inventory acquisition and phonological accuracy between monolingual and bilingual Mandarin-English populations, there are clear differences. Clinicians need to be aware that for Mandarin-English bilinguals, mastery of their phonologies is still a dynamic process even at 7;11 years. There are sounds in both their English and Mandarin phonologies that are mastered in a different sequence to monolingual norms. Additionally, phonological accuracy measures for both English and Mandarin are comparable to younger monolinguals, indicative of more speech sound errors than their monolingual age peers. Clinicians should also note that factors relating to language background and exposure (such as time in New Zealand, and language use in home environment) can impact on phonological accuracy. Effective clinical assessment and decisions should include a detailed case history of language background and exposure, as well as assessment of both English and Mandarin phonologies.

Chapter 4: Phonological Development of Mandarin-English bilinguals: Speech Error Patterns

Lee, T., Ballard, E. & Purdy, S. C. (In preparation). Phonological development of Mandarin-English bilinguals: speech error patterns

This publication is inserted as it will be submitted for publication, with the exception of minor edits and formatting changes to maintain consistency throughout the thesis.

Introduction

Demographic changes in recent years have seen continuous increases in the cultural and linguistic diversity in the population of predominantly English speaking countries (United States Census Bureau, 2012; Statistics New Zealand, 2014; Australian Bureau of Statistics, 2006). The proportion of bilingual and bicultural children and families has increased significantly (McLeod, 2011, 2014; Stow & Dodd, 2003) and this is an issue of growing importance for clinicians. Increasing diversity is progressively altering the caseload of speech and language therapists. There are increasing demands on clinicians to assess, diagnose and provide therapy for children and families that speak a language other than English (McLeod, Verdon & Bowen, 2013; McLeod, 2014). Providing equitable services for these culturally and linguistically diverse populations are beset by numerous difficulties that combine to significantly impact on all aspects of clinical practice from assessment and differential diagnosis to therapeutic interventions and goal setting (McLeod, 2014; McLeod et al., 2013).

This is particularly significant for children with speech sound disorders (SSD) as these are the most commonly referred and diagnosed developmental communication disorders through childhood and form a large portion of clinical caseloads and diagnosis depends on having an accurate understanding of typical speech development (McLeod & Verdon, 2014; McLeod & Harrison, 2009; Broomfield & Dodd, 2004; Law et al, 2000). SSD is an umbrella term which encompasses a heterogeneous group of speech sound difficulties children experience that are not attributed to sensory, motor or structural causes (Dodd, 2005; Flipsen, Bankson, & Bernthal, 2013; Shriberg, 1980; Shriberg et al., 2010; Stackhouse & Wells, 1997). Several different classification systems have been proposed to account for the heterogeneity observed in SSD, such as the psycholinguistic framework (Stackhouse & Wells, 1997), speech disorders classification system (Shriberg et al., 1997; Shriberg et al.,

2010), and the differential diagnosis system (Dodd, 2005). The differential diagnosis system (Dodd, 2005) is a commonly utilised classification system as its categories appear to be the most clinically workable. This classification system has also been shown to be applicable cross linguistically (Waring & Knight, 2013), and has been utilised with children who speak other languages, including Cantonese (So & Dodd, 1994) and Mandarin (Zhu & Dodd, 2000b). The differential diagnosis system described by Dodd (2005) divides SSD into four subgroups; articulation disorder, phonological delay, consistent phonological disorder, and inconsistent phonological disorder. It utilises speech error patterns to distinguish whether a child's phonological development is typical, delayed or disordered, and to determine which subgroup of SSD a child is likely to have. Speech error patterns, also known as phonological processes or phonological errors, are systematic differences between a child's productions of a given phoneme and the adult target (Peña-Brooks & Hegde, 2000; Zhu & Dodd, 2006a). The surface errors produced by children are representative of the underlying difficulties that may be present. Children with a phonological delay produce developmental error patterns that are typical of a younger age group. Children with phonological disorder produce error patterns that are atypical and/or non-developmental (Dodd, 2005).

For clinicians working with bilingual children with SSD, it is a challenging and complex process to extrapolate the possibility of disorder from language difference and possible interactions between languages, and to determine whether these children require intervention (Hemsley, Holm & Dodd, 2014; Zhu, 2002; Baker, 2006; Zhu & Dodd, 2006a). An understanding of the development and course of typical speech error patterns is a fundamental requirement for clinicians to interpret assessment data and differentiate between developmental errors, atypical or disordered errors, to determine whether there is an existing SSD and a need for intervention (Crais, 2011; Owens, 1999; Parkinson & Pate, 2000; Paul, 2012; McLeans et al., 2004). While the development and progression of typical speech error

patterns are well established for English, there is comparatively little information on languages other than English (Caesar & Kohler, 2007; Zhu 2002; Zhu & Dodd, 2006a; McLeod, 2011, 2014; Hoff et al., 2012, Hemsley et al., 2014; Williams & McLeod, 2012). This is further complicated by evidence in the literature that bilingual phonological development is both quantitatively and qualitatively different from monolingual development, following along differing developmental trajectories (Hambley, Wren, McLeod & Roulstone, 2013). Bilingual children often have comparable phonetic inventories to their monolingual peers but more speech error patterns, and these error patterns are not typically found with monolingual peers (Fabiano-Smith & Barlow, 2010; Gildersleeve-Neumann, Kester, Davis, & Pena, 2008; Gildersleeve-Neumann & Wright, 2010; Goldstein & McLeod, 2012; Hambly et al., 2013; Holm & Dodd, 1999; Holm, Dodd, Stow, & Pert, 1999; Law & So, 2006). As consistently reported in the literature, this may well be attributed to the interactions between the phonological systems being acquired (En, Brebner, & McCormack, 2014; Hambly et al., 2013; Hemsley et al., 2014; Paradis & Genesee, 1996). Interactions are bi-directional, with evidence in the literature indicating that the extent of the interactions may be dependent on the characteristics of the language pairing and on factors such as language dominance and (Hemsley et al., 2014; Law & So, 2006). That is to say, the divergence between the two phonological systems being acquired affects the extent of interactions between the two phonologies. Studies of Cantonese-English (Dodd, So, & Li, 1996; Holm & Dodd, 1999; Holm & Dodd, 2006), Korean-English (Anderson, 2004), and Samoan-English (Ballard & Farao, 2008) clearly indicate that there may be more variation and interactions between these typologically different language pairings than pairings that are more similar like Spanish-English (Fabiano-Smith & Barlow, 2010; Fabiano-Smith & Goldstein, 2010). Differential diagnosis for bilingual populations thus becomes a complex issue. Consequently

bilingual children are consistently over -, under- or misdiagnosed with SSD (Winter, 1999, 2001; Stow & Dodd, 2003).

These issues have particular relevance to a major language, which is surprisingly less explored in the literature, Mandarin. Mandarin has the largest native speaking population in the world (Zhu, 2006; Zhu & Dodd, 2000a) and is the most widely spoken language in the global context (Lewis, 2009). Like English, there are in fact several varieties of Mandarin, with differences in pronunciation, vocabulary and to some extent grammar (Duanmu, 2000). Mandarin is also commonly known as standard Mandarin, Chinese Mandarin, Putonghua, Zhongwen, Huayu and Guoyu, the terminology used being largely dependent on the country of origin. While Mandarin is the official language or one of the official languages in countries such as China, Taiwan, Singapore and Hong Kong, there are also significant overseas Mandarin communities in English speaking countries such as the US, UK, Canada, Australia and New Zealand (Australian Bureau of Statistics, 2006; Statistics New Zealand, 2014; United States Census Bureau, 2012).

Given the widespread use of Mandarin in English speaking countries, there is a significant need for normative information on typical speech sound errors of Mandarin-English bilinguals to support clinical diagnosis and decision making with SSD. Thus, the key purpose of this paper is to provide descriptive information on typical speech error patterns of Mandarin-English bilingual children. Information on this bilingual population remains underexplored in the literature, and to date, there has only been one study. Lin and Johnson (2010)'s study on 48 children aged 5 years is one of the only studies on Mandarin-English bilinguals. Lin and Johnson (2010) recruited 25 children from an English immersion preschool, learning English sequentially since 3 years old, and a comparison group of 23 monolingual Mandarin speaking children in Taiwan. Children in the English immersion preschool had Mandarin as the ambient language outside of school and as the main language

at home and the community. Children were assessed using the wordlist from Zhu (2000a) for their Mandarin speech sounds and the Goldman-Fristoe Test of Articulation 2 (Goldman & Fristoe, 2000) for their English speech sounds. Results showed that while bilingual children demonstrated high accuracy rates for phonological accuracy measures in English and Mandarin they also produced speech error patterns that were not found in monolingual peers.

While Lin and Johnson (2010) have provided us with some information about the speech error patterns of Mandarin-English bilinguals, it is restricted to one age range (5 year olds) and within a language context where Mandarin is the dominant language. Findings from this paper will present detailed information on the error patterns from a larger sample of children from a broader age range who are growing up in an English dominant environment in New Zealand.

In recent years, New Zealand has experienced unprecedented growth in the number of Mandarin speakers. Mandarin has become one of the six most common languages spoken in New Zealand. This is due to the growth in migration from China and other Mandarin speaking countries. The Chinese population now constitute 4.3% of the New Zealand population, and have grown 33% from 2006 to 2013 (total of 170, 664) (Statistics New Zealand, 2014). The number of Mandarin speakers has increased by 56% from the 2001 to 2006 census (to 41, 391 speakers), and a further 26% increase from the 2006 to the 2013 census (to 52, 263 speakers) (Statistics New Zealand, 2014). Not only are there increases in the total number of Mandarin speakers, there are also increases in the proportion of Mandarin speakers within this ethnic group with 25.27% of the ethnic Chinese group speaking Mandarin in 2001 growing to 30.62% in 2013. Given this context New Zealand provides a good context to explore children's speech error patterns in this population.

Methodology

Participants

Schools across Auckland, New Zealand were invited to participate, 30 schools consented, 6 schools did not have participants who met the inclusion criteria, the remaining 24 schools went on to participate in the current research. Participant information and consent forms were sent to participating schools. Teachers were asked to identify typically developing children with a Mandarin language background between 5;0 to 7;11 years. Information and consent forms were then sent home for caregivers to send through. Children (*n*=326) aged 5;0 to 7;11 years participated from 24 primary schools in Auckland, New Zealand (Table 13). The majority of the children were sequential bilinguals (98.77%) with Mandarin being the primary language spoken consistently at home and in the local community and English being the ambient language in the wider community, with most children exposed to English more consistently once at an early childhood centre, kindergarten or school. As the Mandarin speaking population in New Zealand is an immigrant population, there was also a small group of children that were exposed to an additional Chinese language in the sample, the most common being Cantonese (Table 14). Teachers were asked to check school hearing and vision records and parent reports determined all children were typically developing, had normal hearing and that there were no concerns regarding general development, cognitive or speech and language skills.

Table 15. *Normative sample by age*

Age group	n	Mean age	% of sample
5;0 – 5;5	57	5;2	17.48
5;6 – 5;11	59	5;7	18.10
6;0 – 6;5	53	6;2	16.26
6;6 – 6;11	53	6;7	16.26
7;0 – 7;5	50	7;2	15.34
7;6 – 7;11	54	7;8	16.56

Table 16. *Language background of participants*

Language background	n	% of participants
Mandarin	283	86.81
Mandarin + other Chinese language*	43	13.19

*most common other Chinese language was Cantonese

Mandarin and English phonologies

As readers may not be familiar with Mandarin, a comparison between Mandarin and English phonologies have been provided (Table 15). Mandarin has 22 consonants with aspiration as a distinctive feature; comparatively English has 24 consonants with voicing as the distinctive feature. There are nine shared consonants between English and Mandarin /p, t, k, m, n, ŋ, f, s, l/. Additionally English has voiced stops /b, d, g/, voiced fricatives /v, z/, interdental fricatives /θ, ð/, post alveolar fricative /ʃ, ʒ/, and affricates /tʃ, dʒ/ which do not occur in Mandarin. While Mandarin has fricatives /ʂ, ɕ, x/, a series of affricates /ts, tsʰ, tɕ, tɕʰ/, including retroflex affricates /tʂ, tʂʰ/, and a retroflex approximant /ɻ/ which are not present in English. The vowel systems for Mandarin and English differ in complexity. The Mandarin vowel system has five simple vowels, a set of three high vowels, a mid vowel, and a low vowel. The high vowels consist of the high front vowel /i/, the high back vowel /u/ and the high front rounded vowel /y/. The mid vowel has several variants [o, e, ə, ɤ, ɛ] as does the low vowel [ɑ, a, æ, ɐ]. There are many different suggestions for the phonemic representation of the mid and low vowels. The general consensus is /ə/ for the mid vowel and /A/ for the low vowel (Norman 1988, Duanmu 2007, Wan and Jaeger 2003). Mandarin also has more complex vowels, with nine diphthongs and four triphthongs. In contrast, the English system has twelve discrete monophthongs / i, ɪ, ɛ, æ, ʌ, a, ɒ, ɔ, ʊ, u, ɜ, ə/ and three diphthongs (Giegerich, 1992). In concert with the vowels, Mandarin is also a tonal language and has four lexical tones; high level tone (T1), high rising tone (T2), contour tone which falls then rises (T3), falling tone (T4). Mandarin syllable structure [C_{0-1}] V [C_{0-1}] is relatively

simple compared with the English syllable structure [C_{0-3}] V [C_{0-4}]. Unlike English, the Mandarin syllable structure restricts onset and coda to one consonant which prohibits consonant clusters. There are also restrictions on the coda consonant which is limited to the nasals /n, ŋ/.

Table 17. *Comparison between Mandarin and English phonologies*

	Mandarin	**English**
Tones	1 high level tone (T1) 2 rising tone (T2) 3 contour tone (T3) 4 falling tone (T4)	No tones
Consonants	p, p^h, t, t^h, k, k^h m, n, ŋ f, s, ʂ, ɕ, x ts, ts^h, tʂ, $tʂ^h$, tɕ, $tɕ^h$ l, ɻ	p, b, t, d, k, g m, n, ŋ θ, ð, f, v, s, z, ʃ, ʒ, h tʃ, dʒ l, ɹ j, w
Vowels	i, y, u, ə, A	i, ɪ, ɛ, æ, ʌ, a, ɒ, ɔ, ʊ, u, ɜ, ə
Consonant clusters	None	CC CCC
Syllable structure	[C_{0-1}] V [C_{0-1}]	[C_{0-3}] V [C_{0-4}]

Assessment

Mandarin phonological acquisition was assessed using the standard Mandarin word list from Zhu (2002)) as this was the most readily accessible. The word list comprises 44 items, 39 everyday nouns, 1 colour adjective and 4 common phrases, of which there are 17 monosyllabic and 27 multisyllabic items (26 disyllabic and 1 trisyllabic). It was administered as a picture naming test that targets all the consonants, vowels and tones of standard Mandarin. Seventeen additional test items were included in the word list to adapt the word list to a broader Mandarin speaking population (see Appendix 1 for items). All items were represented as high quality colour drawings on laminated A5 white cards. English phonological acquisition was assessed using the phonology subtest of the Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd et al., 2006). (Dodd, Zhu, Crosbie, Holm, & Ozanne, 2006). The phonology subtest was selected instead of the articulation

subtest as it contains a comparable coverage of English phonemes to the Mandarin wordlist for Mandarin phonemes. There are 50 test items compared with 30 in the articulation subtest. Additionally it samples a wider range of word shapes, including multisyllabic words, initial and final consonant clusters, and vowels in different words, and offers analysis of error patters (Dodd et al., 2006) (see Appendix 2 and 3 for frequency distribution of phonological features). Although both assessments have normative data associated, they were developed for monolingual populations and as such are not appropriate for use with bilingual populations. Thus, the assessments were used for descriptive analysis purposes.

Procedure

Mandarin and English phonological assessments were completed in two separate sessions. All children were assessed individually in a quiet space at their school by the first author, a trained speech-language therapist and native speaker of Mandarin. The assessment procedures outlined in the DEAP manual were followed (Dodd et al., 2006). Semantic or contextual prompts were provided if the child was unable to produce the target word. If a spontaneous production could not be elicited through prompts, the child was asked to imitate the target word. Imitated responses were then noted on the record form.

Children's productions were evaluated and scored in accordance to the Mandarin standard of their variety of Mandarin. Assessment results were transcribed live on site and all assessment sessions were also recorded on an Olympus WS-100 digital voice recorder. Ten percent of Mandarin and English samples were used to determine inter-judge agreement. One native Mandarin speaking speech language therapy student transcribed the Mandarin samples. Point by point transcription agreement was 98.79% for all phonemes. One native English speaking speech language therapist transcribed the English samples. Point by point transcription agreement was 99.02% for all phonemes.

Error patterns were identified through the assessments and following methodology and classifications set out in Zhu & Dodd (2000a) and Dodd et al. (2003), error patterns were recorded as typical if there were five examples of a particular error type, and 10% of the children in the same age group were found to make the same or similar errors in terms of place or manner of articulation (Appendix 4). Identified error patterns were further categorised into segmental or substitution error patterns (error patterns where one sound is substituted for another) and syllable error patterns (errors affecting the syllabic structure) (Bankson & Bernthal, 1998; Dodd, 1995).

Results

Segmental errors

Speech error patterns were recorded as age appropriate if more than 10% of children in a given age group produced the error pattern at least five times. The mean percentages of occurrence of English speech error patterns observed in Mandarin-English bilinguals across the age groups are summarised in Table 16. Most of the errors were centred on the dental fricatives /θ, ð/ and approximant /ɹ/. Additionally, final consonants were subject to stopping, unreleased and devoicing speech error patterns. English speech error patterns that were observed in less than 10% of the children in a given age group were also noted for comparative purposes. These included velar fronting, assimilation, deaffrication, affrication, retroflexion and omission of final consonants. None of these error patterns had a frequency occurrence of greater than 2% with the exception of omission of final consonants.
Mandarin error patterns were classified according to the methodology and classification system set out in Zhu and Dodd (2000a). Table 17 lists the Mandarin error patterns found in Mandarin-English bilinguals across the age groups. The most common error pattern observed was fronting which incorporated the substitution of the retroflex fricative /ʂ/ and affricates /tʂ, tʂ^{h}/, and the substitution of the alveolo-palatal fricative /ɕ/ and affricates /tɕ, tɕ^{h}/.

Additional error patterns, which occurred in less than 10% of the sample, were noted for comparative purposes. These included velar fronting, affrication, aspiration, deaspiration and assimilation, none with a frequency occurrence of greater than 1%.

Table 18. *English segmental error patterns percentage of children using these error patterns across age groups*

Error patterns (>10%)	Percentage of children using error pattern (%)						Most common error types
	5;0 – 5;5	5;6 – 5;11	6;0 – 6;5	6;6 – 6;11	7;0 – 7;5	7;6 – 7;11	
Fronting	35.76	30.15	27.12	27.52	31.42	22.10	Dental fricatives become labio-dental fricatives Post-alveolar fricatives and affricates become alveolar fricatives and affricates Velar nasal becomes alveolar nasal
Backing	33.18	29.02	23.50	25.77	23.57	27.14	Dental fricatives become alveolar fricatives
Stopping	45.80	45.75	37.54	34.36	38.83	31.02	Dental fricatives becomes stops Fricatives in final position becomes stops
Errors with /ɹ/							
Gliding	30.14	30.02	25.00	21.43	26.43	22.49	/ɹ/→[w]
[l] substitution	9.02	7.51	9.70	10.11	5.57	5.36	/ɹ/→[l]
Devoicing	28.58	17.65	24.68	21.04	13.38	12.54	Voiced stops in final position becomes voiceless
Unreleased	11.71	9.50	9.38	9.17	2.92	2.72	Final consonants becomes unreleased
Additional error patterns (<10%)							
Affrication	0.44	0.21	0	0.24	0.25	0	
Assimilation	1.39	1.20	1.31	0.71	0.67	0.62	
Deaffrication	2.05	0.85	0.94	0	0.33	0.62	
Velar fronting	1.26	0.14	0.42	1.08	0.20	0.08	
Retroflexion	0.28	1.39	0	0	0	0	
Deletion	8.58	4.28	2.59	0.91	1.48	0.21	Deletion of final consonant

Table 19. *Mandarin segmental error patterns and percentage of children using these error patterns across age groups*

Error patterns (>10%)	Percentage of children using error pattern (%)						Most common error types
	5;0 – 5;5	5;6 – 5;11	6;0 – 6;5	6;6 – 6;11	7;0 – 7;5	7;6 – 7;11	
Fronting	52.60	37.80	26.90	27.08	16.35	16.39	Retroflex fricatives and affricates becoming alveolars Alveolo-palatal fricatives becoming alveolars Alveolo-palatal affricates becoming post-alveolars
Backing	6.23	6.02	3.02	2.20	3.60	5.19	Alveolar affricates becoming post alveolars
Stopping	15.26	7.60	10.80	8.19	6.17	4.61	Fricatives becoming stops Affricates becoming stops
Errors with /ɻ/							
[l] substitution	17.54	23.73	16.98	12.26	18.00	14.81	/ɻ/→[l]
[z] substitution	4.39	5.08	2.83	0.94	3.00	2.78	/ɻ/→[z]
/ŋ/→[n]	15.55	14.64	9.80	8.91	7.72	9.77	
Additional error patterns (<10%)							
Assimilation	0.44	0.42	0.47	0	0	0	
Aspiration	0.47	0.42	0	0	0	0	
Affrication	0.44	0	0.26	0.07	0	0	
Deaspiration	0.91	0	0	0	0	0	
Velar fronting	0.22	0.11	0	0	0	0	

Syllabic errors

Speech sound errors affecting syllable structure summarised in Table 18. These syllable level error patterns were focused on English consonant clusters. There were no syllable level error patterns found in Mandarin across the age groups.

Table 20. *English syllable error patterns and percentage of children using these errors patterns across age groups*

	Percentage of children using error pattern (%)					
	5;0 – 5;5	5;6 – 5;11	6;0 – 6;5	6;6 – 6;11	7;0 – 7;5	7;6 – 7;11
Epenthesis	30.14	24.98	28.90	21.20	14.27	15.91
Cluster simplification	26.48	28.99	24.70	24.03	27.455	23.48
Cluster reduction	4.55	2.39	1.29	0.69	0.82	0.25
Unreleased*	3.51	2.70	3.09	3.00	1.18	0.25
Epenthesis and reduction	1.75	0.69	0.34	0.43	0.091	0.25

*unreleased final consonant in final clusters

Discussion

With increasing cultural and linguistic diversity in clinical population and evidence from the literature that bilingual phonological development follows a different developmental trajectory than monolinguals, normative data on specific bilingual populations are essential for clinical decision making with children with SSD. This is highlighted by evidence that bilingual phonological development in typologically different languages is often characterised by increased variation in speech errors and speech error patterns than typically found in monolingual norms. These differences can be attributed to the interaction between the phonological systems being acquired. Findings from the literature indicate that the extent of the interactions may be attributed in some part to the extent of the differences between the phonologies being acquired (Hambly et al., 2013; Hemsley et al., 2014; Law & So, 2006). Normative data on typical bilingual speech error patterns are then crucial for accurate diagnosis and effective therapeutic intervention for children with SSD. Lack of access to such information underlies the many challenges facing clinicians working with bilingual children

with SSD. The purpose of this study was to investigate the typical speech errors produced by 326 Mandarin-English sequential bilingual children aged between 5;0-7;11 years growing up in New Zealand.

Segmental errors

For Mandarin-English bilinguals in the present study, the most common segmental English speech error patterns were centred on the dental fricatives /θ, ð/ and approximant /ɹ/. Fronting, backing and stopping were the error patterns that occurred with the dental fricatives; where both the voiceless and voiced phonemes were replaced with labio-dental fricatives [f] and [v] respectively (fronting), voiceless dental fricative was replaced with the alveolar fricative [s] (backing), and the voiced dental fricative was replaced with the stop [d] (stopping). Error patterns occurring with the approximant were gliding and substitution to [l]. These error patterns were prevalent across the age groups and although the percentage of errors diminishes in older children, errors were still persistent at 7;11 years. It should be noted that language background appeared to exert an influence on the error types evident in the dental fricatives. For children with a Mandarin only background, the prevalence was for fronting, with the voiceless dental fricative being replaced by [f], whereas children with a Mandarin and an additional Chinese language background tended to use backing and replace the phoneme with [s]. As there were only a relatively small number of children with this background in the present study, further investigation is warranted.

Compared to monolingual norms, the observed error patterns would be classified as either significantly delayed, or atypical, since these errors, with the exception of gliding, are either suppressed much earlier in development, by 4;11 years, or absent in typical development (Dodd et al., 2003). The backing error pattern prevalent in the bilinguals is particularly notable as this is an unusual error pattern in monolingual English speakers (Ballard, Wilson, Campbell, Purdy, & Yee, 2011; Dodd et al., 2003). By contrast, the

fronting of the voiceless dental fricative is an emerging trend in New Zealand English (Gordon et al., 2004; Moyle, 2005) and this may play a part in the pervasiveness of this error in the bilingual sample. Additional error patterns noted in the bilingual sample were affrication, assimilation, deaffrication, velar fronting and retroflexion. Frequency occurrences for each of these error patterns did not reach above 2%, it is possible that these error patterns are resolving errors and may have been found in greater numbers in younger age groups. Further research with younger children is needed to verify this.

These findings are in contrast to those from Lin and Johnson (2010) on 25 Mandarin-English bilingual children aged 5 years, where it was reported that Mandarin-English bilinguals had no English segmental error patterns with a frequency of occurrence greater than 10%. There were similar error patterns noted with differing reports on the frequency of occurrences. English errors reported in Lin and Johnson (2010) were stopping of fricatives and affricates (3%). These discrepancies may be attributable to methodological differences with assessment and, classification and analysis of the error patterns. Although the use of speech error patterns is a common clinical analysis of phonological development, there are no set universal criteria on how error types are classified or counted (Miccio & Scarpino, 2008).

Other potential factors may include the heterogeneity of the population in the current study. While the children in the Lin and Johnson (2010) study potentially had exposure through more structured English immersion preschool programmes and were growing up in Taiwan, the children in our study had less of a structured exposure to English and were growing up in New Zealand. Additionally Lin and Johnson (2010) note that there were several vowel errors with their sample. Vowel errors were minimal across all age groups in the current study, possibly due to the English being the ambient language (Vihman, 2002).

In terms of Mandarin segmental error patterns, error patterns with a frequency occurrence of 10% or more for the current study were fronting and stopping. The stopping

error process fell below 10% by the age of 6;6 years. However, fronting was a prevalent error pattern that persisted across the age groups, and was still present, albeit reduced significantly, for children at 7;11 years. This is due to the broad classification adopted by Zhu and Dodd (2000a) where the fronting error pattern encompassed the replacement of the alveolo-palatal fricative /ɕ/ and affricates /tɕ, tɕ^{h}/ with alveolars and post-alveolars, as well as the replacement of the retroflex fricative /ʂ/ and affricates /tʂ, tʂ^{h}/ with their alveolar counterparts [s, ts, ts^{h}]. It is the errors with the retroflex fricatives and affricates that persists through to 7;11 years, as children clearly take a longer period to master these retroflex phonemes. In comparison with monolingual norms set out in Zhu and Dodd (2000)'s study on 129 monolingual Mandarin speakers, all these errors would be classified as delayed. However, it should be noted that a direct comparison was difficult given that these norms were based on a younger cohort (1;6 to 4;6 years), and phoneme mastery was assumed for children over 4;6 years.

Results were again in contrast to Lin and Johnson (2010)'s findings with their Mandarin-English bilingual sample, there were no Mandarin segmental errors with a frequency occurrence greater than 2% with the exception of deretroflexion, deaffrication and y-deviation. Lin and Johnson (2010) stated that these errors were not statistically significant and the higher prevalence rates were most likely due to the small number of test stimuli in their assessment. The comparatively extended period of mastery for the retroflex phonemes with the current study could be attributed to the exposure and influence of a broader Mandarin speaking community in New Zealand. Being an immigrant population, the Mandarin speakers in the community originate from a wide range of Mandarin speaking countries such as Singapore, Malaysia, Taiwan, China and Hong Kong. Children are then exposed to an array of different varieties of Mandarin, most of which do not have the same distinction between retroflex fricative and affricates /ʂ, tʂ, tʂ^{h}/, and alveolar fricative and

affricates /s, ʦ, ʦʰ/ as Mandarin spoken in the northern region of China (Duanmu, 2000, 2007; Norman, 1988; Sun, 2006).

Other error patterns of note were the patterns associated with the approximant /ɻ/ and velar nasal /ŋ/. The approximant was often produced as [l] or [z], and the velar nasal replaced with [n]. These errors were persistent across age groups. However, this may again be attributed to the heterogeneity of the population in the current study as well as the allophonic nature of the approximant and the velar nasal in some varieties of Mandarin (Duanmu, 2000, 2007; Norman, 1988; Sun, 2006).

Additionally, Mandarin error patterns of assimilation, aspiration, affrication, deaspiration and velar fronting, which are present in monolingual Mandarin speakers (Zhu & Dodd, 2000a) were also noted in the current bilingual sample. None of these error patterns had frequency occurrences of 1%, and all the errors are suppressed by 6;0 years.

Syllabic errors

Error patterns affecting syllable structure was noted for English only and focused around consonants in coda position and consonant clusters. Error patterns that were isolated to the final consonant were stopping, unreleasing and devoicing. For this error group, the frequency of occurrence of stopping and unreleasing the final consonant is above 10% in the 5;0-5;5 age group only. Devoicing of the final consonant reduced with age but was still evident at 7;11 years. Deletion of the final consonant was also still prevalent in the 5;0-5;5 age group but did not occur 10% or more of the time. Presence of these final consonant errors is potentially due to the phonotactic differences between English and Mandarin. Mandarin is highly restrictive with word final consonants, only allowing for the nasals /n, ŋ/ (Duanmu, 2000, 2007; Norman, 1988). Moreover, simplification of English final consonants is a common strategy with speakers of other languages with similar phonotactic constraints (such as Spanish) learning English (Gildersleeve-Neumann, Kester, Davis, & Pena, 2008) and by

adult Mandarin-speaking learners (Broselow, Chen, & Wang, 1998). There were similar patterns noted on the Mandarin-English bilinguals from Lin and Johnson (2010) although the errors appeared to be resolving, these included: final consonant deletion 9.95%, final consonant devoicing 7.27%, and syllable reduction 4.45%.

Main error patterns occurring with consonant clusters were epenthesis and cluster simplification. Although a reduction in occurrence frequency was observed across the age groups, with older children less likely to produce these errors, these were still prevalent by 7;11 years. Cluster reduction, although this did not reach more than 10%, was another common error pattern observed in the 5;0-5;5 age group; this was mainly on three element clusters. In comparison to English monolinguals, these errors would be considered either delayed (for cluster reduction and simplification) or atypical (for epenthesis). The commonality of these speech error patterns for this population can be attributed to the phonotactic differences between Mandarin and English syllable structure. In comparison to English, Mandarin syllable structure is simpler and more restrictive as it does not allow for consonant clusters in either initial for final position (Duanmu, 2007; Sun, 2006). Epenthesis in particular can be viewed as a strategy to transform English consonant clusters into a structure that conforms to Mandarin syllabic rules. Additionally, consonant cluster acquisition has been reported as one of the most prolonged aspects of children's speech development, with some clusters not fully mastered until the age of 8;0 in typically developing children (McLeod, van Doorn, & Reed, 2001; Phoon, Maclagan, & Abdullah, 2015; Smit et al., 1990).

In summary, the Mandarin-English bilinguals in the present study, when compared with monolingual norms, had both typical and atypical errors. The typical errors would be classified as delayed as they are found with younger monolinguals while error patterns that were atypical are not found in monolinguals for either language. The phonological

development of these Mandarin-English bilinguals is qualitatively different from monolinguals. Results of the present study were comparable to such studies as Cantonese-English (Dodd, So, & Li, 1996; Holm & Dodd, 1999; Holm & Dodd, 2006), Korean-English (Anderson, 2004), and Samoan-English (Ballard & Farao, 2008). Findings support that there may be more variation and interactions between the phonologies of language pairings that are more typologically different (Anderson, 2004; Hambly et al., 2013). Findings also support that interactions between phonologies may be bidirectional, and that the ambient language plays a role with phonological acquisition (Hambly et al., 2013; Hemsley et al., 2014). For Mandarin-English bilinguals in the current study as compared to Mandarin for Lin and Johnson (2010)'s study, there were many overlapping speech error patterns but clear differences with the frequency of occurrences of these error patterns. Several Mandarin error patterns were still prevalent in the current findings up to the age of 6;6 years and 7;11 years whereas these errors appeared to be suppressed by 5 years in Lin and Johnson (2010)'s bilingual sample. Additionally, Lin and Johnson (2010)'s sample had English vowel errors that were not evident in the current findings. These differences may be attributable to the differing dominant language context the children were exposed to and growing up in.

Clinical implications

Findings from this study provide important information on typical speech sound error development for clinicians working with Mandarin-English bilingual populations. In working with bilingual children, it is essential that clinicians are able to clearly distinguish between typical phonological development and disorder. Accurate differential diagnosis and therapeutic intervention hinges on comparisons with a normative data set that has been provided here. Access to normative data on speech sound error patterns specific to the population is essential as common clinical practice utilises these error patterns to determine not only whether a child has SSD but also the subgroup of SSD. The descriptive data from

this study indicate that for Mandarin-English bilingual children, prevalence of speech error patterns in both English and Mandarin do resolve as children mature, with reductions in frequency occurrence for all error patterns in older children. However, the prevalence of some error patterns such as those centred on language specific sounds (English dental fricatives, approximant and final consonants; Mandarin retroflex sounds), suggest that bilinguals take longer to resolve these errors. Additionally, although there are some overlaps in the speech error patterns in monolingual and bilingual populations, there are distinct differences, with the presence of error patterns specific to this bilingual population. There are error patterns that would be classified as delayed and error patterns that would be classified as atypical in comparison to monolingual norms. These results highlight that comparison of a bilingual child's phonological development, particularly their speech error patterns to that of monolingual development could lead to misdiagnosis and have implications on the effectiveness of therapeutic intervention.

Chapter 5: Overall Discussion

This concluding chapter summarises the main findings in the cross sectional study undertaken for this doctoral thesis, describes the implications for clinical practice, and suggests directions for future research.

Working with Mandarin-English bilingual children in clinical settings

Chapter 2 details general linguistic and cultural characteristics of the Mandarin-English bilingual population and the implications these characteristics have for clinicians working with this population. This chapter may serve as a guide for clinicians working with Mandarin-English bilinguals in a clinical setting. It raises awareness of the impact cultural and linguistic differences can have on clinical practice with Mandarin-English bilingual children and families. The practical considerations provided are intended to support clinicians to develop a more effective clinical partnership with children and families from this background.

Based on the framework on cultural characteristics provided by Hwa-Froelich and Vigil (2004), Mandarin speaking populations generally have a collectivist outlook and value interdependence, and have tendencies to be formal and less explicit. For these types of cultures, family relations are integral and group well-being is considered over individual wishes with decision making. The core family unit tends to be much larger, incorporating members of the extended family, which also have a significant role in daily family life. Family structure tends to be hierarchical. Elders in the family are accorded status and respect as such they, alongside male family members, often have a crucial role in family decision making. Parent interactions with children are more directive, which allows for few play type interactions. There is also a reliance on nonverbal behaviours and indirect language is often used to avoid direct conflict.

An awareness of these cultural characteristics is important for clinicians in their interactions with families in order to build a successful therapeutic relationship and facilitate

effective intervention. In engaging with the children and families, care needs to be taken with the interpretation of actions and nonverbal signals as these are particularly culturally sensitive (Gudykunst et al., 1996; Hwa-Froelich & Vigil, 2004). A clear understanding is better reached through discussion rather than assumptions based on nonverbal signals. Consideration also needs to be given to family dynamics and the need to include extended family members in any decision making. Additionally, clinicians need to be aware of the family's views on disability and expectations for therapy outcomes. Often the view on disability is negative and it is seen as something that can be 'cured' given clear guidelines on how to address the 'problem'(Westbrook, Legge, & Pennay, 1993). Box 1 and 3 provides specific details on these considerations in interactions with families.

In terms of linguistic considerations that clinicians need to be aware of is that, like English, there are in fact several varieties of Mandarin, each with differences in pronunciation, vocabulary and to some extent grammar (Duanmu, 2000, 2007). Therefore, it is important for clinicians to determine the variety of Mandarin a child and family speaks. This can have implications for the assessment interpretation and subsequent intervention. Clinicians also need to be aware of the characteristics of Mandarin phonology, its differences with English phonology and the differences between bilingual and monolingual phonological development. The following chapters delve into the linguistic considerations in more depth.

Phonetic inventory

Findings from Chapter 3 indicate that for Mandarin-English bilinguals, mastery of English and Mandarin speech sounds are not yet fully complete at 7;11 years. By 5;0 years, 90% of bilingual children were able to articulate most sounds of both phonologies. Findings also indicate that the sequence of sound acquisition for Mandarin-English bilinguals generally follows previous normative monolingual studies for English and Mandarin, with the exception of the English post-alveolar fricatives /ʃ, ʒ/, dental fricatives /θ, ð/, voiced affricate

/dʒ/ and central approximant /ɹ/ (Dodd et al., 2003), and the Mandarin affricates /ts, ts^h, tɕ, $tɕ^h$, tʂ, $tʂ^h$/ (Zhu & Dodd, 2000a; Zhu, 2002). Bilingual children acquired the English post-alveolar fricatives /ʃ, ʒ/ and voiced affricate /dʒ/ by 5;6 years, but their dental fricatives /θ, ð/ and the central approximant /ɹ/ are still developing as late as 7;11 years. Bilinguals were still distinguishing between Mandarin affricates /ts, ts^h, tɕ, $tɕ^h$, tʂ, $tʂ^h$/ at 5;6 years and mastered the distinctions between the Mandarin affricates by 6;6 years. There were slight differences with the order of acquisition of some English and Mandarin sounds between the bilinguals in the current study and monolingual norms (Dodd et al., 2003; Zhu & Dodd, 2000a). The English post-alveolar fricatives /ʃ, ʒ/ and voiced affricate /dʒ/ were mastered in reverse order in comparison to monolinguals, and the Mandarin alveolo-palatal affricates /tɕ, $tɕ^h$/ were mastered later than alveolar affricates /ts, ts^h/ with the palatal fricative /ɕ/ and approximant /ɻ/ the last sounds to be mastered. These differences in acquisition between monolingual and bilingual sound mastery are suggestive of a differing acquisitional trajectory for bilinguals.

Sounds mastered later or that were still in the process of being mastered in the bilingual children were unique to English and Mandarin phonologies, found only in English or only in Mandarin. The differences in the order of sound mastery may be attributable to interactional effects well documented in the bilingual phonological acquisition literature (Dickinson et al., 2004; Fabiano-Smith & Barlow, 2009, 2010; Gildersleeve-Neumann et al., 2009; Goldstein & Bunta, 2012; Kim, 2009; Lopez & Greenfield, 2004). Mastery of the English affricate before the post alveolar fricatives may be linked to the fact that Mandarin has significantly more affricates. Likewise, the mastery of Mandarin alveolar affricates /ts, ts^h/ before palatal consonants could well be related to the greater number of consonants in the alveolar region in English.

Phonological accuracy

For Mandarin-English bilinguals, phonological acquisition was still a dynamic process at 7;11 years. Thus, in comparison to monolingual norms, bilinguals have an extended period of sound mastery. This is reflected in the phonological accuracy measures (PCC, PVC, PPC), in comparison to monolinguals. Phonological accuracy for these bilingual children was comparable to younger monolinguals for both English and Mandarin. English monolingual accuracy measures as reported by Dodd et al. (2003) showed that by 7;0 years children achieved 95.86% PCC, 99.19% PVC and 97.03% PPC. For bilingual English accuracy at the same age, children in the current study achieved lower accuracy, especially for consonants (89.47% for PCC, 98.00% for PVC and 92.51% for PPC). Monolingual Mandarin accuracy measures from Lin and Johnson (2010) showed that by 5;0 children achieved 97.17% for PCC and 99.02% for PVC. For bilingual Mandarin accuracy at the same age, children in the current study achieved 84.85% for PCC and 99.65% for PVC. This is indicative of the fact that ambient language environment does have an impact on the children's first language. Unfortunately there were no phonological accuracy measures reported in the cross sectional study on Mandarin monolinguals by Zhu and Dodd (2000a) and as such no comparisons could be made with this cohort.

Factors impacting on phonological accuracy

Possible links between demographic factors (Tables 5 to 7, Chapter 3) and phonological accuracy measures were examined through multiple linear regression. As expected, results from the analyses revealed that age was a significant factor. This is reflected in the clear progression in accuracy percentages for all phonological accuracy measures (PCC, PVC, PPC, and Mandarin tones) for both English and Mandarin across the six month age groups from 5;0 through to 7;11 years. Significant differences were found between age

groups across all English phonological measures and for Mandarin PCC and PPC. There were no significant age differences for Mandarin PVC and tones due to ceiling effects.

There were varying results for gender and SES with results indicating that gender was only a significant factor for English PCC, where girls (mean=85.77%) were more accurate than boys (mean=84.99%). SES was not a significant factor for any of English or Mandarin phonological accuracy measures. This may have been due to the limited range of SES represented in the current study with most children from a high SES area. This is a limitation of the current study and an area for future research. Of more interest were factors relating to exposure and language use. In general, more exposure led to better accuracy. Children who spent more time in New Zealand had higher percentage scores across all English phonological accuracy measures, and those with families that used mainly Mandarin in the home environment were more accurate for Mandarin PCC and PPC percentages compared with those who used a combination of Mandarin, English and other Chinese languages. Additionally, children with a Mandarin-English only background were more accurate with English PCC and PPC compared with children with a Mandarin-English and other Chinese language background.

Speech sound errors

Chapter 4 reported on the typical speech error patterns of Mandarin-English bilinguals. Results showed that when compared with monolingual norms, Mandarin-English bilinguals had error patterns that would be classified as delayed and or atypical in monolinguals for either language. The most common segmental English speech error patterns were fronting, backing and stopping of the dental fricatives /θ, ð/, and gliding and substitution of the approximant /ɹ/. The voiceless and voiced phonemes were replaced with labio-dental fricatives [f] and [v] respectively (fronting), voiceless dental fricative was

replaced with the alveolar fricative [s] (backing), and the voiced dental fricative was replaced with the stop [d] (stopping). Language background appeared to exert an influence on the error types, which was evident in the dental fricatives. For children with a Mandarin only background, the main error prevalence was for fronting, whereas children with a Mandarin and an additional Chinese language background tended to use backing. As there is only a relatively small number of children with this background in the present study further investigation into this is warranted in future research. These error patterns were prevalent across the age groups and were still persistent at 7;11 years. Compared to English monolingual norms, these error patterns would be classified as either significantly delayed, or atypical (Dodd et al., 2003). The backing error pattern prevalent in the bilinguals is particularly notable as this is an unusual error pattern in monolingual English speakers (Ballard, Wilson, Campbell, Purdy, & Yee, 2011; Dodd et al., 2003). Additional error patterns noted in the bilingual sample were affrication, assimilation, deaffrication, velar fronting and retroflexation, however, frequency occurrences for each of these error patterns did not reach above 2%. It is possible that these error patterns are resolving errors and may have been found in greater numbers in younger age groups. Further research with younger children is needed to investigate this.

The most common Mandarin segmental errors were fronting and stopping. The stopping error pattern was suppressed by the age of 6;6 years. However, fronting was a prevalent error pattern that persisted until 7;11 years. This is due to the broad classification adopted by Zhu and Dodd (2000a) where the fronting error pattern encompassed the replacement of retroflex fricatives and affricates /ʂ, tʂ, tʂ^{h}/ with their alveolar counterparts /s, ts, ts^{h}/. It is the errors with the retroflex fricatives and affricates that persisted through to 7;11 years. Bilingual children clearly take a longer period to master these retroflex phonemes. In comparison to Mandarin monolingual norms (Zhu & Dodd, 2000a; Lin & Johnson, 2010), all

these errors would be classified as delayed. This could be due to the influence of a broader Mandarin speaking community since the Mandarin community in NZ is an immigrant population and children are then exposed to a number of different Mandarin varieties, most of which do not have the same distinction between retroflex fricative and affricates /ʂ, tʂ, tʂ^{h}/, and alveolar fricative and affricates /s, ts, ts^{h}/ as Mandarin spoken in the northern region of China (Duanmu, 2000, 2007; Norman, 1988; Sun, 2006). Other error patterns were substitutions of the approximant /ɻ/ with [l] or [z], and the velar nasal /ŋ/ replaced with [n]. These errors were persistent across all age groups. The persistence of these errors may not necessarily be an error given the allophonic patterning for the approximant and the velar nasal in some varieties of Mandarin (Duanmu, 2000, 2007; Norman, 1988; Sun, 2006). Additionally, Mandarin error patterns of assimilation, aspiration, affrication, deaspiration and velar fronting, which were present in monolingual Mandarin speakers (Zhu & Dodd, 2000a), were also noted in the current bilingual sample. None of these error patterns had frequency occurrences of greater than 10%, and all the errors were suppressed by 6;0 years, indicating that these may be resolving errors. Further research with younger children is needed to verify this.

In addition to these segmental errors, Mandarin-English bilinguals also had error patterns affecting the English syllable structure. These syllabic error patterns were isolated in consonant clusters and consonants in coda position. Main error patterns evident with consonant clusters were epenthesis and cluster simplification, which were still prevalent at 7;11 years. Error patterns observed in the final consonant were stopping, lack of unrelease and devoicing. For this error group, the frequency of occurrence of stopping and lack of release of the final consonant was above 10% in the 5;0-5;5 age group only. Devoicing of the final consonant reduced with age but was still evident at 7;11 years. Deletion of the final consonant was also still prevalent in the 5;0-5;5 age group but did not occur 10% or more of

the time. Compared to English monolinguals, these errors would be considered either delayed (cluster reduction and simplification, devoicing, stopping) or atypical (epenthesis, lack of release). The prevalence of these syllabic errors is potentially due to the phonotactic differences between English and Mandarin syllable structure. In comparison to English, the Mandarin syllable structure is more restrictive and does not allow for consonant clusters and restricts the final consonant to the nasals /n, ŋ/ (Duanmu, 2000, 2007; Norman, 1988).

Findings from the present study indicate that bilingual Mandarin-English and monolingual phonological development in these languages are quantitatively and qualitatively different. The findings are consistent with the view that there may be more variation and interactions between the phonologies of language pairings that are more typologically different (Anderson, 2004; Ballard & Farao, 2008; Dodd, So, & Li, 1996; Gildersleeve-Neumann & Wright, 2010; Hambly et al., 2013; Holm & Dodd, 1999; Holm & Dodd, 2006).

Clinical implications

Findings of this thesis provide essential information for clinicians working with the Mandarin-English bilingual population with suspected SSD. Accurate differential diagnosis and therapeutic intervention hinges on comparisons with a relevant normative data set. Descriptive data provided through this thesis is a step towards establishing a normative data set and will help support differential diagnosis and guide therapeutic intervention for this population. These results highlight that a direct comparison of a bilingual child's phonological development to that of monolingual norms could lead to misdiagnosis and have implications for the choice and the effectiveness of therapeutic intervention. For the Mandarin-English bilinguals studied here, mastery of their phonologies was still a dynamic process even at 7;11 years. In terms of phonetic inventory, clinicians need to be aware that although there are many similarities between acquisition of sounds in monolinguals and

bilinguals there are also subtle differences. Some English and Mandarin sounds were mastered in a different sequence, specifically the English post-alveolar fricatives and voiced affricate, and the Mandarin alveolo-palatal affricates, palatal fricative and approximant. Additionally, the phonological accuracy measures for both English and Mandarin were comparable to findings reported in the literature for younger monolinguals, indicating a greater quantity of speech sound errors than their monolingual age-matched peers. It should also be noted that the results reported in the literature for monolingual Mandarin speaking children tend to be more homogenous and are not immigrant populations as is the Mandarin population from New Zealand, and thus the comparison with the bilinguals from the current study should consider the possibility of other factors that may have contributed to the differences such as differences in the variety of Mandarin.

There are more speech error patterns for this population. These include error patterns that overlap with error patterns found in monolingual norms, and also error patterns that would be classified as delayed and error patterns that would classified as atypical. Many of these speech error patterns do reduce and resolve as bilingual children mature. However, there were some error patterns that took longer to be suppressed. These tended to be error patterns centred on language specific sounds (English dental fricatives, approximant and final consonants; Mandarin retroflex sounds), or due to differences between the phonotactic properties of the two phonologies (epenthesis, cluster simplification, final consonant errors).

Clinicians should also note that factors relating to language background and exposure (such as time in New Zealand, and language use in home environment) can impact on phonological accuracy. Effective clinical assessment and decisions should start with a detailed case history exploring language background and exposure, as well as assessment of both English and Mandarin phonologies.

Future directions

There are some limitations in the present study that should be addressed with future research. As noted above, there were a number of additional English and Mandarin error patterns that appeared to be resolving by 5;0 years. Further research with younger bilinguals would provide more information on whether these are in actuality typical error patterns for this population, and provide more detailed information on developmental trajectory. Additionally, language background seemed to have an impact on the type of errors made with the English voiceless dental fricative. Thus future studies incorporating a larger number of children with a Mandarin and other Chinese language background, particularly Cantonese, to further investigate this is warranted. Further research is also needed on the connected speech of these Mandarin-English bilinguals as the current sample is based on assessments that utilise single word naming. Future research might also incorporate families from a wider range of SES backgrounds to determine whether this is a wider contributing factor to bilingual phonological development, as the current study only had a limited range of SES backgrounds.

Case studies on Mandarin-English bilinguals with identified subtypes of SSD should also be a future focus. These case studies can help provide specific descriptive characteristics of different types of SSD and be used to develop clinical guidelines for differential diagnosis purposes for this population. Furthermore, the adapted Mandarin wordlist and its associated assessment and scoring process should be developed further for widespread clinical use.

Closing remarks

Mandarin-English bilinguals are an underexplored population in the bilingual phonological development literature. This study provides clear evidence that bilingual phonological development is distinctly different from monolingual development. Mandarin and English are typologically different languages which is likely to have contributed to the

significant differences found. There are growing Mandarin speaking communities in English speaking countries and high prevalence of SSD in childhood, hence the topic is an important one for many countries and there is a significant clinical need for normative data. This study is the first of its kind on the phonological development of school-aged Mandarin-English bilingual children 5;0 to 7;11 years. Findings from this study add to the understanding of Mandarin-English bilingual phonological development and to the wider body of literature on bilingual phonological development. Findings also can be used as a clinical guide to support clinicians to work effectively with this bilingual population, to optimise differential diagnosis, effective therapeutic intervention and clinical decision making.

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Appendices

Appendix 1

List of Mandarin test items

	IPA	English gloss		IPA	English gloss
1	pi2 tsi0	nose	32	(ɕiɑo3) tɕʰi4 tʂʰɤ(ɹ)1	car
2	ɚ3 tuo0	ear	33	tɕʰiou2	ball
3	tsueɪ3	mouth	34	kɑŋ1 tɕʰin2	piano
4	ʂou3 tʂi3	finger	35	ny3 xæ(ɹ)2	girl
5	tʰou2 fA0	hair	36	nan2 xæ(ɹ)2	boy
6	tɕiɑo3	foot	37	xɯŋ2 sɤ4	red
7	ɕiɛ2 tsi0	shoe	38	ɑi4 ɕin1	heart
8	tɕʰyn2 tsi0	skirt	39	ɕiɛ4 ɕiɛ0	thank you
9	pʰiŋ2 kuo3	apple	40	tsæ4 tɕiɛn4	goodbye
10	ɕi1 kua0	watermelon	41	kuən(ɹ)4 tsi0	stick
11	ɕiɑŋ1 tɕiɑo1	banana	42	ʂu1	book
12	ɹou4	meat	43	tɕia1 tsi0	clip
13	(ʂu1) tsʰæ4	vegetable	44	yan2 tɕʰyan(ɹ)1	circle
14	uan(ɹ)3	bowl	45	tiɛn4 ʂ4	TV
15	kʰuæ4 tsi0	chopsticks	46	kuo4 niɛn2	Chinese New Year
16	tɑo1 (tsi0)	knife	47	kʰu1	cry
17	tʂuo1 tsi0	table	48	kuo3 tʂ1	juice
18	ʂueɪ3	water	49	niou2 næ3	milk
19	ɕi3 liɛn3	wash face	50	pʰao4 pʰao4	bubble
20	ʂua1 iA2	brush teeth	51	niŋ2 mʊŋ2	lemon
21	tʂʰuɑŋ2	bed	52	miɛn4	noodles
22	mən(ɹ)2	door	53	iɑŋ2 tsʰʊŋ1	onion
23	təŋ1	light	54	tʰiɛn1 ɜ2	swan
24	y3 san3	umbrella	55	xu2 tiɛ2	butterfly
25	tʰæ4 iɑŋ0	sun	56	kuæ4 u4	monster
26	yɛ4 liɑŋ0	moon	57	ɕyʊŋ2	bear
27	ɕiŋ1 ɕiŋ(ɹ)0	star	58	piŋ3 kɑn1	biscuit
28	xuA(ɹ)1	flower	59	mi4 fʊŋ1	bee
29	niɑo(ɹ)3	bird	60	in1 yɛ4	music
30	ɕyʊŋ2 mɑo(ɹ)1	panda	61	ɕyɛ2 ɕiɑo4	school
31	fei1 tɕi1	plane			

Appendix 2

Frequency distribution of phonological features in the phonological section of the DEAP (Dodd et al., 2002)

Consonant (24 in total)	Frequency		Syllable (syllable shape)	Frequency
	Syllable initial	Syllable final		
p	1	3	V	4
b	4	1	CV	26
t	6	3	VC	2
d	2	1	CVC	24
k	4	3	CCVC	9
g	1	3	CVCC	2
m	2	2	CCV	5
n	1	5	CCVCC	2
ŋ	-	4	CCCVC	1
f	4	2	CCVCCC	1
v	1	2	CCCV	2
θ	1	2	**Number in word**	
ð	2	0	1 syllable	27
s	3	5	2 syllables	20
z	2	2	3 syllables	2
ʃ	2	2	4 syllables	1
ʒ	-	-	**Initial consonant clusters**	
tʃ	1	1	Plosive + approximant	9
dʒ	1	2	Fricative + approximant	2
l	5	2	/s/ + approximant	1
ɹ	3	-	/s/ + plosive	3
w	2	-	/s/ + nasal	1
j	1	-	/s/ + plosive + approximant	3
h	2	-		

Appendix 3

Frequency distribution of phonological features in the adapted Mandarin word list

Consonant (22 in total)	**Frequency**		**Tones**	**Frequency**
	Syllable initial	**Syllable final**		
p	2	-	Tone 1	24
p^h	3	-	Tone 2	26
t	5	-	Tone 3	18
t^h	3	-	Tone 4	21
k	8	-	**Syllable**	**Frequency**
k^h	2	-	**(syllable shape)**	
m	5	-	V	8
n	7	17	C	2
ŋ	-	17	CV	61
f	3	-	VC	5
l	2	-	CVNasal	31
ɻ	1	-	**Number in word**	
x	5	-	1 syllable	15
s	1	-	2 syllables	45
ts	2	-	3 syllables	1
ts^h	2	-		
ɕ	12	-		
tɕ	5	-		
$tɕ^h$	5	-		
ʂ	5	-		
tʂ	3	-		
$tʂ^h$	2	-		

Appendix 4

Mandarin IPA symbols used

Mandarin consonants		**Mandarin vowels**	
IPA	Description	IPA	Description
p	Voicelss bilabial plosive	i	High front unrounded vowel
p^h	Voiceless aspirated bilabial plosive	u	High back rounded vowel
t	Voiceless alveolar plosive	y	High front rounded vowel
t^h	Voiceless aspirated alveolar plosive	o	Mid back rounded vowel
k	Voiceless velar plosive	e	Mid front unrounded vowel
k^h	Voiceless aspirated velar plosive	ə	Mid central unrounded vowel
m	Bilabial nasal	ɤ	Mid back unrounded vowel
n	Alveolar nasal	ɛ	Mid front unrounded vowel
ŋ	Velar nasal	ɑ	Low back unrounded vowel
f	Voiceless labio-dental fricative	a	Low front unrounded vowel
s	Voiceless alveolar fricative	æ	Low front unrounded vowel
ʂ	Voiceless retroflex fricative	ɒ	Low back rounded vowel
ɕ	Voiceless alveolo-palatal fricative	ɚ	Retroflex vowel
x	Voiceless velar fricative		
l	Alveolar lateral approximant		
ɻ	Retroflex approximant		
ts	Voiceless alveolar affricate		
ts^h	Voiceless aspirated alveolar affricate		
tʂ	Voiceless retroflex affricate		
$tʂ^h$	Voiceless aspirated retroflex affricate		
tɕ	Voiceless alveolo-palatal affricate		
$tɕ^h$	Voiceless aspirated aveolo-palatal affricate		

Appendix 5

Semi structured interview format

Language history and background information

Parents' name/s:_____

Child's name: _____ Date: _____

Date of birth: _____ Age: _____

Address: _____ Contact numbers: _____

School: _____

Birth and early Infancy – complications (prematurity/traumatic birth…etc)
___出生时一切都顺利吗？（早产，生产时是否有任何困难？）

Developmental milestones – motor/speech/toileting (any delays or concerns)
____ 进长过程一切都顺利吗?跟一般的孩子发展速度一样吗？(走路，语言)

Health (hearing, vision, illness and accidents) – grommets/hospitalizations…etc
____是否生过大病？住院过？有过意外？是否有其它器官的问题？（眼睛，耳朵）

Schooling
Did child attend kindergarten (in NZ or elsewhere and how long for……)
____是否有念过幼儿园？在哪个国家？多长时间？

Kindergarten environment (language in kindy/language of other children in kindy)
幼儿园用什么语言？其它小朋友说什么语言

Schooling (in NZ or elsewhere and for how long, in what language…)
____在其它国家有念过小学吗？多长时间？在新西兰年了几年的小学？

Does child attend language school – content + frequency + how long they have been going for
_____是否在新西兰有补习中文/其它语言？

Personality (interests/interaction style…e.g. shy/outgoing, like reading or sports)
可以跟我说说_____ 的个性吗？（开朗，活泼，内向）

Family
Where family is from
您们一家是从哪个国家移民到新西兰来的？

How long child and family have been in NZ + do they go back for holidays (how long for/schooling)
您们来了多久？是否有回国渡假过？读书过？

Family members at home – immediate family/extended family….
您家里成员有谁 （爷爷，奶奶）

Siblings + relationship with siblings
____和兄弟姐妹相处得好吗？

Language and language use
Languages spoken at home –
language parents use with child
您和丈夫/太太通常用什么语言跟____沟通？

language siblings use
兄弟姐妹通常用什么语言和_____沟通？

language other members of the family use with the child
其他家属用什么语言跟_____沟通？

who interacts most with the child
在家里是谁最经常跟_____沟通？

language dialects spoken at home
在家里有说其它方言吗？

language fluency of family members
在家里您们通常是用什么语言跟互相沟通？

哪一种语言是您最能掌控的？最习惯用的？

其它家属呢？

Language use in different functions (with child and by child)

talking to parents
____通常用什么语言跟您们沟通？

talking to siblings
跟兄弟姐妹？

talking to family friends
跟你们的朋友？（比如你们的朋友来到家里做客，_____是用什么语言招呼他们）

Language use in different domains (with child and by child)

At school – does the child attend ESOL, talking to friends/other children at school
____在学校通常用什么语言跟学校的朋友沟通？有上英文补习班吗？

When out with the family (e.g. shopping/dinner etc)
____跟您们出去时（逛街，吃饭，去见亲戚时）通常用什么语言？

Does family go to church (in mandarin)
您们有带____参与华人的教会吗？

Activities with friends
_____爱跟朋友出去玩吗？他的朋友大多数是学校的？还是教会的？都是用哪一种语言沟通

At home/community – access to Chinese media (books/DVDs/TV…)
_____在家里有看中文电视/报纸/杂事/书刊吗？

What language does child prefer to use
_____比较习惯用哪一种语言？

What language is child more proficient at
_____对哪一种语言掌控得比较好一点？

Appendix 6

Definitions of speech error patterns (Dodd et al., 2003; Zhu & Dodd, 2000a)

Pattern	Description	Example
Assimilation	Influence of another phoneme in the target word	/jɛləʊ/ → [lɛləʊ]
Affrication	Replacement of stops with fricatives or affricates	/dɒg/ → [zɒg] /ʂuɪ3/ → [tsuɪ3]
Aspiration	Replacement of non-aspirated sound with aspirated sound	/pi2/ → [p^hi2]
Deaffrication	Modification of the affrication feature	/wɒtʃ/ → [wɒt]
Deaspiration	Replacement of aspirated sound with non-aspirated sound	/t^how2/ → [tow2]
Velar fronting	Place of articulation is moved from velar to alveolar position	/ka/ → [ta]
Retroflexion	Place of articulation is made with retroflex position	/san3/ → [ʂan3]
Fronting	Place of articulation is moved to a more anterior position	/ʃip/ → [sip] /ʂow3/ → [sow3]
Backing	Place of articulation is moved to a more posterior position	/faiv/ → [saiv] /suA/ → [ʃuA]
Stopping	Replacement of fricatives with stops	/ðɪs/ → [dɪs]
	Replacement of affricates with stops*	/tɕiɑo3/ → [tiɑo3]
Devoicing	Postvocalic devoicing	/bɪd/ → [bɪt]
Gliding	Replacement of liquids with glides	/ɹabɪt/ → [wabɪt]
Epenthesis	Insertion of vowel /ə/ in a consonant cluster	/sta/ → [səta]
Cluster simplification	All elements of a consonant cluster is produced but at least one of the elements does not match the target phoneme	/bɹɪdʒ/ → [bwɪdʒ]
Cluster reduction	Deletion of one element from the consonant cluster	/skwɛə/ → [swɛə]
Unreleased	Placement in place without production	/ɛg/ → [ɛg˺]

*from classification used by Zhu and Dodd (2000a) for Mandarin affricates

Appendix 7: Ethics approvals

Office of the Vice-Chancellor
Ethics and Biological Safety Administration

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

The University of Auckland
Private Bag 92019
Auckland, New Zealand

Level 3, 76 Symonds Street
Telephone: 64 9 373 7599
Extension: 83711 / 87830
Facsimile: 64 9 373 7432

UNIVERSITY OF AUCKLAND
HUMAN PARTICIPANTS ETHICS COMMITTEE

13 October, 2008

MEMORANDUM TO:

Dr. Elaine Ballard

Psychology

Re: Application for Ethics Approval

The Committee met on 8 October , 2008 and considered the application for ethics approval for your research titled "Speech development of Mandarin English bilingual children in New Zealand" (Our Ref. 2008 / 404).

The Committee has granted conditional approval for your project. This means that you need to make the required amendments or provide further documentation as per the list below. The changes should be highlighted and accompanied by a covering memo and sent by email to l.lon@auckland.ac.nz or r.kothari@auckland.ac.nz. You will receive an email response within five working days stating whether you can proceed with your project. Please provide only the documents that have the changes and quote the reference no. in all documentation.

1. The Committee comments that the assessment needs more than 15 minutes to complete. Please re-estimate the time and amend it accordingly in the application, Participant Information Sheet and Consent Form.
2. In the Participant Information Sheet indicate that the participants can obtain a lay report if they wish. In the Consent Form, add a bullet point that states "I wish / do not wish to have a copy of the summary."

If the project changes significantly you are required to resubmit your appplication to the Committee for further consideration.

In order that an up-to-date record can be maintained, it would be appreciated if you could notify the Committee once your project is completed.

Please contact the Chairperson if you have any specific queries relating to your application. The Chair and the members of the Committee would be most happy to discuss general matters relating to ethics provisions if you wish to do so.

DEPARTMENT OF PSYCHOLOGY (Speech Science)

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

200 Morrin Road, Glen Innes
Auckland, New Zealand
Telephone 64 9 373 7599 ext. 85221
Facsimile 64 9 373 7011
Email: e.ballard@auckland.ac.nz
The University of Auckland
Private Bag 92019
Auckland, New Zealand

Parent/Guardian Information Sheet

Project title: Speech development of Mandarin-English bilingual children in New Zealand
Investigators: Taiying Lee and Elaine Ballard

Dear Sir/Madam

My name is Taiying Lee and I am a speech and language therapist with the Pakuranga Howick Early & Ongoing Support team, Special Education (SE), a part of the Ministry of Education, and a doctoral student in the Department of Psychology. I am currently undertaking research on typical speech development in Mandarin and English for bilingual children between the ages of four and eight who speak both these languages and looking into Mandarin-English bilingual children with speech sound disorders. I hope that my research will lead to a better understanding of speech development for Mandarin-English bilingual children. I also hope to obtain information on normative development and speech sound disorders for Mandarin and English as well as develop a speech sound assessment that can be used with Mandarin-English bilingual populations in New Zealand.

Permission have been sought and obtained from the head teacher/principal at your child's centre/school for the centre/school to participate in this study. Staff and/or speech language therapists at your child's centre/school have identified your child as someone who might contribute to this research. I would like to invite you and your child to participate. The research will involve an interview with you as well as two assessment sessions. If you agree to participate, I will conduct both the interview and the assessment with you and your child at their centre/school or at your residence whichever is more convenient for you. The assessment sessions will take approximately two hours altogether. The assessment sessions will be audio taped for analysis you may choose to have the recorder turned off at any time without giving a reason. If you are uncomfortable with your child being audio taped during the assessment sessions, you will be unable to participate further in the research project.

Participation is voluntary; you do not have to take part. If you are not interested in participating, please be assured that this will not have any impact or influence on your relationship with the centre/school or your child's grades. If you choose to allow your child to participate in this study, I would also like to look at any speech and language assessments the centre/school may have on file for your child. All personal information will remain strictly confidential and no material that could personally identify you or your child will be used in any report of this study. The data that are gathered during the sessions will only be used for the study described above. The audio-tapes and the data collected will be stored in a locked cabinet at the Tamaki Campus of the University of Auckland by the secretary of the Psychology department. They will be destroyed (tapes erased and paper records shredded) 6 years after completion of the project.

You are free to withdraw from the research at any time, without explanation, should you wish to do so. You are welcome to withdraw your data before 1st October, 2013. A copy of the final report is available to you at your request.

If you are willing for your child to participate in this research, please complete the consent form and return it to Taiying Lee, in the self addressed envelope provided.

If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact the principal investigator, Dr Elaine Ballard.

Thank you for reading this information sheet and considering this invitation. Please do not hesitate to contact me if you require further information.

Regards

Taiying Lee
Speech and Language Therapist
Special Education, Ministry of Education
Unit 1, 16 Bishop Dunn Place, South Botany
Tel: (09) 265 3109 or 021817354
taiying.lee@minedu.govt.nz

My supervisors are:
Dr. Elaine Ballard
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
Tel: (09) 373 7599 ext. 87502
e.ballard@auckland.ac.nz

Dr. Suzanne Purdy
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
sc.purdy@auckland.ac.nz

The Head of Department of Psychology is:
Dr. Douglas Elliffe
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
Tel: 373 7599 ext. 85262
d.elliffe@auckland.ac.nz

For any queries regarding ethical concerns please contact:
The Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Research Office-Office of the Vice Chancellor, Private bag 92019, Auckland. Tel. 373 7599 ext. 87830.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on 06/11/2008 for six years from November 2008 to November 2014. Reference Number 2008/404.

DEPARTMENT OF PSYCHOLOGY (Speech Science)

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

200 Morrin Road, Glen Innes
Auckland, New Zealand
Telephone 64 9 373 7599 ext. 85221
Facsimile 64 9 373 7011
Email: e.ballard@auckland.ac.nz
The University of Auckland
Private Bag 92019
Auckland, New Zealand

Parent/Guardian Consent Form

Title: Speech development of Mandarin-English bilingual children in New Zealand
Researchers: Taiying Lee and Elaine Ballard

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

I have read the Participant Information Sheet and/or have understood a verbal explanation of this research project, and my child and I are prepared to take part in the research. I have had the opportunity to ask questions and have them answered.

- I understand that participation is voluntary and that if I am not interested in participating, this will not have any impact or influence on my relationship with the centre/school/Special Education.
- I understand that my child's speech will be assessed using selected communication tests and that they will be audio-taped for scoring purposes.
- I understand that the assessment sessions will take approximately two hours altogether
- I understand that the interview will also be audio-taped.
- I understand that I may stop the recording at any time for any reason.
- I understand that I may withdraw myself and my child from the study without giving a reason.
- I understand that I may withdraw any data traceable to myself or my child up until 1st October 2013
- I understand that the audio-tapes and the data collected will be stored in a locked cabinet at the Tamaki Campus of the University of Auckland. They will be destroyed six years after completion of the project.
- I understand that all personal information will remain strictly confidential and no material that could personally identify me or my child will be used in any report of this study.
- I wish/do not wish to have a copy of the summary

I agree that _____ (child's name), who is under my guardianship, may participate in this research.

I agree that my child's assessment sessions be audio taped for analysis purposes. **yes / no** (please circle)

I agree that the researcher may have access to my child's existing language assessments at the centre/school/Special Education for the purposes of gathering information relevant to this study. **yes / no** (please circle)

I would like a copy of the report: **yes / no** (please circle)

Signed:

DEPARTMENT OF PSYCHOLOGY (Speech Science)

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

200 Morrin Road, Glen Innes
Auckland, New Zealand
Telephone 64 9 373 7599 ext. 85221
Facsimile 64 9 373 7011
Email: e.ballard@auckland.ac.nz
The University of Auckland
Private Bag 92019
Auckland, New Zealand

父母/監護人參與通知表

主題:　在紐西蘭中.英雙語兒童的語言能力發展
研究員: Taiying Lee 和 Elaine Ballard

親愛的先生/女士們,

我的名字是 Taiying Lee, 是位語言治療師.　我目前代表特殊教育部和奧克蘭大學一起研究中.英雙語兒童的語言能力發展. 由於國際對中.英雙語兒童的語音進展所知甚微, 因此我希望我的研究計劃可增進了解中.英雙語兒童的語言進展. 同時亦希望可以取得建立中.英語音評估基礎, 盼本研究計劃可增進在紐西蘭和世界上說中.英雙語的兒童未來在學習上的幫助.

已獲得你小孩幼稚園/學校校長的同意參與本研究計劃. 校方的職員或語言治療師認同你的小孩可能對本研究計劃做出貢獻. 我期望你和你的小孩的加入. 該計劃將包括和你會談及評估約二個小時. 如果你同意可依你的方便在你小孩的學校或住所會談及評估. 評估期間將被錄音以便做為分析用. 你可以在任何時間無須任何理由而決定停止錄音. 如果你不願意你的小孩再評估期間被錄音時,你將無法進一步參加本研究計劃.

這是自願參與, 你不一定要參加. 如你沒興趣參加, 請安心這不會影響你和幼稚園/學校/教育部之間的關係及小孩在校的成績. 如果你同意讓你的小孩參加本研究計劃, 亦請讓我覆閱你小孩可能在幼稚園/學校/教育部任何的語言評估檔案. 所有個人資料均被嚴格保密,和任何報告裏均無法追認你和你小孩的個人資料. 所有的資料僅限用於該研究計劃. 錄影帶和所收集的資料將被奧克蘭大學 Tamaki Campus 心理學部門的秘書存放在加鎖櫃子裏, 並於完成該研究計劃六年後被銷毀 (錄音帶銷除; 報告用撕碎機銷毀).

你可以在參與期間的任何時候停止參與而無須任何理由, 但請於 2013 年 10 月 1 日前通知. 如你願意我們很樂意給你本研究計劃完成後的報告書.

若你願意你的小孩參加本研究計劃, 請填完授權書並用隨函所附回郵信封寄回.

若你有任何疑問或有關你參加本研究計劃的權益時, 請與指導教授 Elaine Ballard 博士聯絡.

感謝你閱讀和考慮接受我們的邀請. 如須任何進一步資料,請不必客氣和 Taiying 聯絡.

敬上
Taiying Lee
Speech and Language Therapist
Special Education, Ministry of Education
Unit 1, 16 Bishop Dunn Place, South Botany
Tel: (09) 265 3109 or 021817354
taiying.lee@minedu.govt.nz

指導教授:
Dr. Elaine Ballard
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
Tel: (09) 373 7599 ext. 87502
e.ballard@auckland.ac.nz

Dr. Suzanne Purdy
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
sc.purdy@auckland.ac.nz

The Head of Department of Psychology is:
Dr. Douglas Elliffe
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
Tel: 373 7599 ext. 85262
d.elliffe@auckland.ac.nz

任何有關人道疑問請與下面人連絡:
The Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Research office-Office of the Vice Chancellor, Private bag 92019, Auckland. Tel. 373 7599 ext. 87830.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on 06/11/2008 for six years from November 2008 to November 2014. Reference Number 2008/404.

DEPARTMENT OF PSYCHOLOGY (Speech Science)

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

Auckland, New Zealand
Telephone 64 9 373 7599 ext. 85221
Facsimile 64 9 373 7011
Email: e.ballard@auckland.ac.nz
The University of Auckland
Private Bag 92019
Auckland, New Zealand

父母/監護人授權書

主題:　在紐西蘭中.英雙語兒童的語言能力發展
研究員: Taiying Lee 和 Elaine Ballard

這授權書將會保留六年

我已閱讀或經口頭解本頁研究計劃資料並將願意參加該研究計劃. 我與我的孩子預備參加本研究計劃. 我有機會問問題及獲得回覆.

- 我知道這是自願參與,且如不繼續參與該研究計劃時將不影響我和幼稚園/學校/教育部之間的關係及小孩的成績
- 我知道我孩子的語言能力將被特別挑選的語言測試 評估, 和為評分的目的而錄音
- 我知道評估約共二個小時
- 我知道會談時亦將被錄音
- 我知道我可因任何時間, 任何理由而停止錄音.
- 我知道我和我的小孩不必有任何理由取消參與該研究計劃
- 我知道我能在 2013 年 10 月 1 日以前取消我和我小孩的資料
- 我知道錄音帶及資料將存放在奧克蘭大學的 Tamaki Campus 的加鎖櫃子裏.並於完成該研究後六年後被銷毀
- 我知道所有個人資都被嚴格保密 且任何報告裏都無追認我和我小孩個人的資料
- 我想 (要/不要) 一份摘要副本

我同意_____(小孩的名字), 在我監護參加該研究計劃.

我同意我的小孩在評估期間被錄音, 以便做為分析用. **是 / 不是** (請圈其一)

我同意研究員可以到我小孩就讀幼稚園/學校/教育部的語文課收集有本研究計劃的有資料. **是 / 不是** (請圈其一)

我要一份報告副本. **是 / 不是** (請圈其一)

簽名:

名字(請寫正楷):
小孩的幼稚園/學校:　　小孩的生日日期:
聯絡號碼:　　日期:

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Facsimile 64 9
373 7011
Email: e.ballard@auckland.ac.nz
The University of Auckland
Private Bag 92019

Principal Information Sheet

Project title: Speech development of Mandarin-English bilingual children in New Zealand
Investigators: Taiying Lee and Elaine Ballard

Dear Sir/Madam

My name is Taiying Lee and I am a speech and language therapist with Special Education, Ministry of Education. I am currently undertaking a research project with the University of Auckland on typical speech development in Mandarin and English for bilingual children between the ages of four and eight who speak both these languages and looking into Mandarin-English bilingual children with speech sound disorders. As little is known about the order in which speech sounds develop for children who are acquiring both Mandarin and English. I hope that my research will lead to a better understanding of speech development for Mandarin-English bilingual children. I also hope to obtain information on normative development and speech sound disorders for Mandarin and English as well as develop a speech sound assessment that can be used with Mandarin-English bilingual populations in New Zealand.

I would like to invite your school to participate in the research process. I am interested in looking at the development and acquisition of speech sounds in both English and Mandarin. The children we would be interested in are typically developing children aged between five and eight years old who speak both Mandarin and English. We are hoping that this research will lead to a better understanding of the development of English and Mandarin speech sounds in Mandarin-English bilingual children. We also hope to obtain some normative information for a Mandarin speech sound assessment for Mandarin-English bilingual children in New Zealand which can be used to help better identify those children that need speech and language therapy input.

If your school is interested in participating, I would be grateful if you would permit me to access a list of children at your school who speak Mandarin as one of their languages. This list would detail the child's name, date of birth and class number. A participant information and consent form in both English and Mandarin will then be sent out to their parents through the school to invite their participation in this research. The research will involve an interview with the parents as well as two assessment sessions. The sessions would take approximately an hour altogether and be audio-taped for analysis purposes. If the parents are not interested in participating, I would ask that the school assure the parents that this will not have any impact or influence on their relationship with the school or their child's grades. If the parents agree to participate, the school may be requested to provide information on any speech and language assessments the child has in their file as part of the information gathering process. A room for the interview and assessments may also be requested if the parents would like these sessions to take place at the school.

All personal information about the participating children will remain strictly confidential and no material that could personally identify them will be used in any report of this study. The data that are gathered during the sessions will only be used for the study described above. Participants are welcome to withdraw their data before 1st October, 2012. The audio-tapes and the data collected will be stored in a locked cabinet at the Tamaki Campus of the University of Auckland by the secretary of the Psychology department. They will be destroyed (tapes erased and paper records shredded) 6 years after completion of the project.

If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact the principal investigator, Dr Elaine Ballard.

Thank you for reading this information sheet and considering this invitation. Please do not hesitate to contact me if you require further information.

Regards

Taiying Lee
Speech and Language Therapist
Special Education, Ministry of Education
Unit 1, 16 Bishop Dunn Place, South Botany
Tel: (09) 265 3109 or 021817354
taiying.lee@minedu.govt.nz

My supervisors are:
Dr. Elaine Ballard
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
Tel: (09) 373 7599 ext. 87502
e.ballard@auckland.ac.nz

Dr. Suzanne Purdy
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
sc.purdy@auckland.ac.nz

The Head of Department of Psychology is:
Dr. Douglas Elliffe
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
Tel: 373 7599 ext. 85262
d.elliffe@auckland.ac.nz

For any queries regarding ethical concerns please contact:
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Principal Consent Form

Title: Speech development of Mandarin-English bilingual children in New Zealand
Researchers: Taiying Lee and Elaine Ballard

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

I have read the Principal Information Sheet and/or have understood a verbal explanation of this research project. I have had the opportunity to ask questions and have them answered.

- I consent to our students at the school participating in the proposed research.
- I agree that the researcher may approach teachers at my school for assistance in identifying and recruiting participants
- I agree that participation is voluntary and that if the participants are not interested in participating, this will not have any impact or influence on their relationship with the school or their child's grades.
- I understand that participants are welcome to withdraw their data before 1st October, 2012.
- I understand that a room for the interview and assessments may be requested if the parents would like these sessions to take place at the school.
- I understand that the children's speech will be assessed using selected communication tests and that they will be audio-taped for scoring purposes.
- I understand that the audio-tapes and the data collected will be stored in a locked cabinet at the Tamaki Campus of the University of Auckland. They will be destroyed six years after completion of the project.
- I understand that all personal information will remain strictly confidential and no material that could personally identify the parents or children at my school will be used in any report of this study.

I agree that the researcher may have access to existing language assessments at school for the purposes of gathering information relevant to this study

yes / no (please circle)

Signed:

Name: **Date:**
(please print clearly)

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Auckland, New Zealand

Teacher Information Sheet

Project title: Speech development of Mandarin-English bilingual children in New Zealand
Investigators: Taiying Lee and Elaine Ballard

Dear Sir/Madam

My name is Taiying Lee and I am a doctoral student in the Department of Psychology and a speech and language therapist with the Pakuranga Howick Early & Ongoing Support team, Special Education (SE), a division of the Ministry of Education. As part of my degree I will be undertaking research on typical speech development in Mandarin and English for bilingual children between the ages of four and eight who speak both these languages and looking into Mandarin-English bilingual children with speech sound disorders.

I would be very grateful if you would lend me your assistance by helping to identify children in your class that may be suitable to take part in this research. Permission for the school to participate in this study has been sought and obtained from the principal. I am interested in looking at the development and acquisition of speech sounds in both English and Mandarin. The children we would be interested in are typically developing children aged between five and eight years old who speak both Mandarin and English. We are hoping that this research will lead to a better understanding of the development of English and Mandarin speech sounds in Mandarin-English bilingual children. We also hope to obtain some normative information for a Mandarin speech sound assessment for Mandarin-English bilingual children in New Zealand which can be used to help better identify those children that need speech and language therapy input.

If you are able to provide the names and contact details of the parents of any suitable children, a participant information and consent form in both English and Mandarin will be sent out to these parents to invite their participation in this research. The research will involve an interview with the parents as well as two assessment sessions. The sessions would take approximately an hour altogether and be audio-taped for analysis purposes. If the parents are not interested in participating, please assure the parents that this will not have any impact or influence on their relationship with the school or their child's grades. If the parents agree to participate, the school may be requested to provide information on any speech and language assessments the child has in their file as part of the information gathering process. A room for the interview and assessments may also be requested if the parents would like these sessions to take place at the school.

All personal information about the participating children will remain strictly confidential and no material that could personally identify them will be used in any report of this study. The

data that are gathered during the sessions will only be used for the study described above. Participants are welcome to withdraw their data before 1st October, 2012. The audio-tapes and the data collected will be stored in a locked cabinet at the Tamaki Campus of the University of Auckland by the secretary of the Psychology department. They will be destroyed (tapes erased and paper records shredded) 6 years after completion of the project.

If you have any queries or concerns regarding your rights as a participant in this study, you may wish to contact the principal investigator, Dr Elaine Ballard.

Thank you for reading this information sheet and considering this invitation. Please do not hesitate to contact me if you require further information.

Regards,

Taiying Lee
Speech and Language Therapist
Special Education, Ministry of Education
Unit 1, 16 Bishop Dunn Place, South Botany
Tel: (09) 265 3109 or 021817354
taiying.lee@minedu.govt.nz

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Dr. Elaine Ballard
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
Tel: (09) 373 7599 ext. 87502
e.ballard@auckland.ac.nz

Dr. Suzanne Purdy
Department of Psychology
University of Auckland
Private Bag 92019, Auckland
sc.purdy@auckland.ac.nz

The Head of Department of Psychology is:
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Department of Psychology
University of Auckland
Private Bag 92019, Auckland
Tel: 373 7599 ext. 85262
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Teacher Consent Form

Title: Speech development of Mandarin-English bilingual children in New Zealand
Researchers: Taiying Lee and Elaine Ballard

THIS CONSENT FORM WILL BE HELD FOR A PERIOD OF SIX YEARS

I have read the Teacher Information Sheet and/or have understood a verbal explanation of this research project, and I am prepared to identify children at my school who meet the criteria to participate in the research. I have had the opportunity to ask questions and have them answered.

- I understand that I can provide the names and contact details of the parents of any suitable children attending the school. A participant information and consent form in both English and Mandarin will then be sent out to these parents to invite their participation in this research.
- I understand that I am not to indicate participation in this research on behalf of the parents/caregivers.
- I agree that participation is voluntary and that if the participants are not interested in participating, this will not have any impact or influence on their relationship with the school or their child's grades.
- I understand that the children's speech will be assessed using selected communication tests and that they will be audio-taped for scoring purposes.
- I understand that participants are welcome to withdraw their data before 1st October, 2012.
- I understand that the audio-tapes and the data collected will be stored in a locked cabinet at the Tamaki Campus of the University of Auckland. They will be destroyed six years after completion of the project.
- I understand that all personal information about the participants will remain strictly confidential and no material that could personally identify the parents or children at my school will be used in any report of this study.

I agree that the researcher may have access to existing language assessments at school for the purposes of gathering information relevant to this study

yes / no (please circle)

Signed:

Name: **Date:**
(please print clearly)