A COMPARISON OF STUTTERING BEHAVIOR AND FLUENCY IMPROVEMENT IN ENGLISH-MANDARIN BILINGUALS WHO STUTTER

Valerie P. C. Lim

A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

Australian Stuttering Research Centre

The University of Sydney

June 2007

STATEMENT OF AUTHORSHIP

This work has not previously been submitted for any other degree at the University of Sydney or elsewhere. This thesis is the work of the writer. No other person's work has been used without due acknowledgement in the main text of the thesis. Approval for this study was given by the Institutional Review Board of The National University of Singapore (dated 27/6/2005), the Singapore General Hospital (Reference no: 288/2004), and The University of Sydney Ethics Committee (Reference no: 2-2005/1/8002).

Valerie P. C. Lim: ……………………………………. Date: …………………..

STATEMENT OF COMPLETION

I, Michelle Lincoln, hereby certify that Valerie Lim's thesis entitled *A Comparison of Stuttering Behavior and Fluency Improvement in English-Mandarin Bilinguals Who Stutter* is in a form that is acceptable for the degree of Doctor of Philosophy.

Associate Professor Michelle Lincoln: …………………….. Date: …………………..

ABSTRACT

Despite the number of bilinguals and speakers of English and Mandarin worldwide, up till now there have been no investigations of stuttering in any of the Chinese languages, or in bilinguals who speak both English and Mandarin. Hence, it is not known whether stuttering behavior in Mandarin mimics that in English, or whether speech restructuring techniques such as Prolonged Speech produce the same fluency outcomes in Mandarin speakers as they do for English speakers.

Research into stuttering in bilinguals is available but far from adequate. Although the limited extant studies show that bilinguals who stutter (BWS) may stutter either the same or differently across languages, and that treatment effects in one language can automatically carry over to the other language, it is unclear whether these findings are influenced by factors such as language dominance or language structure. These issues need to be clarified because speech language pathologists (SLPs) who work with bilinguals often do not speak the dominant language of their clients. Thus, the language of assessment and treatment becomes an important clinical consideration.

The aim of this thesis was to investigate (a) whether the severity and type of stuttering was different in English and Mandarin in English-Mandarin bilingual adults, (b) whether this difference was influenced by language dominance, (c) whether stuttering reductions in English generalized to Mandarin following treatment in English only, and (d) whether treatment generalization was influenced by language dominance. To achieve these aims, a way of establishing the dominant language in bilinguals was a necessary first step.

The first part of this thesis reviews the disorder of stuttering and the treatment for adults who stutter, the differences between English and Chinese languages, and stuttering in bilinguals. Part Two of this thesis describes the development of a tool for determining language dominance in a multilingual Asian population such as that found in Singapore. This study reviews the complex issues involved in assessing language dominance. It presents the rationale for and description of a self-report classification tool for identifying the dominant language in English-Mandarin bilingual Singaporeans. The decision regarding language dominance was based on a predetermined set of criteria using self-report questionnaire data on language proficiency, frequency of language use, and domain of language use. The tool was administered to 168 English-Mandarin bilingual participants, and the self-report data were validated against the results of a discriminant analysis. The discriminant analysis revealed a reliable three-way classification into English-dominant, Mandarin-dominant, and balanced bilinguals. Scores on a single word receptive vocabulary test supported these dominance classifications.

Part Three of this thesis contains two studies investigating stuttering in BWS. The second study of this thesis examined the influence of language dominance on the manifestation of stuttering in English-Mandarin BWS. Results are presented for 30 English-Mandarin BWS who were divided according to their bilingual classification group: 15 English-dominant, four Mandarin-dominant, and 11 balanced bilinguals. All participants underwent comprehensive speech evaluations in both languages. The English-dominant and Mandarin-dominant BWS were found to exhibit greater stuttering in their less dominant language, whereas the balanced bilinguals evidenced similar levels of stuttering in both languages. An analysis of the types of stutter using the Lidcombe Behavioral Data Language showed no significant differences between English and Mandarin for all bilingual groups.

In the third study of this thesis, the influence of language dominance on the generalization of stuttering reductions from English to Mandarin was investigated. Results are provided for seven English-dominant, three Mandarin-dominant, and four balanced bilinguals who underwent a Smooth Speech intensive program in English only. A comparison of stuttering between their pretreatment scores and three posttreatment interval scores indicated that the degree of fluency transfer from the treated to the untreated language was disproportionate. English-dominant and Mandarin-dominant participants showed greater fluency improvement in their dominant language even if this language was not directly treated.

In the final chapter, Part Four, a hypothesis is provided to explain the findings of this thesis. A discussion of the limitations of the thesis and suggestions for future research are also presented. The chapter concludes with a summary of the main contributions that this thesis makes to the field of stuttering in bilinguals.

ACKNOWLEDGEMENTS

This thesis would not have been possible without the invaluable guidance and support of my Principal Supervisor, Associate Professor Michelle Lincoln, and my Associate Supervisor, Professor Mark Onslow, from the Australian Stuttering Research Centre, The University of Sydney. Both were extremely generous with their expertise and knowledge. I will forever be grateful to Michelle for her personal guidance, her wisdom, clarity of thought, and availability throughout this process. I was always calmed by her kind and encouraging words, especially in times of anxiety. Most importantly, I thank her for believing in me, and for helping me to believe in myself. She was an inspiring supervisor and an outstanding role model. I am extremely appreciative of Mark's astuteness and thoroughness in my research work, and for his wonderful support throughout this process. I have learned so much more about the art of thesis and grant writing, and about the research process. I thank him for sharing his enthusiasm and for helping me to develop as a researcher.

My deepest thanks to my Associate Supervisor, Dr Chan Yiong Huak from the Faculty of Medicine, The National University of Singapore, for his guidance and patience in assisting me with the design of and statistical analyses in this thesis.

I would like to acknowledge, with gratitude, all the participants in this study for their time, generosity, and their fighting spirit. Their determination to better themselves was remarkable yet humbling, and it was gratifying to watch them improve.

I thank Professor Ann Packman for her input and constructive feedback on parts of this thesis, and Julie Story for ensuring that the manuscripts submitted for publication were in APA format. I am also thankful to all the staff and postgraduate students at the School of Communication Disorders and Sciences, and the Australian Stuttering Research Centre, The University of Sydney, for their encouraging words along this journey.

I am indebted to all the speech language therapists and support staff at the Speech Therapy Department, Singapore General Hospital, who helped with the recruitment of participants, collection of speech samples, and the administrative work that was necessary for the smooth completion of this thesis. Special thanks need to be given to Ms Gwyneth Lee, Ms Kristl Alphonso, Ms Goh Geling, Ms Tan Lilian, and Ms Judy Choy for the extra load they had to carry. I am particularly grateful to Ms Melissa Chua who supported my study leave and was flexible with the research and clinic arrangements, and for her encouragement and friendship.

I am deeply grateful to my friend and colleague, Associate Professor Susan Rickard Liow, Department of Psychology, the National University of Singapore, for her time, support, and invaluable input on parts of this thesis. Her involvement was crucial for the completion of the bilingual classification study.

To Mr Noah Tan and Ms Cherine Graham, I wish to say a very big thank you for rating the numerous speech samples. I also thank Mr Mark Lu for digitizing all the speech samples and Ms Anita Hui for her administrative help in the bilingual classification study.

Several of my mates require special mention: Dr Christine Bracy for her understanding of the process and of me, and for saying the right things at the right time to help me through this process; Ms Cherine Graham for being there "on skype" daily (our friendship would not have grown if not for this PhD); and Ms Gerri Katz for her camaraderie, encouragement, and sense of humour which helped me to maintain my sanity during the final phase of this thesis. I would like to specifically thank Ms Janelle Ho for 20 plus years of friendship. I am thankful every day for her presence in Sydney as it certainly made living here feel so much more like home.

I could not have done this without the perpetual love and support of my husband, Hoden. Thank you for enduring our time apart, for agreeing to call back later when I was deep in writing and could not talk, and for assuming that this day would come even before I started the process. Most of all, I thank him for reminding me that there are more important things to life than a PhD.

Finally, I thank my family for their prayers and their unwavering love. Mum and Dad, this is for you.

In loving memory of Mama, my late grandmother,

whose life stories taught me the meaning of endurance,

and who was with me in mind and spirit throughout this journey.

PREFACE

The research in Chapter Four of this thesis was designed by the candidate with the assistance of Michelle Lincoln, Chan Yiong Huak, and Susan Rickard Liow. The candidate administered the multilingual British Picture Vocabulary Scales (MBPVS) and the Self-Report Classification Tool to all participants. The MBPVS (Rickard Liow, Hong, & Tng, 1992) is an adapted version of British Picture Vocabulary Scales (BPVS) (Dunn, Dunn, Whetton, & Pintillie, 1982b). Permission from the original publisher (dated 25 May 2005) was given to the candidate to use the MBPVS for this research. Categorization of language dominance was performed by the candidate using the predetermined set of criteria. The candidate acknowledges the assistance of Anita Hui who helped with the administrative procedures during data collection. Susan Rickard Liow helped with the ethics application for this research to be conducted at the National University of Singapore, and she and Chan Yiong Huak provided significant input in the statistical analysis of data and the editing of the manuscript. The material in Chapter Four has been submitted for publication.

The candidate, with the support of Michelle Lincoln and Mark Onslow, designed the research reported in Chapters Five and Six of this thesis. The candidate received the assistance of the speech language therapists at the Singapore General Hospital in the delivery of treatment and the collection of speech samples, but was solely responsible for the analysis and reporting of client data. The candidate acknowledges the assistance of Mark Lu who edited the speech samples, and the help of Noah Tan and Cherine Graham who acted as listener judges. Randomization of the speech samples for purpose of speech ratings was completed by the candidate. The research reported in both chapters was supported by a National Medical Research Council grant (NMRC/0983/2005) in Singapore, and the Postgraduate Research Support Scheme (PRSS) awarded by The University of Sydney in 2005 and 2006. The two manuscripts which arose from this research were written by the candidate with editorial assistance from Michelle Lincoln and Mark Onslow. Both papers have been submitted for publication.

The candidate employed Joan Rosenthal as copyeditor for Chapters One to Three and Seven of this thesis. The services she provided were proofreading and identification and provision of advice in matters of structure (the need to restructure and reword, deletions, additions); the conventions of grammar and syntax; use of clear language; logical connections between phrases, clauses, sentences, paragraphs, and sections; voice and tone; and avoiding ambiguity, repetition and verbosity.

All the investigations were conducted with approval of the Human Ethics Committees of The University of Sydney (Ref # 2-2005/1/8002) and the National University of Singapore (dated 27/6/2005), and the Institutional Review Board at the Singapore General Hospital (SGH IRB Application #288/2004).

PUBLICATIONS / CONFERENCE PAPERS

ARISING FROM THIS THESIS

PUBLICATIONS

Lim, V., Lincoln, M., Chan, Y. H., Rickard Liow, S. J., & Onslow, M. (2007). Determining language dominance in English-Mandarin bilinguals: A self-report classification tool for clinical use. Manuscript submitted for publication, Applied Psycholinguistics.

Lim, V., Lincoln, M., Chan, Y. H., & Onslow, M. (2007). Stuttering in English-Mandarin bilingual speakers: The influence of language dominance on stuttering severity. Manuscript submitted for publication, Journal of Speech, Language, and Hearing Research.

Lim, V., Lincoln, M., Chan, Y. H., & Onslow, M. (2007). Stuttering in English-Mandarin bilingual speakers: Generalization of Treatment Effects from English to Mandarin. Manuscript submitted for publication, Journal of Speech, Language, and Hearing Research.

CONFERENCE PAPERS

Lim, V., Lincoln, M., Onslow, M., & Chan, Y. H. (2005). A Comparison of Stuttering Behavior in English and Mandarin Bilingual Speakers. 5th International Symposium on Bilingualism, Barcelona (March).

Lim, V., Lincoln, M., Onslow, M., & Chan, Y. H. (2005). Generalization Effects to the Non-Treated Language in English-Mandarin Bilinguals who stutter. 7th Oxford Fluency Conference, Oxford (June).

ABBREVIATIONS

Acronym	**Meaning**
PWS	People, person or persons who stutter
BWS	bilinguals who stutter
CWS	children who stutter
SLP	speech language pathologist(s)
AoA	age of acquisition
AoE	age of exposure
AOA	age of arrival
BPVS	British Picture Vocabulary Scales
MBPVS	Multilingual British Picture Vocabulary Scales
PPVT	Peabody Picture Vocabulary Test
L1	first language
L2	second language
TOEFL	Test Of English as a Foreign Language
WLD	Word Listing by Domain
AQT	Alzheimer's Quick Test
NUS	National University of Singapore
HOB	History of Bilingualism
LBQ	Language Background Questionnaire
SPM	syllables per minute
%SS	percent syllables stuttered
SEV	severity rating
LBDL	Lidcombe Behavioral Data Language
RM	repeated movement(s)
FP	fixed posture(s)

Acronym	Meaning
SB	superfluous behavior(s)
SR	syllable repetition(s)
ISR	incomplete syllable repetition(s)
MSUR	multisyllabic unit repetition(s)
FPWAA	fixed posture(s) with audible airflow
FPWOAA	fixed posture(s) without audible airflow
VSB	verbal superfluous behavior(s)
NVSB	nonverbal superfluous behavior(s)
CD-R	compact disc-readable
fMRI	functional magnetic resonance imaging
DLPFC	dorsolateral prefrontal cortex
CRH	Covert Repair Hypothesis

TABLE OF CONTENTS

PART ONE: INTRODUCTION

PART TWO: DETERMINING LANGUAGE DOMINANCE

PART THREE: STUTTERING IN ENGLISH-MANDARIN BILINGUAL SPEAKERS

CHAPTER FIVE

CHAPTER SIX

PART FOUR: CONCLUSIONS

LIST OF TABLES

LIST OF FIGURES

PART ONE

INTRODUCTION

CHAPTER ONE

OVERVIEW OF STUTTERING

Introduction

Speech is essential for occupational, mental and social health in modern society, yet at least 1% of the world's population has and lives with the speech disorder known as stuttering (Bloodstein, 1995). The epidemiology and nature of stuttering presents a pressing concern to the public health of those who have the disorder. This is because stuttering occurs at an early age in large numbers of children, and if it remains untreated, it may insidiously erode the wellbeing of the individual and may affect the individual's future employability and occupational potential (for a review, see Craig & Calver, 1991; Hayhow, Cray, & Enderby, 2002; Hurst & Cooper, 1983).

The empirical focus of this thesis is the manifestation and treatment of stuttering in English-Mandarin bilingual adults who stutter. Part One of this thesis provides an overview of the literature on what is known about (a) the disorder of stuttering, (b) the differences between the English and Chinese languages, and (c) stuttering in bilinguals. Each of these topics is presented in separate chapters. This chapter outlines the nature and development of stuttering and discusses current theoretical perspectives on stuttering. It also gives a brief history of the treatment of chronic stuttering and reviews the development of speech restructuring treatments such as Prolonged Speech, which is the most efficacious treatment available for adolescents and adults who stutter.

The Nature of Stuttering

Stuttering is a developmental condition that has been described as "a disorder in which the rhythm or fluency of speech is impaired by interruptions, or blockages" (Bloodstein, 1995, p. 1). The core behaviors of stuttering are traditionally referred to as repetitions of sounds or syllables, blocks or prolongations of sounds. However, since such traditional terms are not behavioral, and lack operationalism and specificity, Packman and Onslow (1998) developed the Lidcombe Behavioral Data Language (LBDL) which describes the behaviors of stuttering in terms of repeated movements, fixed postures, and superfluous behaviors. Packman and Onslow claimed that this taxonomy of stuttering better reflects the kinematics of the speech mechanism, and hence can be used reliably to describe stuttering behaviors across all ages and languages.

Stuttering may begin gradually or suddenly, and is most likely to begin between the ages of 2 and 5 years (Onslow, 1996) when children are starting to produce multiword utterances. The core behaviors of stuttering may develop sequentially (Van Riper, 1982). Repeated movements are most typical at the onset of stuttering whereas fixed postures are usually but not always the last behavior to emerge (Guitar, 2006). These behaviors may persist for a few seconds or longer than half a minute (Van Riper, 1982), and may be associated with superfluous behaviors such as eye blinks, head nods, tremors in the lip or jaw, use of interjections, or word avoidance.

As stuttering behaviors are often overt, individuals who continue to stutter without remission (discussed later) may develop speech-associated negative feelings and attitudes (Guitar, 2006). Thus, if untreated, stuttering may become a source of social anxiety and emotional stress, and fear of speaking and avoidance behaviors may result. There is an association between stuttering and trait anxiety, a link that has been established across a range of self-report assessments with both adults and adolescents (see e.g., DiLollo, Manning, & Neimeyer, 2003; Kraaimaat, Vanryckeghem, & Van Dam-Baggen, 2002; Menzies, Onslow, & Packman, 1999; Messenger, Onslow, Packman, & Menzies, 2004). Compared to non-stuttering people, people who stutter (PWS) have been found to score higher on measures of social anxiety (Kraaimaat, Janssen, & Van Dam-Baggen, 1991; Mahr & Torosian, 1999; Messenger et al., 2004). In particular, PWS have been reported to display social discomfort scores that are within the range of a group of highly socially anxious psychiatric patients (Kraaimaat et al., 2002), with some individuals warranting a comorbid diagnosis of social phobia (Menzies et al., 2007; Stein, Baird, & Walker, 1996).

Prevalence and Incidence of Stuttering

From a review of 37 epidemiological studies of stuttering from several countries, Bloodstein (1995) estimated that approximately 1% of the world's population stutters at a given time, and the lifetime incidence rate for stuttering is between 4% to 5%. However, there appears to be some variation in the prevalence and incidence of the disorder across different countries or cultures. For example, Andrews and Harris (1964) suggested that the incidence rate in England is 4.19% while Månsson (2000) reported an incidence rate of 5.19% in Denmark. Similarly, the prevalence rate for stuttering in children has been reported to vary between 0.58% in Belgium (Van

Borsel et al., 2006), to 0.97% in the United States, to 1.2% in the United Kingdom (Andrews & Harris, 1964), and between 0.33% and 1.4% in Australia (Craig, Hancock, Tran, Magali, & Peters, 2002; McKinnon, McLeod, & Reilly, 2007). More specifically, Craig and colleagues reported a 0.72% prevalence of stuttering over the entire life span (from age 2 onwards) and found that the prevalence rate decreased after childhood: 1.4% for preschoolers (2-5 years), 1.44% for school-age children (6-10 years), 0.53% for adolescents (11-20 years), 0.78% in adulthood (21-50 years), 0.37% in older adults (> 51 years).

Recovery and Sex Ratio

The difference in prevalence and incidence rates and the apparent downward trend in prevalence figures over time reflect the high degree of natural recovery for childhood stuttering (Yairi & Ambrose, 1999). It has been estimated that approximately 50% to 85% of children who stutter spontaneously recover from the disorder (Guitar, 2006; Kalinowski & Saltuklaroglu, 2006). Although it is difficult to predict who will recover from stuttering, it is possible that individuals who have lower stuttering severity, good language abilities, no family history of stuttering or relative who has recovered from the disorder, and who are female, are more likely experience remission without professional treatment (Guitar, 2006; Yairi & Ambrose, 1999). The proposed gender linkage in unassisted recovery is supported by the increase in the male to female ratio in stuttering with age: 2.1:1 to 3:1 in young children and 5:1 in school age children (Bloodstein, 1995; Yairi & Ambrose, 1992). A recent study by Craig and Tran (2005) also showed that the prevalence rate for stuttering in male children (2%) and adolescents (0.8%) was higher than in female children (0.8%) and adolescents (0.2%).

Theoretical Explanations of Stuttering

Numerous theoretical perspectives have been postulated to account for the origin, development, and nature of stuttering (for a review, see Bloodstein, 1995; Guitar, 2006; Packman & Attanasio, 2004). Packman and Attanasio reviewed a number of causal theories and models of stuttering which they categorized loosely in terms of understanding stuttering as a disorder of (a) speech motor control, (b) systems control modeling, (c) cognitive and linguistic processing, (d) anticipatory struggle, and (e) as multifactorial models. According to these authors, the terms *theory* and *hypothesis* refer to propositions concerning a phenomenon whereas the term *model* is defined as a conceptual framework that has been developed to guide research and thinking. This section provides a brief overview of the more current theoretical perspectives with reference to Packman and Attanasio's broad classifications.

Speech Motor Control

Webster (1985; 1986; 2004) and Foster and Webster (2001) described the *Interhemispheric Interference* model in which they argued that stuttering occurs because the left supplementary motor area (SMA) of PWS is particularly vulnerable to disruption. Due to its location and extensive connections with other areas of the brain, disturbance in the SMA is caused by concurrent neural activity in the left hemisphere and interference from an overactive right hemisphere arising from increased negative emotions associated with stuttering. The insufficiency in the SMA and a labile system of hemispheric activation together affect the initiation, planning, and sequencing of motor speech output. The findings of poorer performance on manual tasks in people who stutter, and the results of brain imaging research, are thought to provide some evidence for their theory (see Guitar, 2006; Packman & Attanasio, 2004; Webster, 1998).

Systems Control Modeling

There are several causal models and theories that incorporate systems control modeling. Examples include the *Inverse Internal Models of Speech Production* (Guitar, 2006) or *Sensory-motor Modelling Theory* (Packman & Attanasio, 2004) proposed by Neilson and Neilson (1987; 2000), the *Neuroscience Model* (Nudelman, Herbrich, Hoyt, & Rosenfield, 1989), the *Neuropsychological Model of the Origin and Maintenance of Stuttering* (Fiedler & Standop, 1983), and the *Variability Model* (Vmodel; Packman, Code, & Onslow, 2007; Packman, Onslow, Richard, & VanDoorn, 1996).

Although the theories and models cited differ in the extent to which they are modeled on system control theory, and in their explanations of stuttering, they commonly point to an unstable speech motor system as the basis of stuttering. In general, the sensory-motor modeling theory, the neuroscience model, and the neuropsychological model propose that higher linguistic or task demands lead to disruptions in the complex multiloop feedback or monitoring system which subserves speech production. In contrast, the Vmodel suggests that the motor speech system is susceptible to destabilization because of variability that is inherent in the production of one aspect of prosody: syllable stress. More specifically, Packman and colleagues theorized that the proximal cause or the trigger for stuttering is difficulty in the initiation of the motor plans for syllable production. In their recent publication (Packman et al., 2007), the authors linked difficulty with syllable initiation to an underlying problem with the SMA. To summarize, Packman and colleagues (Packman et al., 1996, p. 253) stated that "it is the particular interaction of linguistic and motoric factors inherent in prosody that induces stuttering, and psychological and environmental factors then influence the course of the disorder."

Cognitive and Linguistic Processing

A number of theories suggest a link between stuttering and cognitive and linguistic processing (see Guitar, 2006; Packman & Attanasio, 2004; Sasisekaran, De Nil, Smyth, & Johnson, 2006). They include the *EXPLAN theory* (Howell & Dworzynski, 2005), the *Covert Repair Hypothesis* (Postma & Kolk, 1993), and the *Neuropsycholinguistic theory* (Perkins, Kent, & Curlee, 1991), all of which suggest that stuttering occurs because of a disruption at the level of phonological encoding during the speech production process. Of these, the Covert Repair Hypothesis (CRH) is frequently cited. According to the CRH, disturbance in phonological encoding leads to a greater number of errors during the formulation of the phonetic plan for speech. Such errors are detected by the internal speech monitor and attempts are made to correct them. Stuttering, therefore, reflects the covert, prearticulatory repairing of speech programs before speech motor execution. Although other researchers (e.g., Anderson, 2007; Bernstein Ratner & Sih, 1987; Newman & Bernstein Ratner, 2007) have associated the occurrence of stuttering with higher linguistic processes such as lexical retrieval, this view has not been translated formally as a causal theory or model of stuttering.

Anticipatory Struggle

According to Bloodstein (1995; 1997), stuttering emerges when a child develops a negative anticipation of speaking after experiencing frustration and embarrassment from communicative failure. This negative anticipation may arise from unrealistic linguistic demands or from deficits in speech and language ability, and results in anticipatory struggle which in turn brings tension to the initiation of speech, leading to speech fragmentation. This view has since been amended to incorporate the increasing body of evidence for a genetic link in stuttering (see Bloodstein, 2000). In the revised version, Bloodstein proposed two causes of stuttering: (a) children have a genetically based predisposition to stuttering, (b) stuttering in older children or adults is caused by anticipatory struggle that is learned in response to the initial genetically based stuttering (Bloodstein, 2001; Packman & Attanasio, 2004).

Multifactorial Models

Examples of multifactorial models include the *Demands and Capacities* (DC) model (Starkweather & Gottwald, 1990) and the *Dynamic Multifactorial* (DM) model (Smith & Kelly, 1997). The theoretical perspective that drives such models is that stuttering is a multidimensional disorder that is caused by a combination of innate—genetic, emotional, cognitive, linguistic—and environmental factors rather than a single factor. The combination of causal factors is believed to vary across individuals. Proponents of the DM model postulate that speech motor processes may be positively or negatively influenced by cognitive, emotional, and linguistic factors. On the other hand, according to the DC model, stuttering occurs when demands exceed the individual’s capacity for fluency. Demands can present in the form of innate or environmental pressure on time and on language complexity, anxiety, or parental demands for increased cognitive functioning. If such demands go beyond developmental levels of language, speech motor control, and social, emotional and cognitive functioning, stuttering will result. The devotion of an entire issue of the *Journal of Fluency Disorders* (2000, Volume 25, Issue 3) to a discussion of the DC model is testimony of its popularity over the DM and other models.

Current View of Stuttering

Despite the many theories about the cause and nature of the disorder, the actual cause of stuttering is still unknown. However, the current view is that stuttering is genetically transmitted with a sex linkage (Suresh et al., 2006). There also appears to be an interaction between heredity and learning and developmental factors within the environment in explaining the etiology of the disorder (Felsenfeld et al., 2000; Howie, 1981; Kidd, 1977). Such evidence is drawn from family, twin, and adoption studies which reveal that: (a) PWS are more likely, albeit not always, to have relatives who stuttered, (b) more females than males who stutter have stuttering relatives, (c) there is an increased concordance rate for stuttering in monozygotic twins compared to dizygotic twins, and (d) both biological and adoptive families of PWS have reported a history of stuttering (e.g., Felsenfeld, 1997; Felsenfeld et al., 2000; Guitar, 2006; Kidd, 1980; Ooki, 2005). Recent genetic studies have also found evidence for a transmission of stuttering via specific chromosomes (1, 8, 13, and 16), although they have not yet located the specific gene(s) involved in stuttering (Guitar, 2006).

At present, stuttering is widely viewed as a disorder of speech motor planning that is genetically transmitted, and caused by a deficit in the neural processing of speech (Büchel & Sommer, 2004; Packman et al., 2007). The disorder is also believed to be influenced by a complex association between linguistic, physiological, environmental, and psychological factors (Guitar, 2006; Packman et al., 1996). There is a growing corpus of data from brain imaging studies indicating that the disruption in motor speech control is underpinned by a problem in the neural function of the SMA (e.g., Büchel & Sommer, 2004; Chung, Im, Lee, & Lee, 2004; Forster & Webster, 2001; Ingham, Fox, Ingham, & Zamarripa, 2000; Packman et al., 2007).

The History of Stuttering Treatment

There are different types of stuttering treatment available for individuals diagnosed with early, intermediate and chronic stuttering (for review, see Bloodstein, 1995; Guitar, 2006). As the focus of this thesis is on individuals with chronic stuttering, this section presents treatment programs that are specific for this population.

Stuttering treatment can be traced back to the 4th century when Demosthenes tried to overcome stuttering by speaking with pebbles in his mouth (Bloodstein, 1995). Since then, the treatment of stuttering evolved, often reflecting the perceived pathogenesis of the disorder at the time. In the 18th and 19th century, the ideas of Aristotle who ascribed stuttering to a malfunctioning tongue was adhered to, so early treatment for stuttering involved the use of a special apparatus to stabilize the tongue musculature (Brosch & Pirsig, 2001; Büchel & Sommer, 2004) or tongue surgery to inhibit spasms of the speech organs (Bloodstein, 1995; Brosch & Pirsig, 2001). Psychoanalysis emerged as a treatment method in the later part of the 19th century after Freudian supporters related stuttering to repressed needs (Bloodstein, 1995). In the early 20th century, stuttering treatment shifted towards retraining unilateral dominance for speech and other motor tasks following the proposals by Samuel Orton and his student Lee Edward Travis that insufficient cerebral dominance was the cause of stuttering (Guitar, 2006; Orton & Travis, 1929; Travis, 1978). However, the popularity of these treatments diminished after they failed to yield effective reductions in stuttering.

After 1930, stuttering therapy was significantly influenced by the work of three protégés of Travis: Bryng Bryngelson, Wendell Johnson, and Charles Van Riper. Although Bryngelson, Johnson, and Van Riper differed in their opinions regarding the cause of stuttering, the primary focus of their therapeutic methods was to reduce the fear associated with stuttering and to eliminate avoidance behaviors. In particular, they became recognized for their promotion of "easy, tension-free, voluntary stuttering" (Kalinowski & Saltuklaroglu, 2006, p. 15) and cancellations and pull-outs (Van Riper, 1982). These techniques formed the basis for the development of one of the two major approaches to treating stuttering: the *stutter more fluently* approach (Guitar, 2006; Kalinowski & Saltuklaroglu, 2006). Under this approach, PWS were taught how to amend each stuttering moment so as to stutter more fluently and easily.

During the 1960s, following the rising popularity of behavioral therapy in the field of clinical psychology, stuttering was viewed as an aberrant speech behavior which could also be observed, measured and modified. Thus, operant conditioning and behavior modification techniques were used to achieve fluency. These therapies paved the way for the second main approach to stuttering treatment—the *speak more fluently* approach—which emphasized positive reinforcement of stutter-free speech, fluency shaping or motor speech retraining (Guitar, 2006; Kalinowski & Saltuklaroglu, 2006). In speech restructuring, stuttering behaviors are supplanted by a novel speech pattern which eliminates stuttering and its associated behaviors. Negative feelings and attitudes about speech may or may not be directly targeted during therapy. Examples of speech restructuring treatments include prolonged speech, smooth speech and rhythmic speech (Cream, O'Brian, Onslow, & Packman, 2007). Of these, prolonged speech (PS) and smooth speech have been used frequently with individuals who have chronic stuttering, and are treatments which have abundant efficacy data. The next section reviews the development and efficacy of PS and its variants in the treatment of chronic stuttering.

Prolonged Speech (PS) and Its Variants

Goldiamond (1965) was the first to experiment with the slow, protracted but fluent speech pattern that was produced when delayed auditory feedback (DAF) was used as an adverse stimulus contingent on stuttering. Other investigators have since modified Goldiamond's behavioral conditioning program: DAF was first used to establish stutter-free speech, then gradually phased out, and the slow, unnatural sounding speech was systematically shaped to approximate normal speech (e.g., Craven & Ryan, 1984; Curlee & Perkins, 1969; Curlee & Perkins, 1973; Perkins, 1973; Webster, 1980). Eventually, the use of DAF was dispensed with, and the novel speech pattern—generically referred to as PS—was learned by imitation of the clinician or examples on a tape (Helps & Dalton, 1979).

Variants of PS were also established in the ensuing years. These included smooth motion speech or smooth speech (e.g., Block, Onslow, Packman, Gray, & Dacakis, 2005; Howie, Tanner, & Andrews, 1981). Like PS, these behavioral treatments for stuttering also emphasize soft contacts or gentle onsets, slow onset of phonation, "continuous airflow and movement of articulators throughout each utterance, and extension of vowel and consonant durations" (Howie et al., 1981, p. 104). However, unlike PS, smooth speech does not use continuous vocalization.

Prolonged speech and its alternatives have traditionally been taught in group intensive treatment programs in North America, Australia, and Europe. Generally, clients receive programmed clinical instruction regarding the components of PS, and fluency is instated using mass practice of the new speech pattern at slow speech rates. Clients then progress through a performance-contingent schedule of graded speech rates (e.g., 40, 60, 100 syllable per minute and so on) until they acquire more natural-sounding speech. Subsequently, maintenance and transfer phases are usually, but not always, added to the programmed establishment phase.

The service delivery model of intensive treatment programs has seen some changes over the years. Whereas many of the earlier programs involved more than 100 hours of treatment (e.g., Helps & Dalton, 1979; Howie et al., 1981; Neilson &

Andrews, 1993), and were residential in nature (Boberg & Kully, 1985, 1994; Ingham, 1987; Ingham & Andrews, 1973; Onslow, Costa, Andrews, Harrison, & Packman, 1996), other programs were non-residential and offered significantly shorter treatment times (Block et al., 2005; Franck, 1980; Harrison, Onslow, Andrews, Packman, & Webber, 1998). In particular, Harrison et al. simplified the intensive schedule by reducing the duration of fluency instatement to 12 hours and eliminating the transfer phase of treatment.

Two findings led to further modifications of PS treatment programs: (a) stutter-free speech could be achieved without programmed instruction (Packman, Onslow, & van Doorn, 1994), and (b) clinicians' judgments of the components of PS may be unreliable (Onslow & O'Brian, 1996). Therefore, O'Brian and associates (O'Brian, Cream, Onslow, & Packman, 2001; O'Brian, Onslow, Cream, & Packman, 2003) taught PS without reference to the descriptors of the speech pattern, and omitted the intensive treatment format, the programmed instruction of rate control, and the formal transfer procedures. Yet these investigators and Harrison et al. (1998) found that their clients were able to sustain satisfactory control of chronic stuttering for up to 12 months post-treatment.

Overall, due to their capacity to achieve reductions in stuttering, speech restructuring techniques such as PS or smooth speech have been established as an efficacious treatment for individuals with chronic stuttering (Andrews et al., 1983; Block et al., 2005; Boberg & Kully, 1994). These findings have also been consistently substantiated by a number of literature reviews conducted during the last two decades. In their meta-analysis of 42 studies conducted across several countries published before 1979, Andrews, Guitar and Howie (1980) found that treatments that taught prolonged and gentle onset techniques were superior to other types of treatment in both the short term and the long term (up to 6 months). Cordes (1998) perused the literature between 1965 and 1996 and confirmed that PS and its variants were not only the most regularly used techniques but plausibly the most efficacious techniques available to clinicians for the treatment of chronic stuttering.

More recently, two groups of researchers (Bothe, Davidow, Bramlett, & Ingham, 2006; Onslow, Jones, O'Brian, & Menzies, 2007) have applied systematic criteria in their appraisal of the published literature with the view to guiding clinicians in evaluating evidence based treatment practices. Bothe and colleagues used five methodological criteria and four outcome criteria to systematically review 162 published articles about stuttering treatment. Only 39 articles were found to meet their trial quality assessment inclusion criterion. Bothe and colleagues found that PS-type procedures were the most powerful treatments for adults who stutter in terms of speech, social, cognitive, and emotional outcomes. However, such PS-type procedures were best conducted within a comprehensive treatment framework that included "initial intensive work, practice in front of groups, specific transfer or generalization tasks, self-evaluation of speech and/or self-management of program steps, a focus on speech naturalness and feedback of naturalness measurements, and an active contingent maintenance program that continues to address not only stuttering but also speech naturalness and self-evaluation skills" (p. 335).

Onslow et al. (2007) argued that the criteria posited by Bothe et al. were too laborious for clinicians. They developed another taxonomy for evaluating stuttering treatment research, designing a three-point definition of what constitutes a clinical trial of a stuttering treatment. The trial must (a) explore at least one entire treatment, (b) provide at least one pretreatment and one follow-up outcome of at least 3 months, and (c) have outcomes based on speech observations that can be verified noncontemporaneously from recordings of conversational speech beyond the clinic. The authors also applied the principles of randomization and effect size to allocate published treatments into one of three phases of evidence—Phase I, II, and III—with Phase III trials being the "gold standard" of evidence for a treatment (for details, see Onslow et al., 2007). In their subsequent evaluation of clinical trials published to circa 2007, Onslow and colleagues found that there were replicated Phase I and II clinical trials of multiday, intensive, programmed speech restructuring treatments to suggest that such treatments are efficacious for school-age children, adolescents and adults who stutter.

In sum, speech restructuring treatment such as PS can be considered best practice for controlling chronic stuttering in both adolescents and adults. As a result, multiday, intensive, programmed speech restructuring treatments involving PS continue to be conducted in Australia and even in South East Asian countries such as Singapore. In Singapore, the Smooth Speech program is conducted with a population that is essentially bilingual, of whom the largest proportion are of Chinese descent who speak both English and Mandarin.

Stuttering in Asian Languages

Although stuttering is considered a universal disorder there is some suggestion that its prevalence and development may be different across cultures (Bloodstein, 1995; Van Riper, 1982). There exists a large number of studies of stuttering in Western populations, but little is known about stuttering in Asian people. Except for the study by Ooki (2005) which examined the genetic and environmental influences on stuttering in Japanese twin children, there are no further data about the prevalence and incidence of stuttering in other Asian populations. There are also no investigations about how stuttering presents in Chinese languages such as Mandarin, Cantonese, and Hokkien, or whether stuttering in Chinese languages responds to treatment in the same way as in English. Consequently, this thesis investigates the presentation and treatment of stuttering in Chinese languages. It is possible, however, that the manifestation of stuttering in Chinese may not mimic that observed in English. This is because the Chinese language differs from English in almost all facets of linguistic structure. To better understand how and why it is possible that stuttering may manifest differently across English and Chinese, a description of the two languages is provided in the next chapter.

CHAPTER TWO

OVERVIEW OF ENGLISH AND CHINESE LANGUAGES

Introduction

This chapter contains an overview of the main similarities and differences between the English and Chinese languages, and the models of speech production that account for the differences. The chapter ends with a summary of possible suggestions as to how such differences in linguistic structure may affect stuttering in each language.

Differences Between English and Chinese

English and Chinese originate from separate language families: Indo-European and Sino-Tibetan. There is a vast difference between the two languages in terms of their respective written forms, syntax, morphology, phonology, and syllable structure. There are many variants of English (e.g., Cockney, American English, Scottish English) and Chinese (e.g., Mandarin, Cantonese, Hokkien), and their respective spoken forms vary according to the dialect, or the region or country in which the language is spoken. Often, the varieties of English and of Chinese can be so different that they can become mutually unintelligible languages. In what follows, a brief overview of the main dissimilarities between the standard form of English and Chinese is presented (for a comprehensive discussion, see Lin, 2001).

English has an alphabetic script whereas the Chinese script is considered to be logographic. English words are made up of one or more letters. Although letter-to-sound correspondence may be weak in some instances, it is possible to read many unknown English words by decoding their constituent parts. Conversely, Chinese words are formed using either one or more Chinese characters. Each Chinese character is a monosyllabic morpheme and so the meaning of each word is easily apparent. In contrast with English, one must know the pronunciation that is associated with the Chinese character in order to read it correctly (for details, see Weekes et al., 1998).

Unlike English syntax and morphology, there is no use of inflectional devices in Chinese. In particular, there are no plural markings on the verb, no case or agreement markings, and no tense suffixes. Additionally, English and Chinese contrast with respect to word order and word order cues (Li, Bates, & Macwhinney, 1993). English and Chinese also have distinct segmental phonemic inventories and their phonotactic constraints are language-specific. The English syllable can be very complex; syllables may begin with up to three consonants (as in *straight* or *splash*), and occasionally end with as many as four (as in *prompts*). The phonotactic system of Chinese languages is relatively simpler. There are no consonant clusters in Chinese; the syllable structure consists of syllable initials—usually vowels or single consonants—and syllable finals, the most complex being of VVVC structure. The Chinese syllable also has fewer consonant terminals. For example, Mandarin-Chinese has only two consonant terminals, that is, /n/ and /ŋ/ (Tseng, 1988). However, unlike the syllable structure of English, the Chinese syllable must be affiliated with the tonal system in order for any syllable to become lexically meaningful.

Chinese languages are tonal in nature. Tonal languages are languages which use lexical tones to minimally distinguish individual words not differentiated by segmental (consonant or vowel phonemes) information (Baudoin-Chial, 1986; Gandour, 1987). Lexical tones are described as contrastive variations in pitch or fundamental frequency (F_0) at the syllable level and have been regarded to be tonal phonemes by several researchers (Keung & Hoosain, 1979; Packard, 1992; Yiu & Fok, 1995). The number and type of lexical tones are known to vary across the different Chinese language. For example, Mandarin has four lexical tones whereas Cantonese has six (see Table 2.1). In bisyllabic or multisyllabic Chinese words, the production of certain tones is altered by phonological rules called *tone sandhi* (Li & Thompson, 1981; Matthews & Yip, 1994). When applied, these tone sandhi rules modify the original production of lexical tones at the phonetic level (i.e., spoken level). For instance, in Mandarin, when two third tone syllables are articulated in succession (e.g., tone 3-tone 3), a tone sandhi rule stipulates that the former syllable is always pronounced as a second tone (e.g., tone 2-tone 3).

On the other hand, in English, differences in pitch are not tied to the lexicon in the same way (Cruttenden, 1986). English is a stress-timed language where stress patterns are used to influence the timing and rhythm of speech. Syllable stress refers to the relative emphasis that may be given to certain syllables in a word, and is produced by changes in the pitch, duration, and loudness of sounds. The production of syllable stress may vary according to the length and context of the utterance produced. Moreover, English utterances also use intonation—variations in time, amplitude, and voice pitch that are superimposed over phrases or sentences—to convey syntactic, pragmatic, and affective information and to minimally distinguish sentence types (Blumstein & Cooper, 1974; Cooper & Klouda, 1987). Intonation and stress-like patterns have also been observed in Chinese, but generally with fewer possibilities than in English (Cruttenden, 1986).

It is believed that utterances need to undergo frequent revisions during the planning and production of propositional speech. Although both English and Mandarin require on-line adjustments to be made to their lexical, syntactic, phonological, and prosodic structures, the speech planning process for Chinese languages also needs to incorporate modifications for lexical tone production. The processing of the English and Chinese languages is discussed in the following section with reference to a model of monolingual speech production.

Table 2.1 Illustration of Lexical Tones for Mandarin and Cantonese.

Tone / Description	Syllable	Word Meaning
Mandarin		
Tone 1 - high-level	ma^1	mother
Tone 2 - high-rising	ma^2	plant
Tone 3 - low-falling-rising	ma^3	horse
Tone 4 - high-falling	ma^4	to scold
Cantonese		
Tone 1 - high-falling	yi^1	clothes
Tone 2 - mid-rising	yi^2	chair
Tone 3 - mid-level	yi^3	opinion
Tone 4 - low-falling	yi^4	son
Tone 5 - low-rising	yi^5	ear
Tone 6 - low-level	yi^6	two

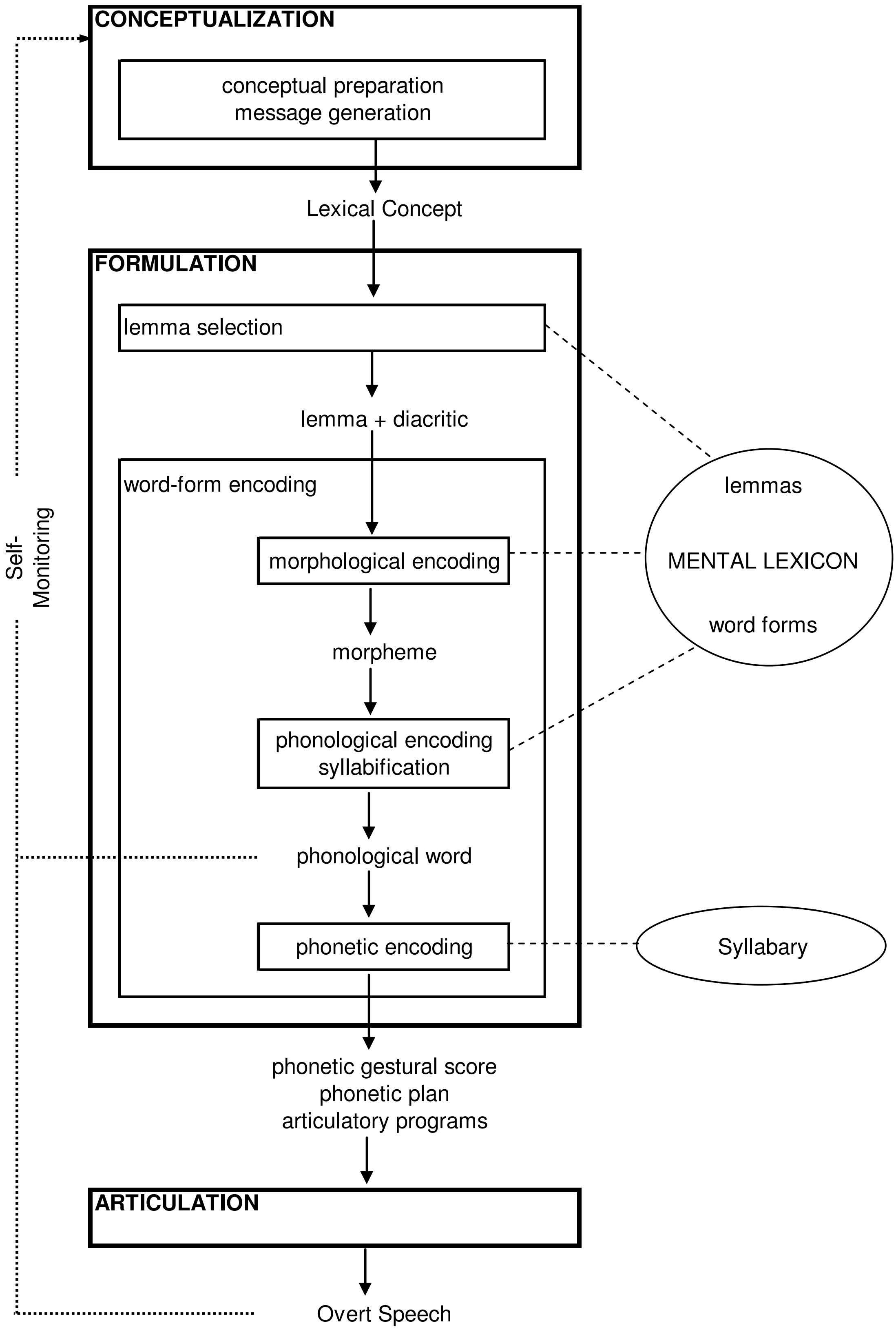
Models of Monolingual Speech Production

Several types of models of speech production are available in the literature (e.g., Dell, 1986; Dell & Oseaghdha, 1992; Garrett, 1982; Levelt, 1989; Levelt, Roelofs, & Meyer, 1999; Roelofs, 2000). Levelt et al.'s WEAVER++ model was developed within Levelt's general theoretical framework for speech production, and is highlighted here since it is the model that has been used by researchers to account for a linguistic explanation of stuttering (e.g., Howell & Dworzynski, 2005; Postma & Kolk, 1993). Although the focus of this thesis is not to identify the origin of stuttering within the speech production process, the theoretical framework of Levelt's model is used to explore the potential differences that may be expected in the manifestation of stuttering between Chinese and English.

According to Levelt and colleagues (1999), word production occurs in a series of distinct stages starting from conceptual preparation of lexical concepts, to lexical selection, and then to word-form encoding, before the initiation of articulation can begin (see Figure 2.1). To illustrate the application of this model for English and Chinese, an example of a person wishing to say 'mother' is used.

This message or lexical concept that is to be verbally expressed is generated at the conceptualization stage. The appropriate English word for this lexical concept is then accessed via lemma retrieval and word-form encoding during the formulation stage of speech production. The lemma is the representation of the syntactic properties of the word that is extracted from memory (Levelt et al., 1999; Roelofs, 2000). Thus, in lemma retrieval, the word *mother* is accessed, and any corresponding information regarding syntactic class, grammatical gender, and number diacritic is made available. The lemma and the number diacritic then undergo three stages of word-form encoding: morphological, phonological, and phonetic. During morphological encoding, the lemma and its singular parameter value is produced as the morpheme <mother>. The phonological encoder then spells out the phonological segments in the word, determines the metrical structure of the word, assigns an appropriate stress pattern, and allocates the segments to structural positions within the word (Hartsuiker, Bastiaanse, Postma, & Wijnen, 2005; Roelofs, 2000). The output of this is the phonological word ['maðə] where the first, stressed syllable has /m/ as onset and /a/ as nucleus, and the second syllable has /ð/ as onset, and /ə/ as nucleus.

Figure 2.1. Sketch of Integrated Word Production Model Adapted from Levelt (1989), Levelt, Roelofs, and Meyer (1999) and Roelofs (2000).



This phonological word representation is then sent to the phonetic encoder where syllabification takes place. During syllabification, syllable gestural scores—learned articulatory programs for syllables—are accessed from the mental syllabary, and the corresponding articulatory program is finally executed. The motor program specifies exactly how the word is to be pronounced (Meyer, 1997). It is assumed that a syllable inventory exists so that articulatory programs do not have to be generated from scratch each time a word is produced. Levelt and co-workers also proposed that speakers can self-monitor their phonological and phonetic representations of their internal speech (see Figure 2.1). However, while researchers generally agree that there is an internal channel which monitors speech before articulation, the exact level where self-monitoring occurs remains contentious (Hartsuiker et al., 2005).

The model above is believed to accommodate the production of words in Chinese. For example, there is similar conceptual preparation, parallel retrieval of segmental and prosodic features, sequential linking of segments in the syllable structure, and the activation of motor programs for syllables. There are, however, some modifications. To produce a two syllable Chinese word, the lemma connects to the two morpheme units, and specifies their order of appearance (Chen, Chen, & Dell, 2002). In the case of the Chinese word 妈妈 (meaning mother), the two identical morphemes [ma^1] and [ma^1] are activated, and a syllable and a tone are also retrieved. At this stage, the syllable has phonological segments but lacks tone representation. There is neurolinguistic evidence for independent phonological tiers for segments and lexical tones in the constitution of a word in tone languages (Gandour, Akamanon, Dechongkit, Khunadorn, & Boonklam, 1994; Snider & van der Hulst, 1992). Studies of aphasic individuals have shown that the production of phonological segments (e.g., consonants and vowels) and tones can be independently disrupted following brain damage (Gandour et al., 1994; Liang & Heuven, 2004; Lim, 1998; Naeser & Chan, 1980; Packard, 1992).

It is postulated that the retrieved lexical tones are represented and processed in a manner similar to linguistic stress in English (Chen, 1999). Hence they are encoded as part of the phonological frame. Once the tonal frame is created and the syllable unit is accessible, the content of the syllable is linked with the tonal frame (Chen et al., 2002). Chen and colleagues also suggested that full preparation of each syllable occurs before stress patterns and tone sandhi rules (where applicable) are applied. The integrated phonological word representation ['ma^{1}ma^1] is then passed down to the phonetic level where the tone is translated into the vowel that carries it and is configured as a pitch contour. The appropriate articulatory programs are then activated. In comparison with English, however, the number of syllables stored in the Chinese syllabary is believed to be smaller. Moreover, whereas online changes in syllable structure and word stress patterns occur frequently in English speech, such resyllabification between syllables in Mandarin is less likely (Chen, Lin, & Ferrand, 2003).

Summary and Relation to Stuttering

This chapter highlights the inherent differences in language structure and linguistic processing between the English and Chinese languages. Given that various theories and models of stuttering have posited stuttering to be associated with a disruption at the level of either lexical retrieval (Newman & Bernstein Ratner, 2007), phonological encoding (Postma & Kolk, 1993; Sasisekaran et al., 2006), or phonetic encoding (Packman et al., 2007), it is conceivable that the presentation of stuttering across English and Chinese may be dissimilar. This notion provided the impetus for an investigation of stuttering in Chinese languages, and more specifically, in bilinguals who stutter who speak both English and Chinese (see Chapter Five). As Bernstein Ratner and Benitiez (1985) have suggested, bilinguals who stutter may be an ideal population for examining the validity of models that postulate that linguistic factors may precipitate stuttering. Follwing this chapter’s review of the existing information about the disorder of stuttering and about the English and Chinese languages, Chapter Three now presents an overview of what is known about stuttering in bilinguals.

CHAPTER THREE

OVERVIEW OF STUTTERING IN BILINGUALS

Introduction

Compared to the number of studies of stuttering in monolingual speakers, there are far fewer investigations of bilinguals who stutter (BWS). The relationship between bilingualism and stuttering has often been described as enigmatic (Karniol, 1992). Indeed, Van Borsel, Maes, and Foulon (2001, p. 180) reported that "many so-called 'facts' about stuttering and its development derive from studies of monolingual speakers, virtually all of whom are English speakers, and have as yet not been tested either crosslinguistically or within bilingual populations". The affiliation between bilingualism and stuttering warrants further examination, as such information will not only have a profound effect on current clinical practice, but also enhance our theoretical understanding of the nature of the disorder itself. Information about the manifestation and treatment of stuttering in BWS who speak English and Chinese will not only expand the current information about stuttering in general, but also guide speech language pathologists (SLPs) in the assessment and treatment of stuttering in BWS.

This chapter begins with a definition of bilingualism and a review of some of the contributions to the literature about the prevalence, development, and manifestation of stuttering in bilinguals. This is followed by a synopsis of the theoretical explanations of stuttering in bilinguals, and its relation to the models of bilingual language processing. Next, a discussion of the current perspectives on the assessment and treatment of BWS is presented. The chapter ends with a summary of the outstanding issues in this area of research, and an explanation for the focus of the present thesis.

Definition of Bilingualism

The literature abounds with varied definitions of bilingualism, but the common concept of bilingualism is that it is a continuum rather than a dichotomy (Macnamara, 1967; Roberts & Shenker, in press). Bilinguals can range from someone who can function in each language according to given needs to someone who has native-like and equal competence in two languages (Grosjean, 1982). Although bilinguals may develop roughly equivalent proficiency levels in each language, the development of native-like competency in each language is difficult to achieve and is considered rare. This is because bilinguals often have areas of linguistic knowledge, such as vocabulary and syntax, which are under-developed. Additionally, their speech may evidence signs of cross-language interference (e.g., accent) despite the acquisition of high levels of proficiency in both languages.

For these reasons, Grosjean (1985; 1989) argued that bilinguals are not two monolinguals in the same person, and should instead be considered as competent speaker-hearers in their own right. In order to achieve a functional definition of bilingualism, it has been recommended that SLPs assess bilinguals' levels of proficiency across the four language modalities of understanding, speaking, reading, and writing, consider how each language is acquired and/or developed, and take into account the differences in the mode, frequency, and domain of language use across the two languages (Grosjean, 1982, 1985, 1989, 1998).

The terms *bilingual, multilingual* and *polyglot* are usually used to refer to someone who has a knowledge of two, or more than two languages respectively. Since there are insufficient data regarding the clinically relevant differences between bilingual and multilingual speakers (Roberts & Shenker, in press), the terms bilingual and multilingual are often used interchangeably. Bilinguals can be further differentiated as *early or late* bilinguals, or as *simultaneous* or *consecutive* bilinguals. The terms early and late refer to the age at which the bilingual's second language is acquired. In simultaneous bilingualism, both languages are usually acquired at the same time whereas in consecutive bilingualism, one language is normally acquired before the other. However, investigators have disagreed on the cut-off ages for a bilingual to be classified as an early or late bilingual, or as a simultaneous or consecutive bilingual (see for e.g., Au-Yeung, Howell, Davis, Charles, & Sackin, 2000; Bialystok & Miller, 1999; Perani et al., 1998). Further, language acquisition research has shown that there is no critical period for first exposure to each language that determines the ultimate level of proficiency that a bilingual will attain (Hakuta, Bialystok, & Wiley, 2003; Piske, Flege, & MacKay, 2001). The level of language proficiency in bilinguals is influenced by a multitude of factors (Flege, Mackay, & Piske, 2002; Grosjean, 1998; Langdon, Wiig, & Nielsen, 2005; Obler, Zatorre, Galloway, & Vaid, 2000). These are discussed in detail in Chapter Four.

Prevalence of Stuttering in Bilinguals

It has been suggested that stuttering is more prevalent in bilinguals than in monolinguals (Karniol, 1992). In an early survey of 4,827 children aged 4 to 17 years, Travis, Johnson, and Shover (1937) reported a higher prevalence rate of stuttering in bilingual children (2.8%) than in monolingual children (1.8%). However, since Travis et al. sampled children from public schools in East Chicago only, the extent to which their findings can be generalized to the larger bilingual community worldwide is limited. In a more recent internet survey (Au-Yeung et al., 2000), responses from 40 countries, 52 different native languages, and more than 70 different second languages were collated, showing no difference between monolingual (21.7%) and bilingual (21.7%) speakers with respect to their likelihood of stuttering in their life. The figures reported by Au-Yeung et al are unusually higher than the 1% prevalence rate more commonly reported. As both surveys contained inherent methodological problems, including a poor definition of stuttering, no formal diagnosis of stuttering by qualified clinicians, and reliance on self-report, their reported prevalence figures are questionable. The current evidence is therefore insufficient to conclude that stuttering is more prominent in bilinguals than in monolinguals.

Cause and Development of Stuttering in Bilinguals

Since the emergence of stuttering in bilingual children has been noted to coincide with the introduction of the second language (Karniol, 1992; Travis et al., 1937), it has been proposed that stuttering might arise out of bilingualism (Karniol, 1992). Karniol studied a Hebrew-English bilingual child, with some exposure to Hungarian, who was found to stutter in both the first (Hebrew) and second (English) language at 25 months of age, one month after the child became aware of her bilingualism. Karniol believed that the child started stuttering because she experienced a syntactic overload when developing two languages. More recently, Au-Yeung et al. (2000) also suggested that bilingual children may have a higher chance of stuttering if they learn a second language (L2) before the first language (L1) is fully developed. However, the existence of a causal link between bilingualism and stuttering has been challenged on two points: (a) not all bilingual children stutter, and (b) stuttering does not occur in bilinguals only.

Considering what is known about the disorder of stuttering (reviewed in Chapter One), it is more likely that BWS, just like their monolingual counterparts, have a genetically linked predisposition for developing the disorder, and that this can be affected by learning and environmental factors. Indeed, several investigators have associated the development of stuttering in bilingual children with factors such as economic insecurity and emotional instability resulting from changes in the living environment (Travis et al., 1937; Van Borsel et al., 2001), the input of linguistically mixed utterances or code switching (Bernstein Ratner, 2004; Lebrun & Paradis, 1984; cf. Shenker, Conte, Gingras, Courcy, & Polomeno, 1998), and similarities of language structure (Van Borsel et al., 2001). The influence of these factors on stuttering in bilinguals has not been thoroughly investigated, and as a consequence, the direction of their effect on stuttering is still unknown.

Manifestation of Stuttering in Bilinguals

Initial accounts of BWS suggested that stuttering may occur in one language but not the other (Dale, 1977; Van Riper, 1971). For example, Dale (1977) reported anecdotally on four bilingual Cuban-American adolescent males who were "quite proficient in Spanish and English" (p. 311), but stuttered in Spanish only. Dale attributed this finding to sociological and cultural factors where normal dysfluency evolved into stuttering; the individuals developed a fear of speaking Spanish after being pressured to do so without error. However, Nwokah (1988) argued that this phenomenon is rare and only occurs when the individual is far more proficient in one language than another.

The majority of past research into BWS indicates that stuttering will occur in all the languages in a speaker's repertoire (e.g., Bernstein Ratner & Benitez, 1985; Jankelowitz & Bortz, 1996; Jayaram, 1983; Nwokah, 1988; Roberts & Shenker, in press; Shenker et al., 1998; Van Borsel et al., 2001). Although some of these studies reported that stuttering patterns were the same in both languages (Lebrun, Bijleveld, & Rousseau, 1990; Van Riper, 1971; Woods & Wright, 1998), these claims were based largely on clinical impressions, with no supporting data. In particular, the study by Lebrun et al. reported on an individual who acquired stuttering following brain damage. It has been suggested that acquired stuttering differs from developmental stuttering because it may be more pervasive and tends to occur across all speech tasks (Ringo & Dietrich, 1995). Therefore, the report of equal manifestation of stuttering in both languages by Lebrun et al may have reflected this pervasiveness. Conversely, there is more evidence to indicate that stuttering behaviors are differentially manifested across languages. For example, Jarayam (1983) found a different degree of stuttering but similar loci of stuttering across languages. Other researchers have observed stuttering to vary in degree, type, and loci across the languages (e.g., Bernstein Ratner & Benitez, 1985; Jankelowitz & Bortz, 1996; Nwokah, 1988; Shenker et al., 1998).

It has been speculated that the uneven pattern of stuttering in bilinguals is dependent on bilinguals' abilities in one language relative to the other (language dominance). However, the influence of language dominance on stuttering in bilinguals is not yet clear. More stuttering has been reported in the language that is more proficient (e.g., Jayaram, 1983), less proficient (e.g., Jankelowitz & Bortz, 1996), and even in one of the languages spoken by balanced bilinguals who are supposed to have similar levels of proficiency in both languages (e.g., Nwokah, 1988). Moreover, linguistic complexity (e.g., Bernstein Ratner & Benitez, 1985) and sociopsychological issues that are associated with speaking a particular language (e.g., Nwokah, 1988) have also been postulated to affect stuttering behavior in BWS. Methodological issues may be likely causes for these equivocal findings: lack of operational definition, an unclear distinction between language proficiency and language dominance, inadequate examination of both languages spoken by BWS, limited speech samples, small sample size, and questionable reliability of measurements (see Chapter Five).

Theoretical Explanations of Stuttering in Bilinguals

Three of the models that were described in Chapter One have been used to account for some of the findings about stuttering in bilinguals. Karniol (1992) applied the neuroscience model (Nudelman et al., 1989) and the demands and capacities model (Starkweather & Gottwald, 1990) to explain the onset of stuttering in a bilingual child. Nwokah (1988) justified the disproportionate degree and pattern of stuttering in balanced bilinguals (equal abilities in both languages) by way of the neuropsychological model of the origin and maintenance of stuttering (Fiedler & Standop, 1983). These models were outlined briefly in Chapter One of this thesis in relation to monolingual speakers. The application of each of these models for BWS is explained in greater detail in Chapter Five, but a gist is provided here. Broadly, Karniol and Nwokah both recognized that BWS may experience higher linguistic or cognitive demands when they develop or use more than one language. The additional processing time or load (i.e., increased demands) may in some way burden the cognitive system, or destabilize the speech production system (i.e., reduced capacity), and consequently, stuttering results or is increased.

An important limitation of the above theories is the lack of reference to the potential influence of language dominance and language structure on the manifestation of stuttering in BWS. This is especially pertinent in light of the proposals that link language demand, which may be subject to crosslinguistic influences, and depressed linguistic skills with stuttering (see Boscolo, Bernstein Ratner, & Rescorla, 2002; Watson & Bernstein Ratner, 2005). Language dominance and language structure should be considered in any model which explains bilingual behavior, since these variables have been shown to significantly influence how bilingual speakers process each of their languages (see below).

Models of Bilingual Speech Production

Although models of bilingual language processing have been extensively investigated, the heterogeneity amongst speakers, both in terms of language combinations and proficiency, is rarely acknowledged. With this caveat in mind, the following section extends the discussion of the monolingual word production model (Levelt, 1989; Levelt et al., 1999; Roelofs, 2000) reviewed in Chapter One.

Levelt's (1989) distinct stage model has been adapted by several researchers to incorporate the framework for a bilingual speaker.[1] Adjustments to the model were necessary to account for the fact that bilinguals have two languages at their disposal, and are able to separate and mix their languages during speech. Whereas some of the models are restricted to bilingual lexical representation (e.g., Green, 1986), others provide more information about morphological and phonological encoding and about articulation in bilingual speech production (e.g., De Bot, 1992; De Bot & Schreuder, 1993; Poulisse & Bongaerts, 1994). The similarities between these models are unsurprising given that they were all based on Levelt's work, but there are also notable differences with respect to the formulation of the preverbal message, the existence of conceptual chunking, and lexical representation and retrieval. An overview of the models is provided here, but see Poulisse (1997) for a detailed review.

Green (1986) proposed the Inhibitory Control (IC) model and put forward the idea of control, activation, and resource in bilingual speech processing. This was intended to explain how bilinguals resist interference from internal and external competitors, disregard irrelevant information (intentionally or unintentionally), and ensure that target information is activated to achieve and maintain communication. Green suggested that to speak in a particular language, a bilingual must first effect control and select that language. Language selection is achieved on the basis of two suppositions: (a) words possess language tags that indicate the language to which they belong, and (b) there is an increase in the activation of words in the lexicon that are appropriately tagged and inhibition of the output from other active languages. Going one step further, De Bot (1992) postulated that the decision to speak in a particular language is made in the conceptualizer since it contains the bilingual's knowledge of the speaking environment, including communicative partners and their knowledge of languages. Such *macroplanning* is not thought to be language-specific. However, as languages differ in terms of how concepts are lexicalized (De Bot & Schreuder, 1993), it is proposed that further *microplanning* occurs where the preverbal message generated

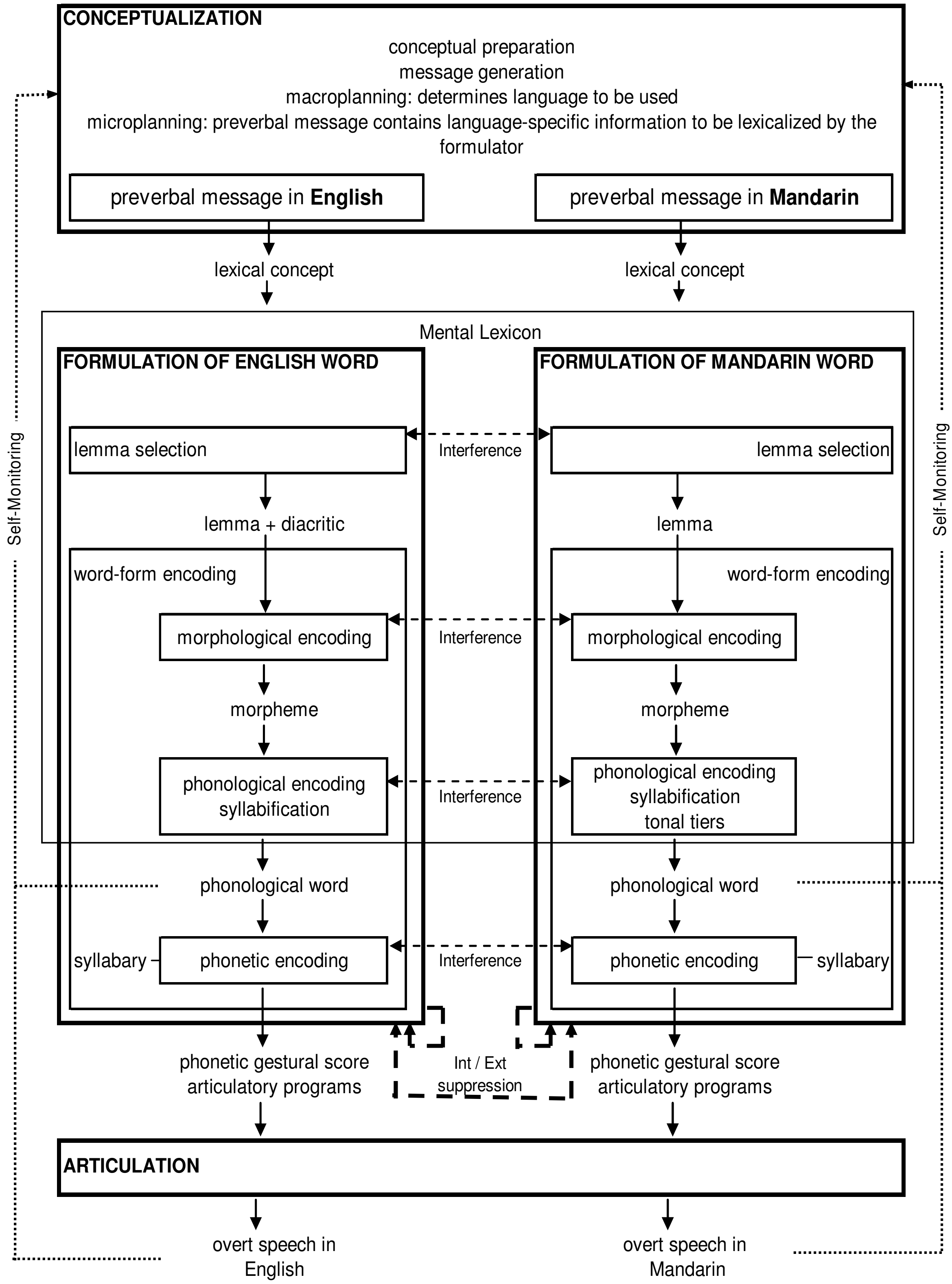
[1] Connectionist models (e.g., Dell, 1986; Dell & Oseaghdha, 1992) have been also adapted to account for bilingual speech production (e.g., Dijkstra & van Heuven, 2002; Grainger & Dijkstra, 1992). Unlike the distinct stage models (e.g., Levelt, 1989), connectionist models assume that activation spreads continuously through the lexicon, and word retrieval and encoding occur in parallel rather than serially.

contains language-specific information to be lexicalized by the formulator (see Figure 3.1).

According to De Bot (1992), lexical items in each language form different subsets, but are stored together in a common mental lexicon. Unlike the case in monolinguals, however, the relationship between the lemma and the word-forms in bilinguals is not one-to-one. Rather, depending on the language, the lemma can be linked to various form characteristics. Thus, the lemmas for each language can be activated simultaneously (Grainger & Dijkstra, 1992; Poulisse, 2000). The lexical items are then put through separate systems for grammatical and phonological encoding, although De Bot argued that this is more the case for languages that are typologically different or that have different scripts (e.g., Chinese vs. English). By the same token, Green (1986) argued that the subsystems mediating perception and production of either language are separable and that different functional systems underlie different languages. Consequently, word input and output for each language is independently represented. Thus, Green and De Bot agreed that Levelt's formulator is language-specific, with the formulator for each language functioning in exactly the same way as that for monolingual speakers. Whereas Green did not make specific reference to the articulator, De Bot proposed the existence of one articulator to which all information converges from different output components, namely syntactic, prosodic, and lexical. Unlike monolinguals, the articulator for bilingual speakers contains an extensive set of sound and pitch patterns from both languages.

The above hypotheses are supported to some extent by the results of brain imaging research. For example, studies of English-Mandarin bilinguals indicate that while proficient users show common regions of activation for both languages (Chee, Tan, & Thiel, 1999; Chee, Caplan et al., 1999; Klein, Milner, Zatorre, Zhao, & Nikelski, 1999), they also recruit a range of distinct neuroanatomical areas for phonological processing in each language (e.g., Tham et al., 2005). Overlapping but also different cortical areas for the two languages have also been reported in bilinguals who speak other alphabetic languages (e.g., Roux & Tremoulet, 2002).

Figure 3.1. Sketch of Integrated Bilingual Word Production Model, Adapted from Green (1989), De Bot (1992), De Bot and Schreuder (1993).



Producing Mixed Speech and Speech Errors

Green (1986) and De Bot (1992) concurred in their explanations of mixed utterances in bilinguals. In the case of code-switching, they suggested that both languages of a bilingual may remain active without the need for language suppression. That is, bilinguals produce two speech plans simultaneously when they code-switch, one for the selected language or the language currently used, and one for the active language, that is, the language that is active but not currently being spoken. To account for a bilingual's ability to translate from one language to another or switch between languages, Green argued that (a) words possessed language tags which allow them to be activated or deactivated depending on communication needs, and (b) a device called *the specifier* specifies how the system must be controlled for such tasks to be performed. Borrowing from Green, De Bot suggested that the availability of two speech plans allows bilinguals to stop encoding one language when problems occur and to continue encoding in the other language.

However, the presence of more than one active language can impose problems of cognitive control (Abutalebi & Green, 2007). Competition between languages can affect performance on various linguistic and cognitive tasks (see Hernandez, Li, & MacWhinney, 2005 for further discussion). Thus there is a need to inhibit the activity of one language when speaking in the other. Language suppression can occur internally within the language itself or externally from the other language, although the latter is more likely during spontaneous use (Green, 1986, 1993). Green (1986) also asserted that the activation and control of languages consumes limited resources. If such resources are insufficient, control becomes imperfect and speech errors result. This may account for the presence of involuntary intrusions and interference in the speech of bilinguals with or without brain damage. For example, bilinguals with aphasia make semantic, phonemic, and even tonal paraphasic errors in their speech, and healthy bilingual individuals frequently demonstrate slip-of-the-tongue phenomena during speech production. Moreover, non-brain-damaged bilinguals also exhibit speech accent (e.g., a French accent on an English word) suggesting the existence of cross-linguistic interference in their sound and pitch patterns. These behaviors, together with evidence from studies employing lexical decision, translation tasks, and priming paradigms, confirm that there is interaction between the bilingual's two languages at the level of semantic, orthographic, phonological, and phonetic processing (see Grainger & Beauvillain, 1988; Jared & Kroll, 2001; Kohnert, Bates, & Hernandez, 1999; Rickard Liow & Poon, 1998; van Heuven, Dijkstra, & Grainger, 1998). The dotted arrows in Figure 3.1 indicate such interaction between the two linguistic systems.

It has been demonstrated repeatedly that interference and bilingual performance during language switching and translation show directional asymmetry associated with language proficiency (Goral, Levy, Obler, & Cohen, 2006). More specifically, bilinguals tend to suffer more interference from the dominant language when speaking in the less dominant language than vice versa. There is also evidence showing that bilinguals are slower in translating from the more proficient language to the less proficient language than vice versa., and that these latency differences decrease with increasing L2 proficiency (e.g., de Groot & Poot, 1997; Kroll & Stewart, 1994). The levels of accuracy, automaticity, and speed in identifying and retrieving lexical items have also been found to correlate with the level of proficiency in each language (e.g., Chen & Leung, 1989; Kotz & Elston-Guttler, 2004; McElree, Jia, & Litvak, 2000), and with factors like the amount of similarity between languages and patterns of language use (e.g., Goral et al., 2006).

To explain why language proficiency affects bilingual performance, Green (1986; 1993) argued that greater energy is expended when bilinguals speak in the weaker language because the production of this language is less automatized and requires greater cognitive control. Hence, there are fewer resources left to suppress the activation of the dominant language (Costa, Miozzo, & Caramazza, 1999). This theory gains some support from neuroimaging data (e.g., Chee, Hon, Lee, & Soon, 2002; Green, Crinion, & Price, 2006; Hernandez & Meschyan, 2006; Perani et al., 1998). For example, Hernandez and Meschyan (2006) found that Spanish-English bilinguals who named pictures in the second, less dominant language relative to the native language exhibited increased activity in the dorsolateral prefrontal cortex (DLPFC) and the anterior cingulate gyrus, brain areas controlling executive function. This was noted in addition to the activity in brain areas involved in processing visual forms like objects or words, motor planning and/or articulation. The DLPFC and the anterior cingulate gyrus have been found to be involved in selecting response alternatives (Garavan, Ross, Li, & Stein, 2000), suppressing irrelevant items held in working memory (Baddeley, Emslie, Kolodny, & Duncan, 1998), and task switching (Dreher, Koechlin, Ali, & Grafman, 2002). Hernandez and Meschyan concluded that naming of pictures in a less dominant language engaged more attentional effort.

Relation to Stuttering

Linguistic Demands

Speaking fluently involves protecting the multilayer incremental system of speech planning and production from potentially interfering internal and external influences (see previous sections). Research has consistently shown that increased linguistic demands on the speech planning and production system can result in increased stuttering (Bernstein Ratner & Benitez, 1985; Bernstein Ratner & Sih, 1987; Kleinow & Smith, 2000; Melnick & Conture, 2000; Silverman & Ratner, 1997; Smith & Kleinow, 2000; Yaruss, 1999). For instance, Berstein Ratner and Sih (1987) found that monolingual children stuttered more on syntactically complex structures, and that syntactic complexity was more highly correlated with stuttering than was syllable length of the utterance. The same effect was also reported by Kleinow and Smith (2000) for monolingual adults who stutter. Using a spatiotemporal index (STI) to quantify the stability of lower lip movements across multiple repetitions of the target phrase, these authors found that adults who stutter evidenced decreased speech motor stability when producing utterances of increasing syntactic complexity, but not when producing utterances of increasing length without a corresponding rise in syntactic complexity. Likewise, Melnick and Conture (2000) showed that the stuttered utterances of the children in their study were significantly more complex and longer than the nonstuttered utterances. They concluded that increased length and/or grammatical complexity of an utterance influenced the frequency of stuttering. Such findings show that the consistency of speech motor control is susceptible to linguistic complexity and hence to processing load.

Cognitive Demands (Dual Tasking)

The vulnerability of the speech motor system to higher processing demands has also been demonstrated in PWS who are subjected to dual task paradigms (Bosshardt, 1997, 1999, 2002; Bosshardt, Ballmer, & De Nil, 2002; Bosshardt & Fransen, 1996). Bosshardt (1997) proposed that "speech dysfluencies can be the result of an interference between the execution of speech movements and concurrently performed cognitive processes” (p. 503). On the premise that subsequent portions of an utterance still undergo processing while earlier portions are being produced, Bosshardt (2006) argued that there is fluctuating cognitive processing load during speech production, and that this affects stuttering frequency. Thus, Bosshardt and his colleagues designed dual task paradigms, using either word repetition or sentence production as primary tasks and verbal-linguistic tasks as secondary tasks, to experimentally manipulate the effect of additional attention-demanding coding processing on speech production, and in particular, speech fluency (Bosshardt, 2006).

In one experiment, Bosshardt (2002) compared the performance of a group of German speaking monolinguals who stuttered with those who did not stutter on a word repetition task. The adult participants performed word repetition as a single task, and again while concurrently performing a secondary task: either silent reading or word memorization. Whereas the non-stuttering adults were not affected by either secondary task, the adults who stuttered were found to stutter more during word repetition when similar words were read or memorized concurrently. Bosshardt concluded that the phonological and articulatory systems of PWS may be more sensitive to interference by attention-demanding processing within the central executive system (cf. Green, 1986, 1993) than those of non-stuttering persons.

In another study, Bosshardt et al. (2002) asked PWS and persons who did not stutter to formulate sentences while performing rhyme and category decisions. In contrast with word repetition, the immediate sentence production task was considered to be more cognitively challenging as it required individuals to generate and produce sentences that contained two specific nouns. Whereas the length of sentences produced by persons who did not stutter was unaffected by the increased processing load, the PWS were found to produce fewer prepositional units and shorter sentences under the dual task than under single task conditions. This indicated that PWS may also decrease the length and content of their verbal productions to cope with increased concomitant cognitive and memory processing. Thus, in addition to increasing their stuttering severity, PWS may also try to moderate the amount of concomitant processing demands by reducing the conceptual work invested in speaking (Bosshardt, 2006).

As a whole, the above findings have been interpreted as suggesting that the subprocesses used in speech planning and production are less modularized in PWS than in those who do not stutter, and that this leads to higher stuttering rates (Bosshardt, 2006). Recent work by Smits-Bandstra and co-workers (Smits-Bandstra & De Nil, 2007; Smits-Bandstra, De Nil, & Rochon, 2006) supports this view. These authors also found that the performance of PWS on practiced dual tasks was comparatively slower, less accurate, and more attention-demanding than that of those who do not stutter. Such data plainly indicate that PWS are affected by higher computational load and have difficulty with the automatization of sequence skill learning even after practice.

The notion that PWS experience greater sensitivity to interference between speaking and concurrent cognitive processing has also been supported by functional magnetic resonance imaging (fMRI) data (see Bosshardt, 2006; De Nil & Bosshardt, 2000). De Nil and Bosshardt (2000) compared the neural activity of PWS and nonstuttering persons while they performed sentence generation and articulation in single and dual task experiments. Compared to those who did not stutter, PWS were found to exhibit (a) bilateral prefrontal cortex and left Broca's area activity under the single task condition, suggesting increased pre-articulatory neural activation, (b) comparatively higher activations in the cortical areas related to motor planning and execution under dual task conditions, and (c) activation of the speech motor areas during both sentence generation and articulation. The authors interpreted this finding to mean that PWS utilized similar neural substrates for speech planning and articulation, and therefore required more central processing capacity to generate and overtly articulate a sentence than nonstuttering individuals (Bosshardt, 2006).

Interference from simultaneous attention-demanding processing has also been shown in PWS who perform nonverbal tasks (Smits-Bandstra et al., 2006; Webster, 1986, 1988, 2004). Webster (1986) found that PWS evidenced significantly more response decrement (i.e., interference) than nonstuttering speakers when performing repetitive sequential finger tapping and index finger tapping with the right hand (a task mediated by the left hemisphere) while concurrently executing paced knob-turning or button-pressing with the left hand. Interestingly, the two groups did not differ in interference under the reversed condition of left-hand finger tapping and right-hand concurrent paced tasks. In the 1988 study, Webster employed a bimanual handwriting task and similarly found that PWS were slower and less accurate than fluent speakers when writing initial letters of words simultaneously using both hands. Webster concluded that such interference effects reflected neurological mechanisms and used these findings to substantiate his Interhemispheric Interference model for the origin of stuttering. In that model, Webster proposed that the left hemisphere was not only engaged in controlling its own neural activity, but was also vulnerable to interference by concurrent right-hemisphere activity (discussed in Chapter One).

Overall, the findings of Webster (1986; 1988) are considered compatible with those of Bosshardt and colleagues (1997; 1999; 2002; Bosshardt et al., 2002), and also with the information presented in the previous sections regarding the impact of linguistic demands on stuttering, and of language proficiency on bilingual language processing.

Bilinguals Who Stutter

Along the same lines, it is reasonable, therefore, to assume that the speech of BWS is also susceptible to interference from concurrently performed cognitive processing. For BWS, however, attention-demanding processing may come in the form of maintaining and controlling two interconnected language and speech systems while simultaneously suppressing competing alternatives, especially if one language is more dominant. Therefore, a feasible question might be whether stuttering patterns are differentially affected in bilinguals, and whether this might be related to language dominance. Further, since stuttering has been associated with a weakness at varying levels of linguistic processing (see Newman & Bernstein Ratner, 2007 for lexical retrieval; Packman et al., 2007 for phonetic encoding; Postma & Kolk, 1993 for phonological encoding), and because there exist inherent crosslinguistic differences at each processing level, another question is whether stuttering patterns in BWS are related to language structure. For instance, in the case of English-Mandarin bilinguals, the additional need for processing lexical tones might further undermine linguistic or motor planning and execution, and lead to more stuttering in Mandarin than in English. An alternative viewpoint is that stuttering may be less in Mandarin compared to English because there are fewer syllables in Mandarin and its phonotactic system is also less complex (Chen et al., 2003). Perhaps the effects of language dominance and language structure on stuttering in BWS are interrelated.

At this stage, the answers to these questions remain unclear. More data are required for a better understanding of how stuttering presents in BWS and the reasons for the observed similarities or differences. Such information will no doubt help SLPs to devise appropriate guidelines for the assessment, diagnosis, and treatment of stuttering in bilinguals. Following this, a discussion of what is known from the literature about each of these clinical issues is provided.

Assessment and Diagnosis of Stuttering in Bilinguals

The assessment of stuttering in bilingual individuals is no doubt more challenging than in monolingual speakers. This is because SLPs need to take comprehensive language histories and conduct speech assessments and analyses in two languages, while remaining mindful of the client's cultural background and how it may affect the completion of such tasks. Clinicians also need to ensure that they perform a detailed assessment of their client's proficiency level in each language.

With regard to interpreting the information collated, Roberts and Shenker (in press) cautioned against potential threats to the validity and reliability of stuttering assessments. These threats include the effects of adaptation or practice, and issues related to assessment reliability, domains of language use, and reduced language proficiency. To overcome (a) the effects of practice and (b) the variable nature of stuttering, when a task is performed twice, Roberts and Shenker recommended the counterbalancing of speech sampling within and across languages, and the collection of multiple samples of speech in each language. They also advised that observed stuttering behaviors be interpreted with consideration of the client's level of proficiency in one language relative to the other, and the domain of language use and topic of conversation to which the client is accustomed. This is because slower speech rate, pauses, revisions, interjections, or shorter sentences may reflect bilingual coping strategies, or normal disfluencies that are related to limited language proficiency rather than stuttering per se (Roberts & Shenker, in press; Watson & Kayser, 1994). Further, Roberts and Meltzer (2004) observed that certain speech disfluencies can be language-specific. These authors found that nonstuttering French speakers produced twice as many stuttering-like disfluencies, and more prolongations and word repetitions than nonstuttering English speakers. Although a comparison with normative data would prove helpful, this may not always be possible as data about the expected range of normal disfluencies are not available for every language or culture.

Another challenge that SLPs face when assessing BWS is the accuracy with which they can judge the severity and type of stuttering in an unfamiliar language. In a recent study, Van Borsel and Medeiros de Britto Pereira (2005) found that judges who were monolingual in either Portuguese or Dutch experienced greater difficulty and were less accurate in identifying stuttering behaviors in a foreign language than in their native language. This finding has important ramifications for clinical practice. Thus, to facilitate accurate diagnosis and assessment of stuttering in BWS, it is best that SLPs are familiar with their clients' languages and culture. If not, it has been recommended that SLPs compare their identification of stuttering moments with their client's self-judgment (Finn & Cordes, 1997), or seek the assistance of native speakers of the language to gain a better understanding of the cultural issues involved in the assessment of linguistically diverse populations (Bernstein Ratner, 2004; Taylor, 1986).

The above issues also need to be considered when diagnosing stuttering in bilingual speakers. Although there are no specific diagnostic guidelines available in the literature, SLPs should consider the presence or absence of the following factors when making a differential diagnosis of stuttering, especially in young children: (a) stuttering behaviors in both languages, (b) secondary behaviors in both languages, (c) negative reactions towards communication in both languages, and (d) familial history of stuttering (for details, see Mattes & Omark, 1991; Roberts & Shenker, in press; Van Borsel et al., 2001; Watson & Kayser, 1994). Such factors may also apply to older children and adults who stutter. Clearly, a detailed and comprehensive assessment of stuttering in both languages will also improve our understanding of how stuttering presents in BWS.

Treatment of Stuttering in Bilinguals

A review of the literature found few published studies of the treatment of stuttering in bilingual individuals. Not surprisingly, therefore, there is little empirical evidence to guide clinicians in their therapeutic management of BWS. This section presents information about the areas of agreement and controversy surrounding the treatment of stuttering in BWS.

Treatment Outcomes between Bilinguals and Monolinguals

There are few studies with convincing evidence which compare treatment outcomes between bilinguals and monolinguals who stutter. Waheed-Kahn (1998) evaluated the treatment outcomes of a group of bilingual children who stutter (CWS) with those of monolingual CWS at the Hospital for Sick Children in Toronto. The author found that the bilingual children demonstrated a lower degree and slower rate of fluency improvement than their monolingual peers. In other group studies, however, no significant differences were found between monolingual and bilingual CWS in their fluency outcomes following treatment (Druce, Debney, & Byrt, 1997; Shenker, 2004). In addition, Shenker (2004) found that the time taken for each group of children to achieve fluency targets was not significantly different. To the candidate's knowledge, there are no known studies which compare treatment outcomes between bilingual and monolingual adults who stutter. Undoubtedly, more data are required to ascertain whether bilinguals and monolinguals who stutter differ in their response to treatment.

Nonetheless, irrespective of whether one is bilingual or monolingual, there appears to be a broad consensus that the different treatment methods available—stuttering modification, fluency shaping, or a combination of both—produce similar results in other languages to those in English (Roberts & Shenker, in press).

Treatment of Bilingual Children

There is concurrence amongst researchers that stuttering treatment programs for children from multilingual and culturally diverse backgrounds should be culturally sensitive and involve parental participation (Bernstein Ratner, 2004; Shenker, 2004; Waheed-Khan, 1998). Waheed Kahn (1998) compared the results of a group of bilingual CWS who in 1993 were treated in English only, with that of another group of bilingual CWS in 1995 who received treatment in both English and their native language. The bilingual children in the earlier study were found to participate minimally in the treatment program, and only a small percentage were observed to achieve fluency (20%), or self-correct their stutters (15%). Following the modification of the fluency shaping treatment program to incorporate the use of culturally appropriate stimulus materials and mandatory involvement of a family member, Waheed Kahn found that the number of children who improved in fluency (75%) and in their ability to self-correct their stutters (75%) increased in the latter study. Overall participation in the treatment program was also found to improve.

A controversial therapeutic suggestion that has been frequently recommended for bilingual CWS is the temporary interruption of the use and exposure to two languages (Karniol, 1992; Rustin, Botterill, & Kelman, 1996; Van Borsel et al., 2001). In Karniol's (1992) study (discussed earlier), the bilingual child was found to stop stuttering after the language environment was changed to a monolingual one. The re-introduction of English 6 months later resulted in minimal or no stuttering in both languages. It was concluded that a bilingual child should not be exposed to a second language until good control of the first language was achieved.

However, based on what is now known about the natural recovery of stuttering in young children, it is arguable that the child in Karniol's (1992) study might have experienced spontaneous remission of stuttering without the need for the withdrawal of the second language. This viewpoint cannot be proven. Nevertheless, it may not be practical or desirable to prohibit families from using one of their languages so as to avert stuttering, especially if they can only interact with each other in that language (Van Borsel et al., 2001). Such advice could result in social isolation of the child and impact its language development in either or both languages. Other researchers have offered alternative advice. Stahl and Totten (1995) suggested deferring bilingualism only for children who have a familial history of stuttering or who have other speech and language disorders, and Rustin et al. (1996) proposed a "one person, one language" rule for parents of CWS.

At this stage, there is no credible data to support or refute these recommendations (Shenker, 2004). However, evidence is emerging to show that stuttering in young children can be successfully treated while maintaining bilingualism throughout the course of treatment (see Roberts & Shenker, in press; Shenker, Courcy, Gingras, & Polomeno, 1997; Van Borsel et al., 2001).

Treatment in One or Two languages

A logical question when treating stuttering in bilinguals is whether BWS should receive treatment in one or both languages. Although monolingual and bilingual treatment approaches have been trialed previously, both with positive outcomes, it is still unclear whether either method is superior. The issues relating to bilingual intervention are first reviewed, followed by a discussion on the monolingual treatment approach.

Bilingual Intervention

Investigators who have adopted bilingual intervention have delivered stuttering therapy either simultaneously (Harrison, Kingston, & Shenker, in press; Roberts & Shenker, in press; Waheed-Khan, 1998) or via a consecutive approach (Roberts & Shenker, in press; Scott Trautman & Keller, 2000; Shenker, 2004; Shenker et al., 1998). Harrison et al. (in press) described an English-French bilingual preschooler who was treated with the Lidcombe Program, a behavioral treatment program developed by Onslow and colleagues (see Onslow, Packman, & Harrison, 2003). Treatment was delivered in English by the father and in French by the mother, and the child's stuttering in both languages reduced to under 1%SS following treatment. Shenker and colleagues (1998) studied an English-French bilingual child who also underwent the Lidcombe Program. In that study, however, treatment was initially delivered in English, the child's dominant language. Bilingual therapy sessions commenced later, but only after fluency levels in the dominant language decreased to less than 3%SS for 3 consecutive weeks. Although both the frequency and the severity of stuttering were found to reduce in both languages, the degree of fluency improvement was observed to be greater for English than for French.

The above results suggest that better outcomes in both languages may be possible if bilingual intervention is provided at the outset. However, no conclusions can be drawn as yet since the available data were derived from only two single-case studies. In either scenario, language or environmental barriers often exclude the option for therapy to be offered in both languages.

Monolingual Intervention

In spite of the fact that bilingualism is a common phenomenon, most SLPs may be able to administer treatment in only one language. Regardless, there are two points of contention about the monolingual intervention approach: whether stuttering reductions in the treated language spontaneously generalize to the untreated language and which of the two languages should be used to deliver treatment.

There are anecdotal reports and case studies which suggest the occurrence of automatic transfer of treatment effects when treatment is provided in one language only (for details, see Roberts & Shenker, in press; Shenker et al., 1998; Van Borsel et al., 2001). In one of the few published studies, Woods and Wright (1998) reported that it was possible to treat stuttering in the primary language by focussing on treatment in the second language. These authors studied a bilingual adult who reported equal severity of stuttering in both Russian, the native language, and English, the second language. After receiving a simplified regulated breathing treatment program in English only, presumably the weaker language, the participant self-reported that stuttering reductions in English had generalized to the native language of Russian. This study was methodologically weak in that the speech measurements were limited to English, and the conclusion as to positive treatment generalization was based purely on self-report data. The authors rightly highlighted that "objective measures of stuttering in the Russian language would have allowed a more adequate assessment of treatment generalization" (p. 185).

On the other hand, although Shenker and co-workers (1998, 2004) used a consecutive bilingual intervention approach (discussed in the previous section), their results indicated that treatment generalization could also occur when treatment was provided in the participant's dominant language. The authors started to deliver direct treatment in English at week 16, and reported that "stuttering had already begun to reduce in French" (Shenker, 2004, p. 87) when bilingual therapy sessions were initiated at Week 23. However, even though treatment effects were observed to carry over simultaneously and spontaneously to French, the degree of stuttering reduction across the two languages was noted to be asymmetrical. Similarly, Roberts and Shenker (in press) and Van Borsel et al. (2001) also provided other unpublished examples of BWS who experienced varying levels of stuttering reductions in the untreated language following treatment in the dominant language.

As with the case for the manifestation of stuttering in BWS, it has been proposed that treatment generalization in BWS may also be influenced by factors such as language dominance, language similarity, or treatment factors (Roberts & Shenker, in press). In the absence of empirical data, the relationship between these factors and the extent of spontaneous generalization of treatment effects is unclear. Clearly, further research into the treatment of BWS is warranted.

Summary

As highlighted in the preceeding sections, stuttering in bilinguals is an under-researched area. A review of the literature revealed that the majority of the extant studies were unpublished, anecdotal, or based on single case investigations. As a consequence, there is currently little or no empirical evidence on which SLPs can draw to direct clinical practice. Specifically, there are no clear guidelines for the assessment, diagnosis, and treatment of stuttering in bilinguals.

Based on the few studies available for critique, it appears that stuttering may manifest differentially in BWS, and this may be influenced by the level of proficiency and the structural similarity between languages. However, in view of the inconsistent results among previous studies, these issues remain unresolved. Likewise, the information regarding the treatment of stuttering in bilinguals is sketchy. Although the various treatment methods seem to be successful in reducing stuttering in BWS, it is at present unclear whether treatment delivered in both languages yields better fluency outcomes than treatment delivered in one language only. Even if bilingual intervention was found to be more effective, this therapeutic recommendation may not be tenable for the vast majority of SLPs who are either monolingual or who do not speak all of the languages of their clients. Therefore, it is important to know whether treatment effects in one language generalize to the other. Automatic transfer of stuttering reductions from the treated to the untreated language has been reported previously, and this has also been linked to language proficiency or to structural similarities between languages. Again, based on the limited available data, the role that language proficiency and language structure might play in treatment generalization is still poorly understood.

Taken together, the conflicting information about the severity and presentation of stuttering across languages in BWS, and the lack of information about generalization effects means that SLPs cannot make predictions about stuttering in languages with which they are unfamiliar, pre- and posttreatment. One topic that warrants further investigation is the influence of language dominance on stuttering behavior and the extent to which stuttering reductions in one language spontaneously carry over to the other. This topic is of particular clinical importance because it directly affects the accuracy of stuttering assessment and diagnosis, and has an impact on clinical decision making regarding which language to use for intervention.

The Focus of this Thesis

The primary focus of this thesis is to study the influence of language dominance on stuttering behavior and treatment generalization. To this end, it is necessary to resolve two pertinent issues. The first relates to language similarity as a potentially confounding variable. In previous research on BWS, comparisons were commonly made between languages which originated from the same language family (i.e., Indo-European) and so were more structurally similar than dissimilar (e.g., English vs. Spanish). A possible way to delineate the influence of language similarity from that of language dominance is to study a bilingual population who speak two distinct languages, for example, English and Mandarin (see Chapter Two). Another reason why it is interesting to examine stuttering in Mandarin is that there are currently fundamental gaps in our knowledge of the incidence, presentation, assessment and treatment of stuttering in Asian cultures and languages. Although stuttering is a recognized disorder in Chinese speaking populations (Ming, Jing, Wen, & Van Borsel, 2001), stuttering has never been systematically investigated in any Chinese languages in China, or even in other countries where the population is predominately Chinese (e.g., Hong Kong, Singapore, Taiwan).

The second and more important issue concerns the establishment of a method for determining which language is more dominant. Language proficiency and language dominance are overlapping and complex constructs (Birdsong, 2006b), and there is still controversy surrounding their assessment and measurement. However, when comparing relative ability in two languages, it may be more pertinent to measure language dominance rather than language proficiency. To date, a standardized means of assessing language dominance is unavailable. Thus, a necessary first step was to find a suitable tool to measure language dominance. Such a tool would need to be both valid and reliable, as well as convenient to use for clinical and research purposes. Hence, the aim of the first study in this thesis was to develop and validate a bilingual classification tool for identifying the dominant language in English-Mandarin bilingual speakers. This study is presented in Part Two, Chapter Four of this thesis, and contains a review of the relevant issues in assessing language dominance, the factors that influence dominance assessment, and their applicability to multilingual Asian populations.

Following the development of valid tool for classifying language dominance, the next step was to examine the influence of language dominance on stuttering behavior and stuttering treatment in BWS. These topics were examined in two separate studies in Part Three of this thesis. The second study of this thesis investigated the manifestation of stuttering in English-Mandarin BWS and is presented in Chapter Five. In that study, the presentation of stuttering in both English and Mandarin was systematically investigated in a group of English-Mandarin BWS who had different language dominance profiles: English-dominant, Mandarin-dominant, and balanced bilinguals. The results of this study provided pretreatment baseline data for the third study of this thesis in which the stuttering behavior of a subgroup of English-Mandarin BWS was compared pre- and posttreatment. The aim of this third and final study was to examine the influence of language dominance on treatment generalization in English-Mandarin BWS. In that study, treatment was provided in English only, and stuttering in both English and Mandarin at pretreatment was systematically compared with that at three posttreatment intervals. The study is reported in Chapter Six of this thesis.

PART TWO

DETERMINING LANGUAGE DOMINANCE

CHAPTER FOUR

DETERMINING LANGUAGE DOMINANCE IN ENGLISH-MANDARIN BILINGUALS: DEVELOPMENT OF A SELF-REPORT CLASSIFICATION TOOL FOR CLINICAL USE[2]

[2] This chapter is a reprint of an article submitted to Applied Psycholinguistics for publication by the candidate as first author, and co-authored with Michelle Lincoln, Yiong Huak Chan, Susan Rickard Liow, and Mark Onslow. The candidate was the chief investigator in the research described. This article is currently under review.

Abstract

In multilingual Asian communities, determining language dominance for clinical assessment and intervention is often complex. The aim of this study was to develop a self-report classification tool for identifying the dominant language in English-Mandarin bilinguals. Participants (*N* = 168) completed a questionnaire on language history, and single-word receptive vocabulary tests (PPVT-type) in both languages. The results of a discriminant analysis on the self-report data revealed a reliable three-way classification into English-dominant, Mandarin-dominant, and balanced bilinguals. The vocabulary scores supported these dominance classifications whereas the more typical variables such as age of first exposure, years of formal instruction, and years of exposure exerted only a limited influence. The utility of this classification tool in clinical settings is discussed.

Introduction

A bilingual is anyone who can communicate in two languages by speaking, writing, listening, or reading whether or not proficiency is native-like. Bilinguals outnumber unilinguals worldwide (De Bot & Kroll, 2002) but a simple dichotomy may not be tenable in many Asian countries where English is often the lingua franca but family language is very important. For example, bilinguals in Singapore often acquire and use one language at home (Mandarin, Malay, or Tamil) but rely on English for education and subsequent employment. Even for early bilinguals—those who learn their family language and English simultaneously before the age of six—one language is usually dominant. This kind of language history is widespread in Asia and makes speech-language assessments complex. In particular, it raises the question of how much knowledge of a language is required before a person can be classified as a balanced bilingual, and treated accordingly.

Even though bilinguals may be proficient in two languages, their competence may not be equivalent across domains (home vs. classroom/workplace). Moreover, language use and the nature of bilingualism often change across the lifespan if the acquisition of one language is interrupted and insufficient, or if the learning of one language is more structured and formal because it involves reading and writing as well as speaking and listening. In fact, receptive bilingualism (understanding but not speaking/writing a parent's language) is likely to be much more common than academic proficiency in any linguistic setting where the home language receives little emphasis in school.

These complex patterns of language acquisition have made it hard to ascertain which language is the dominant one. Several methods for determining language dominance in bilinguals have been proposed (Flege et al., 2002; see also Grosjean, 1982). However, these have been designed mainly for migrant populations who use a native or first language (L1), and then acquire a second language (L2) after immigrating to the L2-speaking country as adults, usually after 15 years of age. This renders them unsuitable for establishing language dominance in multilingual multicultural countries such Singapore, Malaysia, Taiwan, China, and India, where the distinction between L1 and L2 is less clear-cut and varies from one family to another. To our knowledge, a classification system for language dominance in a multilingual Asian context has not been systematically investigated before, and hence the focus of this methodological study.

Language dominance is easily confused with language proficiency. Birdsong (2006b) suggests that dominance, in psycholinguistic terms, usually indicates a difference in processing ability between L1 and L2 while proficiency is viewed in terms of the mastery of syntax, vocabulary, and pronunciation of a language. Even though "levels of proficiency and degrees of dominance tend to correlate" (Birdsong, 2006b; p. 47), bilinguals can have almost native-like proficiency in both languages but still consider one language to be better than the other. Alternatively, they may be dominant in one language (L1 or L2) but not necessarily be highly proficient in that language.

Despite the considerable overlap between language dominance and language proficiency, for clinical practice it may be more relevant to measure dominance. Speech-language pathologists routinely work with a range of bilingual clients (e.g., Bernstein Ratner, 2004; Finn & Cordes, 1997), and they need to determine which language (if any) is dominant in order to assess the nature of any disorder, and establish which language that they should use for intervention. It is not clear which parameters are important in a particular setting. The array of parameters for *late bilinguals* (i.e., those acquiring L2 after 10 years of age) (Perani et al., 1998) include age of acquisition

(AoA) and age of first exposure (AoE), function and frequency of language use, the manner, environment, and years of language instruction and exposure, stability of language acquisition, age of arrival (AOA) and length of residence (LOR) in the L2 speaking country, language modes, and the level of language proficiency for understanding, speaking, reading, and writing (Flege et al., 2002; Grosjean, 1998; Langdon et al., 2005; Obler et al., 2000). These variables correlate with key theoretical concepts in L2 language processing and representation (Chen & Leung, 1989; Li, Sepanski, & Zhao, 2006) but they are not always meaningful as determiners of language dominance in *early bilinguals*. A priori, there should be differences for AoE, years of language instruction and language exposure for bilinguals in Asian countries such as Singapore who are exposed to both languages before five years of age.

Children in Singapore are usually exposed to at least two of the four official languages—English, Mandarin, Malay and Tamil—in the home through local television and radio broadcasts and other public services (e.g., transport, shopping centers). Depending on their ethnic background, they are expected to become bilingual and literate in English (main medium of instruction) and in either Mandarin, Malay, or Tamil during their primary education which occurs from 6 to 12 years of age. This bilingualism continues through secondary education and into adulthood but pupils vary considerably in their use and level of proficiency in each language. Even though the majority of Singaporeans function at the bilingual end of the Grosjean's (2001) continuum, some may acquire balanced abilities in both languages while others develop dominance in one language, or in particular modalities. For many bilingual Singaporeans, however, a common pattern is to use Mandarin for speaking but to read and write more in English. Whether AoE, years of formal instruction, and the number of years of language exposure—parameters that have been found to correlate strongly with language proficiency and dominance in bilinguals from non-Asian settings—can effectively discriminate the dominant language in bilinguals in Singapore, or are associated with self-rated proficiency in all four language modalities has not been formally investigated. One might expect, for example, an inconsistent pattern in the relationship between the three parameters and the self-rated proficiency for individual language modalities since levels of proficiency may be modality specific.

For studies that have relied exclusively on self-report, the selection and weighting of variables for deciding dominance in bilinguals who speak non-Asian languages varies considerably and seem somewhat arbitrary. Cutler, Mehler, Norris, and Segui (1992) and Golato (2002) asked their French-English participants to state the language they would choose to keep if they were in a hypothetical situation where they could keep only one language. More conventionally, Altarriba (2003) classified her Spanish-English speakers as balanced bilinguals only when there were no significant differences in their self-reported ability to understand, write, and converse in the two languages. Tokowicz, Michael and Kroll (2004) used a similar procedure for their Spanish-English bilinguals but then re-assigned four participants to the L2-dominant group because they were living in an L2 environment.

In addition to using single self-report measures to classify language dominance, other investigators have adopted a combination of two or more parameters including objective measures of proficiency. However, there is little agreement about how to combine measures, or how to interpret the scores from the different tests for the purpose of language dominance classification. In one of the five studies conducted by Flege et al. (2002), self-report and objective tests were used (self-ratings of proficiency and a sentence repetition task) to divide participants into one of three groups: Italian-dominant, English-dominant, and balanced bilinguals. The resulting classifications were then compared with the data obtained for AOA, LOR, language use, and two other objective measures (sentence translation and strength of foreign accent). Self-rating ratios were calculated from the bilinguals' ability to speak and understand Italian compared to English (verbal self-rating ratios), and read and write Italian compared to English (written self-rating ratios). Sentence duration ratios were also derived by dividing the mean duration of English sentences by that of Italian sentences. These three ratios were then ranked-ordered and averaged so that each bilingual received an average rank score. The authors then assigned *equal* numbers of bilinguals in each group: the 18 bilinguals with the highest and lowest ranks were classified Italian-dominant and English-dominant respectively, whereas the remaining 18 were considered balanced bilinguals.

Flege et al.'s (2002) rationale for dividing the 54 participants into equal size groups is unclear, but their use of multiple measures for language dominance classification is commendable. The main problem is how to decide on the combination of tests to use for assessing dominance in Asian bilinguals. It is difficult to generate equivalent objective tests in different languages (Grosjean, 1998), and especially challenging when the two languages are structurally dissimilar. For example, English and Mandarin are sharply contrasted in terms of orthography, phonology and morphology. There is also a range of objective assessments and little consensus about which is best: standardized or non-standardized assessments of language ability (e.g., Bialystok & Miller, 1999; Jared & Kroll, 2001), scores from a standardized examination such as TOEFL (e.g., Golestania, Alario, Meriaux, et al., 2006), and various laboratory tests of speed, fluency, and automaticity (e.g., Flege et al., 2002). Therefore, a more acceptable approach might be to first determine language dominance using self-report ratings (Langdon et al., 2005), and then use the results of objective tests to substantiate rather than used as a determiner of language dominance (Grosjean, 1998).

There is a growing body of research which shows that self-assessments of proficiency are valid and reliable measures of language skills, and are correlated highly with ratings by experienced judges and standardized tests (Grosjean, 1982; Langdon et al., 2005; Oscarson, 1989). However, Grosjean (1982) argued that language dominance assessments should not only consist of proficiency measurements of bilingual's ability to understand, speak, read, and write a language, but also include an examination of how a bilingual uses the two languages. In particular, he emphasized the need to consider the frequency and domain of language use. Previous researchers have used self-report measures to determine language dominance, but prior to this study, none have used data from all three of the key variables: language proficiency, frequency of language use, and domain of language use.

One complication that will arise whenever two or more measurements are employed is that the results derived from different tests do not always converge (e.g., Chincotta & Underwood, 1999; Jared & Kroll, 2001; Langdon et al., 2005). For example, Langdon et al. (2005) discovered that only eight of the 25 bilinguals received the same bilingual group classification across their two objective assessments, Word Listing by Domain (WLD) and the Alzheimer's Quick Test: Assessment of Parietal Function (AQT). A planned deliverable for this study was to develop a way of handling potentially conflicting classification results systematically by using a predetermined set of criteria.

The use of objective tests as a means of validating self-report measures of language dominance may not be easily adopted in Asian countries such as Singapore where a perennial problem is the lack of culturally specific, standardized objective assessments. Therefore, an alternative method of validating our self-report tool was required. In their recent study, Li et al. (2006) used a discriminant analysis to show that their method of measuring overall L2 proficiency could correctly classify their bilingual participants into three L2 proficiency groups: low, medium, and high. This same statistical procedure would also be valuable for validating the accuracy of our self-report classification tool.

To summarize, the main aim of this study was to develop systematic guidelines for interpreting a self-report classification tool comprising ratings of language proficiency, and frequency and domain of language usage. The tool was validated using a discriminate analysis and a simple measure of proficiency such as receptive vocabulary. The second aim was to explore the relationship between the three principal parameters referred to in the literature on bilinguals from non-Asian settings—age of first exposure (AoE), years of formal instruction, and years of exposure—and their utility for distinguishing between bilinguals with different dominance patterns and proficiency self-ratings.

Method

Participants

One hundred and ninety eight bilingual English-Mandarin speaking undergraduates from the National University of Singapore (NUS) volunteered to participate in the study. These bilinguals were (a) of Chinese descent, (b) born in Singapore, and (c) reported having English and Mandarin as the first and/or second language, and exposure to both languages before 7 years of age. Twenty participants were excluded on the basis of incomplete questionnaires or failure to meet the above inclusion criteria. The mean age of the remaining 168 participants was 20.1 years (*SD* = 1.32, range 18 – 24 years). There were 116 women and 52 men in the group.

Materials

Language dominance was determined by examining participants' responses to a self-report classification tool (see Appendix A) before validation using the discriminant analysis and an objective measure of receptive vocabulary in both languages. The tool is essentially a questionnaire which was adapted from the History of Bilingualism (HOB) questionnaire (Paradis, 1987) and the Language Background Questionnaire (LBQ) by Rickard Liow and Poon (1998). It was chosen over more recent tools (e.g., Li et al., 2006) because the questions are less biased towards measuring L2 proficiency. The questionnaire asks participants to provide information about age of first exposure for all languages in their repertoire across the four language modalities: understanding, speaking, reading and writing. Specific questions for each modality include ranking current proficiency of each language using a 7-point self-rating scale (Kohnert, Hernandez, & Bates, 1998) where 1 = very few words and 7 = native speaker, ranking of the language they use most often at home, work, and socially, quantification of how frequently they use each language, and also information about school examination grades.

The Multilingual British Picture Vocabulary Scale (MBPVS) is a version of the long form of the British Picture Vocabulary Scale (Dunn, Dunn, Whetton, & Pintillie, 1982a) (MBPVS; Rickard Liow, Hong, & Tng, 1992) that was adapted with publisher's permission and is similar to the Peabody Picture Vocabulary Test. The original 150-item BPVS is rank-ordered for difficulty but the adapted MBPVS comprises 75 items for each of the English and Mandarin versions. For the MBPVS, the original BBVS even-numbered target items (2, 4, 6 to 150) are retained in English and the odd-numbered items (1, 3, 5 to 149) were translated into Mandarin. This procedure ensures sampling across a range of difficulty but the two versions are not equivalent in terms of difficulty. There are no normative data for adult Singaporeans, so the raw scores were used to validate discriminant analysis classification results determined by self-report.

Procedure

In groups of about 20, participants completed the self-report classification tool before the two MBPVS vocabulary testing sessions. Different target items and picture stimuli are assessed by the MBPVS English and Mandarin, so the tests were administered on the same day but in counterbalanced order such that half the participants received testing in Mandarin first followed by English, and vice versa. The forced-choice (1-from-4) picture plates were presented using an overhead projector while the prerecorded target words were presented free field to participants using a TCD-PROII DAT Recorder with Altec Lansing 220 speakers. Prerecording was conducted by a bilingual English-Mandarin Singaporean female. Pre-recorded target stimuli used to ensure that the presentation of the target words was standardized across data collection sessions. Participants recorded their responses using a separate response sheet for each language.

Categorizing Language Dominance Using the Self-Report Classification Tool

As demonstrated in the introduction, there are three variables that are most relevant to Asian bilingual populations who acquire both languages early and uniformly: (a) language proficiency, (b) frequency of language use, and (c) domain of language use. Thus, the classification as Mandarin-dominant or English-dominant required all three self-report criteria (details below) to be met; failure to satisfy all three criteria was taken to imply balanced bilingualism.

Language Proficiency

In previous research, Langdon et al. (2005) used self-report ratings of language proficiency to determine language dominance. Self-rating scores were calculated by summing the ratings (between 1 to 5) for each language modality in each language. Thus, the maximum total rating score for each language was 20 points. The authors divided the maximum total rating score that a bilingual could achieve into four preset score ranges where each range of scores indicated a different competence level. Using this approach, a difference in overall ratings of one or more competence levels between the languages would indicate language dominance (see also Macnamara, 1967).

The use of a ratio or a range of scores may not be a good discriminator for ratings by many Asian bilinguals, including our Singaporeans, because proficiency varies within and between the languages across the four modalities (speaking, listening, reading and writing). For this reason, a more conservative decision making process was developed based on three criteria: (a) difference in total rating score between English and Mandarin > 0, (b) difference in score between English and Mandarin for understanding, speaking, or reading modalities > +1 or < −1, and (c) difference in score between English and Mandarin for understanding, speaking, or writing modalities > +1 or < −1. Using a 7-point rating scale (discussed above), the maximum total rating score accruable across all four modalities was 28. Criteria (b) and (c) were specifically developed to keep separate the scores for perceived reading and writing skills. This was done because it is possible for bilinguals in Singapore to develop uneven skills for reading and for writing. For example, there is less opportunity for Mandarin-dominant bilinguals to maintain their proficiency in Mandarin writing when they work or study in an environment where English is the main written form used.

Frequency of Language Use

Frequency of use as an important determiner of language dominance is supported by White and Genesee's (1966) finding that it is possible for late learners of a language to achieve native-like competency in that language, and also by the research showing bilinguals lose dominance in a language when it is not used, or is used less frequently (Grosjean, 1998). In Singapore, many Mandarin-dominant participants were expected to use written English in their educational and work environments. Thus, in addition to fulfilling the proficiency ratings criteria, the dominant language had to be spoken and heard daily, and used for either reading or writing weekly (see Paradis, 1987).

Domain of Language Use

Three main domains of language use were identified: home, school/work, and social (see Fishman, 2000 for others). In Singapore, English is the official language used at school and at the workplace, so the dominant language was identified if it was also used in at least two out of the three possible environments.

Data Analyses

Using the self-report tool described above, the participants were divided into one of three groups: English-dominant, Mandarin-dominant, and balanced bilinguals. The accuracy of this classification tool was then tested using a discriminant analysis (Garson, 2006). In this analysis, the grouping variable was language dominance (English-dominant, Mandarin-dominant, balanced) while the independent variables were the *raw scores* for language proficiency, frequency of language use, and domain of language use in both languages. Further, to see if the scores from the English and Mandarin MBPVS supported this dominance classification, the vocabulary scores were examined for both languages, and across the three bilingual groups in separate analyses. For the comparison of MBPVS scores in English and Mandarin, the dependent variable was mean percentage accuracy scores. A paired *t*-test was used to analyze the difference in scores across languages. However, where the normality or homogeneity assumptions were violated, or when sample sizes were small, a Wilcoxon Sign Rank test was computed instead. In the analysis of MBPVS scores across bilingual groups, a Kruskal-Wallis Test was performed when the use of parametric tests was contraindicated. Post hoc testing was accomplished using the Mann-Whitney Test. The dependent variable measured for the between group analyses was median percentage accuracy scores.

To study the usefulness of AoE, years of language instruction, and years of language exposure in distinguishing the language dominance groups, the same statistical procedures as described above for the between group analysis of MBPVS scores was applied. Last, to explore the relationships between AoE, years of language instruction, and years of language exposure, and the self-reported proficiency ratings in each language, separate Spearman's rank-order correlation analyses were performed for the variables in each bilingual group.

An alpha level of .05 was set for all statistical tests, but Bonferroni adjustments were made to prevent the accumulation of Type 1 error for the comparisons across language dominance groups and for the planned correlation analyses (Keppel & Wickens, 2004).

Results

Classification and Profile of Participants

The characteristics of the participants categorized by the classification tool using self-ratings of language proficiency, and frequency and domain of language use are shown in Table 4.1. Of the 168 participants, 73 were classified as balanced bilinguals, 77 as English-dominant bilinguals and 18 as Mandarin-dominant bilinguals. Both the balanced and Mandarin-dominant group reported an earlier exposure to

Table 4.1. Participant Characteristics According to Language Dominance Group

Variables	Balanced	Eng-Dominant	Man-Dominant
Age of First Exposure (AoE)			
English	4 (1 - 7)	1 (0 - 7)	5 (1 - 7)
Mandarin	1 (0 - 7)	3 (1 - 7)	1 (1 - 5)
Year of Language Exposure			
English	17 (12 - 22)	18 (12 - 22)	15 (12 - 19)
Mandarin	18 (12 - 23)	17 (12 - 22)	18 (16 - 22)
Years of Formal Instruction			
English	13 (12 - 16)	12 (12 - 17)	13 (12 - 16)
Mandarin	12 (12 - 15)	12 (12 - 14)	12 (12 - 14)
English Proficiency (1 – 7 scale)			
Understanding	6 (4 - 7)	6 (4 - 7)	5 (4 - 7)
Speaking	5 (4 - 7)	6 (3 - 7)	5 (3 - 6)
Reading	6 (5 - 7)	6 (4 - 7)	5.5 (3 - 6)
Writing	5 (4 - 7)	6 (3 - 7)	5 (2 - 6)
Mandarin Proficiency (1 – 7 scale)			
Understanding	6 (4 - 7)	5 (2 - 7)	7 (6 - 7)
Speaking	6 (4 - 7)	4 (2 - 7)	7 (6 - 7)
Reading	6 (4 - 7)	4 (1 - 6)	6.5 (4 - 7)
Writing	5 (3 - 7)	4 (1 - 7)	6 (4 - 7)

Note. Median scores with range in parentheses.

Mandarin than to English while the English-dominant group was exposed to English before Mandarin. A similar number of years of exposure to both languages was recorded for the English-dominant group as well as the balanced bilinguals. On the other hand, the Mandarin-dominant bilinguals reported a longer exposure to Mandarin than to English. Self-rated proficiency scores for English and Mandarin were noted to be comparable for the balanced bilinguals, whereas both the English- and Mandarin-dominant participants reported higher language proficiency scores in their respective dominant languages. As expected for Singapore, years of formal instruction was similar across the three bilingual groups for both languages.

Validation of Self-Report Classification Tool

The results of the discriminant analysis revealed an overall correct classification rate of 88%. Based on our large sample size of 168 participants, this accuracy rate was high and significant when compared to the random probability of 33% ($p < .001$). This suggested that our classification tool was able to identify above the level of chance and with a high level of accuracy the dominant language in bilingual Singaporeans.

The balanced bilinguals displayed almost identical scores on the MBPVS across the two languages ($M = 88.4\%$, $SD = 4.78$ for the English, and $M = 88.2\%$, $SD = 4.6$ for Mandarin) but the scores for the English-dominant bilinguals were significantly higher on the English MBPVS ($M = 91.30\%$, $SD = 3.29$) than on the Mandarin MBPVS ($M = 82.12$, $SD = 6.56$). The difference in mean MBPVS scores for this group reached significance, $t(74) = 10.61$, $p < .025$ (one-tailed). Finally, the Mandarin-dominant group also produced significantly higher scores on the Mandarin MBPVS ($M = 88.56$, $SD = 3.70$) compared to the English MBPVS ($M = 84.12$, $SD = 3.24$; Wilcoxon signed rank test = 2.64, $p = .008$).

To determine whether the three groups would have distinguishable test scores, performance on the English and Mandarin MBPVS was compared across groups. A Kruskal-Wallis Test revealed significant differences in median scores between the English-dominant, Mandarin-dominant, and balanced bilinguals for both the English MBPVS, χ^2 (2, $N = 168$) = 38.35, $p < .001$, and the Mandarin MBPVS, χ^2 (2, $N = 168$) = 37.22, $p < .001$. Post hoc Mann Whitney tests revealed significant group differences in the English MBPVS scores for all three comparisons: English-dominant bilinguals ($Mdn = 92.00$) achieved significantly higher scores than both the balanced bilinguals (Z

= .4.11; $p < .001$) and Mandarin-dominant bilinguals ($Z = 5.45$; $p < .001$); the balanced bilinguals (*Mdn* = 89.33) were found to perform significantly better ($Z = 3.43$; $p = .003$) than the Mandarin-dominant group (*Mdn* = 84.00). However, for Mandarin MBPVS scores, only the English-dominant bilinguals (*Mdn* = 82.67) produced scores that were significantly different from the Mandarin-dominant (Z = 3,75; $p = .003$) and balanced bilinguals ($Z = -5.71$; $p = .003$). That is, there was no difference in Mandarin vocabulary scores between the Mandarin-dominant group (*Mdn* = 88.00) and the balanced bilinguals (*Mdn* = 89.33).

Distinguishing Language Dominance Using AoE, Years of Language Instruction Exposure

The results of the Kruskal-Wallis Test showed that there were significant group differences for years of English exposure, χ^2 (2, N = 168) = 25.83, $p < .001$, years of Mandarin exposure, χ^2 (2, N = 168) = 10.29, $p = .006$, years of formal Mandarin instruction, χ^2 (2, N = 168) = 28.05, $p < .001$, AoE English, χ^2 (2, N = 168) = 31.17, $p < .001$, and AoE Mandarin, χ^2 (2, N = 168) = 13.69, $p = .001$, but not for years of formal English instruction.

Post hoc testing using a Mann Whitney Test showed that the three bilingual groups only differed significantly from each other in terms of number of years of English exposure and AoE English (see Table 4.2). The English-dominant bilinguals had a higher number of years of English exposure (*Mdn* = 18) than the balanced bilinguals (*Mdn* = 17) who also had more years of English exposure than the Mandarin-dominant bilinguals (*Mdn* = 15). This same pattern was also noted for AoE English but in the reverse order (*Mdn* = 1 for English-dominant bilinguals, *Mdn* = 4 for balanced bilinguals, and *Mdn* = 5 for Mandarin-dominant bilinguals).

The scores for AoE Mandarin and years of formal Mandarin instruction were significantly different in only two group comparisons. For AoE Mandarin, the English-dominant group (*Mdn* = 3) showed a significantly later age of acquisition than the balanced group (*Mdn* = 1) and Mandarin-dominant group (*Mdn* = 1) whereas the difference in median age between the balanced and Mandarin-dominant bilinguals was not statistically significant. The same trend was observed for years of formal Mandarin instruction despite the median score being the same (*Mdn* = 13) for all three groups of bilinguals.

With respect to the number of years of Mandarin exposure, only one group comparison was noted to be significant. Balanced bilinguals were found to have a significantly longer period of Mandarin exposure (*Mdn* = 17) than the English-dominant bilinguals (*Mdn* = 18). However, the scores of both these groups were not significantly different from that obtained by the Mandarin-dominant bilinguals (*Mdn* = 18).

Table 4.2. Results of Mann-Whitney Test Scores for Group Comparisons

Variables	Balanced vs Eng-Dom	Balanced vs Man-Dom	Eng-Dom vs Man-Dom
Age of First Exposure (AoE)			
English	-4.08**	-2.78*	-4.73**
Mandarin	-3.28**	-.43	-2.56*
Years of Formal Instruction			
English	-1.11	-1.41	-2.04
Mandarin	-2.66*	-3.10	-5.52**
Year of Language Exposure			
English	-3.51**	-2.67*	-4.42**
Mandarin	-2.86*	-.40	-2.29

Note. Values represent *Z* scores. Bonferroni adjustments were made to the alpha levels.

* *p* < .05. ** *p* < .01.

Relationship between AoE, Years of Language Instruction, Years of Language Exposure and Self-Ratings of Language Proficiency

The relationship between the self-reported proficiency ratings for understanding, speaking, reading, and writing in each language, and AoE English and Mandarin, years of English and Mandarin instruction, and years of exposure to English and Mandarin was evaluated separately according to bilingual group. For the group of Mandarin-dominant bilinguals, none of the correlation analyses were found to be statistically significant ($p > .05$). In only four out of a possible 12 analyses were significant correlations found for the English-dominant group: English understanding proficiency was positively correlated with the number of years of exposure to English ($r^s = .304$, $p = .048$) and negatively correlated with AoE to English ($r^s = -.303$, $p = .048$), Mandarin speaking proficiency was positively associated with years of Mandarin exposure ($r^s = .352$, $p = 0.012$) and negatively correlated with AoE Mandarin ($r^s = -.356$, $p = .012$). Similarly, only two comparisons were observed to be statistically significant for the balanced bilingual group. For these bilinguals, Mandarin understanding proficiency scores were positively correlated with years of Mandarin exposure ($r^s = .345$, $p < .001$) while their Mandarin speaking proficiency scores were also found to be positively associated with years of Mandarin exposure ($r^s = .31$, $p = .036$). These correlations reveal an inconsistent pattern in the relationship between AoE, years of language instruction, years of language exposure, and self-ratings of language proficiency for the four language modalities.

Discussion

This study assessed language dominance in an Asian population of English-Mandarin bilinguals. The main aim of this study was to develop a self-report classification tool that would reliably and accurately determine the dominant language in English-Mandarin bilingual Singaporeans. A method for interpreting responses on the self-report classification tool was also tested for accuracy of classification. The three-way classification into English-dominant, Mandarin-dominant and balanced bilinguals was based on participants' rating data for specific questions about language proficiency and language usage, and then validated using a discriminant analysis and receptive vocabulary scores for both languages. The results of the discriminant analysis showed that the classification tool was able differentiate with a high level of accuracy (88%) between these three groups, an accuracy rate that was found to be significantly different from chance.

The accuracy of language dominance classification in our group of bilinguals received partial support from the results of the receptive vocabulary tests (MBPVS). The vocabulary performance for the English-dominant, Mandarin-dominant, and balanced groups were consistent with the three-way bilingual grouping, but a comparison across the bilingual groups suggested that the Mandarin score was not as effective as the English score for discriminating the Mandarin-dominant bilinguals from the balanced bilinguals; the scores for these two groups were not distinguishable. Thus, in keeping with Grosjean (1998) and Langdon et al. (2005), the results of this study provide further evidence that objective assessments like the MBPVS may not be suitable for determining language dominance. At best, they may be applied to verify the self-assessments of language dominance for English-dominant bilinguals and balanced bilinguals. As yet, there are no standardized tests of language proficiency for Singaporeans, or most other Asian bilinguals. Thus, pending the development of culturally appropriate language assessment tools for specific bilingual populations, a broad classification of language dominance using the guidelines described in this report, should be of considerable value in clinical settings.

A secondary aim was to examine the group differences in terms of AoE, years of formal instruction, and years of exposure for both languages, and assess at their relationship to self-ratings of proficiency. The data revealed that only two parameters—AoE English and years of English exposure—were able to distinguish the three bilingual groups. For Singaporeans, this result was not surprising since the two variables are likely to be similar for early bilinguals in the same education system. What is more interesting is that the same effect was not found for Mandarin. This is consistent with Rickard Liow and Tng's (2003) work on primary school pupils' Mandarin-English literacy development in Singapore and suggests that home language remains an important factor for proficiency for the ethnic Chinese population. Both the Mandarin-dominant and balanced bilinguals reported comparable AoE Mandarin and years of Mandarin exposure. Similar to the MBPVS results, AoE, years of first exposure, and years of formal instruction generally differentiated, albeit not fully, the

English-dominant bilinguals from the Mandarin-dominant bilinguals and English-dominant and balanced bilinguals, but not the balanced and Mandarin-dominant bilinguals. Taken together, these findings seem to suggest that the three of the principal variables identified in the literature have a less consistent influence on language dominance when the educational system is more uniform. However, for our participants, the restricted range of scores for AoE and years of exposure must be acknowledged. Future research is needed to confirm whether a similar result would be indicated in a more heterogeneous group of Asian bilinguals.

There is at least one explanation for the greater degree of overlap in the profile and performance seen between the balanced and the Mandarin-dominant bilinguals, and the greater observed differences between balanced and English-dominant bilinguals, at least for this group of undergraduate students. As English is the main language of instruction in schools, and since Mandarin education does not usually continue at the tertiary level, it is likely that there was a larger disparity in the degree of dominance between the two languages in English-dominant bilinguals whereas this dominance gap was smaller in the Mandarin-dominant bilinguals. Mandarin-dominant bilinguals were more proficient in their less-dominant language (English) than the English-dominant bilinguals were in their less-dominant language (Mandarin). This made the Mandarin-dominant bilinguals less distinguishable from the balanced bilinguals.

Our results for the associations between AoE, years of formal instruction, and years of exposure and self-ratings of proficiency were interesting. Unlike previous investigations of late bilinguals, we only found a handful of significant associations in our study. These occurred for the English-dominant and balanced bilinguals and were only observed for specific individual modalities in each language. This result contrasts with that of Li et al. (2006) who found significant correlations between AoE, years of learning, and self-assessed proficiency for all four modalities: understanding, speaking, reading, and writing. Additionally, differences in sample sizes and methodology not withstanding, the correlations for the analyses reported here were also markedly weaker ($r^s < 0.32$) than those reported previously (e.g., Birdsong, 2006a; Flege et al., 2002). For instance, in a survey of 10 studies, Birdsong found that the range of correlations between the age at which bilinguals are immersed in an L2 context and attained L2 proficiency was .45 to .77 (*Mdn* = .64). We interpret these findings to mean that these constructs are less relevant for current ratings of language proficiency in bilinguals who acquire both languages early, learn both languages uniformly, use both languages regularly, but yet develop a dominant language. Accordingly, they may not be suitable parameters to use for selecting and dividing participants for clinical or research purposes in this Asian context.

Like Langdon et al. (2005), we found that self-ratings provide valid and reliable measures of language dominance. The difference between our study and the study by Langdon et al. is that these authors did not evaluate the domains of language use. This parameter deserves examination because it determines the genre of language used, and more importantly, the linguistic level used by the bilingual (Fishman, 2000). In our self-report classification tool, the conclusion regarding the dominant language was reached by assessing language proficiency, and frequency and domain of language use. Nonetheless, until a comparative study is conducted, the question regarding the ultimate number of self-assessment parameters to use for the best assessment of language dominance remains equivocal.

Unlike previous research (Flege et al., 2002; Langdon et al., 2005; Li et al., 2006) based on percentage estimates to measure the degree of language usage, frequency of language use in this study was measured categorically. While we concede that the use of percentage estimates may be a more sensitive means of evaluating frequency of language use, we still found a high level of accuracy in classifying language dominance despite using a categorical measurement of frequency of language usage. We undertake to address this issue in our future work.

In conclusion, for our group of English-Mandarin bilingual Singaporeans, our self-report classification tool was found to be reliable for a three-way classification into English-dominant, Mandarin-dominant, and balanced bilinguals. This categorization was achieved on the basis of self-ratings of language proficiency, frequency of language use, and domain of language use by means of a predetermined set of criteria, and was validated statistically using a discriminant analysis, and on a large bilingual population. Prior to this study, clinicians in Singapore habitually relied on their clients' self-ratings of language proficiency and language usage to determine the dominant language without any empirical data to defend their clinical practice. Our study now provides evidence to support the use of our self-report tool as part of standard clinical practice. Researchers and clinicians elsewhere could adapt the methodology reported here to develop classification tools for other bilingual adults and children according to the various language histories and specific situational demands in terms of usage and proficiency.

PART THREE

STUTTERING IN ENGLISH-MANDARIN BILINGUAL SPEAKERS

CHAPTER FIVE

THE INFLUENCE OF LANGUAGE DOMINANCE ON STUTTERING SEVERITY[3]

[3] This chapter is a reprint of an article submitted to the Journal of Speech, Language, and Hearing Research for publication by the candidate as first author, and co-authored with Michelle Lincoln, Yiong Huak Chan, and Mark Onslow. The candidate was the chief investigator in the research described. This article is currently under review.

Abstract

English and Mandarin are the two most spoken languages, yet it is not known how stuttering manifests in English-Mandarin bilinguals. This research investigated whether the severity and type of stuttering is different in English and Mandarin in English-Mandarin bilinguals, and whether this difference was influenced by language dominance. Thirty English-Mandarin bilinguals who stutter (BWS) aged 12 years and older were categorized into three groups of language dominance (15 English-dominant, 4 Mandarin-dominant, and 11 balanced bilinguals) using a self-report classification tool. Three 10-minute conversations in English and in Mandarin were assessed by two English-Mandarin bilingual clinicians for percent syllables stuttered (%SS), perceived stuttering severity (SEV), and stuttering topography using the Lidcombe Behavioral Data Language (LBDL). English-dominant and Mandarin-dominant BWS exhibited higher %SS and SEV scores in their less dominant language whereas the scores for the balanced bilinguals were similar for both languages. The difference in the percentage of stutters per LBDL category between English and Mandarin was not markedly different for either bilingual group. Language dominance appeared to influence the severity but not the topography of stuttering in BWS. Clinicians working with BWS need to assess language dominance when diagnosing stuttering severity in their bilingual clients.

Introduction

Stuttering occurs across cultures and languages and has been found to exist in both bilinguals and monolinguals (Finn & Cordes, 1997; Van Borsel et al., 2001). Although interest in bilinguals who stutter (BWS) has increased in recent years (e.g., Bernstein Ratner, 2004; Hall & Evans, 2004; Roberts & Shenker, in press; Shenker, 2006; Van Borsel et al., 2001), research has mainly focused on speakers of Indo-European languages (e.g., Bernstein Ratner & Benitez, 1985; Dale, 1977; Jankelowitz & Bortz, 1996; Nwokah, 1988). There are fewer studies of BWS who use languages of non Indo-European origin (Jayaram, 1983; Karniol, 1992; Nwokah, 1988). To date, no investigations have addressed stuttering in bilinguals who speak Sino-Tibetan languages such as Mandarin-Chinese. This article reports an investigation of stuttering in English-Mandarin bilinguals.

Mandarin is the most spoken language in the world (Gordon, 2005). Assuming that China—the world's largest Mandarin-speaking population—has a 1% incidence rate of stuttering, and that many other counties also have large populations of Chinese speakers, there are possibly more than 13 million Mandarin speakers who stutter worldwide. Further, many Mandarin speakers outside of China are bilingual and speak English as their other language. In Singapore, for example, multilingualism is the norm (Gupta, 1994) and the majority of the population is Chinese bilinguals who speak English and Mandarin. Even though members of this bilingual cohort frequently present to stuttering clinics in Singapore and elsewhere, speech language pathologists (SLPs) have no empirical information on the presentation of stuttering in Mandarin, let alone in English-Mandarin bilingual individuals, on which to base clinical decisions.

The manifestation of stuttering in bilinguals who speak languages other than Mandarin has been described previously. Dale (1977) and Van Riper (1971) reported on stuttering in one language only in BWS. However, these cases appear to be the exception rather than the norm. In their review of the literature which included studies of BWS who were evaluated in both languages, Van Borsel et al. (2001) concluded that bilingual persons commonly stutter in both languages. In addition, because of the link between genetics, motor processing and stuttering, it would be theoretically expected that BWS would stutter in all of their languages (Roberts & Shenker, in press).

It is, however, unclear whether BWS stutter the same or differently in both languages. Evidence for the "same-hypothesis" (Nwokah, 1988) remains weak as only anecdotal reports are currently available in the literature (Lebrun et al., 1990; Van Riper, 1971). More evidence is available to substantiate the "different-hypothesis" (Nwokah, 1988). According to this hypothesis, BWS in both languages show differential patterns of stuttering across the two languages spoken. This cross-language difference has been noted to affect the frequency (counts of stuttering) but not the loci of stuttering (position of the stutter within an utterance) (e.g., Jayaram, 1983). However, in most studies, both the frequency and the type of stuttering—which together affect stuttering severity—as well as the loci of stuttering were found to vary across the two languages (e.g., Bernstein Ratner & Benitez, 1985; Jankelowitz & Bortz, 1996; Nwokah, 1988).

One proposal for the reason for different degrees of stuttering in each language within an individual is that stuttering severity is affected by language proficiency (Van

Borsel et al., 2001). It has been suggested that BWS stutter more severely in their less proficient language. Support for this view is seen in the work of Jankelowitz and Bortz (1996) and Scott Trautman and Keller (2000). Both groups of authors found their bilingual participant stuttered less in their "predominant" and "more proficient" language relative to their less proficient language. A recent study by Van Borsel, Sunaert, and Engelen (2005) of normally fluent trilinguals also suggested a language familiarity effect. These authors found that their participants exhibited significantly more speech disruptions under delayed auditory feedback (DAF) in French and English which were acquired later and supposedly less proficient than their native language Dutch. However, the findings of three other studies have contradicted the language proficiency argument. In a study of bilingual Kannada-English speakers, Jayaram (1983) found that participants stuttered more in their "primary" language. The author, however, did recognize that the difference between the participants' languages may not have been statistically significant. In contrast, Berstein Ratner and Benitez (1985) and Nwokah (1988) both examined balanced bilinguals who were exposed to both languages since childhood and continued to use both languages until the time of testing. These investigators also concluded that their participants stuttered more in one language than the other, hence language proficiency seemingly did not influence stuttering. As a consequence, the findings on this issue remain inconclusive.

The influence of language proficiency on differential stuttering patterns in BWS cannot be discounted as yet, due to a number of shortcomings in the existing literature. First, different terms have been used to describe the relationship between the two languages in BWS. They include the "primary language" (Jayaram, 1983), the "predominant language" and the "more proficient language" (Jankelowitz & Bortz, 1996), the "native language" (Scott Trautman & Keller, 2000), and "equally competent languages" (Nwokah, 1988). Not all of the terms have been defined clearly in past studies, and this raises the question of whether language dominance or language proficiency was measured. Language dominance and language proficiency are two "overlapping and confusable" yet functionally different constructs (Birdsong, 2006b, p. 47). A bilingual may have a high and almost native-like proficiency in both languages, but still considers one language to be better than the other. In this case, the bilingual has one language which dominates the other. Thus, in investigating whether BWS stutter differently between their two languages and why this may occur, it is more relevant to assess language dominance rather than the absolute levels of language proficiency in each language. Unlike language proficiency which measures a person's command of grammar, vocabulary, and pronunciation and varies *between* bilinguals, language dominance reflects the quantitative differences in processing each of the two languages (Birdsong, 2006b) and indicates the relative ability levels of the two languages *within* the same individual. Evidence is available to show that bilinguals are slower in translating from their dominant to their less dominant language than vice versa (e.g., de Groot & Poot, 1997; Kroll & Stewart, 1994). Bilinguals have also been found to have reduced accuracy, automaticity, and speed when identifying and retrieving lexical items in their less dominant language than in their dominant language (e.g., Chen & Leung, 1989; Kotz & Elston-Guttler, 2004; McElree et al., 2000). We consider language dominance henceforth in this paper.

A second limitation with the existing body of research is that many of the foregoing studies did not perform a systematic and comprehensive evaluation of both languages spoken by their bilingual participants. Grosjean (1982; 1998) cautioned against classifying a language as the predominant or native language without consideration of the complex language histories and backgrounds of bilingual individuals, or the important theoretical constructs that govern bilingual processing. Third, studies in this area have mainly comprised case studies (e.g., Bernstein Ratner & Benitez, 1985; Jankelowitz & Bortz, 1996) limiting the generalization of the findings to other BWS. Further, the speech samples collected in past research were minimal. In several cases, stuttering analysis was based on less than 100 syllables (e.g., Bernstein Ratner & Benitez, 1985; Jayaram, 1983) or fewer than 300 syllables (e.g., Jankelowitz & Bortz, 1996). Finally, methodological problems arise in studies where speech samples are analyzed by the authors themselves (e.g., Jayaram, 1983), or where reliability measures were low (e.g., Jankelowitz & Bortz, 1996).

Researchers have also attempted to explain the disproportionate levels of stuttering severity across languages in BWS by way of the cognitive or syntactic overload associated with speech processing in two languages (e.g., Karniol, 1992), sociopsychological issues such as negative or positive attitudes towards a particular language (e.g., Dale, 1977; Nwokah, 1988), and cross-linguistic differences (e.g., Bernstein Ratner & Benitez, 1985; Jayaram, 1983). To support their respective hypotheses, Karniol (1992) and Nwokah (1988) in particular make reference to various models of stuttering and described their application to bilinguals.

Karniol (1992) drew on the demands and capacities (DC) model (Starkweather & Gottwald, 1990) and the neuroscience model of stuttering (Nudelman et al., 1989) to explain the disappearance of stuttering after their bilingual child discontinued using the non-dominant language. Under the DC model, the child initially stuttered in both languages because the speech demands exceeded the child's capacities. The withdrawal of one language brought speech demands back within the child's capacities. Similarly, in the neuroscience model, the child experienced syntactic overload as a result of bilingualism. This caused the speech motor control system to become unstable as more time was needed for the child to process and coordinate "the selection and programming of speech sounds and the production of these sounds" (Packman & Attanasio, 2004, p. 84) for the two languages.

Conversely, Nwokah (1988) suggested that there were two bases to explain why the balanced bilinguals in that study stuttered differently across languages. The first explanation was based on sociopsychological issues; BWS stutter more in the language that they had negative experiences with. Additionally, Nwokah believed that the findings had a neuropsychological underpinning. Citing the neuropsychological model of the origin and maintenance of stuttering (Fiedler & Standop, 1983), Nwokah claimed that BWS displayed uneven patterns of stuttering behavior because they used the same monitoring system to control and coordinate motor speech as well as bilingual language production. As this monitoring system can behave differently across BWS, stuttering increased when the monitor acted as an *activator*, introducing tension and anticipation to speech and language production. On the other hand, there is decreased stuttering when the monitor acted as an *inhibitor*, resulting in greater conscious control of stuttering behavior.

At present, none of the above theories or models have been able to sufficiently explain the manifestation of stuttering in BWS. This is due in part to the lack of systematic research regarding the role of language dominance in bilingual stuttering. An investigation of this nature is a necessary first step to elucidating our understanding of the theories and models of bilingual stuttering. More importantly, it will help to resolve our current clinical challenges in terms of accuracy of assessment and diagnosis of BWS. If language dominance is found to influence stuttering severity, clinicians worldwide who work with BWS may either underestimate or overestimate the severity of the disorder if they assess stuttering in one language only.

The aim of this research was to examine stuttering behavior in English-Mandarin bilinguals who stutter. Specifically, we compared the severity and type of stuttering in two structurally different languages to see if stuttering was evident to the same degree in both languages, and whether there was a relationship between stuttering and language dominance. In order to accomplish these aims, the severity and type of stuttering was examined in English-Mandarin BWS with three different language dominance profiles: English-dominant, Mandarin-dominant, and balanced bilinguals. Rigorous methods were used to categorize BWS into one of the three language dominance subgroups (Lim, Lincoln, Chan, Rickard Liow, & Onslow, 2007). The specific research questions were as follows:

1. Do English-Mandarin BWS stutter more frequently in one language compared to the other?
2. Do English-Mandarin BWS stutter more severely in one language compared to the other?
3. Is the type of stuttering different across languages?
4. Is the severity and type of stuttering influenced by language dominance?

Method

Participants

Participants were 30 BWS who were referred to the Singapore General Hospital Stuttering Clinic. Inclusion criteria for the participants were as follows: (a) Chinese descent, (b) Singaporean or Singapore Permanent Resident, (c) bilingual in Mandarin and English, (d) 12 years or older, (e) diagnosis of developmental stuttering, (f) stuttering rate of more than 2% syllables stuttered (%SS) as determined by the assessing SLP from a 10-minute within-clinic conversational sample, and (g) no treatment involving a speech pattern change during the previous 2 years. The procedure for determining language dominance is described in the next section. All participants knew that they were volunteering for a study on bilingual stuttering but were unaware of the specific research aims. There were 28 men and two women, ranging in age from 12 to 44 years (*M* = 21.7, *SD* = 7.3).

Materials

The Self-report Classification Tool described by Lim et al. (2007) was used to divide participants into one of three language dominance groups: balanced bilinguals, English-dominant, and Mandarin-dominant. The tool consists of a questionnaire which incorporated items from the History of Bilingualism questionnaire (Paradis, 1987) and the Language Background Questionnaire (Rickard Liow & Poon, 1998). Participants reported on all languages in their repertoire across the four language modalities: understanding, speaking, reading and writing. Specifically, they were asked to (a) provide demographic information including the number of years of language exposure and formal instruction in both languages, (b) state the age of acquisition for each modality, (c) rank their languages from best to worst for each modality, (d) quantify their current proficiency for each modality using a 7-point self-rating scale (Kohnert et al., 1998) where 1 = *very few words* and 7 = *native speaker*, (e) rank the language they use most often at home, work, and socially, (f) quantify how frequently they use each language, and (g) provide information about school examination grades for each language.

The criteria used to determine language dominance were based on the participants' self-ratings of language proficiency, frequency of language use, and domains of language use. For each variable, measures were taken across the four language modalities—understanding, speaking, reading, and writing. This classification tool was validated using a discriminant analysis and an objective test (details below). Although other criterion-based methods of establishing bilingual dominance have been suggested (e.g., Gutiérrez-Clellen, Restrepo, & Simón-Cereijido, 2006), this tool was preferred because it was found to be reliable for establishing the dominant language in English-Mandarin bilingual Singaporeans (Lim, Lincoln, Chan, Rickard Liow et al., 2007).

Participants also completed the English and Mandarin versions of the Multilingual British Picture Vocabulary Scale (MBPVS; Rickard Liow et al., 1992). The MBPVS is an adapted version (with publisher's permission) of the standard long form of the BPVS (Dunn et al., 1982a). Each language version of the test contained 75 of the original 150 items which were rank-ordered for difficulty. Even numbered items remained in the English version, and odd numbered word stimuli were translated into suitable counterparts in Mandarin. This procedure ensured that vocabulary was tested across a range of difficulty. The two versions are not equivalent in terms of difficulty and there are no normative data for adult Singaporeans, hence the raw scores were used to validate language dominance classification results as determined by self-report. The picture stimuli for English and Mandarin MBPVS were presented to participants in separate spiral bound booklets.

Speech Sampling

To obtain a representative sample of stuttering behavior, 10-minute conversational speech samples in both English and Mandarin were collected in three different speaking situations within and beyond the clinic. These included speaking face-to-face with the SLP, speaking with a family member/friend at home, and a telephone conversation with an unfamiliar person. The within-clinic speech samples were video recorded while the two beyond-clinic speech samples were audio recorded. A total of six speech samples were collected per participant, one for each language across the three assessment conditions.

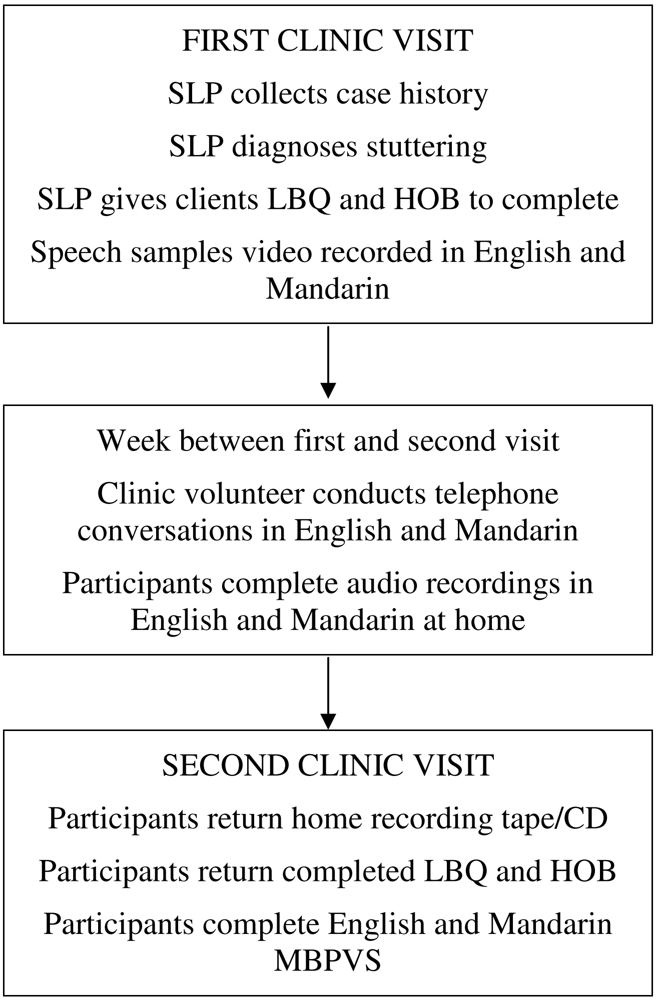
It has been proposed that where a bilingual sits on the monolingual-bilingual mode continuum determines the state of activation of their languages and language processing mechanism, and subsequently affects language production or perception (Grosjean, 1998). During speech sampling, all BWS remained along the bilingual language mode continuum. That is, participants knew that their conversational partners were also bilingual, and were allowed to code-switch temporarily between the two languages despite speaking either English or Mandarin as their base language. This was done to ensure that any normal speech disfluencies and/or difficulties in lexical retrieval that may be associated with reduced language ability (Roberts & Shenker, in press) would not confound stuttering measurements.

Study Procedure

The procedure for the study is summarized in Figure 5.1. All participants underwent a standardized initial assessment protocol. Case history taking and the initial interviews were conducted by a bilingual SLP in English. Video recordings of participants' conversational speech in English and Mandarin were conducted during the first clinic visit by a bilingual English-Mandarin SLP. The assessing SLP conversed with the participant about a familiar topic. Video recordings were front-on headshots recorded in a well-lit clinic room, using a WV-CS320 ¼ inch CDD-COL PTZ Dome Camera and an ES-945 omnidirectional condenser boundary microphone.

The two beyond-clinic audio-recordings in English and Mandarin were conducted in the ensuing week. Participants recorded their conversations with a family member or friend of their choice using either a digital or analog audio recording device.

Figure 5.1. Flow Chart for Study Procedure.



The telephone conversations in English and Mandarin between the participant and the unfamiliar person were initiated by a clinic volunteer. These occurred at unexpected times during the week following the initial assessment and served to remove participant bias in selecting a recording situation that could elicit a more fluent speech sample (Packman, Onslow, O'Brian, & Huber, 2004). The telephone conversations were recorded via a recording jack attached to the telephone. These speech samples were recorded on cassette tapes using a National audiotape recorder.

The order of administration for the video and telephone speech assessments in English and Mandarin was counterbalanced such that half the speech samples were collected in English followed by Mandarin. The remaining half was conducted in the reverse order. This was to minimize as far as possible any differential carry-over or adaptation effects that can influence stuttering behavior during assessment (Hall & Evans, 2004). Audio-recordings of speech in the home environment were not counterbalanced as the recordings depended on the availability of the participants' speaking partners. The English and Mandarin MBPVS were administered during the second clinic visit. Both tests were administered on the same day as different target items and picture stimuli were assessed for each test. The sequence of administration of the English and Mandarin MBPVS was also counterbalanced so that half of the participants received testing in Mandarin first followed by English, and vice versa. However, the order of presentation of test stimuli within the Mandarin and English tests was the same for all participants. Participants received standardized instructions prior to commencement of the assessment. The assessing SLP read out the target words to participants who then recorded their responses using a separate response sheet for each language.

Data collection was completed in two clinic visits. Each session was approximately one hour in duration.

Dependent Variables

Stuttering Severity and Speech Rate

Percent syllables stuttered (%SS) and severity rating (SEV) were used to provide measures of stuttering frequency and severity (O'Brian, Packman, & Onslow, 2004). The 9-point severity rating scale described by O'Brian et al. (2004) was applied where a rating of “1” indicated no stuttering, and “9” indicated extremely severe stuttering. This scale has been shown to be a valid and reliable tool for evaluating stuttering severity by both experienced and inexperienced listeners (O'Brian, Packman, Onslow, & O’Brian, 2004).

Syllables per minute (SPM) was used as a measure of speech rate. It has been suggested that speech rates can reflect the degree of stuttering and its effect on communication (Guitar, 2006): the more severe the stuttering, the lower the speech rate, and the more difficult communication can become. It has also been postulated that language proficiency can influence the rate of speech processing (de Bot, 2000). Bilingual speakers may have reduced speaking rates in their less dominant language(s) which result from the increase in time taken to process the non dominant language. Speaking rate was assessed in order to examine the association between rate of speech, and stuttering severity and language dominance.

Judges

Judges were two English-Mandarin bilingual SLPs from Singapore who were independent of the study and blind to the aims of the study. They were trained and experienced in the assessment and treatment of stuttering. Bilingual English-Mandarin Singaporean clinicians were engaged so that they would be able to make accurate judgments about stuttering behavior in both languages spoken by the participants (Finn & Cordes, 1997; Van Borsel & Medeiros de Britto Pereira, 2005). The first judge rated the entire set of speech samples in English and Mandarin, while the second judge rated a subset of the speech samples.

Speech samples and reliability analyses

There were 180 speech samples collected in total in English and in Mandarin. Due to recording failure, two speech samples were deemed missing data. One was a telephone recording in Mandarin; the other was a home recording in English. The final dataset consisted of 178 speech samples, 89 samples per language. Of these 89 speech samples, 30 were digital video-recordings and 59 were audio-recordings. No video and audio samples contained any identifying information, and were presented to the judges in random order on readable compact discs (CD-Rs). The judges observed or listened to each speech sample and counted %SS and SPM in real-time using a button-press timing and counting device. They also provided a SEV score for each speech sample at the end of each recording. Because %SS scores and SEV ratings may be potentially confounded by normal speech disfluencies which result from reduced language proficiency (Andrade, Sassi, & Zackiewicz, 2004; Roberts & Meltzer, 2004), judges were told to base their assessment on unambiguous stuttering only.

Thirty nine speech samples (22%) were pseudorandomly chosen for the purposes of establishing inter and intrajudge reliability on %SS, SPM and SEV. This constituted an additional 19 recordings in English and 20 recordings in Mandarin. Of the 19 recordings in English, nine were video recordings and 10 were audio recordings. In addition to the total 178 speech samples, the first judge rerated these 39 speech samples for intra-rater reliability measures. The same set of speech samples were rated by the second judge for %SS, SPM and SEV as a measure of interjudge reliability.

The Pearson's correlation between the initial scoring and rescoring of %SS by the first judge was 0.97. Twenty two of the 39 samples (56.4%) differed by 0-1%SS, 37 samples (94.9%) differed by 0-2%SS, and all 39 samples differed by 0-3.4%SS. The correlation between the %SS scores of the first and second judge was 0.91. Twelve of the 39 samples (30.8%) differed by 0-1.0%SS, 27 samples (71.8%) differed by 0-2.0%SS, 32 (82.1%) differed by 0-3.0%SS, 35 samples (89.7%) differed by 0-4.0%SS, and all 39 samples (100%) differed by 0-6.4%SS.

For SEV scores, the Spearman correlation between the initial scoring and rescoring by the first judge was 0.91. Twenty two of the 39 samples (56.4%) achieved identical ratings, 35 samples (89.7%) differed by 0-1 rating points, and all samples (100%) were within a 2 rating point difference. Interjudge reliability analyses for SEV ratings yielded a correlation score of 0.85. Twelve of the 39 samples (30.8%) had identical ratings between the two judges, 28 samples (71.8%) differed by 0-1 rating point, 37 samples (94.9%) differed by 0-2 rating points, 1 sample (97.4%) differed by 0-3 rating points, and all 39 samples (100%) differed by 0-4 rating points.

Syllable per minute results were not analyzed further due to poor reliability; the correlation scores were 0.46 for interjudge reliability and 0.76 for intrajudge reliability.

Type of Stuttering

The Lidcombe Behavioral Data Language (LBDL; Packman & Onslow, 1998; Teesson, Packman, & Onslow, 2003) taxonomy was used to describe the type of stuttering behaviors in English and in Mandarin. The system classifies stuttering behaviors according to three categories: repeated movements (RM), fixed postures (FP), and superfluous behaviors (SB). These are further sub-categorized into seven descriptors: syllable repetition (SR), incomplete syllable repetition (ISR), multisyllabic unit repetition (MSUR), fixed postures with audible airflow (FPWAA), fixed postures without audible airflow (FPWOAA), and verbal superfluous behaviors (VSB) or nonverbal superfluous behaviors (NVSB) (see Packman & Onslow, 1998).

Training

The same pair of judges received training in the use of the LBDL. The instructional package described by Teesson et al. (2003) was modified so that judges were trained to perform LBDL analyses for both English and Mandarin speech samples. The package comprised two LBDL training videos, one for English and one for Mandarin. Each video contained 23 examples of different types of stuttering behaviors taken from different speakers. Each example was presented five times. The English training video consisted of 18 examples of stuttering behaviors from speakers of Australian English, and five examples of stuttering behaviors from speakers of Singaporean English. All 23 exemplars from the Mandarin training video were taken from Singaporean Mandarin speakers. Judges also received the three-page instructional pamphlet written in English, which explained and presented written examples of the LBDL, and provided LBDL descriptors for the stuttering behaviors in both the English and Mandarin videos. Judges were asked to read the instructional pamphlet and watch the videos of the Mandarin and English samples. They were told to spend as much time as they needed and to replay sections of the instructional video if required to better understand how the LBDL was used to describe the stuttering behavior of both English and Mandarin speakers.

Stimulus videos

Only the video recordings of each participant's speech in English and Mandarin were used for LBDL analyses. Each original 10-minute video conversation was edited such that only the first 3 minutes of participants' speech samples was analyzed. Care was taken to ensure that the interval started and ended with complete words. There were 60 videos in total, 30 in each language. The videos were presented in random order on 13 video CD-Rs.

Procedure

Following LBDL training, the judges were told to view the video recordings of the participants in the study. They were allowed to refer to the instructional pamphlet to review the LBDL taxonomy wherever necessary, and were also allowed to replay the video at any time. Each stuttering moment and the time it occurred on the video was then transcribed onto a response sheet and identified accordingly using the LBDL taxonomy. Each stimulus video took between 30 to 60 min to analyze.

Reliability analyses

Six video recordings (10%) were randomly chosen for the purposes of reliability analyses. In addition to analyzing all 60 stimulus videos according to the LBDL taxonomy, the second judge re-measured the six speech samples to establish intrajudge reliability. The same six speech samples were analyzed by the first judge as a measure of interjudge reliability. Judges were told that each stuttering moment could be associated with more than one type of stuttering behavior. For each speech sample, the number of stutters out of the total number of stutters that were identified as repeated movements, fixed postures, and secondary behaviors were calculated. The Pearson's correlation between the initial identification and re-identification of the total number of stutters that were repeated movements, fixed postures, and superfluous behaviors by the second judge was 0.99, 0.87, and .90 respectively. The correlation for the total number of the stutters that were identified as repeated movements, fixed postures, and superfluous behaviors between the first and second judge was 0.60, 0.77, and 0.69 respectively.

Results

Participants and Language Dominance Classification

Using the Self-report Classification Tool described by Lim et al. (Lim, Lincoln, Chan, Rickard Liow et al., 2007), 11 BWS were categorized as balanced bilinguals, 15 were grouped as English-dominant, and four were classified Mandarin-dominant. A discriminant analysis (Garson, 2006) was run on the data to see if the prediction of group membership was accurate. In this analysis, the grouping variable was language dominance (English-dominant, Mandarin-dominant, balanced) while the independent variables were the raw scores for language proficiency, frequency of language use, and domain of language use in both languages. The discriminant analysis yielded a 100% (95% CI 90.5% – 100%) accuracy rate for group membership which was found to be significant when compared with the random probability of 33% ($p < .001$).

Participant characteristics also supported their language dominance classification. Although the balanced bilinguals were exposed to Mandarin earlier than English, they were found to have equivalent proficiency self-ratings and MBPVS scores across the two languages (see Table 5.1). Conversely, the English-dominant bilingual group reported an earlier exposure to English, and produced higher scores for both the English MBPVS and self-reported English proficiency compared to Mandarin. Likewise, Mandarin-dominant bilinguals showed trends that were consistent with their language grouping. They acquired Mandarin earlier than English, and obtained higher scores for the Mandarin MBPVS compared to English. With the exception of the ability to write Mandarin, these bilinguals also self-reported higher proficiency for understanding, speaking, and reading Mandarin than in English. The exception for written proficiency was not unexpected since English is the official written language used at school and at the workplace. In fact, all bilingual groups reported higher proficiency for writing English than for Mandarin. The higher mean age of exposure to English for the Mandarin-dominant group was also notably higher than that for the English-dominant and balanced bilingual groups. This was because two of the four Mandarin-dominant participants were from China and Malaysia originally and were only exposed to English at 12 and 13 years respectively after immigrating to Singapore. As anticipated, years of formal instruction did not fluctuate across the bilingual groups since all Singaporeans undergo uniform education in both languages.

Table 5.1. Profile of BWS According to Language Dominance Group

Variables	Balanced Bilinguals[a]	English Dominant[b]	Mandarin Dominant[c]
Age	22.27 (5.42)	20.07 (6.78)	26.75 (12.50)
Age of First Exposure (AoE)			
English	4.55 (1.44)	2.00 (1.25)	9.25 (3.78)
Mandarin	2.82 (1.60)	3.47 (1.73)	2.00 (.82)
Years of Formal Instruction			
English	13.00 (2.79)	12.00 (3.89)	12.00 (2.16)
Mandarin	11.09 (1.14)	10.06 (2.02)	10.25 (1.26)
Years of Language Exposure			
English	17.73 (4.51)	18.07 (6.33)	17.50 (10.63)
Mandarin	19.45 (5.09)	16.60 (6.58)	24.75 (11.73)
MBPVS Score			
English	85.69 (5.07)	86.75 (5.12)	76.98 (12.21)
Mandarin	83.88 (4.93)	67.12 (13.47)	86.33 (4.53)
English Proficiency (1 -7 scale)			
Understanding	5.00 (.63)	5.73 (.96)	4.25 (.50)
Speaking	5.00 (.63)	5.73 (.96)	4.25 (.50)
Reading	5.27 (.79)	6.20 (.78)	5.25 (1.26)
Writing	5.27 (.79)	6.07 (.88)	6.25 (.50)
Mandarin Proficiency (1- 7 scale)			
Understanding	5.64 (.81)	3.93 (.88)	6.50 (.58)
Speaking	5.09 (.70)	3.40 (1.06)	6.00 (.82)
Reading	5.18 (1.08)	3.33 (.82)	6.25 (.96)
Writing	4. 91 (1.04)	3.20 (1.01)	5.75 (.96)

Note. Mean variable scores with SD in parenthesis. [a]*n = 11.* [b]*n = 15.* [c]*n = 4.*

Stuttering Frequency and Severity Across Languages

To determine whether BWS stuttered more severely in one language compared to the other, two types of analyses were performed. In the first analysis, the number of individuals in each bilingual group who obtained higher %SS and SEV scores in English or Mandarin was tabulated. Notably, all BWS stuttered in both languages and had higher %SS scores in one language than the other. Six of the 11 (54%) balanced bilinguals had higher %SS in English compared to Mandarin while five (46%) had higher %SS in Mandarin compared to English. Of the 15 BWS in the English-dominant group, 12 (80%) were found to have higher %SS scores in Mandarin while only three BWS (20%) were found to have higher %SS scores in English. For the four Mandarin-dominant bilinguals, three (75%) had a higher %SS in English compared to Mandarin while an inverse result was found for remaining participant. Statistical analysis showed that the difference in the number of participants across groups reached significance (p = 0.58, *Fisher's exact test*).

The results were slightly different in the analysis of SEV ratings. Five (46%) balanced bilinguals had higher scores in English, three (27%) had a higher score in Mandarin, and three (27%) had identical SEV scores. For the English-dominant bilinguals, 11 (74%) had higher ratings for Mandarin, two (13%) had higher ratings for English, and two (13%) had the same ratings for both languages. Finally, three (75%) Mandarin-dominant BWS had higher SEV ratings in English than in Mandarin and one (25%) participant received a higher SEV rating in Mandarin compared to English. Likewise, these results were found to reach significance (p = 0.58, *Fisher's exact test*).

The second analysis involved the comparison of the overall group mean %SS and SEV scores (N = 30) across English and Mandarin. Before doing so, we first examined whether %SS and SEV scores differed across the three speaking situations: within clinic, home, and telephone conversations. Separate one-way analyses of variance (ANOVA) with repeated measures were performed for %SS and for SEV for both English and Mandarin. In each analysis, the repeated measure was speaking situation. There were no significant differences in %SS between speaking situations for either English, $F(2, 86) = .325$, $p = .723$, or Mandarin, $F(2, 86) = .512$, $p = .512$. The SEV ratings were also not significantly different across the three speaking situations: $F(2, 86) = .094$, $p = 0.909$ for English, and $F(2, 86) = .995$, $p = .373$ for Mandarin. Thus, the mean %SS and SEV scores for each language were pooled together for further analyses. The overall group mean %SS scores (with SD in parentheses) for English and Mandarin were 7.40 (SD = 5.00) and 8.07 (SD = 5.06) respectively, and were not found to be significantly different, $t(29) = -1.36$, $p = .184$ (two-tailed). Similarly, the overall mean SEV scores between English (M = 5.08, SD = 1.65) and Mandarin (M = 5.17, SD = 1.59) did not reach significance, $t(29) = -.49$, $p = .62$ (two-tailed). A Spearman's rank-order correlation analyses also revealed a significant positive correlation between %SS and SEV ratings for both English ($r^s = .974$, $p < .001$) as well as for Mandarin ($r^s = .949$, $p < .001$).

Stuttering Frequency and Severity as a Function of Language Dominance

The findings were different when %SS and SEV scores were analyzed separately for each bilingual group. Figure 5.2 shows the mean %SS and SEV scores for English and Mandarin for the English-dominant, Mandarin-dominant, and balanced bilinguals. Descriptive statistics provided in Table 5.2 augment the graph. The difference in scores for %SS and SEV were not analyzed statistically because of the small sample size in each group. Balanced bilinguals were found to exhibit almost identical mean %SS scores for both English (M = 6.51) and Mandarin (M = 6.55). Likewise, their mean SEV ratings were not markedly different across the two languages: M = 4.85 for English, and M = 4.53 for Mandarin. In contrast, the English-dominant group produced a higher mean %SS score for Mandarin (M = 9.01) than for English (M = 6.99). A similar pattern was observed for their mean SEV scores (M = 5.44 for Mandarin, M = 4.91 for English). The data also showed that stuttering was greater in English (M = 11.37 for %SS, M = 6.42 for SEV) compared to Mandarin (M = 8.57 for %SS, M = 5.92 for SEV) for the Mandarin-dominant group.

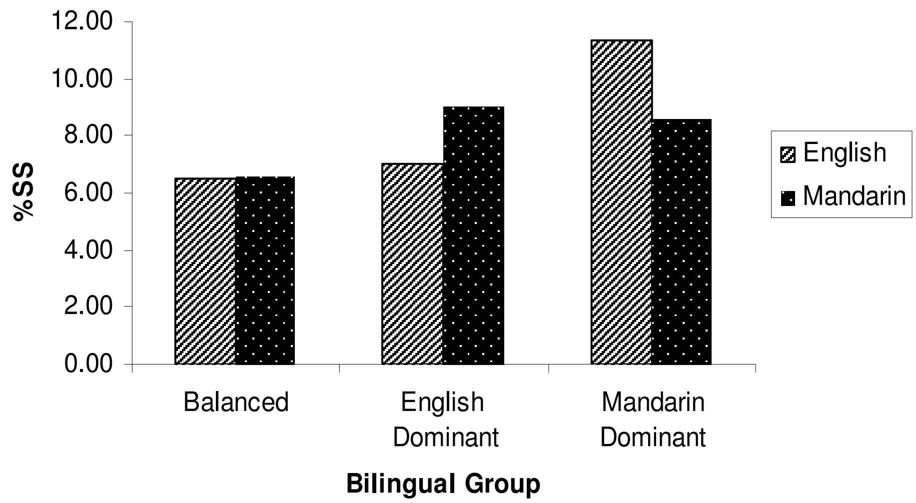
Type of Stutters Across Languages

The mean percentage of stutters for each LBDL descriptor in English and Mandarin is tabulated in Table 5.3 and illustrated in Figure 5.3. As the data for each LBDL descriptor was found to be skewed, a nonparametric test was used to determine whether the types of stutters differed between languages. A Wilcoxon signed rank test revealed that the mean percentage of stutters between English and Mandarin was not significantly different for all seven LBDL descriptors: syllable repetition (-.40, $p = .69$), incomplete syllable repetition (-.86, p = .39), multisyllable unit repetition (-1.02, p = .31), fixed posture with audible airflow (-.86, p = .39), fixed posture without audible airflow (-1.04, p = .30), Verbal superfluous behavior (-.16, p = .87) and verbal superfluous behavior (-.62, p = .62).

Type of Stutters as a Function of Language and Bilingual Group

In order to ascertain whether the types of stutters varied as a function of language dominance, the different stutter types were examined within each bilingual group: Mandarin-dominant, English-dominant, and balanced. As there were no significant differences for each LBDL descriptor across languages, the type of stutters according to bilingual groups were analyzed in terms of their broader categories: repeated movements, fixed postures, and superfluous behaviors. Again, the small sample size within each group precluded the use of statistical analyses. Nonetheless, the difference in percentage of stutters per LBDL category did not appear to be markedly different between English and Mandarin for either English-dominant, Mandarin-dominant, or balanced bilinguals (see Figure 5.4).

Figure 5.2. Mean Percent Syllables Stuttered (%SS) and Severity Rating (SEV) Scores for English and Mandarin According to Bilingual Group.



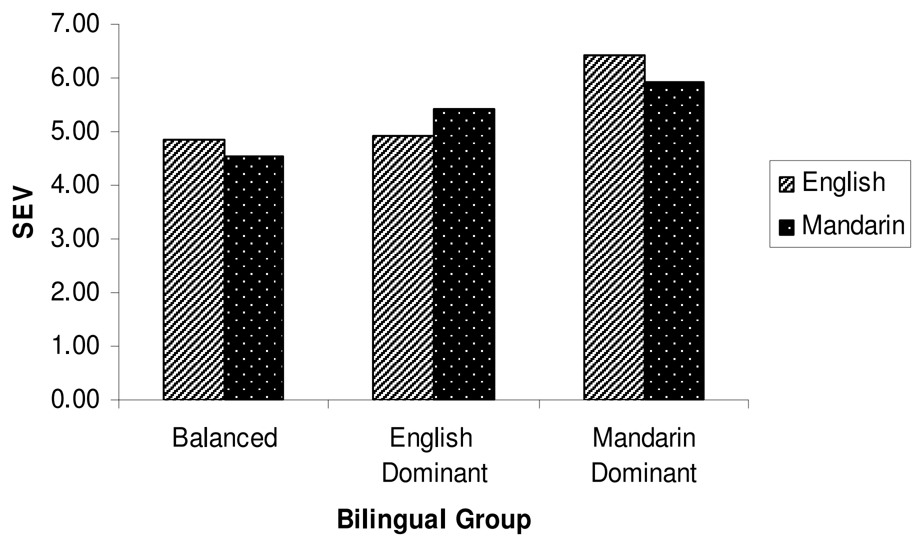


Table 5.2. Descriptive Statistics of Percent Syllables Stuttered (%SS) and Severity Rating (SEV) According to Language and Bilingual Groups.

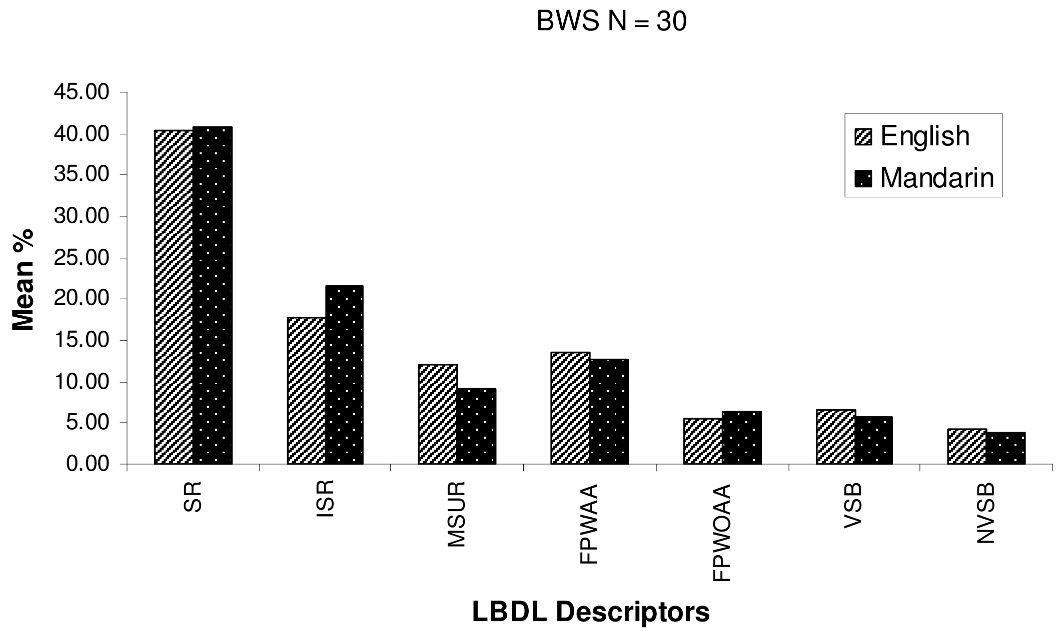
	%SS		SEV	
Variables	English	Mandarin	English	Mandarin
	Balanced Bilinguals (n = 11)			
Mean	6.51	6.55	4.85	4.53
SD	5.09	6.16	1.60	1.76
Median	4.63	5.13	4.33	4.33
Minimum	2.43	1.43	3.00	2.00
Maximum	20.27	24.2	8.33	9.00
	English-Dominant (n = 15)			
Mean	6.99	9.01	4.91	5.44
SD	4.86	4.76	1.61	1.50
Median	5.80	8.10	4.67	5.67
Minimum	1.17	2.03	2.00	2.67
Maximum	19.43	20.00	8.00	8.00
	Mandarin-Dominant (n = 4)			
Mean	11.37	8.57	6.42	5.92
SD	4.50	2.06	1.71	.91
Median	13.11	8.37	6.84	6.00
Minimum	4.70	6.47	4.00	4.67
Maximum	14.53	11.07	8.00	7.00

Table 5.3. Mean Percentage of Stutters for Each LBDL Descriptor in English and Mandarin.

LBDL Descriptors	English	Mandarin
Repeated Movements		
Syllable Repetitions	40.37	40.69
Incomplete Syllable Repetitions	17.78	21.61
Multisyllable Unit Repetitions	12.13	9.02
Fixed Postures		
With Audible Airflow	13.60	12.77
Without Audible Airflow	5.44	6.39
Superfluous Behaviors		
Verbal	6.54	5.79
Nonverbal	4.15	3.74

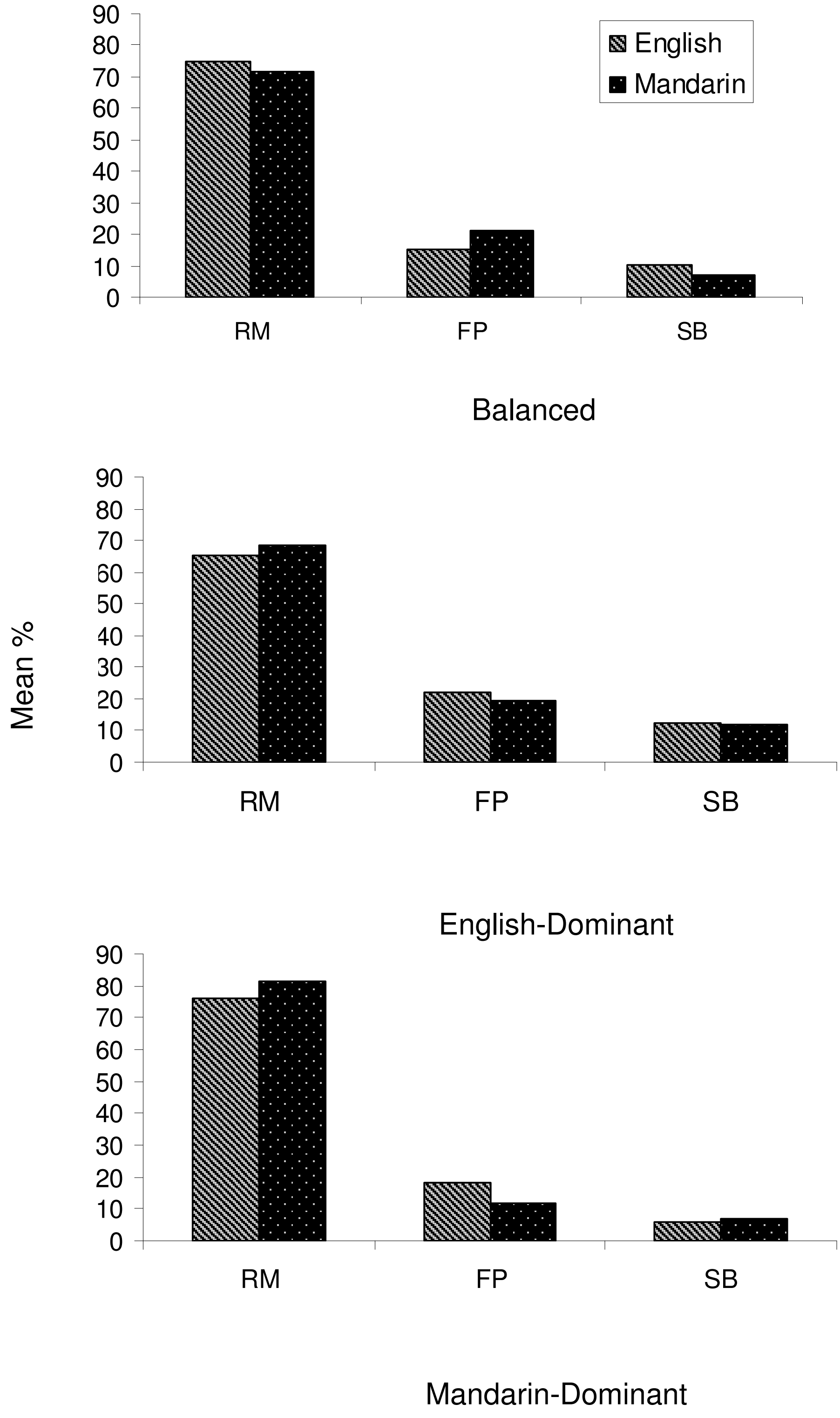
Note. Figures based on N = 30.

Figure 5.3. Mean Percentage of Each LBDL Descriptor of Total Number Stutters for English and Mandarin.



Note. Syllable repetition (SR), incomplete syllable repetition (ISR), multisyllabic unit repetition (MSUR), fixed postures with audible airflow (FPWAA), fixed postures without audible airflow (FPWOAA, verbal superfluous behaviors (VSB), and nonverbal superfluous behaviors (NVSB).

Figure 5.4. Mean Percentage for Repeated Movements (RM), Fixed Postures (FP), and Superfluous Behaviors (SB) for English and Mandarin According to Bilingual Group.



Discussion

The aim of this research was to investigate whether the severity and type of stuttering were differentially affected in English-Mandarin BWS, and whether this difference was influenced by language dominance. Stuttering behavior was examined in English-Mandarin BWS who were assigned to one of three language dominance groups—English-dominant, Mandarin-dominant, and balanced bilinguals—and using a large corpus of speech samples in each language (M = 1018 syllables per speech sample). To ensure that the BWS were appropriately categorized, bilingual classification was achieved using a previously validated self-report classification tool. A discriminant analysis showed that BWS were classified at an accuracy rate of 100%. Participant profiles also complemented their group membership.

The finding that English-Mandarin BWS evidenced stuttering in English as well as in Mandarin is consistent with the studies who examined BWS in two languages and found stuttering to occur in both (for a review, see Roberts & Shenker, in press; Van Borsel et al., 2001). With respect to whether bilinguals stutter the same or differently across languages, the "difference hypothesis" postulated by Nwokah (1988) appeared to be supported in our study. All BWS were found to exhibit disproportionate mean %SS scores across English and Mandarin. Notably, for SEV ratings, 25 BWS had different mean SEV scores between English and Mandarin while five had identical ratings between languages. Thus, although %SS and SEV ratings were found to be highly correlated, our results indicated that %SS was a more sensitive measure for detecting differences in stuttering severity across languages.

However, a closer inspection of individual data showed that a third (10) of the BWS had a difference in mean %SS score of less than 1 percentage point between English and Mandarin. Further, the mean SEV rating scores for 16 (53%) BWS were either identical or were marginally different (i.e., < 1) between the two languages. These results raise the question of how dissimilar %SS scores and SEV ratings need to be before a difference in stuttering severity between two languages is considered significant. In addition, although stuttering severity may vary across time and speaking situations, as a whole, the difference in the degree of stuttering between the languages may not be easily perceptible. This may account for some of the inconsistencies reported by SLP's between %SS measures and their client's self-evaluation of stuttering severity across the languages.

One important outcome of this study was that while the overall group mean %SS and SEV scores were not found to be significantly different across languages, stuttering severity was in fact influenced by language dominance. This was clearly illustrated by the finding that both the English-dominant and the Mandarin-dominant BWS experienced a greater degree of stuttering in their less dominant language whereas the balanced bilinguals had almost equivalent mean %SS and SEV scores for both languages. In concert with the results of Jankelowitz & Bortz (1996), Scott Trautman and Keller (2000), and Van Borsel et al. (2005), our data contributes further evidence to strengthen the language dominance argument in explaining why stuttering severity may be uneven across languages in bilinguals.

The three studies in the literature which did not find stuttering to be more severe in the less dominant language (Bernstein Ratner & Benitez, 1985; Jayaram, 1983; Nwokah, 1988) did not systematically assess language dominance in their bilingual participants. It is possible, therefore, that the participants in the group studies by Jayaram (1983) and Nwokah (1988) were not entirely homogeneous. For example, all but one of Nwokah's balanced bilinguals stuttered more in one language than the other, but there was no consistent pattern as to which language was more affected. As observed in this study, a clearer result may have transpired if the author had assessed language dominance and evaluated the results as a function of language dominance. In the single case study by Bernstein Ratner and Benitez (1985), the balanced bilingual was reportedly not equally dysfluent in both languages even though both the clinician and the participant believed that fluency in both languages was equally compromised. Likewise, this may be attributable to a lack of clarity about the participant's bilingualism, or the limited speech sample on which the analysis of stuttering was based. Their perception of stuttering across the two languages may very well have been accurate especially if it was based on the participant's overall stuttering behavior.

Although we found stuttering severity to be influenced by language dominance, the topography of stuttering was not. For all three bilingual groups, the proportion of stutters that constituted either repeated movements, fixed postures of superfluous behaviors did not differ markedly across the two languages. It appeared, therefore, that the frequency rather than the type of stuttering had influenced overall stuttering severity in the two languages. This finding contrasts with that of Jankelowitz and Bortz (1996) who reported that language ability had not only influenced the frequency but also the distribution and nature of their participant's dysfluencies. Interestingly, when the data were pooled across bilingual groups, there were no noticeable differences in the frequency or the range of stutter types between English and Mandarin. All LBDL descriptors were fairly equally represented in both these languages. Since developmental stuttering may evolve from repeated movements to fixed postures, this may suggest that the disorder progresses in roughly the same way in the two languages.

The observed differences in the frequency but not the topography of stuttering may not be justified by cross-linguistic differences. English and Mandarin are structurally different languages. Specifically, Mandarin is a tonal language and differs from English in terms of orthography, phonology, and morphology. Recent imaging studies provide evidence to show that the cognitive processes and neural substrates for Mandarin and English representation are distinct (Tham et al., 2005). Yet, in our study, we did not find stuttering to be consistently more severe in either language. Therefore, it seems unlikely that the nature of the language per se influenced the differences in stuttering severity in our bilingual individuals. This view makes sense since stuttering has been found to manifest differently in bilinguals whose two languages are structurally similar as well as dissimilar.

The proposal that stuttering severity (specifically the frequency of stutters) in BWS is linked to language dominance and not factors that are inherent in the languages needs to be accounted for in the various models and theories of stuttering. Earlier, we described how Karniol (1992) and Nwokah (1988) had applied the demands and capacities model, the neuroscience model, and the neuropsychological model to explain their respective results on stuttering in bilinguals. Neither author had considered language dominance in their explanations, but it is conceivable that all three models may account for the language dominance effect. Assuming that stuttering is caused by an underlying disturbance of neural processing, and that processing in the less dominant language is slower than and is further compounded by interference from the dominant language, more time is needed to process and coordinate the selection, programming, and production of speech sounds for the less dominant language (i.e., demands exceed the capacities for that language). Thus, the system that monitors speech production acts as an activator increasing tension and anticipation for speech production, and more stuttering results in the less dominant language.

Nevertheless, none of the models seem to specifically and sufficiently explain why the frequency but not the type of stutters was affected by language dominance. While it is not within the scope of this paper to answer this question, we will endeavor to link our findings with other theories and models of stuttering in our future work. Since bilinguals outnumber monolinguals worldwide, we hope that researchers in this field will test the existing models of stuttering—which have been based almost entirely on monolingual populations—with BWS so that we will have better insight into why and how the disorder manifests in bilinguals. Research that extends the theories and models of stuttering to bilinguals should not only consider the influence of language dominance on differential stuttering behavior in BWS, but also the psychosocial issues associated with speaking in the less dominant language.

Even though we may understand why bilinguals stutter differently across languages, further information needs to be sought about the language dominance effect. One future consideration would be to study groups of BWS with varying levels of language proficiency in their less dominant languages. Another area where research is lacking is the interrelationship between language dominance, code-switching, and stuttering in bilinguals. Whether code-switching occurs as a strategy to overcome stuttering (Karniol, 1992), or whether stuttering occurs because one code-switches (Bernstein Ratner, 2004) is not yet clear. As code-switching relates to language processing, an investigation on code-switching in BWS in different language dominance groups may serve to extend our existing knowledge on the language dominance effect. Finally, and more pertinent to our study, it is possible that the bilingual participants used two varieties of English that are commonly spoken in Singapore: Singapore Standard English (SSE) which is a *high* form of English used for formal situations, and Singapore Colloquial English (SCE) which is a *low* variety of English used for informal interaction (Deterding, 2001; Gupta, 1994). This was not controlled for in our study. Since language dominance may also influence the use of SSE and SCE, future investigations of bilingual Singaporeans who speak English as one of their languages may need to assess whether stuttering behavior also varies between the two variants of English.

To summarize, our study of English-Mandarin BWS showed that stuttering occurred in both languages but was found to be more affected in one language relative to the other. Specifically, BWS were found to stutter more frequently in the language that was less dominant. The topography of stuttering, however, did not appear to be influenced by language dominance. Cross-linguistic differences do not seem to account for the findings since stuttering was not found to be more severe in either English or Mandarin.

Our findings are important clinically and suggest that SLPs working in Singapore need to assess the language dominance in BWS in addition to conducting routine evaluation of stuttering in both languages. A self-report classification tool for clinical use has been described here and also in Lim, Lincoln, Chan, Rickard Liow, et al. (2007) which may assist SLPs in determining the dominant language. It is possible that SLPs may risk a misjudgment of stuttering severity in their bilingual clients if they do not consider language dominance, or if they continue to assess stuttering only in one language. The results of this study provide evidence to support a change in current clinical assessment protocols for BWS in Singapore and elsewhere.

CHAPTER SIX

GENERALIZATION OF TREATMENT EFFECTS FROM ENGLISH TO MANDARIN[4]

[4] This chapter is a reprint of an article submitted to the Journal of Speech, Language, and Hearing Research for publication by the candidate as first author, and co-authored with Michelle Lincoln, Yiong Huak Chan, and Mark Onslow. The candidate was the chief investigator in the research described. This article is currently under review.

Abstract

Speech language pathologists often do not speak the dominant language of their clients and so the language of treatment is an important consideration. This research investigated whether stuttering reductions in English generalized to Mandarin following treatment in English only, and whether treatment generalization was influenced by language dominance. Seven English-dominant, three Mandarin-dominant, and four balanced bilinguals who stutter (BWS) underwent a speech restructuring intensive program (IP) in English. Three 10-minute conversations in English and Mandarin, sampled at pretreatment, immediately post-IP, 4 weeks and 12 weeks post-IP, were analyzed by two English-Mandarin bilingual clinicians for percent syllables stuttered (%SS) and perceived stuttering severity (SEV). The overall mean group %SS and SEV scores were not found to be significantly different across English and Mandarin across the assessment occasions. When analyzed according to bilingual groups, the degree of residual stuttering was found to be higher in the less dominant language even if this language had received direct intervention. Stuttering reductions in English spontaneously generalized to Mandarin and stuttering remained fairly low for up to 12 weeks post-IP. However, language dominance appeared to influence the frequency and severity of stuttering in BWS. Clinical implications for treatment of BWS are discussed.

Introduction

Despite bilingualism and stuttering being the focus of multiple research studies over many years, stuttering in bilingual individuals continues to be an area in which there are more questions for clinicians and researchers than there are answers. One clinically relevant area for which there is still limited information is the treatment of bilinguals who stutter (BWS). Currently, best practice guidelines for intervention for BWS have yet to be established. In particular, it is uncertain whether stuttering treatment in one language only will suffice, and if so, which of the two languages should be targeted for treatment. It is also not clear whether BWS need treatment in both languages, and whether the course of bilingual intervention should be simultaneous or sequential.

Although treatment in two languages has been reported to yield positive fluency outcomes in both languages (e.g., Harrison et al., in press; Roberts & Shenker, in press), bilingual intervention may not be a viable option in many clinical settings: Not all speech language pathologists (SLPs) are bilingual, and interpreter training and recruitment can be time-consuming and costly (Roberts & Shenker, in press). Another challenge is that SLPs often need to assess and treat clients whose first language is not the dominant language of the SLP or the community (Waheed-Kahn, 1997). Yet, in America, Canada, Australia, and even in Asian countries like Singapore, English continues to be the preferred and frequently, the only language that SLPs use when assessing and treating BWS. However, these BWS are also likely to spend a portion of each day or week speaking and stuttering in their other language. If treatment is only provided in English, often the less dominant language, BWS may still face difficulty communicating in their dominant language if fluency does not improve to the same degree in this language.

English and Mandarin are two of the most widely spoken languages (Gordon, 2005), and are the international languages of trade and commerce. A large majority of Chinese bilinguals in Asia speak English and Mandarin. The rise in the number in migrants from China over the last decade has also lead to a sizable increase in the number of bilinguals who speak both languages worldwide. In America alone, there are now over two million people who speak a Chinese language (Shin & Bruno, 2003), with Mandarin becoming progressively more prevalent. The number of Mandarin speakers in Australia has also doubled between 1996 to 2001 and is expected to overtake speakers of other Asian languages (Clyne & Kipp, 2002). However, most of what is known about stuttering treatment has been based on English speakers, with virtually no information about treatment effects in speakers of Mandarin, or in bilinguals who speak both languages. Accordingly, it would be important to investigate the treatment of stuttering in English-Mandarin bilinguals and to see if treatment effects in English spontaneously generalize to Mandarin.

The notion of crosslinguistic generalization of treatment effects is not novel. Evidence that therapeutic gains in one language can automatically transfer to the other language has not only been shown in studies of bilingual adults with aphasia (e.g., Kiran & Edmonds, 2004; Kohnert, 2004) but also in studies of bilingual children with speech disorders (e.g., Holm & Dodd, 2001). In particular, Holm and Dodd studied a

Cantonese-English child with an articulation disorder and found that therapy in English generalized successfully to Cantonese. There is a scarcity of information about treatment generalization effects in BWS. In two comprehensive reviews on stuttering in bilinguals, Roberts and Shenker (in press) and Van Borsel, Maes, and Foulon (2001) cited a small number of studies and conference papers which suggest that fluency improvements from the treated language spontaneously transfer to the untreated language, but that the degree of generalization was asymmetrical in some cases. However, these studies are largely anecdotal reports or single case studies, that do not have reliability data, and have not been published in peer-reviewed journals. As such, there is no convincing empirical data on this topic at present.

Recent research on BWS has shown that the severity of stuttering is influenced by language dominance (Lim, Lincoln, Chan, Rickard Liow et al., 2007). The speech of a group of English-Mandarin BWS was investigated and it was found that balanced bilinguals exhibited similar levels of stuttering severity across the two languages. On the other hand, both the English-dominant and Mandarin-dominant bilinguals in the study were found to stutter more in their less dominant language. These findings give impetus to a clinical question about whether treatment generalization is also affected by language dominance.

One hypothesis is that bilinguals who receive treatment in their less dominant language may have greater difficulty achieving and maintaining fluency in this language. For example, Waheed-Khan (1998) found that bilingual children, whose first language was not English, experienced greater trouble in transferring fluency targets to conversation than children who spoke English natively. This proposal is conceivable in view of several important suppositions borrowed from the literature on bilingual language processing: (a) there is interaction between the systems that process the bilingual's two languages, (b) crosslinguistic interference may occur at all input and output levels of language processing including semantic, syntactic, and phonological levels, (c) the direction of inter-language interference is asymmetric, usually occurring from the dominant to the less dominant language, and (d) more time is required to access and process the less dominant language since greater effort is required to inhibit the representations of dominant language, and because there is decreased familiarity and use of this language (e.g., Abutalebi & Green, 2007; Costa, Santesteban, & Ivanova, 2006; Paradis, 1987; Schwartz & Kroll, 2006). Such linguistic demands especially in the less dominant language may have a cascading effect on the stability of the speech motor systems of individuals who stutter (e.g., Jones Maner, Smith, & Grayson, 2000; Kleinow & Smith, 2000) even after treatment. However, as no study has systematically investigated whether therapy in the less dominant language automatically transfers to the dominant language, this hypothesis remains speculative.

Another theory is that the transfer of fluency improvements to the untreated language may be easier if treatment was conducted in the bilingual's dominant language. Shenker (2004) and Shenker, Conte, Gingras, Courcy, and Polomeno (1998) both described the same English-French bilingual preschool age child whose predominant language was English. After the Lidcombe Program, an early intervention for stuttering, was introduced in English, the child made fluency improvements in this language which also generalized to French, the less dominant language. However, even though automatic treatment generalization occurred, the degree of treatment generalization from the treated to the untreated language was found to be disproportionate. Specifically, a higher percent syllable stuttered (%SS) score was noted in French (6%SS), the untreated and less dominant language, than in English (3%SS) posttreatment. This finding suggests that language dominance may possibly influence the extent of spontaneous treatment generalization effects in BWS.

In addition to language dominance, the degree of fluency transfer from the treated to the untreated language may also be dependent on other factors such as crosslinguistic similarities, and the frequency, intensity, and length of treatment (Roberts & Shenker, in press). For example, in the former, a greater treatment generalization effect might be expected when the two languages are more linguistically similar (e.g., English vs. Spanish) than dissimilar (e.g., English vs. Mandarin). At this stage, however, it would be premature to draw any conclusions regarding the influence of language dominance, linguistic similarity, and treatment method on treatment generalization effects since neither of the associations have been specifically examined in the past.

One reason why these relationships remain ambiguous is that most of the reports or conference papers (see Roberts & Shenker, in press; Rousseau, Packman, & Onslow, 2004; Van Borsel et al., 2001) do not provide adequate information about the participants or the treatment approach used, including little or no details about the participant's bilingual background, environments of language learning and use, or how language dominance was defined. Given that many factors influence language dominance (Flege et al., 2002), and since relative language dominance is closely interrelated with the duration, frequency, and domain of language use (Grosjean, 1998), it would be erroneous to assume that the participant's first language is the dominant one. Although Shenker et al. (1998) based their decision about the child's predominant language on the length and complexity of the child's utterances, the analysis was performed on a two parent-child interactions within and beyond the clinic, and hence, may not fully reflect the child's overall language proficiency and patterns of language use. A more valid approach to determining language dominance may be to use criteria based measurements of language proficiency and language use in both languages, and to verify the results using objective tests (Lim, Lincoln, Chan, Rickard Liow et al., 2007).

To recap, whether treatment in the dominant or less dominant language influences the extent of treatment generalization, or whether treatment generalization effects are affected by inherent linguistic features or treatment methods is currently unknown since a comparative study of this nature has yet to be conducted. A plausible way of clarifying the impact of language dominance on treatment generalization effects, while controlling for treatment type and inter-language similarities, is to investigate within the same study a group of BWS from the same bilingual learning background who speak two linguistically distant languages (e.g., English and Mandarin), have different language dominance and language use profiles, but who undergo an identical treatment program in the same language.

The purpose of this study was to investigate whether fluency improvements in English spontaneously generalize to Mandarin following treatment in English only. Importantly, we also assessed whether such generalization effects were influenced by language dominance, and whether the effect was maintained over time. To achieve these research aims, English-Mandarin BWS were divided into three language dominance groups—English-dominant, Mandarin-dominant, and balanced bilinguals—using a self-report classification tool developed previously (Lim, Lincoln, Chan, Rickard Liow et al., 2007), and stuttering severity across languages was compared at pretreatment, and again at three different time-intervals posttreatment.

The research questions were: (a) Will fluency improvements in English spontaneously generalize to Mandarin, and will this be maintained in the short term?

(b) Will the overall stuttering severity in Mandarin and English reduce to similar levels following treatment in English only? (c) Is the extent of spontaneous treatment generalization effects influenced by language dominance?

Method

Participants

Participants were 14 BWS who participated in an earlier study (Lim, Lincoln, Chan, & Onslow, 2007), and who proceeded to receive stuttering treatment at the Singapore General Hospital (SGH) Stuttering Clinic between April 2005 to December 2006. Inclusion criteria for the participants were as follows: (a) of Chinese descent, (b) Singaporean or Singapore Permanent Resident, (c) bilingual in Mandarin and English, (d) aged 12 years or older, (e) diagnosed with developmental stuttering, and (f) stuttering rate of more than 2%SS as determined by the assessing clinician from a 10-minute within-clinic conversational sample.

All participants were men ranging in age from 12 to 33 years (M = 21.57, SD = 7.15) who had not received any past treatment for stuttering. All participants were told that they were involved in a stuttering treatment study for bilinguals, but remained unaware of the specific research aims.

Using a previously validated self-report classification tool (for details, see Lim, Lincoln, Chan, Rickard Liow et al., 2007), four BWS were classified as balanced bilinguals, eleven were categorized as English-dominant bilinguals, and three were grouped as Mandarin-dominant. The criteria used to determine language dominance were based on the participants' self-ratings of language proficiency, frequency of language use, and domains of language use across the four language modalities—understanding, speaking, reading, and writing. A disciminant analysis (Garson, 2006), where language dominance (English-dominant, Mandarin-dominant, balanced) was the grouping variable and the raw scores for language proficiency, frequency of language use, and domain of language use in both languages were entered as the independent variables, yielded a 100% accuracy rate for group membership. This accuracy rate was found to be significant when compared with the random probability of 33% (p < .001) indicating that all participants were correctly classified above the level of chance.

Participant characteristics for each BWS group (see Table 6.1) supported their language dominance group categorization. For the group of balanced bilinguals, mean age of language exposure to English was slightly higher than Mandarin while years of language exposure was correspondingly lower for English than for Mandarin. Yet this group scored slightly higher on the Multilingual British Picture Vocabulary Scale (MBPVS; Rickard Liow et al., 1992; see also Lim, Lincoln, Chan, Rickard Liow et al. 2007) in English compared to Mandarin, and displayed comparable self-rated proficiency scores in both languages. On the other hand, the English-dominant bilingual group reported an earlier and longer exposure to English, and were found to have higher scores on both the MBPVS and the self-rated proficiency scales in English. Similarly, the Mandarin-dominant bilinguals were exposed to Mandarin earlier and longer than English, reported better language proficiency levels in Mandarin, and scored higher on the Mandarin MBPVS compared to English. The higher mean age of exposure to English for the Mandarin-dominant group was attributed to two participant outliers. Two of the three Mandarin-dominant participants were originally from China and were only exposed to English at six and 12 years respectively after immigrating to Singapore. Despite the two outliers, all participants reported higher years of formal instruction in English than Mandarin, reflecting the uniform system of education in Singapore.

The Treatment Program

The treatment program comprised a fluency intensive program (IP) that was adapted from Block and Dacakis (2003). It involved a three-day, non-residential program which ran for eight hours per day. This was followed by six follow-up sessions that were conducted once weekly. Each follow-up session lasted for about two hours. The duration of the entire program was approximately 36 hours. Unlike Block and Dacakis who used student clinicians to deliver therapy, participants in our program received treatment from experienced Speech-Language Pathologists (SLPs). The number of clients in each program was considerably smaller, normally running with two or three participants per program.

Table 6.1. Profile of BWS According to Language Dominance Group.

Variables	Balanced Bilinguals	English Dominant	Mandarin Dominant
Age	22.75 (5.73)	21.14 (9.00)	21.00 (6.00)
Age of Language Exposure			
English (range)	2.75 (2 – 4)	1.86 (1 – 4)	7.67 (5 – 12)
Mandarin (range)	1.50 (1 – 2)	3.14 (1 – 6)	1.67 (1 – 2)
Years of Formal Instruction			
English	13.00 (2.79)	12.00 (3.89)	12.00 (2.16)
Mandarin	11.09 (1.14)	10.06 (2.02)	10.25 (1.26)
Years of Language Exposure			
English	17.73 (4.51)	18.07 (6.33)	17.50 (10.63)
Mandarin	19.45 (5.09)	16.60 (6.58)	24.75 (11.73)
MBPVS Score			
English	88.00 (2.88)	88.18 (3.56)	80.42 (12.35)
Mandarin	85.67 (3.52)	67.05 (14.4)	86.22 (5.55)
English Proficiency (1 -7 scale)			
Understanding	5.75 (0.50)	5.71 (0.95)	5.33 (1.52)
Speaking	5.25 (0.50)	5.43 (1.13)	4.33 (0.57)
Reading	5.50 (0.57)	6.00 (0.81)	5.33 (1.52)
Writing	5.50 (0.57)	5.86 (0.90)	6.33 (0.57)
Mandarin Proficiency (1- 7 scale)			
Understanding	5.50 (0.57)	4.29 (1.49)	6.33 (0.57)
Speaking	5.25 (5.00)	3.00 (1.00)	6.00 (1.00)
Reading	5.25 (5.00)	3.00 (0.81)	6.00 (1.00)
Writing	5.00 (0.00)	2.43 (0.53)	6.00 (1.00)

Note. All values, except age of language exposure, represent mean scores with SD in parentheses. For age of language exposure, the range of years is in parentheses.

The IP involved two days of fluency instatement where participants learnt the speech restructuring technique called *Smooth Speech* which has been shown to successfully alleviate stuttering in adolescents and adults who stutter (e.g., Block et al., 2005). The technique was taught in a graded sequence of speech beginning at 60 syllables per minute (SPM), and advancing to a comfort rate of about 180 to 200 SPM. Participants progressed through the stages of fluency instatement only if they used the speech pattern correctly and remained stutter free. The SLP provided online feedback about the participants' speech where appropriate. Similar to the program by Block and Dacakis (2003), therapy also focused on helping clients achieve natural sounding speech while still practicing Smooth Speech. This usually occurred when participants acquired speech rates of 120 SPM or higher. Participants also had the opportunity for speech practice in small groups throughout the day. Midway through the third day of the intensive program, participants practiced the transfer of fluent speech to every day speaking situations. Details of the IP are found in Appendix C.

Immediately after the IP, the transfer of fluency continued for six weekly follow-up sessions. During these sessions, the SLP reviewed the participants' home practice recordings and use of Smooth Speech, allowed the participant to practice the technique at specified speech rates, and reinforced self-management strategies to facilitate generalization and maintenance of stutter-free speech beyond the clinic. The sessions were participant-specific and any troubleshooting was tailored to the participant's individual needs.

Treatment was conducted in English only for the entire program. However, due to the multilingual context in Singapore, participants were told that they could apply and use the technique in Mandarin wherever necessary outside the clinic. No other specific advice about using the technique in Mandarin was given.

Speech Sampling

To ascertain if treatment effects generalized from English to Mandarin, speech samples were collected in both languages at four assessment occasions: pretreatment, at the end of the third day of the IP, four weeks post-IP, and again at 12 weeks post-IP (see Figure 6.1). At each of these assessment occasions, conversational speech samples were collected in one within-clinic context and in two beyond-clinic situations. They included speaking face-to-face with the SLP, speaking face-to-face or on the telephone with a family member/friend at home, and conversing with an unfamiliar person on the telephone. As far as possible, all conversations were kept to familiar topics such as family, work/school, and social interests or activities, and participants were assumed to be functioning at the bilingual end of Grojean's (2001) language mode continuum (see Lim, Lincoln, Chan, Rickard Liow et al., 2007). Each conversation was approximately ten minutes in duration.

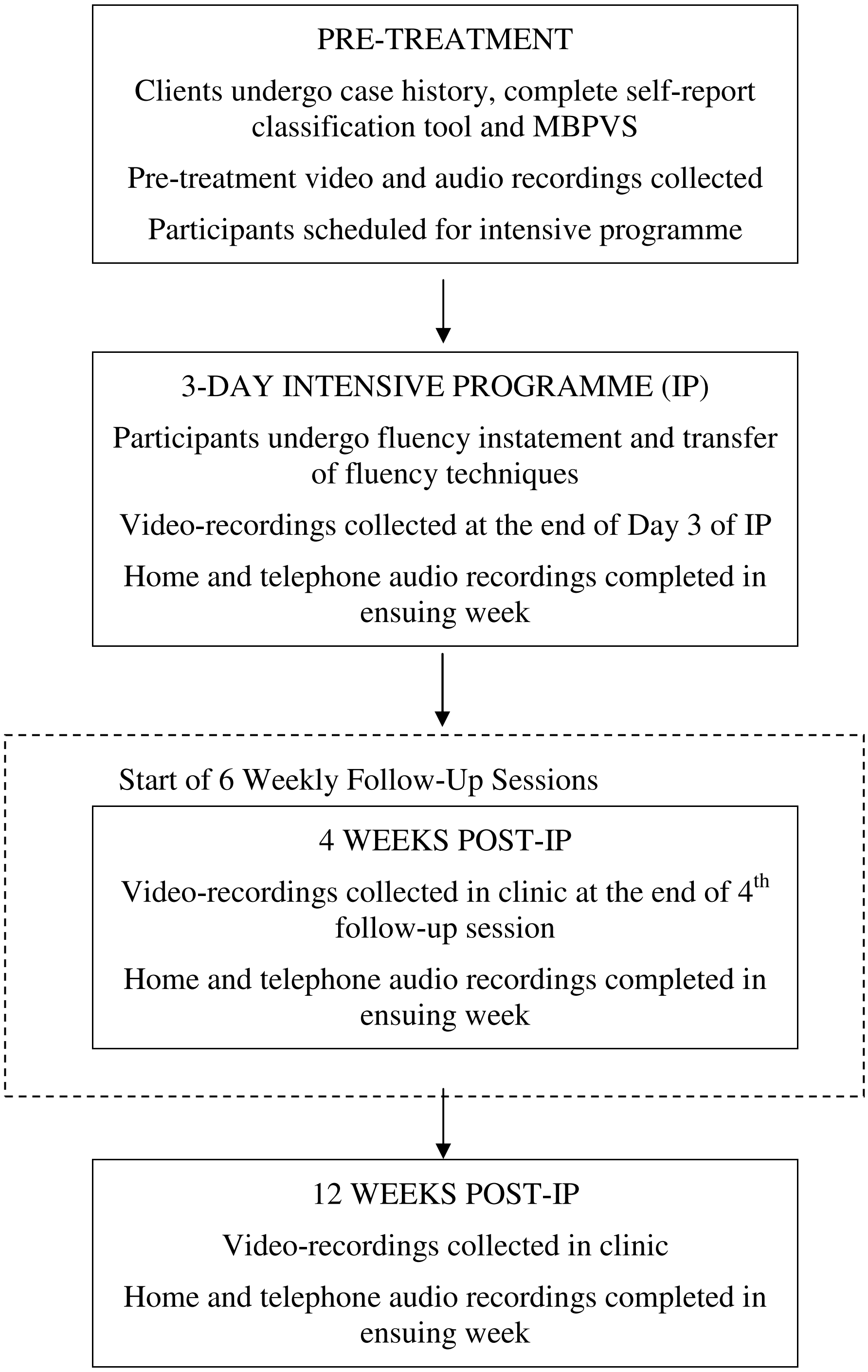
Study Procedure

Prior to commencing treatment, all participants underwent an assessment protocol which comprised case history taking, video and audio recordings of stuttering behavior within and beyond the clinic, and completed the self-report classification tool and vocabulary testing (see Figure 6.1). This protocol was completed over two clinic visits, each lasting approximately one hour. Due to participants' availability to attend the IP, and since the IP was conducted once every two months, a time lapse often occurred between the pretreatment assessments and participants' scheduled attendance at IP. This time lapse ranged between 1 and 23 weeks (*Median* = 7.5).

All conversational samples within the clinic were conducted by a bilingual English-Mandarin SLP. The video recordings were front on headshots of the participants and recorded with a WV-CS320 ¼ inch CDD-COL PTZ Dome Camera and an ES-945 omni directional condenser boundary microphone. Speech samples collected outside the clinic were always completed in the week just following the within clinic sessions. Participants recorded their home conversations using either a portable digital or analog audio recording device. The telephone conversations between the participant and the unfamiliar person were recorded using a National audiotape recorder and a special recording jack attached to the telephone. These telephone calls were made by a clinic volunteer at unexpected times to remove as far as possible any participant bias that could have elicit a more fluent speech sample (Packman et al., 2004).

To minimize any confounding effects of adaptation on stuttering behavior (Hall & Evans, 2004), all video and telephone speech recordings in English and Mandarin were counterbalanced. Half the participants' speech samples were collected in English followed by Mandarin, with the remaining half conducted in the reverse order. As the

Figure 6.1. Speech Sampling Procedure and Study Design.



conversations in the home environment were dependent on the availability of the participants' communication partners, these recordings were not counterbalanced.

The self-report inventory (see next section) was completed at the end of the final follow-up session. All participants were given a 12 week post-IP follow-up appointment. During this final session, speech sampling was again conducted in both English and Mandarin. Again, due to participants' availability, data collection for this final stage was completed between 12 to 18 weeks post-IP (*Median* = 13.5). Participants required a total of 13 clinic visits to complete their involvement in the study.

Dependent Variables

Stuttering Severity and Speech Rate

Percent syllables stuttered (%SS) and severity rating (SEV) were used to measure stuttering rate and severity (O'Brian, Packman, & Onslow, 2004). The %SS measure was calculated by dividing the total number of stuttering moments by the total number of syllables spoken. On the other hand, SEV was measured perceptually using a 9-point severity rating scale (O'Brian, Packman, & Onslow, 2004) where a rating of "1" indicated no stuttering, and "9" indicated extremely severe stuttering. Syllables per minute (SPM) was used as a measure of speech rate. For SPM, the total number of syllables spoken was calculated as a function of the total amount of time taken to complete the sample.

Self-report Inventory

The self-report inventory (O'Brian et al., 2003) is a 16-item questionnaire that was developed to assess qualitatively the participant's self-judgment of their own speech after treatment as well as their perception of the treatment process and overall benefits (Ingham & Cordes, 1997). As the original questionnaire was designed for a monolingual population, two sets of inventories were used for the study, one for each language. The questions on both the Mandarin and English inventories were adapted to ensure that they were language specific. Since fluency improvement is potentially positively correlated with the amount of self-practice, an additional question which examined the amount of time participants reported the practice of Smooth Speech outside the clinic was included to each inventory. Consequently, there were 17 questions in total on both inventories. Information obtained from the self-report inventory included participants' assessment of their: (a) average stuttering severity, (b) speech naturalness, (c) speech satisfaction in each language, (d) difficulties with learning Smooth Speech in English and in using the technique in both languages, (e) amount of self-practice in each language, (f) comfort level in applying the technique in their daily lives, (g) perception of the trade off between speech naturalness and speech fluency, and (h) preference between stuttering and using smooth speech to achieve fluency in each language.

Speech and Reliability Analyses

To ensure that judgments about stuttering behavior in both English and Mandarin were accurate, the two judges who analyzed the speech samples for %SS, SEV, and SPM were SLPs who were themselves English-Mandarin bilingual Singaporeans (Finn & Cordes, 1997; Van Borsel & Medeiros de Britto Pereira, 2005). Both judges were experienced in the assessment and treatment of stuttering, and were blind as to the aims of the study. The first judge analyzed the entire set of speech samples in English and Mandarin while the second judge performed reliability analyses on a subset of the speech samples.

Twenty-four speech samples—taken across the two languages, three speaking situations and four phases of the study—were collected per participant. Hence, the total number of speech samples for the study was 336. Due to recording failure, eight speech samples were classified as missing data. Accordingly, the final dataset analyzed comprised 328 speech samples: 56 digital video recordings in each language, and 137 and 135 audio-recordings in English and Mandarin respectively.

All audio and video samples were edited to eliminate any identifying information. They were then transferred onto readable compact discs (CD-Rs) in a randomized order so that judges were blind to the specific stage where the speech was sampled. The video and audio speech samples were analyzed separately. Judges watched and/or listened to each speech sample and analyzed SPM and %SS in real-time using a button-press timing and counting device. An SEV score was also given to each sample at the end of the recording. Judges only assessed the speech samples for unambiguous stuttering.

To establish inter and intrajudge reliability on %SS, SPM and SEV, one audio and one video recording per participant was pseudorandomly chosen for reanalysis. This constituted an additional 28 recordings (8.5%) for reliability analysis, with an equal number of audio and video recordings in each language. The proportion of pretreatment to posttreatment speech samples selected for reliability analysis was 7:21 which corresponded with the 1:3 ratio of the total number of pre- vs. posttreatment samples actually collected. The first judge remeasured these 28 speech samples for %SS, SPM and SEV. The same set of speech samples was analyzed by the second judge for %SS, SPM and SEV as a measure of interjudge reliability.

The Pearsons correlation between the initial scoring and rescoring of %SS by the first judge was 0.97. For %SS, 17 of the 28 samples (60.7%) differed by 0-1.0%SS between raters, 25 of the 28 samples (89.3%) differed by 0-2.0%SS, all 28 samples (100%) differed by 0-3.0%SS. The correlation between the %SS scores of the first and second judge was 0.98. Nineteen of the 28 samples (67.9%) differed by 0-1.0%SS, 26 of the 28 samples (92.9%) differed by 0-2.0%SS, all 28 samples (100%) differed by 0-3.0%SS.

In terms of SEV ratings, the Spearmans correlation between the initial scoring and rescoring by the first judge was 0.84. Fifteen of the 28 samples (51.7%) achieved identical ratings, 25 samples (89.3%) differed by 0-1 rating points, and all samples (100%) were within a 2 rating point difference. Interjudge reliability analyses for SEV ratings yielded a correlation score of 0.70. Sixteen of the 28 samples (57.1%) had identical ratings between the two judges, 26 samples (92.9%) differed by 0-1 rating point, all 28 samples (100%) differed by 0-2 rating points. The lower correlation coefficient for inter-rater reliability may have been an artifact of an analysis which measures the linear association between two variables. It is noted that there was good agreement in the SEV scores between judges with approximately 9 out of 10 scores within plus or minus 1 scale score (O'Brian, Packman, & Onslow, 2004).

The correlation scores for SPM were 0.22 for interjudge reliability and 0.40 for intrajudge reliability SPM and were not analyzed further due to poor reliability.

Results

Generalization of Treatment from English to Mandarin

To determine whether fluency improvements in English spontaneously generalized to Mandarin, and whether this was maintained in the short term, the overall group mean %SS and SEV scores for English and Mandarin for all 14 BWS were compared across the four assessment occasions (see Table 6.2). The %SS and SEV scores were pooled across speaking situations since the results of a one-way analysis of variance (ANOVA) with repeated measures did not reveal any significant differences between the within clinic, home, and telephone conversations for either English or Mandarin at any of the four assessment occasion ($p < .05$).

The mean pretreatment stuttering rate was 8.3%SS for English and 8.7 %SS for Mandarin, while the mean pretreatment SEV score was 5.6 for English and 5.5 for Mandarin. Following speech restructuring treatment in English, the mean stuttering rate reduced to 1.2%SS, 1.2%SS, and 1.9%SS for English and to 1.6%SS, 1.9%SS, and 2.8%SS for Mandarin at the end of IP, at 4 weeks post-IP, and at 12 weeks post-IP respectively. The same trend was observed for the mean SEV scores for English (M = 2.2 at end of IP, M = 2.1 at 4 weeks post-IP, and M = and 2.6 at 12 weeks post-IP) as well as Mandarin (M = 2.4 at end of IP, M = 2.5 at 4 weeks post-IP, and M = 2.9 at 12 weeks post-IP respectively).

Wilcoxon Signed Rank Tests revealed no significant differences between the English and Mandarin %SS scores at pretreatment (-.53, p = .594), at the end of IP (-1.16, p = .245), at 4 weeks post-IP (-1.85, p = .064), and at 12 weeks post-IP (-.56, p = .572). The SEV scores between English and Mandarin were also not significantly different at pretreatment (.000, p = 1.00), at the end of IP (-.74, p = .454), and at 12 weeks post-IP (-.53, p = .592), but was found to be significant at 4 weeks post-IP (-2.13, p = .033). Nonparametric tests were applied because the sample size was below 20 (Jones, Onslow, Packman, & Gebski, 2006).

Table 6.2. Group Means, SDs, and Ranges of Percent Syllables Stuttered (%SS) and Severity Rating (SEV) Scores According to Language Across the Four Assessment Occasions.

Assessment Occasion	%SS				SEV			
	Mean	SD	Min	Max	Mean	SD	Min	Max
				English				
Pretreatment	8.3	4.8	3.7	19.4	5.6	1.5	3.7	8.0
End of IP	1.2	0.8	0.17	3.0	2.2	0.8	1.5	3.3
4 weeks Post-IP	1.2	1.1	0.13	4.6	2.1	0.6	1.3	3.7
12 weeks Post-IP	1.9	1.7	0.27	6.5	2.6	0.9	1.7	5.0
				Mandarin				
Pretreatment	8.7	4.6	3.7	20.0	5.5	1.4	3.5	8.0
End of IP	1.6	0.8	0.4	2.9	2.4	0.6	1.7	3.7
4 weeks Post-IP	1.9	1.3	0.3	4.2	2.5	0.7	1.5	4.0
12 weeks Post-IP	2.8	2.8	0.5	9.1	2.9	1.4	1.3	5.7

Note. Data have been pooled across the three speaking situations (clinic, home, telephone). Figures based on N = 14.

A Spearmans rank order correlation analyses showed a significant positive correlation between %SS and SEV scores for each language at pretreatment (r^s = 0.92 for English, r^s = 0.83 for Mandarin), end of IP (r^s = 0.88 for English, r^s = 0.73 for Mandarin), 4 weeks post-IP (r^s = 0.87 for English, r^s = 0.94 for Mandarin), and at 12 weeks post-IP (r^s = 0.96 for English, r^s = 0.91 for Mandarin); all of which were found to be significant at p <.001. Overall, these results revealed several important findings: (a) fluency improvements in English had generalized to Mandarin, (b) even though stuttering severity was not significantly different across languages in all except one posttreatment assessment, the absolute figures suggest that fluency in Mandarin did not improve to the same degree as that for English, and (c) although fluency improvements in both languages remained low for up to 12 weeks post-IP, there appeared to be a small but gradual increase in stuttering in Mandarin over time.

Influence of Language Dominance on Treatment Generalization Effects

To ascertain if the extent of spontaneous treatment generalization effects was influenced by language dominance, the mean %SS and SEV scores for English and Mandarin at each of the four assessment occasions were analyzed according to the three bilingual groups: balanced, English-dominant, and Mandarin-dominant. The data were illustrated graphically (see Figures 6.2 and 6.3) and analyzed descriptively (see Tables 6.3 and 6.4). Individual mean %SS data are also available in Appendix B. The results for %SS and SEV will be discussed separately according to each bilingual group.

Balanced Bilinguals

The mean pretreatment stuttering rate for the balanced bilinguals was found to be relatively comparable between English and Mandarin even though the mean %SS score for Mandarin (M = 4.3) was slightly lower than that for English (M = 5.1). The group mean scores for English decreased to 1.2%SS, 1.1%SS, and 1.2%SS at the end of IP, 4 weeks post-IP, and 12 weeks post-IP respectively. Likewise, the mean scores for Mandarin were found to decrease to 1.8 %SS at the end of IP, 1.9 %SS at 4 weeks post-IP, and 2.0 %SS at 12 weeks post-IP. A similar trend was observed for the SEV rating scores (see Figure 6.3 and Table 6.4). These results suggest that the balanced bilinguals experienced an overall reduction in stuttering severity in both languages following treatment in English only. The extent of treatment generalization was noted to be mildly disproportionate across the two languages with stuttering rate and severity slightly higher in Mandarin compared to English. Further, the treatment generalization effect was observed to be fairly stable over time.

Inspection of individual data showed that all four balanced bilinguals experienced a reduction in stuttering in both languages at the end of 3 days of intensive treatment, but were observed to stutter slightly more in Mandarin compared to English.

Figure 6.2. Mean Percent Syllables Stuttered (%SS) Scores for English and Mandarin at Pretreatment, End of IP, 4 weeks-IP, and 12 weeks post-IP Accoding to Bilingual Group.

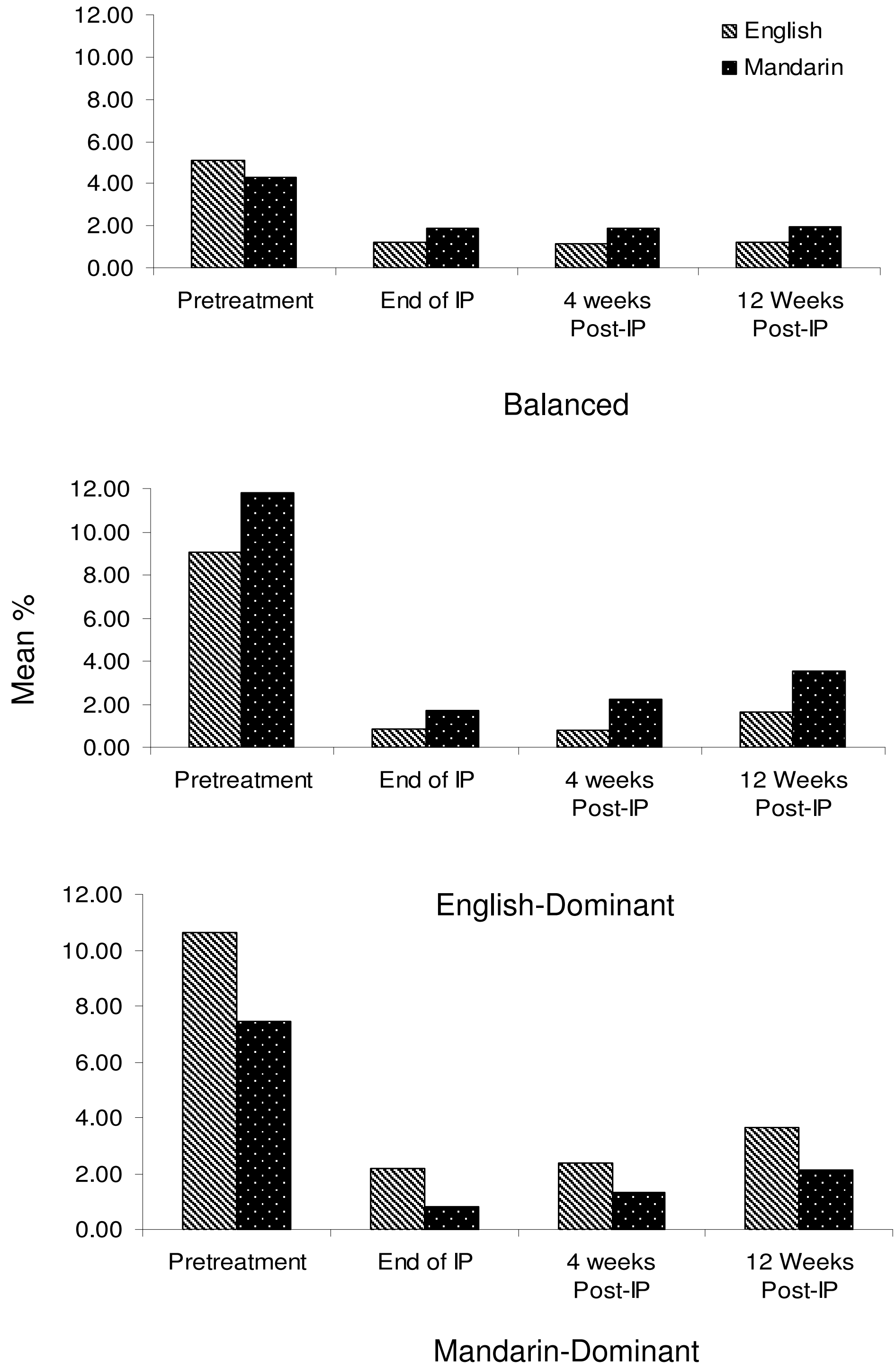


Table 6.3. Means, SDs, and Ranges of Percent Syllables Stuttered (%SS) Scores According to Language and Bilingual Group Across the Four Assessment Occasions.

Assessment Occasion	English				Mandarin			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Balanced Bilinguals (n = 4)								
Pretreatment	5.1	1.8	3.7	7.7	4.3	1.0	3.7	5.8
End of IP	1.2	.4	.8	1.7	1.8	.8	1.1	2.9
4 weeks Post-IP	1.1	.6	.4	1.9	1.9	1.6	.3	4.1
12 weeks Post-IP	1.2	1.0	.3	2.6	2.0	2.5	.5	5.6
English-Dominant (n = 7)								
Pretreatment	9.1	5.4	3.9	19.4	11.8	4.9	7.1	20.0
End of IP	0.8	.9	.2	2.7	1.7	.8	.5	2.8
4 weeks Post-IP	0.8	.5	.1	1.4	2.2	1.3	.3	4.2
12 weeks Post-IP	1.7	.9	.4	3.0	3.6	2.1	1.0	9.1
Mandarin-Dominant (n = 3)								
Pretreatment	10.6	5.2	4.7	14.5	7.4	1.7	6.4	9.4
End of IP	2.2	.8	1.5	3.0	.8	.8	.8	2.3
4 weeks Post-IP	2.4	2.0	.6	4.6	1.3	.8	.5	2.0
12 weeks Post-IP	3.6	3.1	.3	6.5	2.1	1.5	.6	3.5

Note. Data have been pooled across the three speaking situations (clinic, home, telephone).

Figure 6.3. Mean Stuttering Severity (SEV) Scores for English and Mandarin at Pretreatment, End of IP, 4 weeks-IP, and 12 weeks Post-IP According to Bilingual Group.

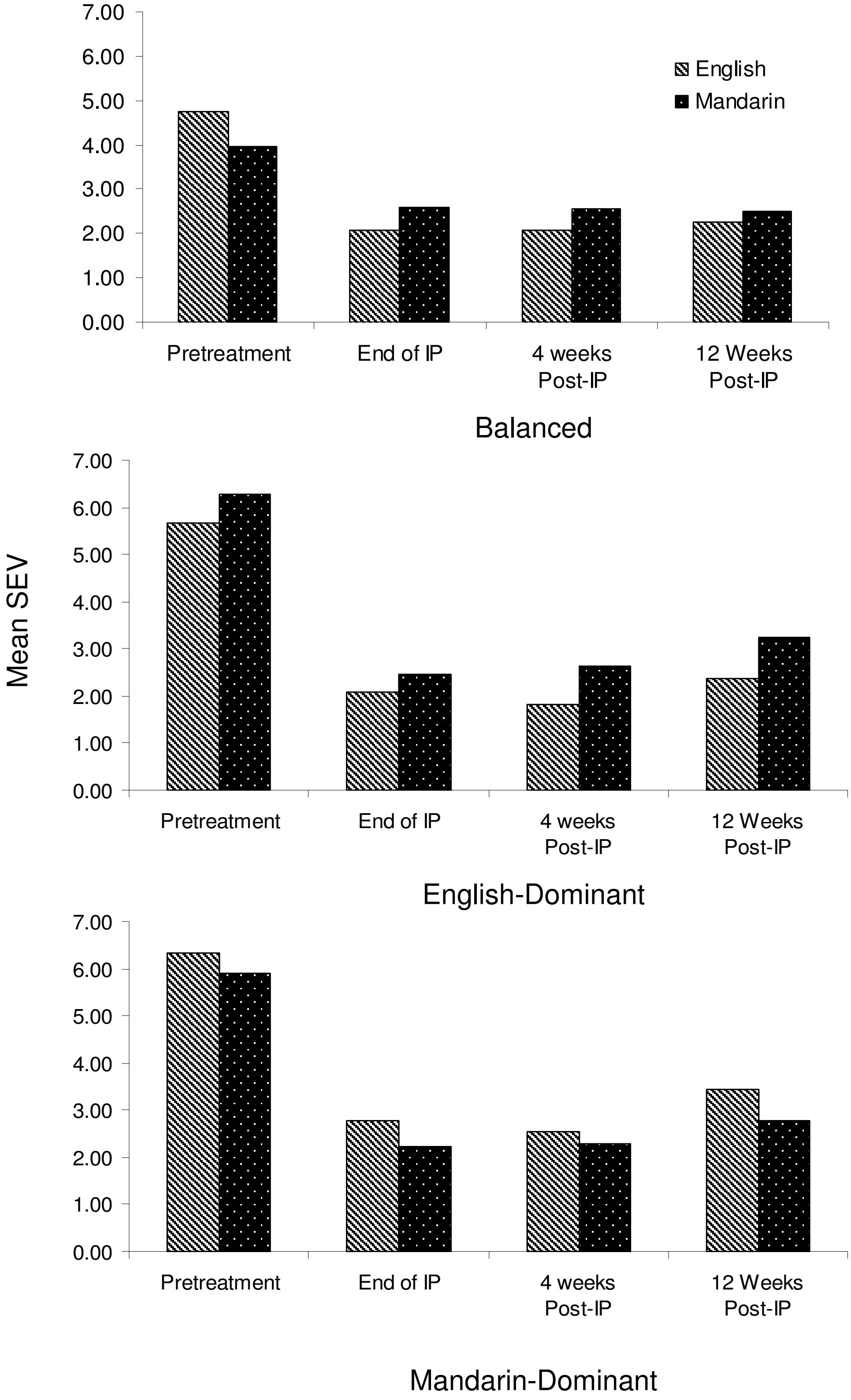


Table 6.4. Means, SDs, and Ranges of Severity Rating (SEV) Scores According to Language and Bilingual Group Across the Four Assessment Occasions.

Assessment Occasion	English				Mandarin			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Balanced Bilinguals (n = 4)								
Pretreatment	4.6	1.1	3.7	6.0	4.0	.7	3.5	5.0
End of IP	2.1	.2	2.0	2.3	2.6	.6	2.0	3.3
4 weeks Post-IP	2.1	.3	1.7	2.2	2.4	1.8	1.0	400
12 weeks Post-IP	2.3	.5	2.0	3.0	2.5	1.5	1.3	4.7
English-Dominant (n = 7)								
Pretreatment	5.7	1.5	4.0	8.0	6.3	1.1	5.0	800
End of IP	2.1	.5	1.5	2.7	2.5	.7	1.7	3.7
4 weeks Post-IP	1.8	.3	1.3	2.0	2.6	.7	1.7	3.7
12 weeks Post-IP	2.4	.4	2.0	3.0	3.2	1.7	2.0	5.7
Mandarin-Dominant (n = 3)								
Pretreatment	6.3	2.1	4.0	8.0	5.9	1.2	4.7	7.0
End of IP	2.8	.5	2.3	3.3	2.2	.4	2.0	2.7
4 weeks Post-IP	2.6	1.0	1.7	3.7	2.3	.3	2.0	2.5
12 weeks Post-IP	3.5	1.7	1.7	5.0	2.8	.8	2.0	3.7

Note. Data have been pooled across the three speaking situations (clinic, home, telephone).

At 4 and 12 weeks post-IP, the results were more variable with participants demonstrating higher or lower levels of stuttering across the two languages. The results of participant S05 were noteworthy: Stuttering in Mandarin decreased by half (M = 2.9%SS) at the end of IP, then increased to 4.1%SS and 5.7%SS at 4 and 12 weeks post-IP respectively suggesting a relapse to pretreatment stuttering levels for this language. In contrast, all posttreatment %SS scores in English were less than half the pretreatment stuttering rate despite a slight increase to 2.6 %SS at 12 weeks post-IP.

English-dominant Bilinguals

Compared to the balanced bilinguals, the English-dominant bilinguals had more severe stuttering in both languages at pretreatment. Furthermore, they displayed a higher mean stuttering rate for Mandarin—the less dominant language—than for English (M = 11.8%SS vs M = 9.1%SS respectively). The mean %SS scores in English fell below 1%SS at the end of IP and at 4 weeks post-IP, but made a slight increase to 1.7%SS at 12 weeks post-IP. Like the balanced bilinguals, mean %SS scores for this group also decreased in Mandarin but to a much lesser extent than English following treatment. For Mandarin, mean scores declined to 1.7%SS at the end of IP, but then increased to 2.2%SS at 4 weeks post-IP, and again to 3.6%SS 12 weeks post-IP. An identical pattern was noted for SEV rating scores.Analysis of individual data showed that 5 participants maintained higher stuttering rates in Mandarin (1.0 to 2.8%SS) than in English (0.2 to 1.0%SS) at the end of IP. By 4 weeks post-IP, all 7 participants continued to stutter more in Mandarin (0.3 to 4.1%SS) than in English (0.3 to 1.4%SS). The %SS scores at 12 weeks posttreatment were more variable with only 4 participants stuttering more in Mandarin than English. The extent of treatment generalization effects was found to be particularly unbalanced for two participants (S19 and S29). For these English-dominant bilinguals, stuttering in Mandarin was found to progressively increase over the three posttreatment occasions. Although their Mandarin %SS scores at 12 weeks post-IP were half their pretreatment stuttering rate, the scores were still relatively high (7.9%SS – 9.1%SS) and may have accounted for the larger group mean %SS score at 12 weeks post-IP.

Mandarin-dominant Bilinguals

As with the English-dominant group, participants in the Mandarin-dominant group also displayed a higher stuttering rate and severity in both English and Mandarin than the balanced bilingual group. At pretreatment, the Mandarin-dominant group also stuttered more severely in their less dominant language as seen by the higher mean %SS score for English (M = 10.6) compared to Mandarin (M = 7.4). Similar to the results of the English-dominant and balanced groups, the mean %SS and SEV scores for the Mandarin-dominant group were also noted to be disproportionately reduced across English and Mandarin following treatment. However, a clinically significant difference was that the Mandarin-dominant group exhibited a greater reduction in mean %SS and SEV scores in Mandarin—the dominant language—than in English. The mean scores at the end of IP, and at 4 and 12 weeks post-IP were 2.2%SS, 2.4%SS, and 3.6%SS respectively for English, and 0.8%SS, 1.3%SS, and 2.1%SS respectively for Mandarin indicating a small but progressive increase in stuttering from one assessment occasion to the other.

Individual data indicated that all 3 Mandarin-dominant participants had lower mean %SS scores in Mandarin than in English at the end of IP and at 4 weeks post-IP. However, while two participants (S07 and S18) maintained lower scores in Mandarin at 12 weeks post-IP, one participant (S13) had a marginally higher mean %SS score in Mandarin.

Self-Report Inventory

Only the responses that are relevant to the research aims are discussed in detail here. In general, participants perceived a decrease in stuttering in both languages even though treatment was conducted in English only. For balanced bilinguals, the reported group mean SEV ratings for English were 5.8 pretreatment and 2.3 posttreatment while the scores for Mandarin were 3.5 pretreatment and 1.8 posttreatment. Following treatment, two balanced bilinguals reported that they still stuttered more in English compared to Mandarin; the other two participants reported that stuttering levels were equal in both languages.

As for the English-dominant bilinguals, the pretreatment and posttreatment group mean SEV ratings were 5.4 and 2.4 respectively for English and 6.0 and 3.4 respectively for Mandarin. Interestingly, five of the seven English-dominant bilinguals reported more stuttering in Mandarin than in English after treatment. Of these five participants, four scored their stuttering severity in Mandarin as between 3 – 6 indicating a perception of mild to severe stuttering severity levels in Mandarin following treatment. The remaining two participants perceived equal levels of stuttering across languages posttreatment. The Mandarin-dominant bilinguals' reported mean SEV ratings for English was 6.3 pretreatment and 2.0 posttreatment while the scores for Mandarin were 4.7 pretreatment and 1.7 posttreatment. One Mandarin-dominant participant perceived that stuttering was greater in English following treatment while the other two participants reported equivalent levels of stuttering in both languages. Despite the varied levels of stuttering posttreatment, all but one participant reported naturalness (NAT) ratings of 1 – 3 for both languages. The only exception was an English-dominant bilingual whose self-rated NAT score was four for both languages, suggesting the need for a significant amount of speech pattern to control stuttering.

Irrespective of bilingual group, all participants reported greater satisfaction with speech after treatment. Using a satisfaction scale where 1 = *extremely satisfied* and 9 = *extremely dissatisfied*, the balanced bilinguals were either more satisfied with their speech in Mandarin than English or equally satisfied with their speech in both languages. In contrast, the majority of the English-dominant bilinguals were more satisfied with their English speech than their Mandarin speech. Only two English-dominant bilinguals reported identical satisfaction levels across English and Mandarin and none were more satisfied with their Mandarin speech. The results for the Mandarin-dominant group were more variable with each of the three participants reporting a different pattern in their posttreatment speech satisfaction levels across the two languages.

All 14 participants reported an improvement in their control over stuttering in both languages following treatment with the majority of participants indicating control over speech "more than half of the time". Notably, despite treatment in English only, the group mean scores for control over stuttering (1 = *none of the time* and 9 = *all of the time*) were equal across languages for both the balanced bilinguals (M = 7.3) and the Mandarin-dominant bilinguals (M = 7.7) and not markedly different for the English dominant group (M = 6.7 for English and M = 6.3 for Mandarin).

In relation to the difficulty in learning and using Smooth Speech within and outside the clinic, participants' responses were variable across English and Mandarin. Nonetheless, the majority of participants scored below the midpoint of the scale (1 = *very easy* and 9 = *extremely difficult*) suggesting that they did not find significant difficulty in learning and using Smooth Speech in both languages. The only exceptions were participants from the English-dominant group who found applying and using Smooth Speech more difficult in Mandarin than in English.

With the exception of one English-dominant bilingual and two Mandarin-dominant bilinguals, all other participants reported that they had practiced Smooth Speech in English more than in Mandarin outside the clinic. The three participants in exception reported an equal amount of Smooth Speech practice in both languages outside the clinic. However, two of the four balanced bilinguals reported that they needed a greater amount of time thinking about controlling stuttering in English compared to Mandarin while the other two reported equal scores across the two languages. In contrast, all three Mandarin-dominant bilinguals reported a greater need to think about controlling stuttering in their less dominant language, English. Of the seven English-dominant bilinguals, four were of the opinion that they needed to think about controlling stuttering more in Mandarin—the less dominant language—than in English, while the remaining three participants felt that they needed an equal amount of time for controlling stuttering in both languages.

Discussion

In this study, we investigated whether fluency improvements in English spontaneously generalized to Mandarin following speech restructuring treatment in English only. We also examined whether this generalization effect would be maintained over a 3 month period, and whether it would be affected by language dominance. To disentangle the influence of language dominance on spontaneous generalization of treatment effects, %SS and SEV scores in English and Mandarin were compared across three groups of English-Mandarin BWS—English-dominant, Mandarin-dominant, and balanced bilinguals—at four different time intervals: pretreatment, immediately post-IP, 4 weeks post-IP, and at 12 weeks post-IP. For all BWS, language dominance was determined using the self-report classification tool (Lim, Lincoln, Chan, Rickard Liow et al., 2007), and this was validated by a discriminant analysis and participant performance a vocabulary test.

In relation to the question about whether fluency improvements in English would generalize to Mandarin, a unanimous and positive result was obtained. All 14 BWS demonstrated reductions in stuttering in Mandarin following treatment in English only indicating that spontaneous generalization had occurred. The analysis of the total sample also revealed that mean posttreatment stuttering levels for both languages remained significantly lower than pretreatment levels for up to 12 weeks post-IP. The fact that the SEV and %SS scores were highly and significantly correlated meant that both the frequency and severity of stuttering had decreased across the two languages. Our results also showed that stuttering in the untreated language appeared to increase over time. This observation may indicate a possible dissipation of the treatment generalization effect over time. Nevertheless, the mean %SS results for English and Mandarin obtained at the end of IP and at 12 weeks post-IP in this study were found to be comparable with the outcome data reported by Block et al. (2005) who conducted a similar intensive speech restructuring program for monolingual English speaking adults. This suggests that BWS may achieve the same fluency outcomes as monolingual speakers in both their languages even when treatment is provided in one language only.

The results of this study also showed that English-dominant and Mandarin-dominant bilinguals displayed greater fluency improvements in their dominant language whether or not this language received direct intervention. While the analysis of the group means for the total sample showed an asymmetric treatment generalization effect in favor of the treated language, a different result was observed when the results were analyzed according to bilingual group. Principally, we found the extent of treatment generalization to be possibly associated with language dominance. Despite undergoing treatment in English only, the English-dominant and Mandarin-dominant groups both exhibited lesser fluency improvement in their less dominant languages. Individual data also supported this finding with eight out of the 10 BWS (80%) who were either English-dominant or Mandarin-dominant evidencing higher mean levels of residual stuttering in their weaker language across the three posttreatment assessments. Further, the English-dominant bilinguals were found to stutter more in Mandarin in 76% of the posttreatment sampling occasions whereas the Mandarin-dominant bilinguals stuttered more in English in 77% of the assessments. Although such residual stuttering in the less dominant language appeared to increase over time, this was only observed for some BWS. What was notable was that the Mandarin-dominant bilinguals showed greater fluency improvement in Mandarin even after receiving therapy in English. Taken together, these data suggest that language dominance influences the successful transfer to fluency improvements to the less dominant language, particular if treatment is conducted in the dominant language. However, when the less dominant language is treated, it appears that the effects of stuttering treatment in this language may have been obscured by relative language dominance.

Interestingly, the balanced bilingual group also exhibited uneven fluency gains across English and Mandarin albeit the difference between the two languages was smaller. Nonetheless, except for one balanced bilingual, the gains in fluency in both languages obtained by the balanced group were relatively more stable over time. We interpret these findings to mean that bilinguals who have balanced abilities in both languages may experience a treatment effect where better levels of fluency are achieved in the language that is treated.

The discovery of lesser fluency improvement in the less dominant language after treatment coupled with the finding that fluency in this language may dissipate over time lends support for the theory that BWS have greater difficulty in achieving and maintaining fluency in the less dominant language (Waheed-Khan, 1998). We attempt to explain these results by drawing together existing information about stuttering and bilingual language processing.

In a previous study (Lim, Lincoln, Chan, & Onslow, 2007), we had proposed that BWS stutter more in their less dominant language because they need to use the same attentional system or internal monitor to perform concomitant cognitive functions. In other words, during speech production, BWS not only need to formulate and integrate multiple linguistic factors (e.g., phonological, grammatical, semantic) simultaneously and incrementally, but also inhibit competing signals from the dominant language during speech input and/or output. Stuttering increases in this language as such concurrent "interference from attention-demanding processing within the central executive system" (Bosshardt, 2002, p. 108) may further undermine an already unstable motor speech system. This proposal is consistent with the findings of increased stuttering during dual task performances (e.g., Bosshardt, 1999, 2002) as well as the production of syntactically complex utterances (e.g., Bernstein Ratner & Benitez, 1985).

Stuttering is currently understood to be a disorder of speech motor planning that is caused by a deficit in the neural processing of speech, and underpinned by a disturbance of neural function of the supplementary motor area (Büchel & Sommer, 2004; Packman et al., 2007). Thus, it is not unexpected that a treatment which alters the rate and configuration of speech output in one language would also improve fluency in the other language. The reduced speech rate also allows BWS more time to process speech output and control stuttering. It is plausible that BWS continue to have higher residual stuttering in their less dominant language even after treatment since (a) language proficiency remains unchanged after stuttering treatment, and (b) there are still ongoing processing demands placed on the speech planning and production system in this language. This proposal may be contentious given that increased concomitant cognitive load has also been linked with decreased stuttering frequency in monolingual adults who stutter (Vasic & Wijnen, 2005). Perhaps, a study of BWS which compares their loci of stuttering and code switching events pre- and posttreatment, and laboratory studies which examine BWS under dual tasking procedures will shed more light on the impact of concurrent language processing on the degree of fluency improvements in the less dominant language.

Nonetheless, data from the self-report inventory seem to support this line of thinking. For instance, a large number of participants reported that they did not have significant difficulty in learning and applying Smooth Speech in both languages, and had improved in their control of their speech in both languages. However, the majority of the participants who were English- and Mandarin-dominant (70%) reported that they needed more time to think about controlling stuttering in the less dominant language. A further intriguing finding was that none of the Mandarin-dominant bilinguals reported that they had more Smooth Speech practice in Mandarin than in English outside the clinic, yet their %SS scores indicated that they had stuttered less in Mandarin posttreatment.

Although Costa et al. (2006) suggested that inter-language interference may be higher when the two languages are structurally less distinct (e.g., Mandarin vs. Cantonese) rather than more distinct (e.g., English vs. Mandarin), it is unlikely that language dissimilarity affected the extent of treatment generalization effects observed in our English-Mandarin BWS. First, even though Mandarin and English are derived from separate language families and should be less sensitive to interference effects, the extent of automatic transfer of fluency improvements was still noted to be disproportionate across the two languages. Second, methodological differences notwithstanding, the individual posttreatment English and Mandarin %SS scores reported in this study did not vary markedly from those reported in BWS who speak two languages from the same language family (see e.g., Roberts & Shenker, in press; Shenker et al., 1998). Nevertheless, this suggestion remains tentative at best until further empirical data is collected.

In sum, the results of this study show that fluency improvements can spontaneously generalize from English to Mandarin, and that the extent of treatment generalization effects may be affected by language dominance. Specifically, the degree of residual stuttering may be higher in the less dominant language even if this language had received direct intervention. Moreover, the residual stuttering in the less dominant language may increase gradually over time, and some individuals may experience significant deterioration of fluency in this language when treatment concludes.

These findings have important clinical implications. Speech language pathologists who are only able to treat in one language may confidently expect that fluency improvements in the treated language will spontaneously generalize to the untreated language whether or not the language being treated is the dominant language of their clients. However, the data suggest that SLPs may need to initiate fluency practice in the untreated language especially if the client needs to communicate more fluently in this language posttreatment. Fluency practice in the untreated language may be incorporated in a sequential manner, for example, after a certain level fluency has been instated in both languages. This clinical recommendation has been trialed in some single case reports (see Roberts & Shenker, in press; Shenker et al., 1998; Van Borsel et al., 2001) and show that further decreases in stuttering in the untreated language when treatment commenced in this language. Plans are currently underway to conduct a comparative study of English-Mandarin BWS who receive treatment in English only, and those for whom therapy in Mandarin is introduced after fluency is instated following treatment in English. This will provide important data for determining the best treatment options for adult BWS.

One consideration in establishing treatment guidelines for BWS is whether the speech produced posttreament is natural sounding. As the present study was not intended to be a treatment outcome study, speech naturalness was not analyzed formally. Nonetheless, self-report data indicated that most participants perceived their speech to be natural sounding in both languages after treatment in English only. We aim to validate such self-report ratings of speech naturalness with the perceptions of blind, naïve listeners in a forthcoming study.

Even though the detection of a language dominance influence on the extent of treatment generalization effects in BWS was based on a small number of participants, it is noted that the sample size in each bilingual group reported here was still larger than the combined participant samples from previous treatment studies of BWS. While the current study provides initial evidence with reliability data to guide the treatment of adult BWS, there continues to be several outstanding issues in stuttering treatment for bilinguals. Further investigations are required to see if the results reported here can be replicated with adult BWS who speak other language combinations, and to assess whether treatment generalization outcomes can be maintained in a longer follow-up period (i.e., 12 months). Future studies should also explore the whether language dominance has the same effect on the extent of spontaneous generalization of treatment effects in bilingual children who stutter who acquire both languages either simultaneously or consecutively.

PART FOUR

CONCLUSIONS

CHAPTER SEVEN

CONCLUSIONS AND FINAL COMMENTS

Thesis Overview

This thesis investigated stuttering behavior in bilingual speakers of English and Mandarin before and after speech restructuring treatment. Chapter One provided background information about the nature of stuttering, and explained some of the theoretical perspectives about the disorder. That chapter also contained a review of the history of speech restructuring treatments for chronic stuttering, namely, PS and its variants. From that review of the literature, it was established that the wealth of information about stuttering to date has been derived almost entirely from studies of monolinguals and speakers of English. Despite the sizable number of bilinguals and speakers of Chinese worldwide, until now there have been no investigations of the disorder in Chinese, and surprisingly few studies of stuttering in bilingual speakers. Accordingly, the extant theories and models of stuttering have not fully incorporated information about stuttering in bilinguals, or about stuttering in languages other than English.

Chapter Two presented a discussion of the Chinese language and the main similarities and differences between English and Chinese. It also explained how the two languages are processed with reference to a commonly cited model of speech production. It questioned whether the inherent processing differences between English and Chinese could affect the manifestation of stuttering across the two languages, and suggested that an investigation of bilinguals who spoke English and Chinese would be an ideal way to cast more light on the topic. In Chapter Three, a review of the existing literature about stuttering in bilinguals was presented. This review offered more questions than answers, especially regarding the impact that language dominance might have on the presentation of stuttering in bilinguals, and on the extent to which treatment effects automatically generalized from the treated to the untreated language. It was argued that the main reason for the equivocal findings to date was the lack of systematic evaluation of language dominance and of stuttering in both languages.

Chapter Four reviewed the current approaches to assessing language dominance, and the suitability of these methods for examining language dominance in multilingual Asian populations. That chapter provided justification for the development of a self-report classification tool to identify the dominant language in bilinguals; a tool which could be used in the clinical setting. It also presented the methodology and results of a large-scale study which validated the criterion-based, self-report classification tool on 168 nonstuttering, English-Mandarin bilingual undergraduates in Singapore. Results showed that the self-report classification tool was reliable in achieving a three-way categorization into English-dominant, Mandarin-dominant, and balanced bilinguals. This was validated using a discriminant analysis, and confirmed by the scores obtained on a receptive vocabulary test in each language.

In Chapters Five and Six, two subsequent studies were presented where stuttering was systematically evaluated in English-Mandarin BWS with different language dominance profiles. The study in Chapter Five examined whether stuttering manifested differently in English-Mandarin BWS and whether this was affected by language dominance. This study involved 30 participants of whom 15 were English-dominant bilinguals, four were Mandarin-dominant bilinguals, and 11 were balanced bilinguals. Results showed a positive language dominance effect on the frequency of stuttering in English- and Mandarin-dominant bilinguals but not for the balanced bilinguals. It was also found that the type of stuttering in BWS was not significantly different across languages. Finally, Chapter Six presented the methodology and results of a treatment generalization study. That study assessed whether stuttering reductions in English transferred spontaneously to Mandarin following speech restructuring treatment in English only, and whether treatment generalization was influenced by language dominance. Results obtained from the 14 participants—seven English-dominant, three Mandarin-dominant, and four balanced bilinguals—confirmed that spontaneous generalization of treatment effects had occurred for all BWS. However, whereas the balanced bilinguals showed greater stuttering reductions in the treated language, that is, a treatment effect, the English- and Mandarin-dominant bilinguals both exhibited less fluency improvement in their less dominant language. These findings suggested that the extent of the carry-over effects were likely influenced by language dominance.

Conclusions

Many speech language pathologists (SLPs) who work with BWS often pose questions about which language or languages to work in during assessment and treatment, whether language dominance affects stuttering behavior pretreatment and posttreatment, and whether it is better to treat stuttering in one or two languages. For a long time these questions have been unanswered. The studies in this thesis constitute the first in a line of studies to come which will hopefully elucidate our understanding of stuttering in BWS and provide evidence based responses to these questions.

Assessment of Language Dominance

In investigating two languages, researchers and clinicians alike frequently face the challenge of how best to assess language dominance. The solution to this problem is not clear-cut, especially in Asian bilingual populations where the language background or history is complex, and objective language assessments in the bilingual's two languages are unavailable. The methodological study in Chapter Four produced a self-report classification tool that SLPs in Singapore can now use to identify the dominant language in their bilingual clients. This tool was validated on healthy bilingual individuals, and has also been shown to accurately determine the dominant language in BWS. Thus, the results of this thesis indicate that the self-report classification tool has wide-ranging applicability for bilinguals with or without speech disorders, and can be used for clinical as well as for research purposes within Singapore. Another important outcome of the bilingual classification study was that it verified the view that there are significant differences between bilingual speakers who reside in Asian countries such as Singapore, and elsewhere. Variables such as age of exposure, years of formal instruction, and the number of years of language exposure, which have been commonly found to correlate strongly with language proficiency and dominance in bilinguals from non-Asian settings, had a less consistent influence on language proficiency and dominance in bilinguals in Singapore. On the other hand, self-report measures of language proficiency and the frequency and domain of language use were found to be more relevant for this population of speaker-hearers, and hence are more suitable parameters for selecting and dividing participants for clinical or research purposes in this Asian context.

Accounting for the Findings: A Potential Bilingual Stuttering Model

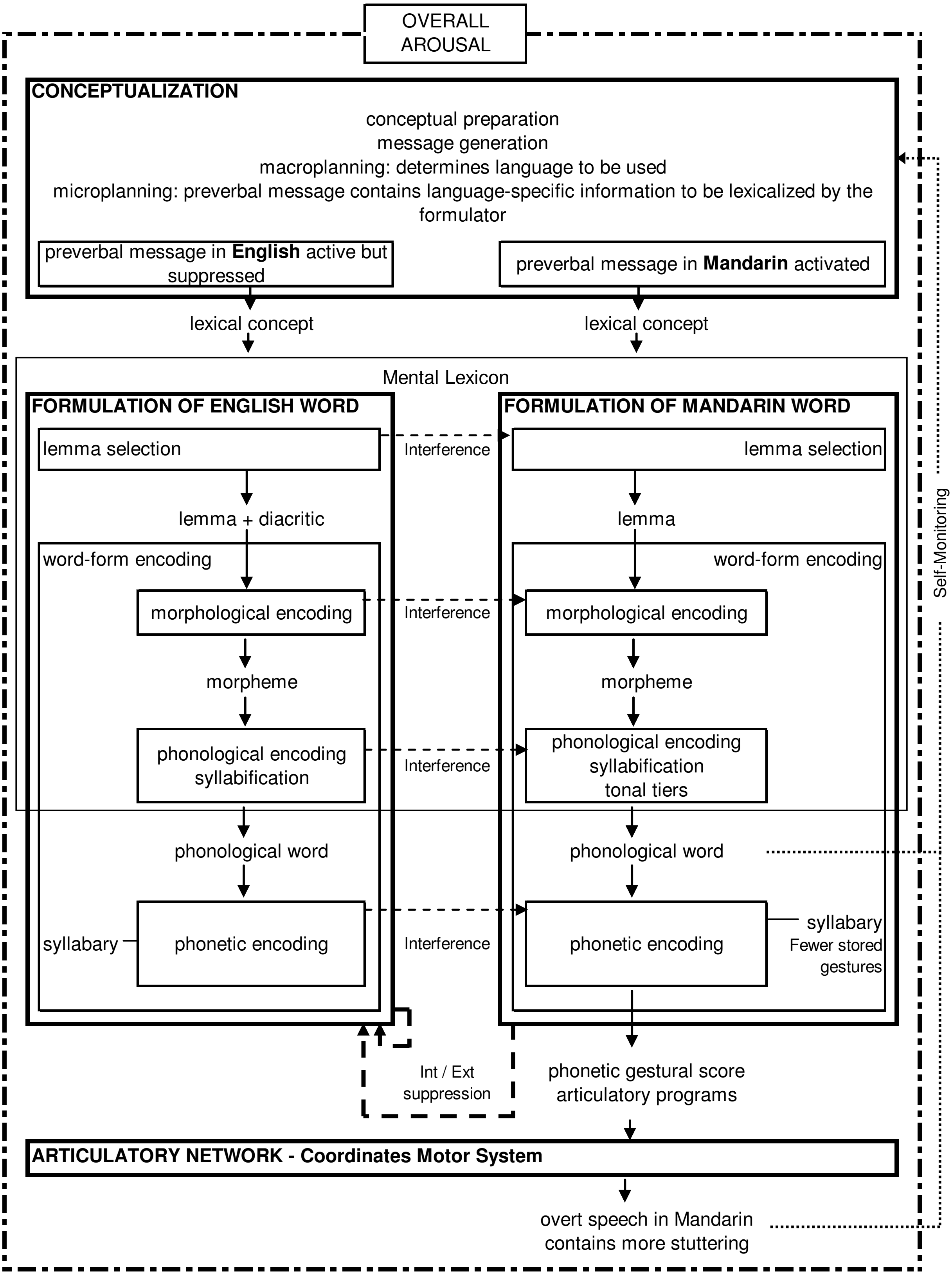
The study of stuttering manifestations in BWS in Chapter Five produced some interesting findings. First, it provided evidence to reject speculations that stuttering in

Chinese languages, Mandarin in this case, does not evidence the stuttering patterns observed in English because of the apparent differences in linguistic processing between the two languages. Rather, it showed that language dominance and not language structure, namely language dissimilarity, affected the way in which stuttering was displayed in BWS. Second, although the frequency of stuttering in each language was found to be related to language dominance, the result of no significant difference in the topography of stuttering between the two languages may imply that stuttering in English and in Mandarin reflects a similar manner of breakdown during the process of speech production.

Thus, the finding of greater stuttering in the less dominant language might be better explained by factors which affect the processing of two languages, and of a less familiar language. To illustrate this explanation, Figure 7.1 portrays the scenario of an English-dominant BWS who stutters more in Mandarin. The model in Figure 7.1 is an extension of the bilingual word production model depicted in Figure 3.1 (see Chapter Three).

As discussed in Chapters Five and Six, bilinguals may stutter more in their less dominant language because of the need to perform concurrent attention-demanding processes in that language (Bosshardt, 1999, 2002, 2006; Bosshardt et al., 2002). To speak in the less dominant language, bilinguals need to formulate and integrate the semantic, syntactic, phonological, and phonetic features of a word both simultaneously and incrementally; the accuracy, speed, and automaticity of such processing is affected by language dominance. While this is occurring, they also need to suppress activation and interference from competing signals from the dominant language. Suppression of the dominant language can occur internally by the dominant language itself or externally from the less dominant language, but the latter is more likely during spontaneous use (Green, 1986, 1993). These processes may impose overlapping demands on an assumed deficient motor speech system. This drains the system's resources (Green, 1986, 1993), reduces the level of speech control, and stuttering results. This may account for findings that BWS stutter in both languages, but more so in the language that is less dominant and which requires greater control. Drawing on the view of Bosshardt (2006), further variability in the way stuttering presents in BWS may be due to individual differences in "the robustness of their speech processing

Figure 7.1. Sketch of Model of a English-dominant Adult BWS Speaking in Mandarin, the Less Dominant Language.



Adapted from Green (1989), De Bot (1992), De Bot and Schreuder (1993).

system to interference from concurrent processes in different parts of the system" (p. 381). Moreover, since there is a reliable link between stuttering and anxiety (see Menzies et al., 1999), the model also incorporates the sociopsychological factors that may influence stuttering (Nwokah, 1988). Consequently, the model is encircled by an overall arousal level which can affect speech production at various levels or as a whole. The arousal influence is likely to be individualized as well, since BWS can respond differently to anxiety or other sociopsychological factors.

It is emphasized that the model proposed here is not meant to explain the cause of stuttering. The model was designed purely to illustrate a proposed explanation for the findings uncovered in this thesis. Nonetheless, authors who associate the source of stuttering with a weakness in lexical retrieval (e.g., Anderson, 2007; Newman & Bernstein Ratner, 2007), phonological encoding (e.g., Postma & Kolk, 1993; Sasisekaran & De Nil, 2006), or in varying linguistic stress patterns during phonetic encoding (e.g., Packman et al., 1996, 2007) may need to consider how the findings of this thesis assimilate with their respective theories of stuttering, causal or otherwise. This is because such concurrent attention-demanding processing in BWS can occur at either of the levels postulated to be deficient.

At present, it is still undetermined whether more stuttering in the less dominant language reflects a fundamental deficit at a specific level of linguistic processing or whether it is the product of a more generalized limitation in attentional processing which affects the motoric encoding of linguistic elements (Newman & Bernstein Ratner, 2007). Conceivably, it may be a combination of both. Although this thesis was not set up to answer the question regarding the precise level at which stuttering occurred for both languages, the writer offers some speculation.

Bosshardt (1997; 2006) argued that the suggestion that the linguistic subsystems are less effectively protected against interference from current activities in other parts of the cognitive system was not commensurate with the Covert Repair Hypothesis (CRH) presented by Postma and Kolk (1993). In the CRH, Postma and Kolk asserted that stuttering was the audible result of concealed attempts by PWS to compensate for erroneous phonological encoding. Such speech monitoring requires greater attentional control (Oomen & Postma, 2002). Bosshardt maintained that if the central executive functions were reduced under dual task conditions, then speech monitoring and error detection and correction would also be reduced, thereby makingspeech more fluent than dysfluent. This was the case in Vasic and Wijnen's (2005) study where PWS were found to decrease the amount of stuttering during dual tasks. Vasic and Wijnen argued that the speech monitoring system of PWS was moderated when these individuals redirected their attention to the challenging tasks of dual-task experimentation. To the contrary, the results of this thesis and those of Bosshardt and other researchers (for a review, see Bajaj, 2007) show otherwise.

Taking into consideration the above contention, and given the evidence that people who stutter can display dysfluency when playing wind instruments at advanced levels (see Packman & Onslow, 1999), it is possible that stuttering is initiated further down the line in the speech production process. Although the actual cause of stuttering remains unknown (Büchel & Sommer, 2004), it may well be that the proximal trigger or the final link in the causal chain for stuttering, as Packman and colleagues (2007) have suggested, lies in the difficulty in initiating syllabic stress. The difficulty in initiating the motor plans for syllables is thought to be underpinned by a problem in the neural function of the SMA, an area of the brain which is understood to play a critical role in syllable initiation and sequencing. Perhaps in the Vmodel of Packman et al., more stuttering in Mandarin in this case may be explained in terms of a less equipped mental syllabary in the less dominant language (see Figure 7.1). That is, although the number of syllables stored in the Mandarin syllabary is believed to be smaller, there are fewer learned articulatory programs for syllables for Mandarin. As such, there is an increase in computational time or load when initiating syllables in this language. Recent research by Cholin, Levelt, and Schillar (2006) provides general support for this viewpoint. These authors found syllable-frequency effects during the retrieval of pre-compiled gestural scores from the mental syllabary; the gestural scores for high-frequency syllables were accessed more quickly than those for low-frequency syllables. Thus, the syllable gestures in the Mandarin syllabary may be less frequently used and their computation is less automatic, affecting the speed and fluency of spoken word production in this language.

Additionally, in BWS, the triggering of more stuttering in the less dominant language may come from interference at various processing levels as well. The need to inhibit concomitant interference from the dominant language at various linguistic levels may also create a cascading effect on the stability of the speech motor system which influences the threshold for the appearance and degree of stuttering. Other factors such as level of arousal may similarly affect this threshold. These hypotheses are in line with the claim of Packman et al. (1996) that "it is the particular interaction of linguistic and motoric factors inherent in prosody that induces stuttering, and psychological and environmental factors then influence the course of the disorder" (p. 253). As with the syllable initiation theory, the hypothesis put forward here is also congruent with Webster's (1986; 2004) proposal that the SMA in people who stutter is fragile and susceptible to interference from (a) concurrent neural activity in the left hemisphere which results from processing one but controlling two languages, and (b) an overactive right hemisphere arising from increased negative emotions associated with stuttering.

The findings in the treatment generalization study in Chapter Six seem to support this model. Speech restructuring techniques like Smooth Speech help BWS to reclaim control of the complex sequential movements involved in initiating propositional speech in either language, a task that is mediated by the SMA (Webster, 2004). According to Packman and colleagues (2000), speech restructuring treatment is efficacious because it reduces the variability of linguistic stress. Together the above speculations may explain why the English-Mandarin BWS in the study experienced stuttering reductions in both languages even when treatment was provided in only one language. Yet despite the improvement in fluency in both languages, the English-Mandarin BWS still stuttered more in the less dominant language after treatment. This may be because the number of stored syllable gestures in the mental syllabary of the less dominant language remained unchanged, as did language competence. Further, the BWS still had to contend with the other ongoing processing demands within this language, and also to contain the interference from the dominant language. Certainly these speculations need be tested in future research.

Implications for Assessment and Treatment of BWS

The results of this research provide some guidelines for the assessment and treatment of BWS. Since more stuttering can be observed in the language that is less dominant, it is important for SLPs to gather information about and/or to systematically assess language dominance in their bilingual clients. Wherever possible, stuttering assessments should ideally be conducted in both languages so as to avoid under- or overestimating the severity of the disorder in BWS.

Speech language pathologists who can deliver treatment in only one language may expect with assurance that stuttering reductions in the treated language will spontaneously and simultaneously generalize to the untreated language. Such treatment generalization may occur regardless of whether the language being treated is the client's dominant language. As the extent of treatment generalization effects may be affected by language dominance, SLPs may need to extend stuttering treatment to the untreated language, particularly if fluent communication in that language is an important goal of the client after treatment. A clinically important finding was that fluency practice in the untreated language may not need to be initiated at the start of treatment but rather after a certain level of fluency has been instated in both languages.

In Chapter Three, several controversies regarding the treatment of stuttering in bilinguals were highlighted. The findings of the treatment study in Chapter Six provide evidence to clarify two previously ambiguous issues. First, that investigation represents the first study with objective measurements and reliability data to show that speech restructuring treatments such as Smooth Speech are useful in reducing stuttering in Mandarin. Second, since the posttreatment fluency levels obtained by the BWS in this thesis were comparable with the outcome data reported for monolingual English speaking adults (e.g., Block et al., 2005), this thesis provides further evidence to support the notion that monolingual and bilingual adults who stutter do not differ in their fluency outcomes following treatment. The findings reported here are consistent with those of Druce, Debney, and Byrt (1997) and Shenker (2004), who also found no significant differences in fluency outcomes between monolingual and bilingual children who stutter.

Summary

In sum, language dominance was found to be a critical factor in the interpretation of the results for both stuttering manifestation and treatment generalization effects in BWS. Were it not for analyzing the data according to language dominance groups, a discernable pattern in the findings in either of these areas would not have been established. Therefore, the results of this thesis underscore the need for SLPs and researchers who work with bilinguals to interpret bilingual behavioral data in light of the bilinguals' language dominance profile. This conclusion has implications not only for stuttering or other speech and language disorders in bilinguals, but also for normal bilingual behavioral data as well.

Study Limitations and Suggestions for Future Research

The studies in the present thesis are not without limitations. Indeed, many more issues need to be clarified to improve our overall understanding of the assessment of language dominance, the manifestation of stuttering in bilinguals, and the treatment generalization effects in BWS.

Assessment of Language Dominance

(1) The self-report classification tool described in Chapter Four was tested only on English-Mandarin bilinguals from one South-East Asian country, Singapore. As this group of bilingual Singaporeans may represent a unique bilingual cohort, it is essential for researchers to test the applicability of the classification tool with other groups of bilinguals who reside in neighbouring countries such as Malaysia and Indonesia, or further away. The tool also needs to be tested with bilinguals who speak other language pairs such as English-Spanish.

(2) As the tool was developed on bilingual adults who had stable bilingualism, it would be useful to explore the feasibility of the tool in determining language dominance in bilingual children in Singapore and elsewhere who are still developing their two languages.

(3) Even though all 168 participants were exposed to both languages early (before 7 years of age), it is possible that there might have been two further participant subgroups; those who developed both languages simultaneously and those who were exposed to their languages sequentially. Analysis of the self-report data in this thesis was not conducted for these bilingual subgroups. It would be worthwhile to investigate whether the reliability and accuracy of the classification tool is maintained for sequential and simultaneous bilinguals. It would also be interesting to know whether those two subgroups of bilinguals differ in how age of acquisition, years of formal education, and years of

language exposure influence their language proficiency and language dominance.

(4) Future research should also focus on developing more culturally appropriate and standardized assessments to validate the self-report data.

Manifestation of Stuttering in BWS

(1) This study in Chapter Four demonstrated support for the notion that there is increased stuttering in the language that is less dominant. It remains to be seen whether more stuttering in the less dominant language is also sensitive to the level of proficiency in this language. Such information might be gained by analyzing stuttering severity scores in relation to the participants' proficiency level in the less dominant language: low, medium, high (see Li et al., 2006). This could yield invaluable additional data about the nature of the language dominance effect on stuttering behavior in bilinguals, and may indicate whether a larger dominance gap between languages affects the severity of stuttering in both languages.

(2) Considerably more research is needed into other factors that might play a role in the manifestation of stuttering in bilinguals. This thesis made preliminary suggestions that the differential stuttering patterns observed in English-Mandarin BWS might not be associated with the inherent differences between the languages or their structure. However, in this thesis, direct comparisons were not made between BWS who had the same dominant language but whose other language was more structurally similar (e.g., Mandarin-Cantonese) than dissimilar (e.g., Mandarin-English). Such data could confirm whether language similarity has any place in explaining stuttering behaviors in bilinguals. Further, the study reported here did not control for factors such as language register, and so there may have been some variation amongst the speech samples in terms of the genre of language used: colloquial vs. formal varieties. Given that language register may affect the linguistic level used by the bilingual (Fishman, 2000), further research may need to investigate whether this variable also affects stuttering, and/or to look into ways to control for it.

(3) The argument for higher attention-demanding processing in the less dominant language would be corroborated by a finding of slower speech rate in this language. Although our syllables per minute (SPM) data showed this trend, the poor reliability of SPM ratings constrained their useful interpretation in this thesis. Future studies with reliable speech rate data will no doubt provide additional evidence on this issue.

(4) This thesis did not provide any unequivocal answers to the questions related to the cause or the loci of stuttering. It showed, however, that BWS who speak two distinct languages might be a good resource for investigators who propose that stuttering stems from linguistic formulation difficulties. Linguistic analyses of stuttering including an examination of whether phonetic features, word frequency effects, lexical and phonological neighbourhood density, and language mixing or code-switching have a predictable effect on stuttering in such individuals should be undertaken in future research. Such data might provide more insight into the speech production processes of BWS, and perhaps assist in uncovering the potential mechanisms that lead to the production of stuttered speech.

(5) The bilingual participants reported on in this thesis were above 12 years of age, and so the information gathered here cannot be generalized to younger children. No research has yet investigated the manifestation of stuttering in English-Mandarin bilingual children with different language dominance profiles, but who are still developing their two languages. This is another area that may provide more information about the development of stuttering in bilingual children.

Treatment Generalization Effects in BWS

(1) The study of treatment generalization effects in BWS still provides only initial, short term data from a limited number of bilinguals. Further research is essential to replicate and confirm these results and particularly to provide longer-term generalization data. This should provide important information as to whether substantial relapse occurs in the untreated or less dominant language, especially since the present data gave some indication that treatment generalization effects might dissipate in the short term.

(2) In the study design, there was in effect only one posttreatment data point (12 weeks post-IP) at which the participants' speech was sampled after complete cessation of treatment. It may be worthwhile in future to consider a different posttreatment speech sampling time schedule. To obtain a better picture of the stability of fluency improvements in both languages before, during, and after treatment, speech sampling at 6 weeks post-IP (the final follow up session) could either replace the 4 weeks post-IP sampling, or be added to the overall time schedule.

(3) The results reported in Chapter Five do not provide evidence as to whether a monolingual intervention approach is more effective than bilingual intervention, or whether treatment should be delivered sequentially or simultaneously. A randomized controlled trial would be an ideal way to compare the different treatment approaches for BWS with a view to establishing best practice therapeutic guidelines for BWS. For example, one could evaluate the monolingual intervention approach against a bilingual intervention approach in BWS who are matched for language dominance.

(4) The bilingual stuttering model used to explain the findings in this thesis was based on bilingual adults who stutter. Future research should ascertain whether such a model would still be applicable for bilingual children who stutter.

Future Directions

There are three upcoming studies arising from this thesis.

(1) It is reiterated that the treatment study in Chapter Six was not intended to be an outcome study. However, as speech naturalness is an important outcome variable of studies which employ speech restructuring treatment, a forthcoming study will investigate whether there are any perceived differences in speech naturalness between Mandarin and English following treatment. The writer hopes to examine whether the participants' speech in Mandarin after treatment is more natural sounding than their English speech since direct intervention was not provided in Mandarin. It would be interesting to know whether the tonal features of Mandarin have a positive effect on the naturalness of Mandarin speech when Smooth Speech is applied.

(2) Although it was found that stuttering reductions in English spontaneously generalized to Mandarin, the BWS in the treatment study continued to have residual stuttering in their less dominant language. In a follow up study, an aim is to compare balanced bilinguals, English-dominant, and Mandarin-dominant BWS who receive treatment in English only with those who also receive treatment in Mandarin (i.e., bilingual intervention) after fluency is instated in both languages. It is envisaged that the evaluation of fluency outcomes between a monolingual intervention approach and a sequential bilingual intervention approach will provide additional but necessary data to guide the course of stuttering treatment for BWS.

(3) Plans are also in progress to conduct a linguistic analysis of the pretreatment loci of stuttering moments in English and Mandarin. The aim is to assess the relationships of phonological and syntactic structure to the frequency and location of fluency breakdown in BWS.

What This Thesis Has Contributed

The body of research in this thesis has made contributions both to the field of bilingualism and to the topic of stuttering in bilingual individuals. First, this research provided a validated self-report classification tool which clinicians and researchers can use to reliably identify the dominant language in bilingual speakers from Singapore. Second, it presented evidence for determining language dominance by means of a predetermined set of criteria, and for the use of a discriminant analysis as a novel way of validating the self-report data. Third, this thesis supplied comprehensive and reliable data about the manifestation of stuttering in bilinguals, and provided systematic, short term, objective data on the generalization of treatment effects in bilinguals who received treatment in only one language. Notably, the present research suggested that language dominance is an important variable to consider when assessing and treating BWS. In addition, this research offered preliminary evidence-based information that can be used to guide the assessment and treatment of BWS. It also filled a sizable gap in knowledge about stuttering in Mandarin, the most widely spoken Chinese language, and showed the effectiveness of speech restructuring treatment in this language. Finally, this thesis presented a theoretical model to explain why stuttering can present differentially across the bilingual's two languages both before and after treatment.

Despite the above contributions, there is still much to learn about stuttering in BWS. It is hoped that this thesis stimulates further research and that investigators worldwide may be able to collaborate to unravel the mysteries that have surrounded this field of study for many years.

REFERENCES

Abutalebi, J., & Green, D. W. (2007). Bilingual language production: The neurocognition of language representation and control. *Journal of Neurolinguistics, 20*(3), 242-275.

Altarriba, J. (2003). Does *cariño* equal "liking"? A theoretical approach to conceptual nonequivalence between languages. *The International Journal of Bilingualism, 7*(3), 305-322.

Anderson, J. D. (2007). Phonological neighborhood and word frequency effects in the stuttered disfluencies of childron who stutter. *Journal of Speech Language and Hearing Research, 50*(1), 229-247.

Andrade, C. R. F., Sassi, F. C., & Zackiewicz, D. V. (2004). Aspects of normally fluency speech in Brazilian adults. In A. Packman, A. Meltzer & H. F. M. Peters (Eds.), *Theory, research and therapy in fluency disorders: Proceedings of the fourth World Fluency Congress on fluency disorders* (pp. 376-381). Nijmegen: Nijmegen University Press.

Andrews, G., Guitar, B., & Howie, P. (1980). Meta-analysis of the effects of stuttering treatment. *Journal of Speech and Hearing Disorders, 45*, 287-307.

Andrews, G., & Harris, M. (1964). *The syndrome of stuttering*. London: Heinemann Medical Books.

Andrews, G., Hoddinott, S., Craig, A., Howie, P., Feyer, A.-M., & Neilson, M. (1983). Stuttering: A review of research findings and theories circa 1982. *Journal of Speech and Hearing Disorders, 48*(3), 226-246.

Au-Yeung, J., Howell, P., Davis, S., Charles, N., & Sackin, S. (2000). UCL survey of bilingualism and stuttering. *3rd World Congress of Fluency Disorders, 7-11 August* Retrieved 11 May, 2007, from http://www.speech.psychol.ucl.ac.uk/PAPERS/PDF/22bilingual.pdf

Baddeley, A., Emslie, H., Kolodny, J., & Duncan, J. (1998). Random generation and the executive control of working memory. *Quarterly Journal of Experimental Psychology Section a-Human Experimental Psychology, 51*(4), 819-852.

Bajaj, A. (2007). Working memory involvement in stuttering: Exploring the evidence and research implications. *Journal of Fluency Disorders*, doi:10.1016/j.jfludis.2007.1003.1002.

Baudoin-Chial, S. (1986). Hemispheric lateralization of Modern Standard Chinese tone processing. *Journal of Neurolinguistics, 2*(1-2), 189-199.

Bernstein Ratner, N. (2004). Fluency and stuttering in bilingual children. In B. A. Goldstein (Ed.), *Bilingual language development and disorders in Spanish-English speakers* (pp. 287-308). Baltimore, Maryland: Paul H. Brookes Publishing Co.

Bernstein Ratner, N., & Benitez, M. (1985). Linguistic analysis of a bilingual stutterer. *Journal of Fluency Disorders, 10*(3), 211-219.

Bernstein Ratner, N., & Sih, C. C. (1987). Effects of gradual increases in sentence length and complexity on children's disfluency. *Journal of Speech and Hearing Disorders, 52*, 278–287.

Bialystok, E., & Miller, B. (1999). The problem of age in second-language acquisition: Influences from language, structure, and task. *Bilingualism: Language and Cognition, 2*, 127-145.

Birdsong, D. (2006a). Age and second language acquisition and processing: A selective overview. *Language Learning, 56*(s1), 9-49.

Birdsong, D. (2006b). Dominance, proficiency, and second language grammatical processing. *Applied Psycholinguistics, 27*(1), 46-49.

Block, S., & Dacakis, G. (2003). *La Trobe Fluency Clinic. Student Manual*. Melbourne: La Trobe University.

Block, S., Onslow, M., Packman, A., Gray, B., & Dacakis, G. (2005). Treatment of chronic stuttering: outcomes from a student training clinic. *International Journal of Language & Communication Disorders, 40*(4), 455-466.

Bloodstein, O. (1995). *A handbook on stuttering* (5th ed.). London: Chapman & Hall.

Bloodstein, O. (1997). Stuttering as an anticipatory stuggle reaction. In R. F. Curlee & G. M. Siegel (Eds.), *Nature and treatment of stuttering: New directions* (2nd ed., pp. 169-181). Boston, MA: Allyn & Bacon.

Bloodstein, O. (2000). Genes versus cognitions in stuttering: A needless dichotomy. *American Journal of Speech-Language Pathology, 9*(4), 358-359.

Bloodstein, O. (2001). Incipient and developed stuttering as two distinct disorders - Resolving a dilemma. *Journal of Fluency Disorders, 26*(1), 67-73.

Blumstein, S., & Cooper, W. (1974). Hemispheric processing of intonation contours. *Cortex, 10*(2), 146-158

Boberg, E., & Kully, D. (1985). *Comprehensive stuttering program*. San Diego, CA: College-Hill Press.

Boberg, E., & Kully, D. (1994). Long-term results of an intensive treatment program for adults and adolescents who stutter. *Journal of Speech and Hearing Research, 37*(5), 1050-1059.

Boscolo, B., Bernstein Ratner, N., & Rescorla, L. (2002). Fluency characteristics of children with a history of specific expressive language impairment (SLI-E). *American Journal of Speech-Language Pathology, 11*, 41–49.

Bosshardt, H.-G. (1997). Mental effort and speech fluency. In W. Hulstijn, H. F. M. Peters & P. H. H. M. Van Lieshout (Eds.), *Speech production: Motor control, brain research and fluency disorders* (pp. 503-514). The Netherlands: Elsevier Science.

Bosshardt, H.-G. (1999). Effects of concurrent mental calculation on stuttering, inhalation and speech timing. *Journal of Fluency Disorders, 24*(1), 43-72.

Bosshardt, H.-G. (2002). Effects of concurrent cognitive processing on the fluency of word repetition: Comparison between persons who do and do not stutter. *Journal of Fluency Disorders, 27*(2), 93-114.

Bosshardt, H.-G. (2006). Cognitive processing load as a determinant of stuttering: Summary of a research programme. *Clinical Linguistics & Phonetics, 20*(5), 371-385.

Bosshardt, H.-G., Ballmer, W., & De Nil, L. F. (2002). Effects of category and rhyme decisions on sentence production. *Journal of Speech Language and Hearing Research, 45*(5), 844-857.

Bosshardt, H.-G., & Fransen, H. (1996). Online sentence processing in adults who stutter and adults who do not stutter. *Journal of Speech and Hearing Research, 39*(4), 785-797.

Bothe, A. K., Davidow, J. H., Bramlett, R. E., & Ingham, R. J. (2006). Stuttering treatment research 1970-2005: I. Systematic review incorporating trial quality assessment of behavioral, cognitive, and related approaches. *American Journal of Speech-Language Pathology, 15*(4), 321-341.

Brosch, S., & Pirsig, W. (2001). Stuttering in history and culture. *International Journal of Pediatric Otorhinolaryngology, 59*(2), 81-87.

Büchel, C., & Sommer, M. (2004). What causes stuttering? *PLoS Biology, 2*(2), 159-163.

Chee, M. W., Tan, E. W., & Thiel, T. (1999). Mandarin and English single word processing studied with functional magnetic resonance imaging. *Journal of Neuroscience, 19*(8), 3050-3056.

Chee, M. W. L., Caplan, D., Soon, C. S., Sriram, N., Tan, E. W. L., Thiel, T., et al. (1999). Processing of visually presented sentences in Mandarin and English studied with fMRI. *Neuron, 23*(1), 127-137.

Chee, M. W. L., Hon, N., Lee, H. L., & Soon, C. S. (2002). Relative language proficiency modulates BOLD signal change when bilinguals perform semantic judgments. *NeuroImage, 13*(6), 1155-1163.

Chen, H.-C., & Leung, Y.-S. (1989). Patterns of lexical processing in a nonnative language. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*(2), 316-325.

Chen, J.-Y. (1999). The representation and processing of tone in Mandarin Chinese: Evidence from slips of the tongue. *Applied Psycholinguistics, 20*, 289–301.

Chen, J.-Y., Chen, T.-M., & Dell, G. S. (2002). Word-form encoding in Mandarin Chinese as assessed by the implicit priming task. *Journal of Memory and Language, 46*(4), 751-781.

Chen, J.-Y., Lin, W.-C., & Ferrand, L. (2003). Masked priming of the syllable in Mandarin Chinese speech production. *Chinese Journal of Psychology, 45*(1), 107-120.

Chincotta, D., & Underwood, G. (1999). Non-temporal determinants of bilingual memory capacity. *Bilingualism: Language and Cognition, 1*, 117-130.

Cholin, J., Levelt, W. J. M., & Schiller, N. O. (2006). Effects of syllable frequency in speech production. *Cognition, 99*(2), 205-235.

Chung, S. J., Im, J. H., Lee, J. H., & Lee, M. C. (2004). Stuttering and gait disturbance after supplementary motor area seizure. *Movement Disorders, 19*(9), 1106-1109.

Clyne, M., & Kipp, S. (2002). Australia's changing language demography. *People and Place, 10*(3), 29-35.

Cooper, W. E., & Klouda, G. V. (1987). Intonation in aphasic and right-hemisphere-damaged patients. In J. H. Ryalls (Ed.), *Phonetic approaches to speech production in aphasia and related disorders* (pp. 59-77). Boston: College-Hill Press.

Cordes, A. K. (1998). Current status of the stuttering treatment literature. In A. K. Cordes & R. J. Ingham (Eds.), *Treatment efficacy for stuttering: A search for empirical bases*. San Diego: Singular Publishing Group.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in the bilingual's two lexicons compete for selection? *Journal of Memory and Language, 41*(3), 365-397.

Costa, A., Santesteban, M., & Ivanova, I. (2006). How do highly proficient bilinguals control their lexicalization process? Inhibitory and language-specific selection mechanisms are both functional. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 32*(5), 1057-1074.

Craig, A., Hancock, K., Tran, Y., Magali, C., & Peters, K. (2002). Epidemiology of stuttering in the community across the entire life span. *Journal of Speech, Language, and Hearing Research, 45*(6), 1097(1099).

Craig, A., & Tran, Y. (2005). The epidemiology of stuttering: the need for reliable estimates of prevalence and anxiety levels over the lifespan. *Advances in Speech Language Pathology, 7*(1), 41-46.

Craig, A. R., & Calver, P. (1991). Following up on treated stutterers - studies of perceptions of fluency and job status. *Journal of Speech and Hearing Research, 34*(2), 279-284.

Craven, D. C., & Ryan, B. P. (1984). The use of a portable delayed auditory feedback unit in stuttering therapy. *Journal of Fluency Disorders, 9*(3), 237-243.

Cream, A., O'Brian, S., Onslow, M., & Packman, A. (2007). Self-modelling as a relapse intervention following speech restructuring treatment for stuttering: A Phase I trial. *Journal of Speech, Language, and Hearing Research*, Manuscript in preparation.

Cruttenden, A. (1986). *Intonation*. New York: Cambridge University Press.

Curlee, R., & Perkins, W. H. (1969). Conversational rate control therapy for stuttering. *Journal of Speech Hearing Disorders*(34), 245-250.

Curlee, R. F., & Perkins, W. H. (1973). Effectiveness of a DAF conditioning program for adolescent and adult stutterers. *Behaviour Research and Therapy, 11*(4), 395-401.

Cutler, A., Mehler, J., Norris, D., & Segui, J. (1992). The monolingual nature of speech segmentation by bilinguals. *Cognitive Psychology, 24*(3), 381-410.

Dale, P. (1977). Factors related to dysfluent speech in bilingual Cuban-American adolescents. *Journal of Fluency Disorders, 2*(4), 311-313.

De Bot, K. (1992). A bilingual production model: Levelt's 'speaking' model adapted. *Applied Linguistics, 13*, 1-24.

de Bot, K. (2000). A bilingual production model: Levelt's 'speaking' model adapted. In W. Li (Ed.), *The bilingualism reader*. London: Routledge.

De Bot, K., & Kroll, J. F. (2002). Psycholinguistics. In N. Schmitt (Ed.), *Introduction to Applied Linguistics* (pp. 133 - 149). London: Arnold Publishers.

De Bot, K., & Schreuder, R. (1993). Word production and the biligual lexicon. In R. Schreuder & B. Weltens (Eds.), *The bilingual lexicon* (pp. 191-214). Amsterdam: John Benjamins.

de Groot, A. M. B., & Poot, R. (1997). Word translation at three levels of proficiency in a second language: The ubiquitous involvement of conceptual memory. *Language Learning, 47*(2), 215-264.

De Nil, L. F., & Bosshardt, H. G. (2000). Studying stuttering from a neurological and cognitive information processing perspective. In H. G. Bosshardt, J. S. Yaruss

& H. F. M. Peters (Eds.), *Fluency Disorders: Theory, Research, Treatment and Self-Help. Proceedings of the Third World Congress of Fluency Disorders in Nyborg, Denmark* (pp. 53-58). Nijmegen: Nijmegen University Press.

Dell, G. S. (1986). A spreading-activation theory of retrieval in sentence production. *Psychological Review, 93*(3), 283-321.

Dell, G. S., & Oseaghdha, P. G. (1992). Stages of lexical access in language production. *Cognition, 42*(1-3), 287-314.

Deterding, D. (2001). The measurement of rhythm: a comparison of Singapore and British English. *Journal of Phonetics, 29*(2), 217-230.

Dijkstra, T., & van Heuven, W. J. B. (2002). The architecture of the bilingual word recognition system: From identification to decision. *Bilingualism: Language and Cognition, 5*(3), 175-197.

DiLollo, A., Manning, W. H., & Neimeyer, R. A. (2003). Cognitive anxiety as a function of speaker role for fluent speakers and persons who stutter. *Journal of Fluency Disorders, 28*(3), 167-186.

Dreher, J. C., Koechlin, E., Ali, S. O., & Grafman, J. (2002). The roles of timing and task order during task switching. *Neuroimage, 17*(1), 95-109.

Druce, T., Debney, S., & Byrt, T. (1997). Evaluation of an intensive treatment program for stuttering in young children. *Journal of Fluency Disorders, 22*(3), 169-186.

Dunn, L. M., Dunn, L. M., Whetton, C., & Pintillie, D. (1982a). *British Picture Vocabulary Scale*. Windsor, Berks: NFER-Nelson.

Dunn, L. M., Dunn, L. M., Whetton, C., & Pintillie, D. (1982b). British Picture Vocabulary Scale. Windsor, Berks: NFER-Nelson.

Felsenfeld, S. (1997). Epidemiology and genetics of stuttering. In R. Curlee & G. M. Siegel (Eds.), *The nature and treatment of stuttering: New directions* (2nd ed., pp. 3-23). Boston: Allyn & Bacon.

Felsenfeld, S., Kirk, K. M., Zhu, G., Statham, D. J., Neale, M. C., & Martin, N. G. (2000). A study of the genetic and environmental etiology of stuttering in a selected twin sample. *Behavior and Genetics 30*(5), 359-366.

Fiedler, P. A., & Standop, R. (1983). *Stuttering: Integrating Theory and Practice* (S. R. Silverman, Trans.). London: An Aspen Publication.

Finn, P., & Cordes, A. K. (1997). Multicultural identification and treatment of stuttering: A continuing need for research. *Journal of Fluency Disorders, 22*(3), 219-236.

Fishman, J. A. (2000). Who speaks what langauge to whom and when? In W. Li (Ed.), *The bilingualism reader* (pp. 89-106). London: Routledge.

Flege, J. E., Mackay, I. R. A., & Piske, T. (2002). Assessing bilingual dominance. *Applied Psycholinguistics, 23*(4), 567-598.

Forster, D. C., & Webster, W. G. (2001). Speech-motor control and interhemispheric relations in recovered and persistent stuttering. *Developmental Neuropsychology, 19*(2), 125-145.

Franck, R. (1980). Integration of an intensive program for stutterers within the normal activities of a major acute hospital. *Australian Journal of Human Communication Disorders, 8*(1).

Gandour, J. (1987). Tone production in aphasia. In J. Ryalls (Ed.), *Phonetic approaches to speech production in aphasia and related disorders* (pp. 45–57). Boston, MA: College-Hill.

Gandour, J., Akamanon, C., Dechongkit, S., Khunadorn, F., & Boonklam, R. (1994). Sequences of phonemic approximations in a Thai conduction aphasic. *Brain and Language, 46*(1), 69-95.

Garavan, H., Ross, T. J., Li, S. J., & Stein, E. A. (2000). A parametric manipulation of central executive functioning. *Cerebral Cortex, 10*(6), 585-592.

Garrett, M. F. (1982). Production of speech: Observations from normal and pathological use. In A. W. Ellis (Ed.), *Normality and pathology in cognitive functions* (pp. 19-76). London: Academic Press.

Garson, D. G. (2006). Discriminant Function Analysis. Retrieved September 12, 2006, from http://www2.chass.ncsu.edu/garson/pa765/discrim.htm

Golato, P. (2002). Word parsing by late-learning French English bilinguals. *Applied Psycholinguistics, 23*, 417-446.

Goldiamond, I. (1965). Stuttering and fluency as manipulatable operant response classes. In L. Krasner & L. P. Ullman (Eds.), *Research in behavior modification* (pp. 106-156). New York: Holt, Rinehart & Winston.

Golestania, N., Alario, F.-X., Meriaux, S., Bihan, D. L., Dehaene, S., & Pallier, C. (2006). Syntax production in bilinguals. *Neuropsychologia, 44*(7), 1029-1040.

Goral, M., Levy, E. S., Obler, L. K., & Cohen, E. (2006). Cross-language lexical connections in the mental lexicon: Evidence from a case of trilingual aphasia. *Brain and Language, 98*(2), 235-247.

Gordon, R. G., Jr. (2005). *Ethnologue: Languages of the World* (15 ed.). Dallas, TX: SIL International.

Grainger, J., & Beauvillain, C. (1988). Associative priming in bilinguals: Some limits of interlingual facilitation effects. *Canadian Journal of Psychology, 42*(3), 261-273.

Grainger, J., & Dijkstra, T. (1992). On the representation and use of language information in bilinguals. In R. J. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 207-220). Amsterdam: Elsivier.

Green, D. W. (1986). Control, activation, and resource: A framework and a model for the control of speech in bilinguals. *Brain and Language, 27*(2), 210-223.

Green, D. W. (1993). Towards a model of L2 comprehension and production. In R. Schreuder & B. Weltens (Eds.), *The bilingual lexicon* (pp. 249-278). Amsterdam: John Benjamins.

Green, D. W., Crinion, J., & Price, C. J. (2006). Convergence, degeneracy, and control. *Language Learning, 56*, 99-125.

Grosjean, F. (1982). Life with two languages: An introduction to bilingualism. *Bilingualism: Language and Cognition, 1*(2), 131-149.

Grosjean, F. (1985). The bilingual as a competent but specific speaker-hearer. *Journal of Multilingual and Multicultural Development, 6*, 467-477.

Grosjean, F. (1989). Neurolinguists, beware! The bilingual is not two monolinguals in one person. *Brain and Language, 36*(1), 3-15.

Grosjean, F. (1998). Studying bilinguals: Methodological and conceptual issues. *Bilingualism, 1*(2), 131-149.

Grosjean, F. (2001). The bilingual's language modes. In J. L. Nicol (Ed.), *One mind, two Languages: Bilingual language processing* (pp. 1-22). Malden, Massachusetts: Blackwell Publishers Ltd.

Guitar, B. (2006). *Stuttering: an integrated approach to its nature and treatment* (3rd ed.): Baltimore: Lippincott Williams & Wilkins.

Gupta, A. F. (1994). *The step-tongue: children's English in Singapore*. Clevedon [England]; Philadelphia: Multilingual Matters.

Gutiérrez-Clellen, V. F., Restrepo, M. A., & Simón-Cereijido, G. (2006). Evaluating the discriminant accuracy of a grammatical measure with Spanish-speaking children. *Journal of Speech, Language and Hearing Research, 49*, 1209-1223.

Hakuta, K., Bialystok, E., & Wiley, E. (2003). Critical evidence: a test of the critical-period hypothesis for second-language acquisition. *Psychological Science, 14*(1), 31-38.

Hall, N. E., & Evans, D. L. (2004). Examining adaptation and bilingualism in stuttering. In A. Packman, A. Meltzer & H. F. M. Peters (Eds.), *Theory, research and therapy in fluency disorders: Proceedings of the fourth World Fluency Congress on fluency disorders* (pp. 363-368). Nijmegen: Nijmegen University Press.

Harrison, E., Kingston, M., & Shenker, R. C. (in press). Case studies in evidence-based management of stuttering preschoolers. In M. Onslow (Ed.), *Evidence based clinical management of stuttering*. Austin, TX: Pro-Ed.

Harrison, E., Onslow, M., Andrews, C., Packman, A., & Webber, M. (1998). Control of stuttering with prolonged speech: Development of a one-day instatement program. In A. Cordes & R. J. Ingham (Eds.), *Treatment efficacy in stuttering: A search for empirical bases*. San Diego, CA: Singular Publishing Group.

Hartsuiker, R. J., Bastiaanse, R., Postma, A., & Wijnen, F. (2005). Phonological encoding and monitoring in normal and pathological speech. In R. J. Hartsuiker (Ed.), *Phonological encoding and monitoring in normal and pathological speech*. Hove, East Sussex: Psychological Press.

Hayhow, R., Cray, A. M., & Enderby, P. (2002). Stammering and therapy views of people who stammer. *Journal of Fluency Disorders, 27*(1), 1-17.

Helps, R., & Dalton, P. (1979). Effectiveness of an Intensive Group Speech-Therapy Program for Adult Stammerers. *British Journal of Disorders of Communication, 14*(1), 17-30.

Hernandez, A., Li, P., & MacWhinney, B. (2005). The emergence of competing modules in bilingualism. *Trends in Cognitive Sciences, 9*(5), 220-225.

Hernandez, A. E., & Meschyan, G. (2006). Executive function is necessary to enhance lexical processing in a less proficient L2: Evidence from fMR1 during picture naming. *Bilingualism: Language and Cognition, 9*(2), 177-188.

Holm, A., & Dodd, B. (2001). Comparison of cross-language generalisation following speech therapy. *Folia Phoniatrica et Logopaedica, 53*(3), 166-172.

Howell, P., & Dworzynski, K. (2005). Planning and execution processes in speech control by fluent speakers and speakers who stutter. *Journal of Fluency Disorders, 30*(4), 343-354.

Howie, P. M. (1981). Concordance for stuttering in monozygotic and dizygotic twin pairs. *Journal of Speech Hearing Research, 24*(3), 317-321.

Howie, P. M., Tanner, S., & Andrews, G. (1981). Short-term and long-term outcome in an intensive treatment program for adult stutterers. *Journal of Speech and Hearing Disorders, 46*(1), 104-109.

Hurst, M. I., & Cooper, E. B. (1983). Employer Attitudes toward Stuttering. *Journal of Fluency Disorders, 8*(1), 1-12.

Ingham, R. J. (1987). *Residential prolonged speech stuttering therapy manual*. Santa Barbara: Department of Speech and Hearing Sciences, University of California.

Ingham, R. J., & Andrews, G. (1973). Details of a token economy stuttering therapy programme for adults. *Australian Journal of Human Communication Disorders, 1*, 13-20.

Ingham, R. J., & Cordes, A. (1997). Self-measurement and evaluating stuttering treatment efficacy. In R. Curlee & G. Siegel (Eds.), *Nature and treatment of* *stuttering: New directions* (2nd ed., pp. 413 - 437). Needham Heights, MA: Allyn & Bacon.

Ingham, R. J., Fox, P. T., Ingham, J. C., & Zamarripa, F. (2000). Is overt stuttered speech a prerequisite for the neural activations associated with chronic developmental stuttering? *Brain and Language, 75*(2), 163-194.

Jankelowitz, D. L., & Bortz, M. A. (1996). The interaction of bilingualism and stuttering in an adult. *Journal of Communication Disorders, 29*(3), 223-234.

Jared, D., & Kroll, J. F. (2001). Do bilinguals activate phonological representations in one or both of their languages when naming words? *Journal of Memory and Language, 44*(1), 2-31.

Jayaram, M. (1983). Phonetic influences on stuttering in monolingual and bilingual stutterers. *Journal of Communication Disorders, 16*(4), 287-297.

Jones, M., Onslow, M., Packman, A., & Gebski, V. (2006). Guidelines for statistical analysis of percentage of syllables stuttered data. *Journal of Speech Language and Hearing Research, 49*(4), 867-878.

Jones Maner, K., Smith, A., & Grayson, L. (2000). Influences of utterance length and complexity on speech motor performance in children and adults. *Journal of Speech Language and Hearing Research, 43*(2), 560-573.

Kalinowski, J. S., & Saltuklaroglu, T. (2006). *Stuttering*. San Diego: CA: Plural Publishing, Inc.

Karniol, R. (1992). Stuttering out of bilingualism. *First Language, 12*, 255-283.

Keppel, G., & Wickens, T. D. (2004). *Design and analysis: a researcher's handbook* (4th ed.). Upper Saddle River, N.J.: Pearson Prentice Hall.

Keung, T., & Hoosain, R. (1979). Segmental phonemes and tonal phonemes in comprehension of Cantonese. *Psychologia: An International Journal of Psychology in the Orient, 22*(4), 222-224.

Kidd, K. K. (1977). A genetic perspective on stuttering. *Journal of Fluency Disorders, 2*(4), 259-269.

Kidd, K. K. (1980). Genetic models of stuttering. *Journal of Fluency Disorders, 5*(3), 187-201.

Kiran, S., & Edmonds, L. A. (2004). Effect of semantic naming treatment on crosslinguistic generalization in bilingual aphasia. *Brain and Language, 91*(1), 75-77.

Klein, D., Milner, B., Zatorre, R. J., Zhao, V., & Nikelski, J. (1999). Cerebral organization in bilinguals: a PET study of Chinese-English verb generation. *Neuroreport, 10*(13), 2841-2846.

Kleinow, J., & Smith, A. (2000). Influences of length and syntactic complexity on the speech motor stability of the fluent speech of adults who stutter. *Journal of Speech Language and Hearing Research, 43*(2), 548-559.

Kohnert, K. (2004). Cognitive and cognate-based treatments for bilingual aphasia: A case study. *Brain and Language, 91*(3), 294-302.

Kohnert, K. J., Bates, E., & Hernandez, A. E. (1999). Balancing bilinguals: Lexical-semantic production and cognitive processing in children learning Spanish and English. *Journal of Speech, Language, and Hearing Research, 42*(6), 1400-1413.

Kohnert, K. J., Hernandez, A. E., & Bates, E. (1998). Bilingual performance on the Boston Naming Test: Preliminary norms in Spanish and English. *Brain and Language, 65*(3), 422-440.

Kotz, S. A., & Elston-Guttler, K. (2004). The role of proficiency on processing categorical and associative information in the L2 as revealed by reaction times and event-related brain potentials. *Journal of Neurolinguistics, 17*(2-3), 215-235.

Kraaimaat, F. W., Janssen, P., & Van Dam-Baggen, R. (1991). Social anxiety and stuttering. *Perceptual and Motor Skills, 72*(3), 766-766.

Kraaimaat, F. W., Vanryckeghem, M., & Van Dam-Baggen, R. (2002). Stuttering and social anxiety. *Journal of Fluency Disorders, 27*(4), 319-331.

Kroll, J. F., & Stewart, E. (1994). Category Interference in Translation and Picture Naming - Evidence for Asymmetric Connections between Bilingual Memory Representations. *Journal of Memory and Language, 33*(2), 149-174.

Langdon, H. W., Wiig, E. H., & Nielsen, N. P. (2005). Dual-dimension naming speed and language-dominance ratings by bilingual hispanic adults. *Bilingual Research Journal, 29*(2), 319.

Lebrun, Y., Bijleveld, H., & Rousseau, J.-J. (1990). A case of persistent neurogenic stuttering following a missile wound. *Journal of Fluency Disorders, 15*(5-6), 251-258.

Lebrun, Y., & Paradis, M. (1984). To be or not to be bilingual? In Y. Lebrun & M. Paradis (Eds.), *Early bilingualism and child development* (pp. 9-18). Lisse: Swets & Zeitlinger.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation*. Cambridge, Mass: MIT Press.

Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22*(1), 1-+.

Li, C. N., & Thompson, S. A. (1981). *Mandarin Chinese: A functional reference grammar*. Berkeley, CA: University of California Press.

Li, P., Bates, E., & Macwhinney, B. (1993). Processing a language without inflections: A reaction time study of sentence interpretation in Chinese. *Journal of Memory and Language, 32*(2), 169-192.

Li, P., Sepanski, S., & Zhao, X. (2006). Language History Questionnaire: A web-based interface for bilingual research. *Research Methods, 38*, 202-210.

Liang, J., & Heuven, V. J. v. (2004). Evidence for separate tonal and segmental tiers in the lexical specification of words: A case study of a brain-damaged Chinese speaker. *Brain and Language, 91*(3), 282-293.

Lim, V., Lincoln, M., Chan, Y. H., & Onslow, M. (2007). Stuttering in English-Mandarin bilingual speakers: The influence of language dominance on stuttering severity. *Journal of Speech, Language and Hearing Research*, Manuscript submitted for publication.

Lim, V., Lincoln, M., Chan, Y. H., Rickard Liow, S. J., & Onslow, M. (2007). Determining language dominance in English-Mandarin bilinguals: A self-report classification tool for clinical use. *Journal of Speech, Language and Hearing Research*, Manuscript submitted for publication.

Lim, V. P. C. (1998). *Impairment of lexical tone production in stroke patients with bilingual aphasia.* Unpublished Masters Thesis, La Trobe University, Victoria, Australia.

Lin, H. (2001). *A grammar of Mandarin Chinese*. Muenchen: LINCOM Europa.

Macnamara, J. (1967). The bilingual's linguistic performance: A psychological overview. *Journal of Social Issues, 23*, 59-77.

Mahr, G. C., & Torosian, T. (1999). Anxiety and social phobia in stuttering. *Journal of Fluency Disorders, 24*(2), 119-126.

Månsson, H. (2000). Childhood stuttering: Incidence and development. *Journal of Fluency Disorders, 25*(1), 47-57.

Mattes, L. J., & Omark, D. R. (1991). *Speech and language assessment for the bilingual handicapped.* College-Hill Press, San Diego.

Matthews, S., & Yip, V. (1994). *Cantonese: A comprehensive grammar*. London: Routledge.

McElree, B., Jia, G., & Litvak, A. (2000). The time course of conceptual processing in three bilingual populations. *Journal of Memory and Language, 42*(2), 229-254.

McKinnon, D. H., McLeod, S., & Reilly, S. (2007). The prevalence of stuttering, voice, and speech-sound disorders in primary school students in Australia. *Language, Speech & Hearing Services in Schools, 38*(1), 5.

Melnick, K. S., & Conture, E. G. (2000). Relationship of length and grammatical complexity to the systematic and nonsystematic speech errors and stuttering of children who stutter. *Journal of Fluency Disorders, 25*(1), 21-45.

Menzies, R. G., O'Brian, S., Onslow, M., Packman, A., St Claire, T., & Block, S. (2007). An experimental clinical trial of a cognitive behaviour therapy package for chronic stuttering. *Journal of Speech, Language and Hearing Research*, Manuscript submitted for publication.

Menzies, R. G., Onslow, M., & Packman, A. (1999). Anxiety and stuttering: exploring a complex relationship. *American Journal of Speech Language Pathology, 8*(1), 3-10.

Messenger, M., Onslow, M., Packman, A., & Menzies, R. (2004). Social anxiety in stuttering: measuring negative social expectancies. *Journal of Fluency Disorders, 29*(3), 201-212.

Meyer, A. S. (1997). Word form generation in language production. In W. Hulstijn, H. F. M. Peters & P. H. H. M. Van Lieshout (Eds.), *Speech production: Motor control, brain research and fluency disorders* (pp. 73-88). The Netherlands: Elsevier Science.

Ming, J. X., Jing, Z., Wen, Z. Y., & Van Borsel, J. (2001). Public awareness of stuttering in Shanghai, China. *Logopedics Phoniatrics Vocology, 26*(4), 145 - 150.

Naeser, M. A., & Chan, S. W. C. (1980). Case-Study of a Chinese Aphasic with the Boston Diagnostic Aphasia Exam. *Neuropsychologia, 18*(4-5), 389-&.

Neilson, M., & Andrews, G. (1993). Intensive fluency training of chronic stutterers. In R. F. Curlee (Ed.), *Stuttering and related disorders of fluency*. New York: Thieme Medical Publishers.

Neilson, M. D., & Neilson, P. D. (1987). Speech motor control and stuttering: A computational model of adaptive sensory-motor processing. *Speech Communication, 6*(4), 325-333.

Neilson, M. D., & Neilson, P. D. (2000). A computational theory of motor synergy development: Implications for stuttering. *Journal of Fluency Disorders, 25*(3), 171-171.

Newman, R. S., & Bernstein Ratner, N. (2007). The role of selected lexical factors on confrontation naming accuracy, speech, and fluency in adults who do and do not stutter. *Journal of Speech Language and Hearing Research, 50*(1), 196-213.

Nudelman, H. B., Herbrich, K. E., Hoyt, B. D., & Rosenfield, D. B. (1989). A neuroscience model of stuttering. *Journal of Fluency Disorders, 14*(6), 399-427.

Nwokah, E. E. (1988). The imbalance of stuttering behavior in bilingual speakers. *Journal of Fluency Disorders, 13*(5), 357-373.

O'Brian, S., Cream, A., Onslow, M., & Packman, A. (2001). A replicable, nonprogrammed, instrument-free method for the control of stuttering with prolonged speech. *Asia Pacific Journal of Speech, Language, and Hearing, 6*, 91-96.

O'Brian, S., Onslow, M., Cream, A., & Packman, A. (2003). The Camperdown Program: Outcomes of a new prolonged-speech treatment model. *Journal of Speech, Language and Hearing Research, 46*(4), 933-946.

O'Brian, S., Packman, A., & Onslow, M. (2004). Self rating of stuttering severity as a clinical tool. *American Journal of Speech-Language Pathology, 13*, 219-226.

O'Brian, S., Packman, A., Onslow, M., & O'Brian, N. (2004). Measurement of stuttering in adults: comparison of stuttering-rate and severity-scaling methods. *Journal of Speech, Language, and Hearing Research, 47*(5), 1081-1087.

Obler, L. K., Zatorre, R., J., Galloway, L., & Vaid, J. (2000). Central lateralization in bilinguals: Methodological issues. In L. Wei (Ed.), *The Bilingualism Reader* (pp. 381-393). London: Routledge.

Onslow, M. (1996). *Behavioral management of stuttering*: San Diego, CA: Singular Publishing Group.

Onslow, M., Costa, L., Andrews, C., Harrison, E., & Packman, A. (1996). Speech outcomes of a prolonged-speech treatment for stuttering. *Journal of Speech and Hearing Research, 39*(4), 734-749.

Onslow, M., Jones, M., O'Brian, S., & Menzies, R. G. (2007). Biostatistics for clinicians: Defining, evaluating, and identifying clinical trials of stuttering treatments. *American Journal of Speech Language Pathology*, Manuscript in preparation.

Onslow, M., & O'Brian, S. (1996). Reliability of clincians' judgements about prolonged speech targets. *Journal of Speech Language and Hearing Research, 41*, 969-975.

Onslow, M., Packman, A., & Harrison, E. (2003). *The Lidcombe Programme for early stuttering intervention: A clinician's guide*. Austin, TX: Pro-ed.

Ooki, S. (2005). Genetic and environmental influences on stuttering and tics in Japanese twin children. *Twin Research and Human Genetics, 8*(1), 69-75.

Oomen, C. C. E., & Postma, A. (2002). Limitations in processing resources and speech monitoring. *Language and Cognitive Processes, 17*(2), 163-184.

Orton, S. T., & Travis, L. E. (1929). Studies in stuttering - IV. Studies-of action currents in stutterers. *Archives of Neurology and Psychiatry, 21*(1), 61-68.

Oscarson, M. (1989). Self-assessment of language proficiency: rationale and applications. *Language Testing, 6*, 1-13.

Packard, J. (1992). *A linguistic investigation of aphasic Chinese speech.* Amsterdam: Kluwer Academic.

Packman, A., & Attanasio, J. S. (2004). *Theoretical issues in stuttering*. Hove, East Sussex: Psychology Press.

Packman, A., Code, C., & Onslow, M. (2007). On the cause of stuttering: Integrating theory with brain and behavioral research. *Journal of Neurolinguistics, doi:10.1016/j.jneuroling.2006.11.001*.

Packman, A., & Onslow, M. (1998). The behavioral data language of stuttering. In A. Cordes & R. J. Ingham (Eds.), *Treatment efficacy in stuttering: A search for empirical bases*. San Diego, CA: Singular Publishing Group.

Packman, A., & Onslow, M. (1999). Fluency disruption in speech and in wind instrument playing. *Journal of Fluency Disorders, 24*(4), 293-298.

Packman, A., Onslow, M., & Menzies, R. (2000). Novel speech patterns and the treatment of stuttering. *Disability and Rehabilitation, 22*(1-2), 65-79.

Packman, A., Onslow, M., O'Brian, S., & Huber, A. (2004). Measuring the outcomes of behavioral stuttering treatments: What are our data telling us. In A. K. Bothe (Ed.), *Evidence-based treatment of stuttering: Empirical issues and clinical implications*: Mahwah, NJ: Lawrence Erlbaum Associates.

Packman, A., Onslow, M., Richard, F., & VanDoorn, J. (1996). Syllabic stress and variability: A model of stuttering. *Clinical Linguistics & Phonetics, 10*(3), 235-263.

Packman, A., Onslow, M., & van Doorn, J. (1994). Prolonged speech and modification of stuttering: Perceptual, acoustic, and electroglottographic data. *Journal of Speech and Hearing Research, 37*(4), 724-737.

Paradis, M. (1987). *The assessment of bilingual aphasia*. Mahwah, NJ: Lawrence Erlbaum.

Perani, D., Eraldo, P., Galles, N. S., Dupoux, E., Dehaene, S., Bettinardi, V., et al. (1998). The bilingual brain: Proficiency and age of acquisition of the second language. *Brain, 121*, 1841 - 1852.

Perkins, W. H. (1973). Replacement of stuttering with normal speech. 2. Clinical procedures. *Journal of Speech and Hearing Disorders, 38*(3), 295-303.

Perkins, W. H., Kent, R. D., & Curlee, R. F. (1991). A theory of neuropsycholinguistic function in stuttering. *Journal of Speech and Hearing Research, 34*(4), 734-752.

Piske, T., Flege, J. E., & MacKay, I. R. A. (2001). Factors affecting degree of foreign accent in an L2: a review. *Journal of Phonetics, 29*(2), 191-215.

Postma, A., & Kolk, H. (1993). The Covert Repair Hypothesis - Prearticulatory Repair Processes in Normal and Stuttered Disfluencies. *Journal of Speech and Hearing Research, 36*(3), 472-487.

Poulisse, N. (1997). Language production in bilinguals. In A. M. B. de Groot & J. F. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 201-224). Mahwah, NJ: Lawrence Erlbaum Associates.

Poulisse, N. (2000). Slips of the tongue in first and second language production. *Studia Linguistica, 54*(2), 136-149.

Poulisse, N., & Bongaerts, T. (1994). First language use in second language production. *Applied Linguistics, 15*, 36-57.

Rickard Liow, S. J., Hong, E. L., & Tng, S. K. (1992). *Singapore primary school norms for the multilingual British Picture Vocabulary Scale: English, Mandarin and Malay. Working Paper No. 43*: Department of Social Work & Psychology, National University of Singapore.

Rickard Liow, S. J., & Poon, K. K. L. (1998). Phonological awareness in multilingual Chinese children. *Applied Psycholinguistics, 19*, 339–362.

Rickard Liow, S. J., & Tng, S. K. (2003). Biscriptal literacy development of Chinese children in Singapore. In C. McBride-Chang & H. C. Chen (Eds.), *Reading development in Chinese children*. Westport: Praeger.

Ringo, C. C., & Dietrich, S. (1995). Neurogenic stuttering: An analysis and critique. *Journal of Medical Speech-Language Pathology, 3*, 111-122.

Roberts, P., & Meltzer, A. (2004). Normal rates and disfluencies in French and English. In A. Packman, A. Meltzer & H. F. M. Peters (Eds.), *Theory, research and therapy in fluency disorders: Proceedings of the fourth World Fluency Congress on fluency disorders* (pp. 389-395). Nijmegen: Nijmegen University Press.

Roberts, P., & Shenker, R. C. (Eds.). (in press). *Bilingualism: Issues affecting stuttering* (3rd ed.).

Roelofs, A. (2000). WEAVER++ and other computational models of lemma retrieval and word-form encoding. In L. Wheeldon (Ed.), *Aspects of language production*. Hove, East Sussex: Psychological Press.

Rousseau, I., Packman, A., & Onslow, M. (2004). *Treatment of early stuttering in a bilingual child*. Paper presented at the Conference Program and Abstracts of the 26th World Congress of the International Association of Logopedics and Phoniatrics.

Roux, F. E., & Tremoulet, M. (2002). Organization of language areas in bilingual patients: a cortical stimulation study. *Journal of Neurosurgery, 97*(4), 857-864.

Rustin, L., Botterill, W., & Kelman, E. (1996). *Assessment and therapy for young dysfluent children: Family interaction*. London: Whurr.

Sasisekaran, J., & De Nil, L. F. (2006). Phoneme monitoring in silent naming and perception in adults who stutter. *Journal of Fluency Disorders, 31*(4), 284-302.

Sasisekaran, J., De Nil, L. F., Smyth, R., & Johnson, C. (2006). Phonological encoding in the silent speech of persons who stutter. *Journal of Fluency Disorders, 31*(1), 1-21.

Schwartz, A. I., & Kroll, J. F. (2006). Bilingual lexical activation in sentence context. *Journal of Memory and Language, 55*(2), 197-212.

Scott Trautman, L., & Keller, K. (2000). *Bilingual intervention for stuttering: a case in point*. Paper presented at the ASHA annual convention, Washington, DC, November 16-19.

Shenker, R. C. (2004). Bilingualism in early stuttering: Empirical issues and clinical implications. In A. K. Bothe (Ed.), *Evidence-based treatment of stuttering: Empirical bases and clinical applications* (pp. 81-96). Mahwah, NJ: Lawrence Erlbaum Associates.

Shenker, R. C. (2006). Connecting stuttering management and measurement: I. Core speech measures of clinical process and outcome. *International Journal of Language & Communication Disorders, 41*(4), 355-364.

Shenker, R. C., Conte, A., Gingras, A., Courcy, A., & Polomeno, A. (1998). *The impact of bilingualism on developing fluency in a preschool child*. Paper presented at the Second World Congress on Fluency Disorders Proceedings, August 18-22.

Shenker, R. C., Courcy, A., Gingras, A., & Polomeno, A. (1997). Stuttering therapy for bilingual children. *Journal of Fluency Disorders, 22*(2), 91.

Shin, H. B., & Bruno, R. (2003). Language use and English-speaking ability: 2000, US Census 2000 Brief. from http://www.census.gov/prod/2003pubs/c2kbr-29.pdf

Silverman, S. W., & Ratner, N. B. (1997). Syntactic complexity, fluency, and accuracy of sentence imitation in adolescents. *Journal of Speech Language and Hearing Research, 40*(1), 95-106.

Smith, A., & Kelly, E. (1997). Stuttering: A dynamic, multifactorial model. In R. F. Curlee & G. M. Siegel (Eds.), *Nature and treatment of stuttering: New directions* (2nd ed., pp. 204-217). Boston, MA: Allyn & Bacon.

Smith, A., & Kleinow, J. (2000). Kinematic correlates of speaking rate changes in stuttering and normally fluent adults. *Journal of Speech Language and Hearing Research, 43*(2), 521-536.

Smits-Bandstra, S., & De Nil, L. F. (2007). Sequence skill learning in persons who stutter: Implications for cortico-striato-thalamo-cortical dysfunction. *Journal of Fluency Disorders*, doi:10.1016/j.jfludis.2007.1006.1001.

Smits-Bandstra, S., De Nil, L. F., & Rochon, E. (2006). The transition to increased automaticity during finger sequence learning in adult males who stutter. *Journal of Fluency Disorders, 31*(1), 22-42.

Snider, K., & van der Hulst, H. (Eds.). (1992). *The Phonology of tone: The representation of tonal register*. Berlin: Mouton de Gruyter.

Stahl, V., & Totten, G. (1995). *Bilingualism in young dysfluent children*. Paper presented at the Stuttering: Proceedings of the first world congress on fluency disorders, August 8-11, 1994.

Starkweather, C. W., & Gottwald, S. R. (1990). The demands and capacities model II: Clinical applications. *Journal of Fluency Disorders, 15*, 143-157.

Stein, M. B., Baird, A. M. A., & Walker, J. R. (1996). Social phobia in adults with stuttering. *American Journal of Psychiatry, 153*(2), 278-280.

Suresh, R., Ambrose, N., Roe, C., Pluzhnikov, A., Wittke-Thompson, J. K., Ng, M. C.-Y., et al. (2006). New complexities in the genetics of stuttering: significant sex-specific linkage signals. *American Journal of Human Genetics, 78*(4), 554(510).

Taylor, O. L. (1986). *Nature of communication disorders in culturally and linguistically diverse populations*. San Diego: College-Hill Press.

Teesson, K., Packman, A., & Onslow, M. (2003). The Lidcombe behavioral data language of stuttering. *Journal of Speech, Language, and Hearing Research, 46*, 1009-1015.

Tham, W. W. P., Rickard Liow, S. J., Rajapakse, J. C., Tan, C. L., Ng, S. E. S., Lim, W. E. H., et al. (2005). Phonological processing in Chinese-English bilingual biscriptals: An fMRI study. *NeuroImage, 28*(3), 579-587.

Tokowicz, N., Michael, E. B., & Kroll, J. F. (2004). The roles of study-abroad experience and working memory capacity in the types of errors made during translation. *Bilingualism: Language and Cognition, 7*(3), 255-272.

Travis, L. E. (1978). Cerebral Dominance Theory of Stuttering:1931-1978. *Journal of Speech and Hearing Disorders, 43*(3), 278-281.

Travis, L. E., Johnson, W., & Shover, J. (1937). The relation of bilingualism to stuttering: A survey in the East Chicago, Indiana, schools. *Journal of Speech Disorders, 2*, 185-189.

Tseng, T. F. (1988). *Colloquial Cantonese and Putonghua equivalents*. New York: Hippocrene Books.

Van Borsel, J., Maes, E., & Foulon, S. (2001). Stuttering and bilingualism: A review. *Journal of Fluency Disorders, 26*(3), 179-205.

Van Borsel, J., & Medeiros de Britto Pereira, M. (2005). Assessment of stuttering in a familiar versus an unfamiliar language. *Journal of Fluency Disorders, 30*(2), 109-124.

Van Borsel, J., Moeyaert, J., Mostaert, C., Rosseel, R., Van Loo, E., & Van Renterghem, T. (2006). Prevalence of stuttering in regular and special school populations in Belgium based on teacher perceptions. *Folia Phoniatrica et Logopaedica, 58*(4), 289-302.

Van Borsel, J., Sunaert, R., & Engelen, S. (2005). Speech disruption under delayed auditory feedback in multilingual speakers. *Journal of Fluency Disorders, 30*(3), 201-217.

van Heuven, W. J. B., Dijkstra, T., & Grainger, J. (1998). Orthographic neighborhood effects in bilingual word recognition. *Journal of Memory and Language, 39*(3), 458-483.

Van Riper, C. (1971). *The nature of stuttering*. Englewood Cliffs: NJ: Prentice-Hall.

Van Riper, C. (1982). *The nature of stuttering* (2nd ed.). Englewood Cliffs: NJ: Prentice-Hall.

Vasic, N., & Wijnen, F. (2005). Stuttering as a monitoring deficit. In R. J. Hartsuiker, R. Bastiaanse, A. Postma & F. Wijnen (Eds.), *Phonological encoding and monitoring in normal and pathological speech* (pp. 226-247). Hove, England: Psychological Press.

Waheed-Khan, N. (1998). *Fluency therapy with multilingual clients*. Paper presented at the Second World Congress on Fluency Disorders Proceedings, August 18-22.

Watson, J. B., & Bernstein Ratner, N. (2005). *Cultural & linguistic diversity in fluency assessment and treatment*. Paper presented at the American Speech-Language-Hearing Association Convention.

Watson, J. B., & Kayser, H. (1994). Assessment of bilingual/bicultural children and adults who stutter. *Seminars in Speech and Language, 15*, 149-164.

Webster, R. L. (1980). Evolution of a target-based behavioral therapy for stuttering. *Journal of Fluency Disorders, 5*(3), 303-320.

Webster, W. G. (1985). Neuropsychological models of stuttering-I. Representation of sequential response mechanisms. *Neuropsychologia, 23*(2), 263-267.

Webster, W. G. (1986). Neuropsychological models of stuttering-II. Interhemispheric interference. *Neuropsychologia, 24*(5), 737-741.

Webster, W. G. (1988). Neural mechanisms underlying stuttering: Evidence from bimanual handwriting performance. *Brain and Language, 33*(2), 226-244.

Webster, W. G. (1998). Brain models and the clinical management of stuttering. *Journal of Speech-Language Pathology and Audiology, 22*, 220-230.

Webster, W. G. (2004). From hand to mouth: Contributions of theory to evidence-based practice. In A. K. Bothe (Ed.), *Evidence-based treatment of stuttering* (pp. 17-26). Mahwah, NJ: Lawrence Erlbaum.

Weekes, B., Chen, M. J., Qun, H. C., Lin, Y. B., Yao, C., & Xiao, X. Y. (1998). Anomia and dyslexia in Chinese: A familiar story. *Aphasiology, 12*(1), 77-98.

Woods, D. W., & Wright, L. W. (1998). Dismantling simplified regulated breathing: A case of a bilingual stutterer. *Journal of Behavior Therapy and Experimental Psychiatry, 29*(2), 179-186.

Yairi, E., & Ambrose, N. (1992). Onset of stuttering in preschool children: Selected factors. *Journal of Speech and Hearing Research, 35*(4), 782-788.

Yairi, E., & Ambrose, N. G. (1999). Early childhood stuttering I: Persistency and recovery rates. *Journal of Speech and Hearing Research, 42*(5), 1097-1112.

Yaruss, J. S. (1999). Utterance length, syntactic complexity, and childhood stuttering. *Journal of Speech Language and Hearing Research, 42*(2), 329-344.

Yiu, E. M. L., & Fok, A. Y. Y. (1995). Lexical tone disruption in Cantonese aphasic speakers. *Clinical Linguistics and Phonetics, 9*(1), 79-92.

APPENDICES

APPENDIX A

A SELF-REPORT CLASSIFICATION TOOL

DETERMINING LANGUAGE DOMINANCE IN ENGLISH-MANDARIN BILINGUALS:

A SELF-REPORT CLASSIFICATION TOOL

Date:		
ID Number:		
Nationality:		
Gender (pls circle):	**M / F**	
Country of Birth:		
Date of Birth:		**Age: yrs and mths**
Yrs Living in Singapore:		
Highest Qualification:		**(e.g., PSLE, O or A Levels, Degree etc.)**
No. years of formal instruction in:	**English =** **(count from Primary School)**	**Mandarin =**
No. of years of exposure to:	**English =**	**Mandarin =**
Handedness:	**Left / Right**	

(A) UNDERSTANDING

Please write down a number to show which languages you **UNDERSTAND BEST**. For example, if you understand English best, put the number **'1'** next to the word "English". If you understand Mandarin second best, put a number **'2'** next to the word "Mandarin". If you cannot understand any of the languages, put a **'0'** next to that language.

Also, please report the age at which you started to **UNDERSTAND** each of the languages that you know. For example, you may have started to hear and understand Mandarin at home (age = 1 year) but you did not start hear and understand English until kindergarten (age = 5 years). If you cannot remember exactly, make an educated guess.

Language	Ranking	Age of First Exposure
English		
Mandarin		
Others: (specify)		
Others: (specify)		

Please **circle** a number on the rating scale below to indicate the proficiency /competency with which you can **CURRENTLY UNDERSTAND** each language. You can rate yourself in comparison to the general population in Singapore. **DO NOT USE** half-points (e.g., 3.5)
.

How proficient are you in **understanding** English?

Very few words — Native proficiency

1 2 3 4 5 6 7

How proficient are you in **understanding** Mandarin?

1 2 3 4 5 6 7

How proficient are you in **understanding** other languages (specify ____________)?

1 2 3 4 5 6 7

How proficient are you in **understanding** other languages (specify ___________)?

1 2 3 4 5 6 7

(B) SPEAKING

Please write down a number to show which languages you **SPEAK BEST**. For example, if you speak English best, put the number **'1'** next to the word "English". If you speak Mandarin second best, put a number **'2'** next to the word "Mandarin". If you cannot speak any of the languages, put a **'0'** next to that language.

Also, please report the age at which you started **SPEAKING** each of the languages that you know. For example, you may have started speaking Mandarin at home (age = 1 year) but you did not start speaking English until kindergarten (age = 5 years). If you cannot remember exactly, make an educated guess.

Language	Ranking	Age of First Exposure
English		
Mandarin		
Others: (specify)		
Others: (specify)		

Please **circle** a number on the rating scale below to indicate the proficiency /competency with which you can **CURRENTLY SPEAK** each language. You can rate yourself in comparison to the general population in Singapore. **DO NOT USE** half-points (e.g., 3.5).

How proficient are you in **speaking** English?
Very few words   Native proficiency
1   2   3   4   5   6   7

How proficient are you in **speaking** Mandarin?
1   2   3   4   5   6   7

How proficient are you in **speaking** other languages (specify ____________)?
1   2   3   4   5   6   7

How proficient are you in **speaking** other languages (specify ____________)?
1   2   3   4   5   6   7

(C) READING

Please write down a number to show which languages you **READ BEST**. For example, if you read English best, put the number **'1'** next to the word "English". If you read Mandarin second best, put a number **'2'** next to the word "Mandarin". If you cannot read any of the languages, put a **'0'** next to that language.

Also, please report the age at which you started **READING** each of the languages that you know. For example, you may have started reading Mandarin at home (age = 1 year) but you did not start reading English until kindergarten (age = 5 years). If you cannot remember exactly, make an educated guess.

Language	Ranking	Age of First Exposure
English		
Mandarin		
Others: (specify)		
Others: (specify)		

Please **circle** a number on the rating scale below to indicate the proficiency /competency with which you can **CURRENTLY READ** each language. You can rate yourself in comparison to the general population in Singapore. **DO NOT USE** half-points (e.g., 3.5).

How proficient are you in **reading** English?
Very few words Native proficiency
1 2 3 4 5 6 7

How proficient are you in **reading** Mandarin?
1 2 3 4 5 6 7

How proficient are you in **reading** other languages (specify ____________)?
1 2 3 4 5 6 7

How proficient are you in **reading** other languages (specify ___________)?
1 2 3 4 5 6 7

(D) WRITING

Please write down a number to show which languages you **WRITE BEST**. For example, if you write English best, put the number **'1'** next to the word "English". If you write Mandarin second best, put a number **'2'** next to the word "Mandarin". If you cannot write any of the languages, put a **'0'** next to that language.

Also, please report the age at which you started **WRITING** each of the languages that you know. For example, you may have started writing Mandarin at home (age = 1 year) but you did not start writing English until kindergarten (age = 5 years). If you cannot remember exactly, make an educated guess.

Language	Ranking	Age of First Exposure
English		
Mandarin		
Others: (specify)		
Others: (specify)		

Please **circle** a number on the rating scale below to indicate the proficiency /competency with which you can **CURRENTLY WRITE** each language. You can rate yourself in comparison to the general population in Singapore. **DO NOT USE** half-points (e.g., 3.5).

How proficient are you in **writing** English?
Very few words Native proficiency
1 2 3 4 5 6 7

How proficient are you in **writing** Mandarin?
1 2 3 4 5 6 7

How proficient are you in **writing** other languages (specify ____________)?
1 2 3 4 5 6 7

How proficient are you in **writing** other languages (specify ___________)?
1 2 3 4 5 6 7

(E) LANGUAGE USAGE

Please write down a number to show which languages you **USE MOST** at home, work and socially. For example, if you use English most at home, put the number **'1'** next to the word "English". If you use Mandarin at home but to a lesser extent, put a number **'2'** next to the word "Mandarin". If you don't use any of the languages at home, put a **'0'** next to that language. Do the same for the languages you use most at work and socially.

Language	Use Most At Home	Use Most At Work	Use Most Socially
English			
Mandarin			
Others: (specify)			
Others: (specify)			

Please indicate (✚) how **OFTEN** you would speak, hear, read and write each of the languages in your daily life.

Speaking	Every day	Every week	Every Month	Every Year	Less than once a year
English					
Mandarin					
Others: (specify)					
Others: (specify)					
Hearing	**Every day**	**Every week**	**Every Month**	**Every Year**	**Less than once a year**
English					
Mandarin					
Others: (specify)					
Others: (specify)					
Reading	**Every day**	**Every week**	**Every Month**	**Every Year**	**Less than once a year**
English					
Mandarin					
Others: (specify)					
Others: (specify)					
Writing	**Every day**	**Every week**	**Every Month**	**Every Year**	**Less than once a year**
English					
Mandarin					
Others: (specify)					
Others: (specify)					

(F) SCHOOL EXAMINATION GRADES

Please report examination grades for **ALL** languages.

Language	'O' Level (or equiv.)	'AO' Level (GP) (or equiv.)	Other Certificates: (specify)
English			
Mandarin			
Others: (specify)			

Have you previously taken Mandarin as a first language? ☐ Yes ☐ No

Have you previously taken Chinese Literature at the 'A' level (or equivalent)"? ☐ Yes ☐ No

Are you presently taking or have taken Chinese Language modules at University or equivalent? ☐ Yes ☐ No

Are you presently taking or have taken Chinese Studies modules at University of equivalent? ☐ Yes ☐ No

APPENDIX B

INDIVIDUAL %SS SCORES AT EACH ASSESSMENT OCCASION ACCORDING TO GROUP

Individual %SS Scores at Each Assessment Occasion According to Group

	Pretreatment		End of IP		4 weeks Post-IP		12 weeks Post-IP	
Participant	Eng	Man	Eng	Man	Eng	Man	Eng	Man
				Balanced Bilinguals (n = 4)				
S03	4.6	3.8	1.0	1.3	0.4	0.4	0.3	0.6
S05	7.7	5.8	1.7	2.9	1.9	4.1	2.6	5.7
S12	3.7	4.0	1.2	2.1	1.1	2.0	0.8	0.5
S21	4.2	3.7	0.8	1.1	1.1	1.1	1.2	1.1
				English Dominant (n = 7)				
S02	7.5	10.9	0.4	1.8	0.5	1.4	1.6	1.8
S04	12.7	15.4	0.6	1.2	1.3	2.1	2.0	1.7
S11	8.9	8.1	2.7	2.0	1.3	2.1	3.0	1.6
S15	3.9	10.0	0.2	1.0	0.3	1.8	0.4	1.9
S16	5.8	7.1	0.6	0.5	0.1	0.3	1.1	1.0
S19	19.4	20.0	1.0	2.8	1.4	4.1	1.8	9.1
S29	5.3	11.2	0.5	2.6	0.6	3.7	1.7	7.9
				Mandarin-Dominant (n = 3)				
S07	12.7	6.4	3.0	1.3	4.6	2.0	6.5	2.3
S13	4.7	6.5	2.0	.4	0.6	0.5	0.3	0.6
S18	14.5	9.4	1.5	0.8	1.9	1.5	4.2	3.5

APPENDIX C

THE TREATMENT PROGRAMME

3-DAY FLUENCY INTENSIVE PROGRAMME
SCHEDULE OUTLINE

DAY 1	ACTIVITY	TARGET STAGES
0900 - 0930	Introduction	
0930 - 1045	Individual Session	1 – 3
1045 - 1100	Morning Tea	
1100 - 1230	Individual Session	4 (60 spm)
1230 - 1330	Lunch	
1330 - 1500	Individual Session – change ST	5 (80-100 spm)
1500 - 1515	Afternoon Tea	
1515 - 1630	Individual Session – change ST	6 (120 spm)
1630 - 1700	Group Session	

DAY 2	ACTIVITY	TARGET STAGES
0900 - 0930	Review Homework – original ST	
0930 - 1045	Individual Session – original ST	7 (150 spm)
1045 - 1100	Morning Tea	
1100 - 1230	Individual Session – change ST	8 (170 spm)
1230 - 1330	Lunch	
1330 - 1500	Individual Session – change ST	9 (comfort rate)
1500 - 1515	Afternoon Tea	
1515 - 1630	Individual Session – original ST	9 Cont'd (comfort rate)
1630 - 1700	Group Session	

DAY 3	ACTIVITY	TARGET STAGES
0900 - 0930	Review Homework – original ST	
0930 - 1045	Individual Session – original ST	Review 9 (comfort rate)
1045 - 1100	Morning Tea	Start Transfer Tasks
1100 - 1230	Individual Session – change ST	Transfer Tasks
1230 - 1330	Lunch	
1330 - 1500	Individual Session – change ST	Transfer Tasks
1500 - 1515	Afternoon Tea	
1515 - 1630	Individual Session – original ST	Transfer Tasks
1630 - 1700	Group Session	

NOTE:
'Target Stages' serve as rough guidelines only. For each time slot, clinicians are allowed to stay at the same stage if targets are not achieved, or to advance to the next stage as appropriate.

3-DAY FLUENCY INTENSIVE PROGRAMME

Stage I

Consonant repetition 20/20	
Echoic vc syllables 20/20	
Echoic cv syllables 20/20	
Echoic vc cv syllables 10/10	
Echoic cv vc syllables 10/10	

Comments ______________________________

Stage II

1) Echoic monosyllabic words 20/20	
2) Echoic bisyllabic words 20/20	
3) Read monosyllabic words 20/20	
4) Read biyllabic words 20/20	
5) Spontaneous words 20/20	

Comments ______________________________

Stage III

1) Echoic phrase production 20/20	
2) Read phrases 20/20	
3) Read sentences 20/20	

Comments ______________________________

Stage IV (60 spm)

1) ½ min R 60 syll/min	
2) ½ min R 60 syll.min	
3) 1 min R 60 syll/min	
4) ½ min M 60 syll/min	
5) ½ min M 60 syll/min	
6) 1 min M 60 syll/min	
7) ½ min C 60 syll/min	
8) 1 min C 60 syll/min	
9) 2 min M 60 syll/min	
10) 2 min C 60 syll/min	

Comments ____

____

____

____

____

____

Stage V (80-100 spm)

1) ½ min R 80-100 syll/min	
2) 1 min R 80-100 syll.min	
3) ½ min M 80-100 syll/min	
4) 1 min M 80-100 syll/min	
5) ½ min C 80-100 syll/min	
6) 1 min C 80-100 syll/min	
7) 2 min C 80-100 syll/min	
8) 2 min C 80-100 syll/min	
9) 2 min R 80-100 syll/min	
10) 5 min C 80-100 syll/min	

Comments ____

____

____

____

____

Stage VI (120 spm)

Criteria: 100% fluency, use of all fluency techniques and natural sounding speech.
Naturalness Rating: (0-9), 9 = very natural

		SEV	NAT
1) 1 min R 120 syll/min			
2) 2 min R 120 syll.min			
3) ½ min M 120 syll/min			
4) 1 min M 120 syll/min			
5) 2 min C 120 syll/min			
6) 2 min M 120 syll/min			
7) 2 min C 120 syll/min			
8) 3 min C 120 syll/min			
9) 1 min T 120 syll/min			
10) 5 min C 120 syll/min			

Comments ____

____

____

____

Stage VII (150 spm)

Criteria: 100% fluency, use of all fluency techniques and natural sounding speech.
Naturalness Rating: (0-9), 9 = very natural

		SEV	NAT
1) 1 min R 150 syll/min			
2) 2 min R 150 syll.min			
3) 1 min M 150 syll/min			
4) 1 min C 150 syll/min			
5) 2 min M 150 syll/min			
6) 1 min T 150 syll/min			
7) 2 min C 150 syll/min			
8) 2 min C 150 syll/min			
9) 5 min C 150 syll/min			
10) 2 min T 150 syll/min			

Comments ____

____

____

____

Stage VIII (170 spm)

Criteria: 100% fluency, use of all fluency techniques and natural sounding speech.
Naturalness Rating: (0-9), 9 = very natural

		SEV	NAT
1) 1 min R 170 syll/min			
2) 2 min R 170 syll.min			
3) 1 min M 170 syll/min			
4) 2 min M 170 syll/min			
5) 1 min C 170 syll/min			
6) 2 min C 170 syll/min			
7) 5 min C 170 syll/min			
8) 2 min T 170 syll/min			
9) 5 min C 170 syll/min			
10) 5 min C 170 syll/min			

Comments ____

____

____

Stage IX ("Comfort Rate")

Criteria: 100% fluency, use of all fluency techniques and natural sounding speech.
Naturalness Rating: (0-9), 9 = very natural

		SEV	NAT
1) 1 min R comfort rate			
2) 1 min M comfort rate			
3) 2 min M comfort rate			
4) 1 min C comfort rate			
5) 2 min C comfort rate			
6) 2 min T comfort rate			
7) 5 min C comfort rate			
8) 5 min C comfort rate			

Comments ____

____

____

____

____

Stage IX ("Comfort Rate" cont'd)

Criteria: 100% fluency, use of all fluency techniques and natural sounding speech.
Naturalness Rating: (0-9), 9 = very natural

		SEV	NAT
9) 1 min R comfort rate			
10) 1 min M comfort rate			
11) 2 min M comfort rate			
12) 1 min C comfort rate			
13) 2 min C comfort rate			
14) 2 min T comfort rate			
15) 5 min C comfort rate			
16) 5 min C comfort rate			

Comments ____

R = Reading, M = Monologue, C = Conversation, T = Telephone