THESIS

THE EFFECT OF AUDITORY-MOTOR MAPPING TRAINING IN KOREAN ON THE

SPEECH OUTPUT OF CHILDREN WITH AUTISM

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ABSTRACT

THE EFFECT OF AUDITORY-MOTOR MAPPING TRAINING IN KOREAN ON THE

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Given the lower verbal output in many children with autism spectrum disorders (ASD), a number of interventions in English are available for them. However, currently there are no interventions specifically researched with children with ASD who come from different language backgrounds other than English. The present study examined the effect of an intonation-based treatment called auditory-motor mapping training (AMMT) to facilitate verbal output in two children with a diagnosis of ASD from Korean-speaking households. Both participated in a total of nine AMMT sessions in addition to four assessments over a 4-week period. A baseline assessment was conducted prior to the first treatment, and probe assessments were conducted after treatment session 3, 6, and 9. Each child's verbal production including consonants and vowels were measured. The results showed some improvements in the production of consonants and vowels over the treatment period; however, the differences were not significant. Although no statistically significant results were observed in this pilot study, more conclusive results may be observed in future studies adhering to the suggested recommendations.

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DEFINITION OF TERMS

Aphasia: an acquired communication disorder that impairs a person's ability to process language due to damage to lesions of the brain that are responsible for language. It impairs the ability to speak and understand others, and most individuals with aphasia experience difficulty reading and writing. Among the types of aphasia, the two broad categories of aphasia include *nonfluent aphasia* (also known as Broca's aphasia), in which language production is severely impaired, but comprehension is relatively spared and *fluent aphasia* (also known as Wernicke's aphasia), in which language comprehension is severely impaired while language production is relatively spared.

Broca's area: "The opercular and triangular parts of the inferior frontal gyrus, usually on the left. Broca's area has traditionally been considered critical for the production of language, but more recent work indicates that other structures such as the insula and the head of the audate nucleaus may be at least equally important.

A foreign-born or immigrant: A foreign-born person or immigrant refers to anyone who is born outside the United States and its territories. This can include naturalized citizens, lawful permanent residents, temporary migrants (such as foreign students), humanitarian migrants (such as refugees), and undocumented migrants. Anyone born in the United States, Puerto Rico, or U.S. island areas, or those born abroad of at least one U.S. citizen parent, are native born (U.S. Census Bureau, 2012).

Heritage language: In the United States, the term 'heritage language' refers to an immigrant, indigenous, or ancestral language that a speaker has a personal relevance and desire to (re)connect with (Lee & Shin, 2008). The term 'heritage language' has been used synonymously with 'community language,' 'native language,' and 'mother tongue' to refer to a language other

than English used by immigrants and possibly their children. In addition, heritage language speakers have been referred to as 'native speakers,' 'quasi-native speakers,' 'residual speaker,' 'bilingual speakers,' and 'home-background speakers' (Lee & Shin, 2008).

Bilingual: The term 'bilingual' refers to a heterogeneous population in terms of the relative levels of proficiency speakers have in their two languages. Today the most commonly accepted understanding of the term bilingual is that it refers to individuals who use two or more languages or dialects in their everyday lives (Petersen et al., 2012).

Arcuate fasciculus: a fiber bundle that connects the posterior temporal region (Wernicke's area) and the posterior inferior region (Broca's area) as well as the adjacent premotor cortex (Schlaug, Marchina, & Norton, 2009).

CHAPTER I: INTRODUCTION

Purpose of Study

The purpose of this study was to determine whether providing auditory-motor mapping training (AMMT) in Korean would improve the overall verbal production of children with autism spectrum disorder, who live in bilingual Korean-English speaking environment.

Background

Individuals with autism spectrum disorder (ASD) are characterized with social impairments, language and communication difficulties, and repetitive behaviors (American Psychiatric Association [APA], 2000). In particular, impairment in speech and language has been regarded as one of the most significant deficits in children with ASD, which provokes their parents to eagerly seek professional treatments (Kremer-Sadlik, 2005; Lim, 2012). There is a widespread belief among parents and professions that bilingualism causes additional burden and negative influence on language development to children with autism who already exhibit with language difficulties (Hambly & Fombonne, 2012; Petersen, Marinova-Todd, & Mirenda, 2012). They consider bilingualism is an option for normally developing children and assume that it is not possible for children with autism (Lowry, 2012). In the United States, many immigrant or refugee families, therefore, are advised by clinicians and educators to speak only one language with their children with autism (Wharton, Levine, Miller, Breslau, & Greenspan, 2000; Kremer-Sadlik, 2005; Jordaan, 2008; Paradis, Genesee, & Cargo, 2011), regardless of children's environments. This recommendation often results in eliminating the use of parent's heritage language, or the language of the country of origin and instead speaking English only.

Nonetheless, no studies support these assumption and recommendation; in fact, many studies have shown that children with autism can become speaking more than one language, and bilingualism does not induce negative influences on these autistic children's language development (Hambly & Fombonne, 2012; Petersen et al., 2012; Seung, Siddiqi, & Elder, 2006; Ohashi et al., 2012). In addition, limiting family's heritage language not only can cause even greater emotional gap between family members including the child with ASD (Kremer-Sadlik, 2005), but also can decrease child's chances in social interaction due to the language barrier (Wharton et al., 2000). Therefore, instead of restricting the use of the native language of these families, providing interventions related to their culture and language is appropriate and needed.

Music therapy has been recommended as an effective treatment for individuals with speech and communication disorders. Since its first development in 1973, melodic intonation therapy (MIT) has been reported as an effective treatment approach to individuals with nonfluent (Broca's) aphasia who exhibit difficulties with expressive language (Albert, Sparks, & Helm, 1973). MIT has shown to utilize the musical elements of speech (rhythm and melody) to elicit expressive language by capitalizing on preserved singing skills of Broca's aphasia patients and to stimulate and engage language-capable regions in the undamaged right hemisphere (Baker & Tamplin, 2006; Norton, Zipse, Marchina, & Schlaug, 2009). Based on the successful use of MIT, Wan and colleagues (2011) developed a new music-based intervention, called auditory-motor mapping training (AMMT), particularly for children with autism who also exhibit verbal language difficulties. The results from their study by Wan et al., (2011) has shown significant improvements in the ability to articulate words and phrases of six minimally verbal children with autism after receiving forty sessions of AMMT, which contains the use of intonation (singing) and rhythm to facilitate speech production of these children.

AMMT is based on the observations that children with ASD exhibit a heightened interest and response to music, despite impairments in expressive language and social communication (Thaut, 1988). In particular, autistic children enjoy auditory-motor activities such as making music, through singing or playing an instrument (Wan, Demaine, Zipse, Norton, & Schlaug, 2010b; Wan & Schlaug, 2010; Wan et al., 2011). Presumably, AMMT can not only capitalize on inherent musical strengths of children with ASD but also offer activities that they intrinsically enjoy. Also, this intervention engages and potentially modifies neural network called mirror neuron systems, involved in cognitive abilities such as empathy and learning by imitation, which are understood to affect speech and language dysfunction of ASD (Wan et al., 2010b; Wan & Schlaug, 2010).

Impairment in speech and language has been regarded as one of the most pervasive developmental deficits in children with ASD. To date, there are no studies using AMMT to bilingual population, especially in Korean population; therefore, based on the potential benefits of music-based interventions such as MIT and AMMT, this study sought to determine the effect of AMMT applied in Korean for children with ASD who live in Korean and English bilingual environments. The study also sought to identify modifications of English AMMT protocol (Wan et al., 2011) necessary to make the technique amenable for use with Korean children with ASD.

Research Questions

The aim of the current study was to replicate a study by Wan et al. (2011) based on the positive outcome of speech production of children with ASD. Of interest is how the results of the original study may differ when auditory-motor mapping training (AMMT) is implemented in a different language, Korean in this study. The following research questions will be addressed:

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- Does auditory-motor mapping training provided in Korean have beneficial effects on Korean verbal production, including consonants and vowels, in children with ASD who come from Korean language background?

- Does the use of auditory-motor mapping training in Korean promote changes in the perspective to the parents/caregivers on bilingualism and children with autism?

CHAPTER II: LITERATURE REVIEW

Autism Spectrum Disorder (ASD):

Definition of ASD

The term *autism*, which derives from the Greek word *autós* meaning "self," was first coined by Swiss psychiatrist Paul Eugen Bleuler in 1911 to refer to inward, self-absorbed symptoms in adult patients diagnosed with schizophrenia (Wire, 2005). Later in 1943, Dr. Leo Kanner, a psychiatrist at Johns Hopkins University, borrowed this term but was the first person to define autism as a distinct developmental disorder, labeling it "infantile autism" in his paper entitled "Autistic Disturbances of Affective Contact" (Gupta, 2004; Khetrapal, 2009). Since it was first defined, the diagnostic labels and criteria for autism have been changed and refined over the last few decades (Adamek, Thaut, & Furman, 2008). There has also been a rapid increase in the number of children diagnosed with autism over the years (Autism speaks, 2012). As of 2013, approximately 1 out of every 50 school-aged (6-17) children in the United States present with an ASD, according to the latest estimates from Center for Disease Control and Prevention (CDC) (Blumberg et al., 2013). ASD occurs in all financial levels, educational levels, cultures, races, and socioeconomic groups throughout the world. A single etiology for autism or for any of the disorders on the autistic spectrum has yet to be determined; this disorder is three to four times more likely to affect boys than girls (Khetrapal, 2009; Autism speaks, 2012).

The Diagnostic and Statistical Manual of Mental Disorders (DSM) published by the American Psychiatric Association is the primary manual used by clinicians to provide a standard diagnosis for the classification of mental disorders including autism and related disorders (APA, 2000). Until recently, autism spectrum disorders were identified as a set of pervasive

developmental disorders (PDD), according to the DSM, Fourth Edition, Text Revision (DSM-IV-TR). The related diagnoses of PDD included autistic disorder, Asperger's disorder, Rett's disorders, childhood disintegrative disorder (CDD), and pervasive developmental disorder not otherwise specified (PDD-NOS) (APA, 2000). Based on the DSM-IV-TR, diagnosis of ASD was made upon identifying marked impairments in following areas: (1) social interaction, (2) communication, and (3) restricted repetitive and stereotyped patterns of behavior, interest, and activities. The individuals with autism also must demonstrate delays or abnormal functioning in at least one of the following areas, with onset prior to age 3: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play (APA, 2000).

As of May 2013, which is 19 years since the DSM-IV was originally published in 1994, APA published a new edition of the manual, DSM-5 with modifications to the criteria and categories of ASD (Autism speaks, 2012). In the DSM-5, the previously separate subcategories on the autism spectrum, including autistic disorder, Asperger's disorder, CDD, and PDD-NOS, have folded into a one dimensional term, autism spectrum disorder (ASD). This means the deletion of Rett's syndrome and CDD, and autism, Asperger's syndrome and PDD-NOS collapsed into a single diagnosis, autism spectrum disorder (ASD). Further distinctions are made according to severity levels, which is based on the amount of support needed, due to challenges with social communication, restricted interest, and repetitive behaviors. In regards to symptoms of ASD, the traditional two domains of autism symptoms (i.e., social and communication) in DSM-IV-TR have merged into one, titled "social communication deficit" in DSM-5. This category includes deficits in social-emotional reciprocity, in nonverbal communicative behaviors used for social interaction, and in developing and maintaining relationships, appropriate to developmental level (Autism society, 2012). A second category includes deficits in restricted,

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repetitive patterns of behavior, interests, or activities. Also, under the new DSM-5, diagnosis requires a person with ASD to present the symptoms stated above in early childhood, and the symptoms together must limit and impair everyday functioning of the individual (American Psychiatric Association, 2012). Such diagnostic changes in DSM-5 are expected to make identifying ASD less confusing for clinicians and to create more consistent diagnoses for ASD.

Language Development in Children with ASD

According to the American Academy of Pediatrics' developmental milestones (2009), the beginning signs of communication occur may soon after birth when infants start to make noises of their own such as crying, cooing, and laughing. Usually around 6 or 7 months of age, as the children's speech mechanism (jaw, lips, tongue, and throat) and voice mature, cooing develops into real, language-like sounds, called babbling – a significant language milestone – which consists of sequences of consonant–vowel syllables (e.g., "ba, ba, ba" or "da, da, da"). By their first birthday, most toddlers typically exhibit a variety of communicative behaviors including saying a word or two, turning and looking when they hear their name, pointing when they want something, and making it obvious that the answer is "No" when offered something undesirable. During the 12- to 18- month period, there is a gradual increase in both receptive and expressive vocabulary, and children's average expressive vocabulary size reaches about 50 to 100 words at 18 months (Brandone, Golinkoff, & Salkind, 2006). The period of 18 to 24 months is a time of important developments because most children begin combining words into two-word sentences and telegraphic speech. Also, children develop in conversational ability during this time (Tager-Flusberg, Paul, & Lord, 2005). Additionally, a young child during this period begins to learn to sing songs, to provide sounds that animals and objects make, and to fill-in words to reinforce

phrases. By two years of age most children can provide their first name when asked, fill in various phrases, and respond to simple questions and words associations (Sundberg, 2008). As children grow, their vocabulary size continues to increase, and as their grammar becomes more complex, sentence length increases and children begin to use a variety of sentence forms including statements, negation, and questions.

For children with ASD, reaching such milestones may not be so straightforward. There is an enormous variation in the timing and patterns of language development among children with autism (Tager-Flusberg et al., 2005). On the one hand, some parents notice differences in their child very early (even at birth) and these children are referred to as having early-onset autism. On the other hand, some parents report that their child seemed to develop normally and then had a major regression resulting in autism, usually around 12-24 months. These children are referred to as having late-onset or regressive autism (Adams, Edelson, Grandin, Rimland, & Johnson, 2012). The regression is a gradual process in which the children do not learn new words and fail to engage in communicative routines in which they may have participated before (Tager-Flusberg et al., 2005). Over the past few years, there has been some debate as to whether regression is a real phenomenon or the autism was simply unnoticed by the child's parents (Adams et al., 2012). Various retrospective studies using parent interviews and videos collected during infancy and the toddler years suggest that these children who were diagnosed later with autism show verbal and nonverbal characteristics such as delayed onset of babbling, extremes of temperament and behavior (ranging from marked irritability to alarming passivity), poor eye contact, poor back-and-forth gestures (such as pointing, showing, or waving), and poor response to other people's voices or attempts to play and interact (Lim, 2012).

Nearly one third to one half of individuals with autism may not fully develop enough functional language to meet their daily communication needs (Lim, 2012). As many as 25 percent of all children with autism may never develop expressive communication skills (Tager-Flusberg et al., 2005), but many of them, who demonstrate communicative intent, eventually communicate in some way using various forms or modes (Adamek et al., 2008). Augmentative and Alternative Communication (AAC) methods such as sign language and the Picture Exchange Communication System (PECS) are widely used for these nonverbal individuals in order to make requests and interact with others (Wan et al., 2011). On the one hand, some children with autism become verbal yet exhibit some aberrant speech features such as echolalia, pronoun reversal, odd word choice, incoherent discourse, aberrant prosody, unresponsiveness to questions, and paucity of drive to communicate (Lim, 2009). Also, Tager-Flusber identified that these children, who are verbal, frequently exhibit various deficits in intonation and vocal quality (i.e., prosody), linguistic function (i.e., pragmatics), semantics, questions seeking information, adding to a conversational topic, and expressive gestures (as cited in Lim, 2012). Overall, such deficits in language and communication of children with ASD not only diminish quality of life for the affected children but also present a lifelong challenge for their families and loved ones.

Children with ASD Living in Bilingual/Bicultural Environments

Since 1970, the foreign-born population of the United States has increased rapidly due to large-scale immigration, primarily from Latin America and Asia, with 13 percent of the total U.S. population in 2010 having been born elsewhere (U.S. Census Bureau, 2012). In fact, this population has been growing far more quickly than the native-born population. As the foreign-born population increases, the number of people who speak a language other than English has

also increased simultaneously; approximately 20 percent (55.4 million) of the total population (281.0 million) speak a language other than English at home (U.S. Census Bureau, 2012). Statistics from the U.S. Department of Education (2011) have shown that the number of school-aged children (children ages 5-17) who speak a language other than English at home increased from 3.8 to 11.2 million between 1979 and 2009. Along with the growth of immigrant populations, the number of children with special needs who are foreign-born or have immigrant parents has also grown in the United States. While increasing racial and ethnic diversity has been apparent in the U.S., unfortunately specialized services in their native language are very limited for these immigrant families and their children with special needs (Wharton et al., 2000).

In the United States, autism spectrum disorders (ASD) appear to be the fastest-growing developmental disability that causes problems with social interaction and communication (Autism society, 2012). Upon the diagnosis of ASD in children, the deficits in speech and language of this disorder provoke parents to seek treatments to enhance their children's language skills (Kremer-Sadlik, 2005). In the U.S., bilingual families who have children with autism are frequently counseled by physicians, speech and language pathologists, teachers, and often even by other family members to speak only one language to their children (Wharton et al., 2000; Kremer-Sadlik, 2005; Jordaan, 2008). Many of these families confront difficulties of determining the choice of language for their autistic children (Toppelberg, Snow, & Tager-Flusberg, 1999; Lowry, 2012). Unfortunately, this often results in parents speaking a language to the child in which they are not fluent (Jordaan, 2008; Kay-Raining Bird, Cleave, Trudeau, Thordardottir, & Sutton, 2005). In fact, monolingual communication also appears to be almost universally offered to parents of children with other neurodevelopmental disorders that have consequences for language development, like Down syndrome, specific language impairment (SLI), as well as of

children with cognitive limitations (Paradis, Crago, Genesse, & Rice, 2003; Paradis et al., 2011; Wharton et al., 2000).

This recommendation stems from the belief that bilingual exposure will have adverse effects on language development, especially for children with autism who already experience significant delays or impairments in this area (Hambly & Fombonne, 2012; Petersen et al., 2012). First, many clinicians and bilingual parents often assume that dual language acquisition can cause additional delays in language development in children with ASD (Hambly & Fombonne, 2012). Second, bilingual parents with autistic children reported that they believed that the dual language exposure would confuse the children due to their difficulties with generalizing learned skills to new situations. They believe that bilingualism is for children who are developing normally and can easily generalize across languages and language environments as well as generalize what they have learned to new situations (Döpke, 2006). Lastly, individuals with autism need consistency in their environment and daily routine; parents choose English as the target language because it is the dominant language used in school and society (Kremer-Sadlik, 2005; Yu, 2009). Therefore, parents and clinicians may assume that bilingualism is not a possible option for children with ASD (Lowry, 2012).

Nonetheless, no known research supports the rationale behind and the effect of this English-only recommendation. Also, no known research shows that bilingual environments cause negative impacts on children with language impairments. Several studies on bilingual exposure in children with SLI (Paradis et al., 2003; Paradis, 2007; Gutierrez-Clellen, Simon-Cereijido, & Wagner, 2008) and Down syndrome (Feltmate & Kay-Raining Bird, 2008) found that such exposure does not have a harmful impact on their language development and that these children have the capability to become bilingual. Researchers have also found similar results

showing that children with ASD are capable of learning two languages and they do not experience additional delays in their language development from bilingual environments (Hambly & Fombonne, 2012; Kay-Raining Bird et al., 2012; Kremer-Sadlik, 2005; Petersen et al., 2012; Ohashi et al., 2012).

In fact, the English-only approach can produce a ripple effect that alters children's environment in ways that may have more significant undesirable results for the development of linguistic, social, and emotional competence. Children of immigrants are more likely to come from two-parent households where languages other than English are spoken (Chaudry & Fortuny, 2010). Many of these minority parents and other family members, especially recent immigrants, do not know English well and have limited English proficiency, demonstrating some difficulties with speaking, reading, and writing (Genesee, 2009; Jordaan, 2008; Kay-Raining Bird et al., 2005). The home environment is significant; it is where a child first encounters language and gains a strong foundation on language development. Therefore, most often parents or primary caregivers play a crucial role in children's literacy and language development. If parents speak to their children in a language in which the parents lack full competence themselves (English in this case), they can possibly provide a model for children of a language that is not fully developed. This can cause even more confusion to their children, and children will not gain appropriate language development in their second language, English (Ohashi, 2011). At the same time, their children will not have acquired the native language. Thus, with the vital role of parents in children's language development, Hambly and Fombonne (2012) encourage parents and primary caregivers to speak their native language or the language they speak well in order to provide correct modeling of language for children's language development.

The restrictive recommendation to use only English may also confine effective interchanges between parents and children, which then limit a child's opportunities for maximum socialization (Wharton et al., 2000). As Ochs and Schieffelin (1984) state, "the process of language acquisition is closely related with the process of socialization." This means that the acquisition of rules governing language is in part the acquisition of meanings and functions of these forms in social situations. That is, the knowledge of linguistic forms is embedded in socio-cultural knowledge (Kremer-Sadlik, 2005). In addition, the understanding of the social organization of everyday life, ideologies, moral values, beliefs, identities, norms and expectations of a certain cultural community are largely obtained through language. Kremer-Sadlik (2005) emphasized that a person is not only socialized to use language, is but also socialized through language. In this view, the family environment is the key site in which a child not only learns how to socialize through the modeling of their parents, of their siblings, and other relatives who are part of their lives, but also have the opportunity to practice that type of social language and pragmatic rules. Therefore, if children experience limited interchanges with their parents due to the language barrier, it could restrict not only the process of language learning but also the process of social growth (Wharton et al., 2000).

In the same context, imposing a non-native language on a family can create emotional distance between family members and children with ASD (Kremer-Sadlik, 2005). As Bowlby explains, all children develop attachment to their parents (or caregivers) by the end of their first year of life, according to attachment theory (as cited in Oppenheim, Koren-Karie, Dolev, & Yirmiya, 2008). By this age, they develop a strong emotional bond toward their parents and express distress to threats to this bond. Researchers indicate that the majority of children with ASD, however, tend to display a less secure attachment to their parents in comparison to children

without ASD (van Ijzendoorn et al., 2007). As noted previously, some infants as young as 8 to 12 months who were later diagnosed with autism do not present normal infant behaviors including babbling, eye contact, or back-and-forth gestures (Autism speaks, 2012). Also, some may not respond to their name or seek their mothers after a separation (van Ijzendoorn et al., 2007). Therefore, speaking a different language rather than the home or heritage language can possibly create even greater detachment between the child and other family members. A study from Tseng and Fuligni (2000) showed that adolescents who speak a common language with their immigrant parents have more parent-adolescent closeness than did their peers who did not speak the same language with their parents. King and Fogle (2006) emphasize that generally learning parents' heritage language can provide more connection between the family members (e.g., father, mother, and grandmother) and the child with ASD.

A bilingual circumstance is most often a necessity, not a choice for many immigrant families with autistic children (Döpke, 2006). Upon the advice of professionals and clinicians, immigrant parents with autistic children need to give up the language they are used to speaking. Even though they intend to speak only English to their child with autism, it is unavoidable and extremely challenging to avoid speaking their native language (Döpke, 2006; Ohashi, 2011). According to Chaudry and Fortuny (2010), many immigrant households tend to include more extended family, such as grandparents, than native households (U.S. Census Bureau, 2012). Often times, grandparents are the primary caregivers for children (Chang-Muy & Congress, 2008) and are not able to speak English, which means that eliminating the use of the child's home language would prevent the primary way to communicate. Moreover, interviews with parents with autistic children demonstrate that it seems impractical and impossible to manipulate the surroundings in which use of their native language naturally occurs (Kremer-Sadlike, 2005;

Ohashi, 2011). For instance, when immigrant parents from Japan have their friends or relatives

visiting their house, go to church or other religious services in Japanese, or make trips back to

the country of origin, their children with autism are naturally exposed to Japanese. Unless these

immigrant families completely discontinue the use of their native language and their social life in

their minority community, it is impossible to control the acquisition of their native language that

is a "natural" process for their children.

In addition, preserving the heritage language, or the language of the country of origin,

appears to be particularly critical for immigrant families and their communities (Lee & Shin,

2008; Larsen, 2011). In the United States, acquisition of English is necessary for the integration

of immigrants and their children into American culture (Phinney, Romero, Nava, & Huang,

2001). Thus, many immigrant parents wish their children to attain a high level of English

proficiency and adapt to the American culture as soon as possible (Lee & Shin, 2008).

Nevertheless, in addition to learning English, these parents want to maintain their native

language. A recent study by Kay-Raining Bird and colleagues (2012) explained the importance

of bilingualism by surveying 49 parents or guardians of children with ASD who were members

of a bilingual family. The results of this survey indicated that these parents or caregivers feel that

bilingualism is significant for their child with various reasons including the need to communicate

with family members, schools or neighbors, and living environments (i.e., a bilingual

city/country). Seventy five percent of these families were actually raising their child with ASD to

be bilingual or multilingual in spite of the English-only recommendation. In addition, being a

bilingual speaker from a bilingual family can maintain the parent heritage and culture, improve

cognitive and academic advantages, and promote cross-cultural understanding and

communication in general (King & Fogle, 2006). Additional benefits of bilingualism include

personal enrichment, travel opportunities, better access to jobs, and additional life opportunities (Kay-Raining Bird et al., 2012).

To conclude, bilingual parents should not be discouraged from exposing children with autism to more than one language. Removal of their home language is definitely impractical and not a family-centered approach (Ohashi, 2011; Döpke, 2006). As described above, when providing advices for language use, professionals and teachers have to consider whether replacing the parent/home language with English is optimal (Kremer-Sadlike, 2005). Parents and practitioners should rather support their multilingual, multicultural circumstances and seek effective ways to promote their children's learning more than one language, so these children can successfully become members of their community and learn both their native language and English. Currently, several studies have examined the effect of bilingualism on children with ASD (Hambly & Fombonne, 2012; Petersen et al., 2012; Seung et al., 2006; Ohashi et al., 2012). These studies not only reveal that children with ASD are capable of becoming bilingual, but also support that bilingualism does not cause negative effect on language development of children with ASD.

Bilingualism in Children with ASD

A search of the literature revealed only one study that specifically examined bilingual language intervention with a child with ASD. As a longitudinal study, Seung et al. (2006) observed the language development focused on vocabulary building and pragmatic goals (i.e., negotiation to select a toy for an activity, transition from task to task, social greetings, social smiles, verbal requests, and turn taking) of a 3-year-old Korean boy with ASD who was from a Korean-English household over a two-year period. The speech and language intervention moved

from Korean-only to English provided by a Korean-English bilingual speech-language pathologist (SLP). At four time points every 7 months, his progress was measured using Peabody Picture Vocabulary Tests-III (PPVT-III; Dunn & Dunn, 1997) and Expressive Vocabulary Test (EVT; Williams, 1997), which examine expressive vocabulary development. Other instruments used in this study included MacArthur Communicative Development Inventories (MCDI): Words and Sentences (Fenson et al., 1993), Reynell Developmental Language Scales (Reynell & Gruber, 1990), and Parenting Stress Index (PSI; Abidin, 1995).

For the first twelve months, the speech and language intervention was to provide therapy in his primary language twice a week, and the child made noticeable improvements. The next six months consisted of interventions that gradually introduced English, and the final six months involved interventions that were conducted entirely in English. After two years of treatment, the child had made significant gains in language production and comprehension development in both languages. Also, there were some increases in social interactions and decreases in the frequency of aberrant behaviors. The boy went from correctly answering 13 out of 24 administered items on the PPVT at Time 1 to a standard score of 81 on the PPVT at Time 4. Also, he was unable to complete the EVT at Time 1, but obtained a standard score of 105 on the EVT at Time 4 after 24 months of intervention. This study provides evidence that a child should be spoken in the cultural language that he lives with and the one he has heard since birth. Even though the results of this study are limited due to the small number of participants, this study supports that children with ASD can become bilingual and the practice of providing services in the primary language is needed when English is not the language used at home to establish a linguistic foundation of the primary language as well as second language (Seung et al., 2006).

A second study by Hambly and Fombonne (2012) examined the early language milestones and vocabulary size of children with autism living in either monolingual or bilingual environments. They recruited 75 families with children with autism, between 3 and 6 years of age, residing in Québec and Ontario, Canada. Assessments measures were available in French, English, Chinese, Farsi, Hebrew, Italian, Romanian, Spanish, and Tamil; therefore, only children who spoke one of these languages were recruited. Children were divided into three groups: 30 English monolinguals, 24 bilinguals who were exposed to a second language before 12 months of age, and 21 bilinguals who were exposed to a second language after 12 months of age. Eleven children were trilingual. Phone interviews were administered to families and included a detailed caregiver language history, specific questions from the Autism Diagnostic Interview-Revised (Le Couteur, Lord, & Rutter, 2003), and the Vineland Adaptive Behavior Scales-II (Sparrow, Cicchetti, & Balla, 2005); these measured an estimate of their child's language exposure and also described developmental history and current general function. Parents were also asked to finish questionnaires and diagnostic tests such as MCDI (Fenson et al., 1993) to measure vocabulary, Social Responsiveness Scale (SDS; Constantino, 2002), and Language Environment Interview (LEI).

The researchers found no significant difference on receptive and expressive language abilities and early language milestones between bilingually-exposed children with autism and the children with autism exposed to only one language. The only significant difference was shown in families in which mothers were not native speakers of the language they used with their children, and these children had significantly lower scores on both language and social measures. This means that reduced quality of input of language can negatively affect children's language learning outcomes. Hambly and Fombonne (2012) concluded that this study provides

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preliminary evidence that bilingual/multilingual environments do not contribute to additional delays in language development of children with ASD.

Another study by Petersen and colleagues (2012) also indicated that the language development of bilingual children with ASDs was not delayed in comparison to matched monolinguals with ASD. Researchers examined language development in 28 children diagnosed with ASD, 14 English-Chinese (Mandarin/Cantonese) bilingual and 14 English monolingual children. These children were between the ages of 3 ½ and 5 years of age, with a mean of almost 5 years of age. Various language assessments were used including PPVT-III (Dunn & Dunn, 1997), which assesses single word receptive vocabulary skills, the Preschool Language Scale-3 (PLS-3; Zimmerman, Steiner, & Pond, 1992), which measures receptive and expressive language skills, the Mullen Scales of Early Learning (MSEL; Mullen, 1995), which measures nonverbal IQ, and the Communication Development Inventories (CDI) both in English (Fenson et al., 1993) and Chinese (Tardif & Fletcher, 2008). The results of this study revealed that there were no differences between monolingual and bilingual groups on all measures. The bilingual group had even larger conceptual vocabulary sizes and English vocabulary sizes than the monolingual group. Consistent with the previous study by Hambly and Fombonne (2011), bilingual environments do not disadvantage language development of children with ASD (Petersen et al., 2012).

A recent study by Ohashi et al. (2012) also compared early language development between young monolingual and bilingual children with ASD. This study included 20 bilingually-exposed (BE) children and 40 monolingually-exposed (ME) children who matched with regard to both chronological age and nonverbal IQ score. While ME children had been exposed to only one language (either French or English) since birth, the BE group included

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children exposed to a variety of second languages, including Mi'kmaq, French, English, Croatian, Cantonese, Greek Urdu, Arabic, Italian, Spanish, Mandarin, Japanese, and Berbere. The mean age for BE children was 40.87 months and the mean age for ME children was 41.0 months. The results found that there is no significant difference between the bilingual and monolingual groups for age of first words and age of first phrases. In addition, this study found no differences across the bilingual and monolingual children on receptive language, expressive language, and functional communication abilities. Similar to the findings from previous studies (Hambly and Fombonne, 2012; Petersen et al., 2012), this study also supports that exposure to more than one language does not add an additional delay on language development of children with ASD.

To summarize, while there is only a limited amount of research on bilingualism and the ASD population, current studies support not only that children with ASD are able to become bilingual, but also that their language development is not harmed by being in a bilingual environment (Seung et al., 2006; Hambly & Fombonne, 2012; Petersen et al., 2012; Ohashi et al., 2012). Meanwhile, responsibility for preserving as well as development of the heritage language usually depends on the family, and in the United States, public schools rarely offer training in any languages other than English or Spanish at the K-12 level (Lee & Shin, 2008). Consequently, instead of imposing the use of a family's home language, clinicians should encourage parents/caregivers to continue speaking their native language to their children with ASD as well as to provide interventions that are delivered in children's home language in order to develop and improve speech output in children with ASD (Döpke, 2006).

Interventions

Music is a unique and multimodal stimulus that includes the processing of simultaneous visual, auditory, somatosensory, and motoric information; many neuroimaging studies have shown how experience in music (music making and intensive musical training) can not only engage multiple regions of the brain, but also produce modifications in brain structure and function (Wan, Rüber, Hohmann, & Schlaug, 2010a; Schlaug et al., 2009). For instance, it has been demonstrated that instrumental musicians have increased gray matter volume in the inferior frontal gyrus compared to non-musicians (Wan & Schlaug, 2010). Also, professional singers have a pronounced structural difference in the larger right arcuate fasciculus, a fiber bundle which connects auditory with motor regions, relative to healthy adults who may only occasionally sing (Wan et al., 2010b). Given the potential benefits of music making in inducing neural plasticity, emerging studies have demonstrated that music-based interventions can be used to facilitate speech output in individuals with acquired brain injuries (e.g., stroke, Parkinson's Disease) and neurodevelopmental disorders (e.g., autism) by using music as a valuable therapeutic tool (Wan et al., 2010b; Schlaug, Norton, Marchina, Zipase, & Wan, 2010; Wan et al., 2011).

Melodic Intonation Therapy

Melodic intonation therapy (MIT) is one of the well-known treatment methods for the speech rehabilitation of individuals who have Broca's aphasia (Albert et al., 1973; Baker & Tamplin, 2006; Thaut, 2005; Norton et al., 2009). Aphasia is an acquired communication disorder due to stroke or other brain injuries with damage to one or more parts of the brain that results in an impairment of language production and/or comprehension (Wan et al., 2010b;

National Aphasia Association, 2012). The location and extent of the brain damage or atrophy will determine the nature and severity of language dysfunction; accordingly, aphasia can be classified into various types. Broadly, aphasia can be classified into two types: fluent or nonfluent (Schlaug, Marchina, & Norton, 2008; Wan et al., 2010b). Fluent aphasia is often the result of damage to a lesion involving the posterior superior temporal lobe known as Wernicke's area. Patients with this form of aphasia may speak fluently in long, complex sentences but have no meaning to the listener, and are littered with jargon as well as incorrect syntactic. These patients typically have a prominent comprehension deficit. On the contrary, nonfluent aphasia, also known as expressive aphasia or Broca's aphasia, generally results from a lesion in the left frontal lobe, involving the posterior inferior frontal gyrus, known as Broca's area. Patients who are nonfluent tend to have relatively preserved comprehension of conversational speech, yet have marked impairments in speech production and articulation (Baker & Tamplin, 2006; Schlaug et al., 2008).

To facilitate recovery of language production in individuals with this Broca's aphasia, Albert, Spark, and Helm (1973) developed a music-based intervention, MIT, and demonstrated a report of its successful use in three chronic Broca's aphasics. These patients were able to produce intelligible, linguistically accurate words while singing, but not during speech. Unlike other speech therapies for this population, MIT contains two unique components: (1) intonation (singing) of words and phrases using a melodic contour that follows the prosody of speech, and (2) simultaneous rhythmic tapping of each syllable with the patient's unaffected hand. In addition to the musical elements, MIT requires an intense treatment up to 1.5 h/day, 5 days/week over a long period of time until the patient masters all three levels of MIT (Schlaug et al., 2008; Norton et al., 2009).

The effectiveness of MIT is derived from its use of these musical components, melody and rhythm, in the production of speech (Thaut, 2005). According to Schlaug, Marchina, and Norton (2009), the intonation (singing) component of MIT seemed to engage the right hemisphere, which has a dominant role in processing spectral information, global features of music and prosody. Also, the right hemisphere is more sensitive than the left hemisphere to the slow temporal features in acoustic signals. Even though singing and speaking both engage the frontotemporal cortices of both hemispheres, singing tends to show stronger right hemisphere activation than speaking. Therefore, the slower rate of articulation associated with intonation enhancing the prosodic and contour aspects of the stimulus may increase the involvement of the right hemisphere (Schlaug et al., 2009). In addition, the left hand rhythmic tapping serves as a metronome, which paces the speaker and provides continuous cueing for syllable production. It engages a right hemispheric sensorimotor network that controls both hand and articulatory movements (Schlaug et al., 2009). Also, the sound produced by hand tapping facilitates auditory-motor coupling, which is a critical component of meaningful vocal communication (Schlaug et al., 2008). Thus, the rationale of MIT is based on the use of melodic intonation and singing, which stimulates activation in the homologous language and speech-motor regions in the right hemisphere in order to assist the speech production of patients who are damaged with left-hemispheric lesions involving language-related regions (Thaut, 2005).

A few neuroimaging studies have shown the positive therapeutic effectiveness of using MIT in patients with nonfluent aphasia. A study by Schlaug and colleagues (2008) compared the efficacy of MIT with a control intervention, speech repetition therapy (SRT), on picture naming performance and measures of propositional speech for two patients with Broca's aphasia. The researchers also measured brain changes after the two therapies using functional magnetic

resonance imaging (fMRI). Patient #1 underwent 75 MIT-only sessions, and patient #2 underwent 40 sessions of SRT first and underwent additional 40 sessions of MIT that followed the SRT sessions. While MIT uses a simple form of singing and rhythm, SRT uses intensive repetition of a set of words and phrases without melodic intonation and rhythmic tapping. Following treatment, both interventions yielded significant improvement on measures of propositional speech and confrontational naming; however, patient #1, who only underwent MIT, presented greater improvement on all outcomes than patient #2. Also, fMRI showed that patient #1 showed greater activation and changes in a right-hemisphere network involving the premotor, inferior frontal, and temporal lobes while patient #2 had more involvement and changes in the left hemisphere consisting of the inferior pre- and post-central gyrus and the superior temporal gyrus. Thus, this study established the effectiveness of MIT in eliciting greater activity in right-hemispheric brain regions.

Furthermore, another study employing diffusion tensor imagining (DTI) has revealed that plasticity of white matter was evident in individuals with aphasia who underwent intensive MIT (Schlaug, et al., 2009). Schlaug and colleagues examined whether MIT leads to possible connectivity changes in white matter tracts, particularly the arcuate fasciculus (AF), which is a fiber bundle that connects the frontal and temporal hemisphere, and is known to play an important role in auditory-motor mapping (Schlaug et al., 2009). Researchers provided intensive MIT sessions 1.5 hour/day, five days a week for 75-80 days to six patients with moderate to chronic nonfluent aphasia. This DTI study revealed that all six patients showed increased numbers of fibers and overall size of the right AF after a course of MIT that improved language function. The more arcuate fasciculus fibers identified after melodic intonation therapy, the greater was the language improvement (Schlaug et al., 2009).

The findings have important implication that this highly structured and hierarchical intonation-based intervention with motor activity can effectively facilitate language production of patients with aphasia. Also, it not only results in increased activation in the right hemisphere but also increases functional connectivity (arcuate fasciculus) of language homologue regions in the right hemisphere as a function of response to treatment.

Auditory-Motor Mapping Training

As a variant of MIT, Wan and colleagues (2011) developed a new intonation-based intervention termed auditory-motor mapping training (AMMT) that is specifically designed to facilitate speech in children with autism (Wan et al., 2010a; 2010b; 2011). AMMT is based on the argument that dysfunction of a particular neural network, the mirror neuron system (MNS), might underlie some of the language deficits in autism (Wan et al., 2010a). The MNS was first discovered serendipitously in the macaque ventral premotor cortex (F5) as individual neurons in the brain that fired both when a macaque monkey observed an action and performed that action himself (Iacoboni & Dapretto, 2006). Over decades, researchers found that a homologue system is also present in humans in the corresponding region of the pars opercularis of the inferior frontal gyrus, which mainly overlaps with Broca's area. Other areas, such as the inferior parietal lobule and the superior temporal sulcus, are also understood to contain mirror neurons (Iacoboni & Dapretto, 2006; Wan & Schlaug, 2010; Wan et al., 2010b). These neurons are believed to play a central role in the understanding of actions and processing of language as well as in other social-cognitive processes including imitation, theory of mind, and empathy (Southgate & de C. Hamilton, 2008; Rizzolatti & Fabbri-Destro, 2010; Wan et al., 2010a,; 2011).

Wan et al. (2010a, 2010b) proposed that AMMT can help facilitate the acquisition of language skills via regions of the brain that overlap with this putative MNS system (Wan et al., 2010b, Wan, Landers, Norton, & Schlaug, 2012). AMMT includes three main components: (1) intonation of words and phrases, (2) motor activities, and (3) imitation. First, intonation seems to engage a bilateral reciprocal network between the frontal and temporal regions, which contains some components of MNS, more prominently than speaking (Wan et al., 2010a). Second, while it contains the motor activity feature of MIT, the AMMT protocol requires a set of percussion instrument (e.g., tuned drums) using both hands in rhythmic motor activity. This motor component (through playing an instrument) not only can capture a child's interest in therapy, but also engage or prime the sensorimotor network that controls orofacial and articulatory movements in speech (Wan & Schlaug, 2010; Wan et al., 2010b). Also, similar to MIT, the auditory feedback (the sound produced by the drums) in AMMT can facilitate the auditory-motor mapping that is significant to meaningful vocal communication (Wan et al., 2010a, 2010b). Therefore, this process (the perception of sounds with oral articulatory and motor actions) can engage and possibly strengthen language-related anatomical pathways such as the arcuate fasciculus and the uncinate fasciculus, which connect auditory and motor brain regions. Lastly, the benefit of imitation in expressive speech production is already apparent in MIT. According to Catmur et al., the human brain, including MNS, is capable of reorganization in response to intensive sensorimotor training (as cited in Wan et al., 2010a). AMMT consists of multiple repetitions where the child with ASD attends to the therapist's orofacial actions, and imitates the intoned phrases produced by the therapist with visual cues. This repetitive effect of imitation through visual, auditory, and motor representation can possibly engage brain regions including the temporal lobe, and posterior inferior and middle frontal regions that overlap with the putative

MNS (Wan et al., 2010a). This intensive and repetitive treatment can facilitate learning and modify responses in the mirror neuron system (Wan et al., 2010b; 2011).

A recent proof-of-concept study by Wan et al. (2011) demonstrated that AMMT had a significant therapeutic effect on the speech output of six children with autism who exhibited limited verbal abilities. All children (five boys and one girl) had formal autism diagnoses, and they were between 5 years 9 months to 8 years 9 months. Prior to AMMT treatment, all the children received at least two years of extensive speech therapy but had shown little progress. Each child received 40 one-on-one AMMT sessions over the eight-week period, with each session lasting 45 minutes. Employing a single-subject multiple baseline design, the consonant-vowel production of each child before treatment was compared with that monitored during treatment as well as during the follow-up after receiving the intervention. Results from this study indicated that all children made significant gains in their verbal production abilities as well as generalization to untrained items separate from the treatment context (Wan et al., 2011). Most importantly, these skills were maintained at 4 week and 8 week follow-ups.

Currently, Wan and colleagues are investigating a larger scale study of AMMT to examine whether AMMT produces superior results in comparison with a control therapy (CT), which is a nonintonation speech therapy treatment (Wan et al., 2012). Like AMMT, CT is designed to promote speech production; however, the two main components of AMMT, intonation and hand-motor activities, are absent. In this study, 10 minimally verbal children with ASD underwent one-on-one treatment 5 times per week for a total of 25 sessions. Additionally, researchers utilized DTI to investigate whether the language deficits in these minimally verbal children with ASD are due to abnormalities in certain language pathways of the brain. This study resulted in significantly greater improvements in speech production using AMMT relative to CT.

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Also, consistent with a previous study by Wan et al. (2011), generalization of items that were not trained during the therapy sessions was observed (Wan et al., 2012). Interestingly, results from the DTI study showed that both arcuate fasciculus and uncinate fasciculus, two major language-related tracts, were present in all minimally verbal children with ASD; however, reduced volume of the arcuate fasciculus was observed in the minimally verbal children with ASD compared to typically developing children, and no differences were observed in the uncinate fasciculus (Wan et al., 2012).

While previous studies using AMMT (Wan et al., 2011, 2012) successfully resulted in improving expressive speech in children with ASD, a few clarifications regarding AMMT need to be addressed. First, Wan et al. (2011) described all participants in their study as completely nonverbal, which is defined as having the complete absence of intelligible words; nonetheless, the data indicated that at baseline only two out of the six children seemed nonverbal, and the rest of the children actually had some percentage of consonant-vowel (CV) combinations at baseline. Also, in their next study, Wan et al. (2012) did not include the term "nonverbal" but changed the term to "minimally verbal" instead. Based on these observations, even though AMMT was initially developed to facilitate expressive speech for "nonverbal" children with ASD, this protocol can also be applied to children with autism who are already minimally verbal based on positive outcomes of studies by Wan et al. (2011, 2012). Second, it is worth stating that the inclusion criteria for AMMT require children who can exhibit sustained attention for long periods of time, follow one-step directions, and imitate.

Overall, although further research on AMMT is needed, the studies that focus on the use of AMMT in children with ASD appear very encouraging for adapting this intervention to bilingual populations. The cited studies provide an obvious foundation supporting the use of

music, especially intonation and rhythm, to improve expressive language abilities in minimally verbal children with autism (Wan et al., 2011, 2012). Thus, this study will examine the effect of adapted AMMT in Korean on facilitating speech output in a child with ASD who are from Korean/English bilingual environments.

Syllables and Pronunciation of Korean Language

In order to use AMMT method in Korean and measure Korean outcomes with children with ASD, the characteristics of Korean language should be considered. The Korean alphabet, also known as Hangeul (한글), is the native official alphabet of the Korean language. According to the National Institute of the Korean Language (n.d.), Hangeul is composed of forty phonic symbols. Twenty-one of these represent vowels (including thirteen diphthongs), and nineteen represent consonants. Like English, a combination of vowels and consonants creates a syllable in Korean. Every word in Korean initiates with a consonant and has a vowel; however, the sound of consonants can change when it appears at different locations of a word. Thus, there is a distinction between written (or underlying) syllables and spoken (or surface) syllable structure. The alterations in syllable structure and pronunciation that occur in the conversion from written to spoken forms are not random, but follow rigid pronunciation rules including a) resyllabification, b) neutralization, c) nasal assimilation, d) tensification, and e) consonant-cluster simplification (Sohn, 2006).

First, resyllabification applies to a consonant at the end of the first written syllable when this consonant is followed by a vowel or the fricative consonant h ㅎ at the beginning of the

second written syllable. The following examples show the merger of a stop consonant with a

following h ㅎ in resyllabification.

> Resyllabification
> Written   Spoken
> 책을 [chaek.eul]   →   채글 [chae.geul]   'book (object)'
> 대답해 [dae.dab.hae] →   대다패 [dae.da.pae] 'Answer!'

Second, the neutralization rule neutralizes the aspirates and tense consonants in the

(written) syllable-final position into the corresponding plain (lax) consonant in pronunciation.

> Neutralization
> a. ㅍ [p'] becomes ㅂ [p] in syllable-final position:
>   갚다 [gap'.da]   →   갑따 [gap.tta]   'to pay back'
> b. ㅋ[k'] and ㄲ [kk] become ㄱ [k] in syllable-final position:
>   부엌 [bu.eok']   →   부억 [bu.eok]   'kitchen'
>   밖 [bakk]   →   박 [bak]   'outside'
> c. ㅌ [t], ㅈ [j], ㅊ [ch], ㅅ [s], and ㅆ[ss] become ㄷ [t] in syllable-final position:
>   같다 [gat.da] →   갇따 [gat.tta]   'to be the same'
>   낮 [naj]   →   낟 [nat]   'daytime'
>   및 [mich]   →   믿 [mit]   'and'
>   곳 [gos]   →   곧 [got]   'place'
>   섰다 [seoss.da]→   섣따 [seot.tta]   'stood'

Third, the nasal assimilation rule changes a non-nasal consonant to a nasal before a nasal

consonant, on the one hand, and a nasal consonant to a lateral before a lateral consonant, on the

other. This is an assimilatory process occurring when adjacent sounds are produced in the same

place of articulation.

> Nasal assimilation
> a. Before ㅁ [m] or ㄴ [n], ㅂ [p] and ㅍ [p'] become ㅁ [m]; ㄷ [t], ㅌ [t'], ㅅ [s],
>   ㅆ [ss], ㅈ [j], ㅊ [ch'], ㅎ [h] become ㄴ [n]; ㄱ [k], ㅋ [k'], ㄲ [kk] become ㅇ
>   [ng]:
>   집문 [jip.mun]   →   짐문 [jim.mun]   'door of a house'
>   옷농 [os.nong]   →   온농 [on.nong]   'wardrobe'
>   학문 [hak.mun]   →   항문 [hang.mun]   'learning'
> b. Before ㄹ [l], ㄴ[n] becomes ㄹ [l]:
>   진리 [jin.ri]   →   질리 [jil.li]   'truth'

Fourth, the tensification rule changes a plain (lax) consonant to a corresponding tense one after a stop or a fricative sound other than ㅎ [h]. After ㅎ, a plain consonant and ㅎ merge to become a fricative sound, as in 낳다 [nah.da] → 나타 [na.t'a] 'to give birth' and 많다 [manh.da] → 만타 [man.t'a] 'to be many, much.' After a stop or a fricative other than ㅎ [h], ㄱ [k], ㄷ [t], ㅂ [p], ㅈ[j], and ㅅ[s] become the corresponding tense sounds.

학교 [hak.gyu]	→	학꾜 [hak.kkyu]	'school'
식당 [sik.dang]	→	식땅 [sik.ttang]	'restaurant'
낮잠 [naj.jam]	→	낟짬 [nat.jjam]	'nap'
밥상 [bab.sang]	→	밥쌍 [bap.ssang]	'dining table'

Fifth, the rule of consonant-cluster simplification drops one of the two syllable-final consonants before another consonant or in word-final position. The deleted consonant is the second one in the cluster except for a few cases (e.g., ㄻ → ㅁ, as in 굶다, ㅄ→ ㅂ, as in 값).

The alteration rules in syllable and pronunciation are followed by the standard Korean pronunciation. Therefore, this study will determine the effect of AMMT in Korean by measuring the number of correct consonant and correct vowels and diphthongs produced based on the pronunciation rules.

CHAPTER III: METHODOLOGY

Participants

Upon the approval by the Colorado State University Institutional Review Board for the protection of human subjects on September 5, 2013 (Appendix A), recruitment flyers (Appendix B) and word-of-mouth were utilized to recruit participants in the Tri-valley area, California where a large number of Koreans reside. The goal was to recruit, at most, five children with ASD between the ages of 5 and 9 who exhibit limited verbal abilities and live in Korean speaking home environments. As attention deficit disorder (ADD)/attention-deficit hyperactivity disorder (ADHD) is one of the commonly co-occurring conditions with children with ASD (Close, Li-Ching, Kaufmann, & Zimmerman, 2012), participants with the primary diagnosis of autism with or without secondary disparate disabilities (i.e., autism and ADD/ADHD) were not excluded from the current study. Other inclusion criteria included (a) negative report of other major medical conditions (i.e., deafness or blindness), (b) ability to sit in a chair for more than 15 minutes, (c) ability to imitate simple gross motor and oral motor movements (i.e., clapping hands, stomping feet, and opening mouth), and (d) ability to commit to three weekly treatments for the duration of the four weeks. Participants were not excluded based on gender and level of functioning.

A total of two participants were recruited to participate in the study (Table 1). Participant 1 was nine years and four months of age, and participant 2 was seven years and two months of age at the time of study ($M = 8.25$). Both participants had a formal diagnosis of autism as determined by a personal healthcare provider, and exhibited the following characteristics of autism including communication problems, social impairments, and repetitive and stereotyped

behaviors as identified by the American Psychiatric Association (2000). Participant 2 had a diagnosis of ADD in addition to ASD. Both participants were raised using Korean as primary home language. While participating in the current treatment, both participants continued with school programs, but did not participate in any other new treatment schedules. Prior to participant involvement, parents and participants were made aware of the procedure, limitations, and methodology that were used in the current study by signing the written informed consent (Appendix C) and the assent forms (Appendix D and E).

Table 1

Subject Characteristics

Subject	Gender	Age	Diagnosis	CARS score
1	Male	9:4	ASD	38; severe autism
2	Male	7:2	ASD, ADD	38.5; severe autism

Preparation

Prior to the initiation of this pilot study, the researcher met the parents of each participant separately at each participant's house to agree upon days and times of the treatment. Also, the researcher conducted a brief interview to obtain the participants' basic information such as age, the time of ASD diagnosis, medications, and other issues relating to ASD. The researcher also obtained overall level of functioning of each participant using a rank from Childhood Autism Rating Scale – Second Edition (CARS-2) (Schopler, Van Bourgondien, Wellman, & Love (2010), which is an assessment tool for children over the age of two for the possibility of autism. The resulting scores of CARS indicates whether the child falls in the normal, mild to moderate or severe autism range, and distinguishes autism from other diagnoses or developmental delays. The CARS-2 test scores of both participants fell under the category of severe autism (Table 1).

The research design of the current study was a pilot study to examine the effectiveness of auditory-motor mapping training (AMMT) conducted in Korean on improving Korean speech production in children with ASD. Over a four-week period, each participant took part in a total of nine AMMT sessions in addition to four assessments. During the first week, a baseline assessment was conducted for each child. Over the next three weeks, three treatments were performed at each week and a probe assessment was conducted after the last treatment of each week (Table 2).

All sessions were recorded and videotaped and data was collected on each participant's speech production abilities after every treatment and assessment. Two recruited independent coders, Korean and native Korean speakers, watched video from each treatment and assessment and transcribed to measure the number of correctly pronounced consonants and vowels. The mean percentage of data transcribed from both coders was used in the current study. All procedures of this study were provided in the home of each participant and conducted mainly in Korean but English was also spoken if necessary.

Table 2

Phases of Study

Week	Frequency		
Week 1	Baseline Assessment 1 (A1)		
Week 2	Treatment 1 (T1)	Treatment 2 (T2)	Treatment 3 (T3)/Probe Assessment 2 (A2)
Week 3	Treatment 4 (T4)	Treatment 5 (T5)	Treatment 6 (T6)/Probe Assessment 3 (A3)
Week 4	Treatment 7 (T7)	Treatment 8 (T8)	Treatment 9 (T9)/Probe Assessment 4 (A4)

Auditory-Motor Mapping Training Protocol

Each treatment lasted approximately 30 minutes which began with a "Hello Song" and concluded with a "Goodbye Song" to establish structure in the treatment environment. During

each therapy session and assessment, the participant was seated facing the therapist, and a set of

Roto Toms (6", 8", and 10") by Remo was placed between them, with each drum tuned to a

fixed pitch (one at C4 or 261.626 Hz, the middle one at E4 or 329.628 Hz, and the other at G4 or

391.995 Hz). A set of 10 flashcards with Boardmaker pictures (Mayer-Johnson Inc., Solana

Beach, CA, 2008) paired with words was used to train the participant consisting high-frequency

objects, actions, and social words or phrases in Korean (e.g., "crosswalk", "school", "wash

hands") relevant to the child's daily activities (Figure 1). These 10 flashcards were randomly

selected among 30 flashcards that were assigned for each week.

When introducing the pronunciation of each word/phrase in Korean, therapist strictly

adhered to the pronunciation rules described in Chapter II. Also, the therapist used Boardmaker

pictures as visual cues and introduced the target words or phrases by intoning (singing) the

words on two to three pitches, while simultaneously tapping the drums (on the same pitches), to

facilitate sound-motor mapping of both hands. Based on the AMMT protocol by Wan et al.

(2011), both participants at each individual session were led from listening, to unison production,

to partially-supported production, to immediate repetition, and finally to producing the target

word/phrase on his own (Table 3). Throughout the protocol, each step of AMMT was repeated a

number of times, depending on the child's progress toward mastery of the target words.

Assessments

During the first week, the researcher conducted two baseline assessments which were

identical to the steps of the treatment sessions. The current study used the averaged data from the

two baseline assessments as baseline data. As previously noted, three probe assessments were

also conducted after treatment session 3, 6, and 9. During each probe assessment a new set of

words/phrases that were not trained during the sessions of each week were used to measure both consonants and vowels of each child. Also, the probe assessment procedure was identical to the steps of AMMT protocol outlined in Table 3, but no practice, prompts, or feedback was allowed (Wan et al., 2011).

Table 3

Auditory-Motor Mapping Training Procedures (Wan et al., 2011)

Step	Procedure
1. Listening	Therapist introduces the target words or phrases by presenting a picture and then singing (intoning) the phrase at a rate of one syllable per second.
2. Unison production	Therapist and child intone the target phrase together. Therapist sings "Let's sing it together" and in unison with the child.
3. Partially-supported production	Therapist and child begin to intone the target phrase together, but halfway through the therapist fades out while the child continues to sing the rest of the phrase.
4. Immediate repetition	Therapist intones and taps the target phrase while the child listens. The child immediately repeats the phrase.
5. Own production	The child produces the target phrase on his/her own one more time.

Data Collection

Each child's speech production when presented with the picture stimuli was measured in all assessments and treatment sessions. All recorded treatments and assessments were transcribed offline by two individual coders. To minimize experimental bias, coders were blind as to which active treatment and assessment they were coding. For each target word/phrase, the child's utterances were transcribed and analyzed based on child's best production of the target word within a trial. To determine the number of vowels and consonants uttered correctly, the researcher used the s*tandard Korean dictionary* by the National Institute of the Korean Language as well as the *Naver Korean dictionary*. These dictionaries which follow the pronunciation rules of Korean were used in the transcriptions to capture variations in speech sounds.

Upon the completion of intervention, parents of both participants were asked to complete the descriptive questionnaire (Appendix F) in order to measure their perception about the intervention as well as language use with their child with autism.

Data Analysis

The current study was to measure the percentage of correctly uttered Korean consonants and vowels of each participant using the percentage of consonants correct-revised (PCC-R) and the percentage of vowels and diphthongs correct-revised (PVC-R). Prior to the data analysis, an alpha level of 0.05 was set to serve as the threshold for significance ($\alpha = 0.05$; $p < 0.05$). Data was coded separately by two independent coders.

Percentage Consonants Correct – Revised (PCC-R)

$$\frac{\text{\# C's correct}}{\text{\# C targets}} \times 100$$

Percentage Vowels & Diphthongs Correct – Revised (PVC-R)

$$\frac{\text{\# V's correct}}{\text{\# V targets}} \times 100$$

In order to examine inter-rater reliability, a Pearson's Correlation Coefficient was obtained by comparing two raters' proportions from probe assessments of the two subjects. Results from a Pearson's r data analysis revealed a strong positive correlation both for consonants [$r(8) = .771$, $p = 0.024$] and vowels [$r(8) = .750$, $p = 0.032$], indicating strong inter-rater reliability.

Each coders' raw scores were averaged together and then further analyzed using the Social Sciences (SPSS) PC for Windows Version 22 (SPSS, Inc., Chicago, IL), via Friedman's

Two-way Analysis of Variance, a non-parametric test used for testing the difference in treatment across two participants.

기타	쓰레기통	씻다	비누	반창고
지우개	치약	칫솔	횡단보도	형광펜
화살표	컴퓨터	배게	태극기	김치
옥수수	안경	피아노	지도	거북이
젓가락	무지개	그네	양파	멈추다

Figure 1. *Examples of Boardmaker Pictures in Korean Used in AMMT Sessions*

CHAPTER IV: RESULTS

Treatment Results

The present study examines the results from the Friedman's test conducted using SPSS software. As shown in Figure 2, participant 1 demonstrated an increase in overall speech production (both consonants and vowels) of 20% from the baseline assessment (A1) to AMMT treatment 9 (T9), and participant 2 displayed an overall increase of 26% in speech production from A1 to T9. The averaged data was analyzed utilizing a non-parametric Friedman test through SPSS statistical analysis to compare the effect of auditory-motor mapping training over the 4-week-period. The results from the Friedman test on the difference between a baseline assessment (A1) and treatment 9 (T9) revealed that the difference was not statistically significant, $\chi^2(9, N = 2) = 11.909$, $p = 0.219$ (Table 6).

Table 4

Averaged Raw Data for Participant 1 of Consonant-Vowel Production in AMMT Sessions

Session	Number of consonants correctly pronounced	Number of consonants presented	Number of vowels correctly pronounced	Number of vowels presented
T1	51	67	39	49
T2	22	37	20	27
T3	28	29	23	23
T4	33	39	28	30
T5	30	33	24	25
T6	31	33	22	25
T7	29	34	20	32
T8	31	31	21	22
T9	33	33	24	25

Table 5

Averaged Raw Data for Participant 2 of Consonant-Vowel Production in AMMT Sessions

Session	Number of consonants correctly pronounced	Number of consonants presented	Number of vowels correctly pronounced	Number of vowels presented
T1	55	86	52	67
T2	27	34	24	24
T3	27	41	25	29
T4	25	31	19	20
T5	21	27	21	21
T6	32	37	24	26
T7	27	34	22	24
T8	32	35	22	24
T9	34	36	25	25

Table 6

Friedman's Test Results on Difference between Baseline Assessment and Treatment

N	2
Chi-Square	11.909
df	9
Asymp. Sig.	.219

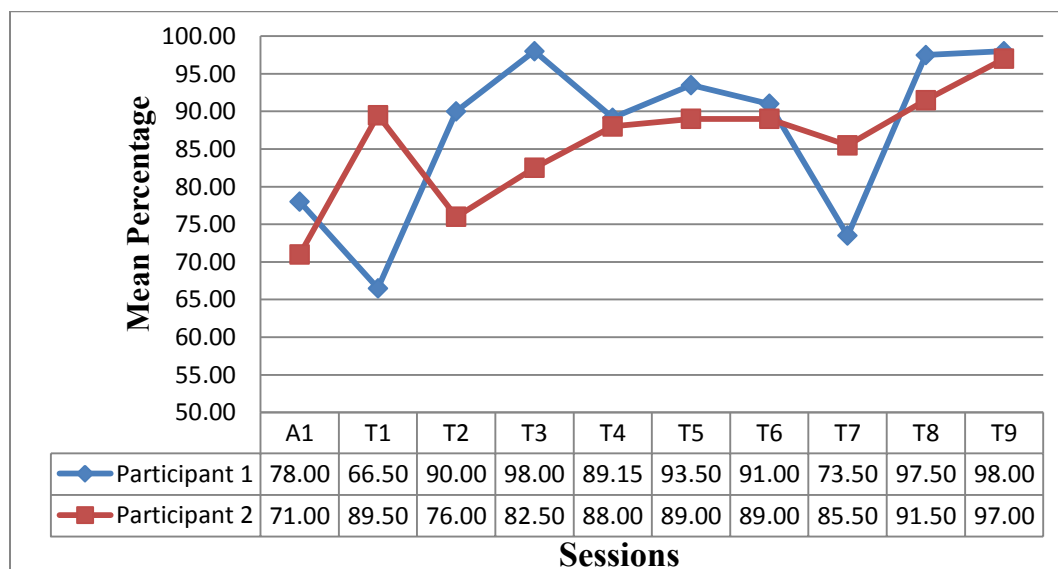|	A1	T1	T2	T3	T4	T5	T6	T7	T8	T9
Participant 1	78.00	66.50	90.00	98.00	89.15	93.50	91.00	73.50	97.50	98.00
Participant 2	71.00	89.50	76.00	82.50	88.00	89.00	89.00	85.50	91.50	97.00

Figure 2. Graphs of Each Participant's Verbal Production across AMMT Sessions (A1 = Baseline Assessment Time, T = Treatment Time)

Assessment Results

Table 7

Averaged Raw Data for Participant 1 of Consonant-Vowel Production across Assessments

Probe session	Number of consonants correctly pronounced	Number of consonants presented	Number of vowels correctly pronounced	Number of vowels presented
A1	51	67	39	49
A2	18	20	13	14
A3	25	29	22	22
A4	27	33	22	24

Table 8

Averaged Raw Data for Participant 2 of Consonant-Vowel Production across Assessments

Probe session	Number of consonants correctly pronounced	Number of consonants presented	Number of vowels correctly pronounced	Number of vowels presented
A1	55	86	52	67
A2	31	43	26	29
A3	28	32	22	22
A4	26	34	22	23

Table 7 and 8 also provide raw data for consonant-vowel production across assessments. The mean percentage of target words for each probe assessment can be found in Figure 3. A Freidman test was used to analyze the overall verbal production of consonants and vowels across the assessments. Results of the analysis indicate no significant difference between the four assessments, $\chi^2(9, N = 2) = 5.400$, $p = .145$ (Table 9).

Table 9

Results of Friedman's test across Assessments

N	2
Chi-Square	5.400
df	3
Asymp. Sig.	.145

	A1	A2	A3	A4
Participant 1	78.06	91.50	93.10	86.91
Participant 2	71.00	81.00	94.00	86.00
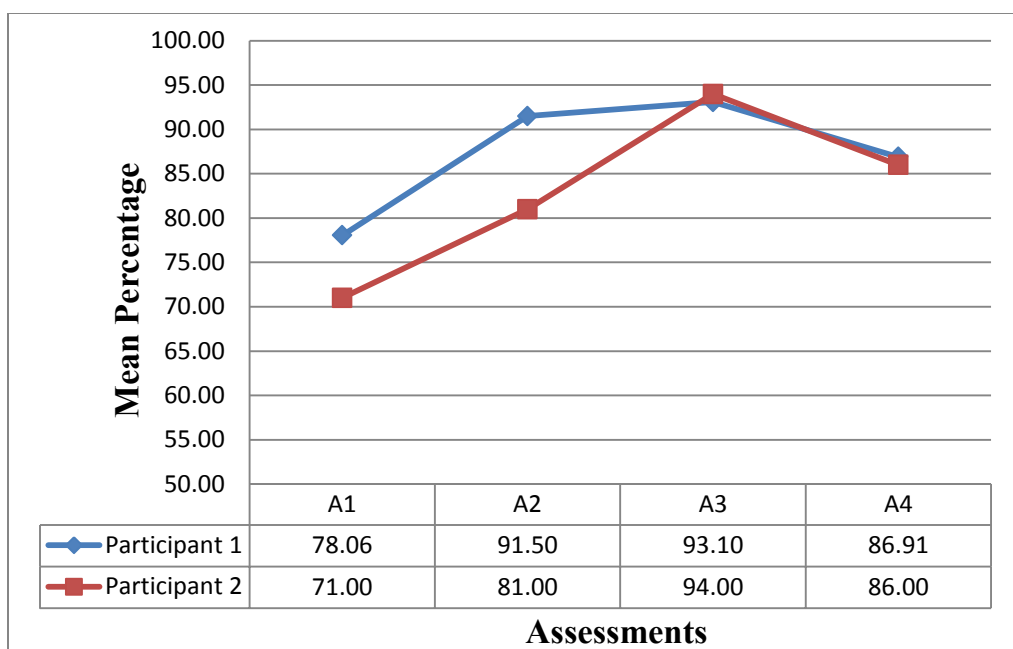
Figure 3. Graphs of Each Participant's Verbal Production across Assessments (A = assessment time)

Qualitative data collected through the post-intervention questionnaires completed by each participant's mother further indicated an encouraging experience for mothers of both participants. When asked if any changes were made to verbal output of their child with autism upon the completion of AMMT, participant 1's mother responded that her son's pronunciation in Korean sounds "much better and clearer." Participant 2's mother also noted that she noticed the improvements on her son's verbal intelligibility after participating in the intervention. Two mothers of each participant commonly mentioned that they were surprised that their children with autism were able to sit and follow AMMT steps. They also indicated that their child with autism enjoyed being with the therapist and in the session. Participant 1's mother said that their child even came downstairs from his room and waited until the therapist came. Participant 2's mother also mentioned that she was surprised to see that her child with autism listened and followed what the therapist said unlike how he did to his mother.

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When asked if auditory-motor mapping training has changed parents' perspective on bilingualism and their children with autism, both mothers of participant 1 and 2 stated that they are encouraged to teach and speak more Korean to their child with autism. Participant 1's mother did not teach Korean to her child due to limited verbal ability, but she stated that "now I feel that I can teach simple Korean words or phrases to him." Participant 2's mother tried her best to speak English only, which is the language their children learn at school, but she said "when I saw how well my child listened to the therapist and learned Korean words, I am encouraged to speak more Korean to my children." She further stated that she wishes that the music therapist can continue providing the intervention to her child with autism.

CHAPTER V: DISCUSSION

This study is the first to provide information about the effects of auditory-motor mapping training provided in Korean to two minimally verbal children with an autism spectrum disorder. Over a 4-week period, two participants with ASD attended nine AMMT sessions and four assessments in Korean conducted by a board-certified music therapist who was a native Korean speaker. CARS-2 scores were obtained by having a parent complete the assessment for each participant. The researcher first wanted to examine if AMMT would increase the verbal output of Korean in the participants who exhibit limited verbal abilities. The second questions posed whether or not this training would promote changing the perspective of the parents/caregivers on the bilingual ability of their children with ASD.

To answer the first research question, let us examine results from the Friedman's test. As shown in the results chapter, even though there was no statistical significance ($p = .219$) found by the Friedman test between the baseline assessment (A1) and last treatment (T9), both participants showed some improvements in their verbal production. As Figure 2 indicates, both participants showed an increase from the baseline assessment to treatment 9. In this time, participant 1 increased from 78% to 98% and participant 2 improved from 71% to 97%.

The first possible explanation for the results is the relationship between the level of verbal functioning of participants and the benefit of AMMT. The original protocol designed by Wan and colleagues (2011, 2012) produced significant improvements in the speech output of six children who ranged from non to minimally verbal, whereas the participants in the current study presented some level of verbal ability. Despite difficulties in communication, participant 1 exhibited some speaking ability and fluency with the presence of echolalia, which is the

immediate echoing or repetition of vocalization made by another person. In contrast, participant 2 did not exhibit echolalia and demonstrated more severe difficulty with speech intelligibility. Participant 2 showed greater improvements in speech output by improving the intelligibility of consonants and vowels after the AMMT sessions, which may indicate that children with low intelligibility can benefit from AMMT. Because AMMT (Wan et al., 2011) was originally designed to promote verbal output rather than fluency in functional communication, children with ASD who are already verbal at a high level, even with echolalia, may not fully gain benefits from the treatment. This suggests that clinicians interested in using AMMT for speech facilitation with this population should consider the child's level of speech.

The time when the treatment was performed is another factor that may have influenced the results of the current study. While each session for participant 2 was during the afternoon between 3:00 p.m. and 5:30 p.m., the time when participant 1 received the AMMT sessions varied. While some sessions (T2, T3, T5, T6, T8, and T9) were conducted between 2:00 p.m. and 5:00 p.m., sessions 1, 4, and 7 were scheduled and conducted at 7:30 p.m. at the request of the child's parents. Participant 1 easily lost concentration in the evening sessions and exhibited some physical and emotional frustration; therefore, the researcher had to soothe/humor the participant or pause the sessions to provide some time for the child to recover. These interruptions certainly reduced the child's verbal production as a result. Later, participant 1's mother reported that the child's regular bedtime was approximately 8:30pm, which was only 10 to 20 minutes after the completion of the sessions. An observable lower level of verbal production during sessions 1, 4, and 7 is shown in Figure 2. These findings indicate that researchers must consider the child's circadian rhythm (natural wake/sleep cycles) and offer the sessions at a similar time throughout the week for more consistent results.

Another important factor may have been the modification of the intensity and frequency of AMMT sessions. In the original protocol by Wan et al. (2011), six children with ASD received AMMT for 45 minutes/day, five days per week over an 8-week period. However, the participants in the current study participated in AMMT 30 minutes/day, three days per week over a 4-week period. The researcher intentionally decreased the length and frequency of treatment due to the limited attention span of these participants based on the observation prior to the intervention. While the usual AMMT session in the current study lasted 30 minutes, sessions including probe assessments lasted approximately 45 to 50 minutes. This still appeared to be too long for these young participants, especially participant 1 who exhibited emotional disturbances. Hence, the modifications of intensity and frequency of AMMT may have affected the results in the current study.

The participants' assessment scores showed no significant difference (Table 9); nonetheless, the results of the study demonstrated only a marginal increase in the children's vocal production of the untrained word/phrase set used in assessments. Participant 1 showed increases from 78% to 87% and participant 2 increased from 71% to 86% in their speech production between the baseline assessment and probe assessment (Figure 3). Due to the very small sample size, it is difficult to conclude that the participants' ability to speak improved; similarly, it is also not possible to conclude that a participant's use of new words and phrases improved as a result of treatment. However, both participants were able to learn the procedures of AMMT, which requires attention, inhibitory control, and imitation in order to produce the correct pronunciation of each target word/phrase.

The second research question aimed to understand, "Will AMMT have an effect on the parents' current perceptions of their children with autism and bilingualism?" The qualitative

information collected through the post-intervention questionnaire provides the answers to this question. The researcher found that the perspective of mothers of both participants on speaking Korean with their child with ASD had been changed. Due to their child's limited verbal abilities and restrictive recommendation, parents of both participants had intended to discontinue speaking Korean to the child and to speak only one language, English, which their child was exposed to at school. Their main concerns were that their child would become "confused" by being exposed to more than one language and that input should be "simplified" by using English only. However, after the observation of their child participating in AMMT, mothers of both participants felt that their child with autism has the capability not only to learn Korean but also understand the concept difference between English and Korean. As a result, the mothers commented that they are more encouraged to speak more Korean while maintaining to speak English.

Anecdotal Observations

Throughout the course of this study, the researcher recorded observations of the behavior of the two children with ASD. Although these participatory behaviors were not directly collected as data, they indicate that the use of drums and Boardmaker pictures were effective in encouraging participation by these children, which could be useful for future studies. Prior to each session both children showed interest in the drums and began playing them, even if they were not verbally instructed to do so. This observation supports observations from previous studies (Wan & Schlaug, 2010; Wan et al., 2010b; 2011) and suggests that musical instruments such as drums may be effective in gaining the attention of children with ASD and helping to facilitate active engagement. The researcher also noted that the participants pronounced target

words more accurately when presented with Boardmaker pictures. According to the parents, neither child had been fully trained to read the written form of Korean words/phrases; however, the Boardmaker pictures were used, the children pronounced each word more correctly than when they were not, in spite of their limited reading ability in Korean. This observation suggests that the combination of picture and word visual cues may be more effective in obtaining the attention of children with ASD and facilitating active verbal production.

Limitations of the Current Study/ Recommendation for Future Study

There were several limitations in the current study, including sample size, medication control, research design, appropriate assessment tools, and the instrument used for the study.

First and foremost, one obvious limitation was related to the sample size. The current study contained a very small number of participants (N = 2), which drastically reduced the power of the statistical analyses. Although there were some positive trends towards improving verbal output of Korean children with ASD, the small sample size affects the external validity and limits possibilities for generalization. Further complicating this issue, persons with autism display a wide spectrum of behaviors and abilities, making the generalizing any findings difficult. Therefore, if the current study is replicated, the use of a larger sample size is recommended and the researchers should attempt to recruit participants with a similar level of verbal ability.

Second, there was a lack of medication control due to ethical consideration which could have been confounding factors. Some results might have been influenced by the types of medications or (medication) ON/OFF states. For instance, participant 2 was on ADD medication (Focalin) during session 6 and 8 as reported by his mother. Normally, the child takes the medication in the beginning of day before attending school and the effect is known to last

approximately 5-6 hours. Even though the treatment was conducted in the late afternoons when the effect of medication is supposed to be low, there might be some influence on the results of the study. To avoid these confounding variables, future studies should consider controlling medication intake during the treatment period if possible or for best result, excluding children who have multiple diagnoses.

Another factor that could have affected the results was the research design. The current study utilized a pilot study using a single subject design, which allows each participant to serve as his or her own control. However, this design does not allow for comparisons between experimental and control groups. Even if the sample size had been larger, and/or if the result proved to be statistically significant, the fact that there was no control or alternative treatment group would have made the internal validity weak, and it would be impossible to conclude anything beyond whether or not AMMT improved the verbal output of the children in the study. The addition of a control group would have allowed the researcher to see how the verbal output of the children would have differed with no music.

Other limitations were related to the instrument used in the current study, which could have also impacted the results. First, problems emerged during AMMT treatment sessions. Both participants had difficulty hearing the researcher's voice while simultaneously tapping the drums and singing together. The auditory feedback produced by the Roto Toms was loud, which made both participants difficult to hear, and they started to produce the wrong pronunciation during the treatment procedure. Often, the researcher had to pause tapping the drums and re-pronounce in order to correct participant's pronunciation. Secondly, both participants showed frustration tapping the drums with their hands due to the metal frame of the Roto Toms. When the children became extremely frustrated from drumming, they refused to participate and showed emotional

disturbances such as crying, so the researcher had to provide mallets to the participants in order to continue with the procedure. Future studies may utilize another type of tunable drum made with a soft animal skin drumhead without a metal frame so that it is not too loud and can be more easily played by hand.

Summary and Conclusion

At present, there are limited available interventions that specifically aim to promote speech production of native languages in children with autism who come from a non-English speaking home environment. The current pilot study attempted to examine if an evidence-based intervention called auditory-motor mapping training is an appropriate technique for improving Korean verbal output in children with autism. The results from the present study do not conclusively suggest that using AMMT to improve verbal output of children with ASD is successful. While the sample size was very small and there were not significant results by any of the measures taken, there is enough anecdotal evidence to warrant further study. Further research could include a larger sample size, exclusion of children with multiple diagnoses, and further modifications to the use of instruments as well as the AMMT technique in order to make the technique more appropriate for small children.

If the present study can be replicated in a large-scale study and include an appropriate control group with better results, there are a number of potential treatment implications for children with autism who grew up in non-English speaking environment. One such implication is the possibility of conducting AMMT at home by parents/caregivers of the children with ASD. Because the AMMT procedure is not complicated, parents/caregivers can easily implement it using real objects instead of using Boardmaker pictures not only to teach the words but also to

facilitate verbal production by the child. This could also lead to more interaction between the parent and the child. Another implication is that the AMMT protocol in Korean used in this current study could be utilized by Korean music therapists, educators, and parents who are in Korea. As long as they strictly adhere to the fundamental mechanisms, intonation and motor activities, this protocol could be used with Korean children with ASD.

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APPENDIX A: HUMAN SUBJECTS APPROVAL

Colorado State University
Knowledge to Go Places

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	September 05, 2013
TO:	Lagasse, Blythe, Music, Theatre, and Dance
	Queen, Todd, Music, Theatre, and Dance, Kim, HaeSun, Music, Theatre, and Dance
FROM:	Barker, Janell, Coordinator, CSU IRB 2
PROTOCOL TITLE:	The Effect of Auditory-Motor Mapping Training in Korean on the Speech Output of Children with Autism
FUNDING SOURCE:	NONE
PROTOCOL NUMBER:	13-4374H
APPROVAL PERIOD:	Approval Date: September 03, 2013 Expiration Date: August 15, 2014

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: The Effect of Auditory-Motor Mapping Training in Korean on the Speech Output of Children with Autism. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Colostate.edu

Barker, Janell

Janell Barker

Barker, Janell

Approval is to recruit up to 5 participants aged 5-9 with the approved parental consent and child assent. The above-referenced project was approved by the Institutional Review Board with the condition that the approved consent form is signed by the participants and each subject is given a copy of the form. NO changes may be made to these documents without first obtaining the approval of the Committee. Subjects under the age of 18 years old must obtain parental permission. NOTE: Please submit the letter/email of cooperation from the Contra Costa School District when available. This can be submitted as an amendment via eProtocol. Recruitment cannot begin until the researchers have received this approval. The IRB found that this protocol involves no greater than minimal risk to children and criteria for §45 CFR 46.404 (Research not involving greater than minimal risk) have been met.

Approval Period:	September 03, 2013 through August 15, 2014
Review Type:	EXPEDITED
IRB Number:	00000202

[Volunteer] Wanted for a Research Study

Department of Neurologic Music Therapy

This research will examine the effectiveness of an intonation-based treatment called Auditory-Motor Mapping Training in Korean on the verbal output of minimally verbal children with autism, who live in a Korean-speaking home environment.

WHO IS ELIGIBLE?
- Child with a diagnosis of Autism Spectrum Disorder (ASD)
- Child who lives in a Korean-speaking home environment
- Child who exhibit no to limited verbal ability
- Ages 5 – 9

WHAT WILL YOUR CHLID BE ASKED TO DO?
If you decided to have your child take part in the research, your child will take part in nine sessions of Auditory-Motor Mapping Training 3 times per week, over a 4-week period, in addition to two baseline assessments.

BENEFITS
Study treatment will be provided at no charge.

COMPENSATION
Participants will receive two vouchers for complementary music therapy sessions led by a qualified music therapist.

**If you have any questions or are interested
in participating, please contact:**

Investigator, Hae Sun Kim (MT-BC) at (714)795-7889 or
email hskim.mt@gmail.com

*The principle researcher for this study is
Dr. Blythe Lagasse (Ph.D., MT-BC) at Colorado State University.*

Consent to Participate in a Research Study
Colorado State University

TITLE OF STUDY: The Effect of Auditory-Motor Mapping training in Korean on the Speech Output of Minimally Verbal Children with Autism

PRINCIPAL INVESTIGATOR: Blythe Lagasse, Music, Ph.D., Theatre, and Dance, Email: Blythe.Lagasse@colostate.edu, Phone: 970-491-4042

CO-PRINCIPAL INVESTIGATOR: Hae Sun Kim, Music, Theatre, and Dance, graduate student, Email: hskim.mt@gmail.com, Phone: 714-795-7889

WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH? Your child is invited to participate in the research study because he or she is 5-9 years old, has a diagnosis of autism, exhibits communication difficulties, as well as lives in a Korean-speaking home environment.

WHO IS DOING THE STUDY? The research will be conducted by Hae Sun Kim, a board-certified music therapist with additional Neurologic Music Therapy training. This researcher is also a graduate student at Colorado State University. The researcher will also have assistance from Dr. Blythe Lagasse, who is an assistant professor at Colorado State University. Other people assisting the researcher will include two Korean coders who will transcribe offline child's utterances.

WHAT IS THE PURPOSE OF THIS STUDY? The researchers hope to discover if using a music-based intervention in Korean called, "Auditory-Motor Mapping Training," can improve speech of children with autism in a short time period.

WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST? This research study will take place at your home in San Ramon, CA. Your child will be asked to participate in 11 total sessions over a 4-week period. The first week will include two baseline assessments: first baseline assessment will take 50-60 minutes and second assessment will take 30 minutes. Treatment sessions will be conducted 3 days per week over the next 3 week period. During the treatment period, assessments will also take place after sessions 3, 6, and 9.

WHAT WILL I BE ASKED TO DO? Your child will be asked to participate in two baseline assessments and nine treatment sessions in addition to three ongoing assessments.
1. **Assessments**: During the first week of study, your child will undergo two baseline assessments prior to the treatment. First baseline assessment will last approximately 50-60 minutes and the researcher will obtain child's overall speech pattern using Childhood Autism Rating Scale (CARS) as well as the baseline of the child's vocal production. Second assessment will last no more than 30 minutes. Also, during the treatment sessions, your child will also take part in 3 ongoing assessments after sessions 3, 6, and 9. Each

assessment will last approximately 20 minutes. Procedures of the assessments will be identical to AMMT procedures except for no practice, prompt, or feedback.

2. **Treatment sessions**: In the second week, your child will undergo a total of nine treatment sessions, conducted 3 days per week over a 3 week period. Each session will last approximately 30 minutes, beginning with a "Hello Song" and ending with a "Goodbye Song". The child will be seated facing the therapist and a set of drums will be placed between them, with each drum tuned to a fixed pitch. During treatment, the set of 10 items of words/phrases which will be relevant to child's activities of daily living will be trained. The therapist will use Boardmaker pictures as visual cues and will introduce the words/phrases by singing the words on two to three pitches, while tapping the drums. AMMT procedures include five steps. The child will be led from passive listening to the therapist's singing, to unison singing with the therapist, to singing partially supported by the therapist, to immediate repetition after the therapist sings, and finally to producing the target word/phrase on his/her own. Each of the steps can be repeated many times, depending on the child's progress toward mastery of the words/phrases.

All sessions will be videotaped. Assessment sessions (both baseline and assessments) will be watched and transcribed by two independent coders who are Korean and native Korean speakers. Also, a recruited observer will watch 4 randomly selected videotaped sessions to monitor the therapist's adherence to the AMMT protocol. Therefore, a video camera will be mounted on top of a tripod facing the child in all session.

ARE THERE REASONS WHY I SHOULD NOT TAKE PART IN THIS STUDY? Your child should only participate in this study if he/she has been diagnosed with autism, speaks Korean as his/her primary language, shows no to limited verbal speaking, and is 5-9 years old.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS? There are no known risks or discomforts for your child by participating in this study; however, your child may experience stress as a result by engaging in a new experience. If your child seems frustrated or tired during the study or show any signs of distress (e.g., crying, verbal outburst, aggression, or self-stimulatory behaviors), the researcher will immediately stop the experiment and your child will be free to leave. It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

ARE THERE ANY BENEFITS FROM TAKING PART IN THIS STUDY? Your child may not directly benefit from participating in this study; however, the findings from the study could provide more understanding of the use of auditory-motor mapping training in a different language rather than English and possible application of auditory-motor mapping training in Korean as a treatment method for speech and language development for Korean children with autism.

DO I HAVE TO TAKE PART IN THE STUDY? Following your consent, participation of your child in this research remains voluntary. If you and your child decide to participate in the study, he/she may withdraw his/her consent and stop participating at any time without penalty or loss of benefits to which his/her is otherwise entitled.

WHO WILL SEE THE INFORMATION THAT I GIVE? We will make every effort to prevent anyone who is not on the research team from knowing that you gave us your information, or what that information is. Any data collected and video recorded will be kept on a password-protected computer, in a locked investigator's room and only the investigators, Hae Sun Kim and Blythe Lagasse, Ph.D., will have access to the data and video recordings. Participant will not be individually identified in any publication or presentation of research results. All digital files will be used for no other purpose, and upon completion of the study, all files will be discarded immediately.

You should know, however, that there are some circumstances in which we may have to show your information to other people. For example, the law may require us to show your information to a court OR to tell authorities if we believe you have abused a child, or you pose a danger to yourself or someone else. We may also be asked to share the research files for audit purposes with the CSU Institutional Review Board ethics committee, if necessary.

CAN MY TAKING PART IN THE STUDY END EARLY? The only reason that your child's participation in the study would end early is when your child fails to participate in all sessions.

WILL I RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY? Upon completion of the study, your child will receive two vouchers for complementary music therapy sessions led by a qualified music therapist.

WHAT IF I HAVE QUESTIONS? Before you decide whether to accept this invitation to take part in the study, please ask any questions that might come to mind now. Later, if you have questions about the study, you can contact the investigator, Hae Sun Kim, MT-BC at 714-795-7889. If you have any questions about your rights as a volunteer in this research, contact Janell Barker, Human Research Administrator at 970-491-1655. We will give you a copy of this consent form to take with you.

This consent form was approved by the CSU Institutional Review Board for the protection of human subjects in research on 9/3/13.

WHAT ELSE DO I NEED TO KNOW? Your signed consent forms give permission to the researcher, Hae Sun Kim,
(1) To access information regarding your child's score on Autism Rating Scale,
(2) Allow two recruited coders to watch videos of your child to transcribe his/her speech production, and
(3) Allow an observer to review your child's videos to monitor the fidelity of the treatment protocol.

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing 4 pages.

_____   _____
Signature of person agreeing to take part in the study   Date

_____
Printed name of person agreeing to take part in the study

_____   _____
Name of person providing information to participant   Date

_____
Signature of Research Staff

PARENTAL SIGNATURE FOR MINOR

As parent or guardian I authorize _____ (print name) to become a participant for the described research. The nature and general purpose of the project have been satisfactorily explained to me by _____ and I am satisfied that proper precautions will be observed.

_____
Minor's date of birth

_____
Parent/Guardian name (printed)

_____   _____
Parent/Guardian signature   Date

Hi!

My name is Hae Sun Kim and I am from Colorado State University. I want to talk to you about something I am doing called <u>research</u>. A research study is when someone collects a lot of information to learn more about something. My research is about how music can help children like you speak more and better. After I tell you about this research study, I will then ask you if you'd like to be in this research study or not.

If you decide to be in this research, you and I will have 11 music classes together over a month. During each class, I will show you pictures with words. You will first listen to me singing and then will sing together while playing drums. We are going to sing and learn different words and phrases! It will take about 30 minutes. Then during each class, I will videotape you to see you how you like the class with me. Don't worry! Your name won't be on the videotape, so no one will know what you did.

It will not help or hurt you if you are in this class. You won't get any gift for doing it. No one will be mad at you if you don't want to be in this study. If you want to be in this music class, tell me that. You can say "yes" now and you can change your mind later and it is still okay. Just let me know.

I will ask your parents if it is okay that you do this, too. If you want to be in this research, sign your name and write today's date on the line below.

안녕!

내 이름은 김혜선이고 나는 콜로라도 대학교에서 왔어. 선생님이 하고 있는 연구라는 것을 이야기 해주고 싶어. 연구는 어떤 사람이 어떤 것을 더 알기 위해 많은 정보를 얻는 것을 뜻해. 선생님 어떻게 하면 음악이 너와 같은 아이들이 말을 더 많이, 잘 할 수 있게 도와 줄 수 있는 지를 연구해. 그래서 선생님이 이 연구에 대해서 이야기한 후에 네가 선생님과 함께 이 연구에 참여 해 줄 수 있는지 물어보고 싶어.

만약 네가 이 연구를 한다고 결정하면, 선생님과 함께 한달 간 총 열한 번의 음악 수업을 하게 될 꺼야. 매 수업시간에 선생님이 단어가 쓰여진 그림들을 보여줄 꺼야. 선생님이 먼저 노래 하는 것을 네가 듣고 드럼을 치면서 함께 노래를 할 꺼야. 이렇게 노래 하면서 다양한 단어들을 배울 거고 한 수업이 약 30 분 정도 걸릴 거야. 그리고 매 수업 때 네가 선생님과 하는 수업을 어떻게 하는지 보기 위해 녹화를 할 거야. 하지만 걱정 마! 너 이름은 비디오 테이프에 나오지 않아서 다른 사람들은 알 지 못할 거야.

네가 이 수업에 참여해도 어떠한 나쁜 것도 없고 좋은 것도 없을 거야. 그리고 이 연구를 참여 해도 선물 같은 거 또한 받지 않을 꺼야. 네가 만약 이 연구에 참여 하기 싫다고 해도 정말 괜찮아. 아무도 화내지 않을 꺼야. 하지만 만약 네가 선생님과 함께 하는 이 음악 수업에 참여 하고 싶으면 선생님한테 말해줘. 지금 네가 한다고 하고 나중에 마음이 변해도 괜찮아. 선생님한테 알려주기만 하면 돼.

그리고 선생님이 너희 부모님께도 한번 여쭤 볼게. 만약 네가 이 연구에 참여 하고 싶다면, 밑에 이름과 오늘 날짜를 적어줘.

_____   _____
Printed Name of Child (아이 이름)   Date (날짜)

_____   _____
Signature of Researcher (연구자 서명)   Date (날짜)

Check which applies (to be completed by person conducting assent discussion):
☐ The child is capable of reading and understanding the assent form and has signed above as documentation of assent to take part in this study.
☐ The child is not capable of reading the assent form, however, the information was explained verbally to the child who signed above to acknowledge the verbal explanation and his/her assent to take part in this study.

Child Assent Script for Children under Age 7

My name is Hae Sun Kim and I'm a student at college. I am learning about how music can help kids like you to speak better. If you say it is okay, we will sing and play drums together. You don't have to if you don't want to. Is it okay if we do these things today?

안녕 내 이름은 김혜선이고 나는 대학원 학생이야. 난 어떻게 음악이 (학생이름) 같은 아이들이 더 말을 잘 할 수 있게 하는지 배우고 있어. 그래서 네가 괜찮으면 우리 같이 노래하고 드럼치자. 네가 하기 싫으면 안 해도 상관없어. 오늘 같이 할래?

To be completed by person conducting assent discussion:

☐ The assent information was explained verbally to the child. The child is capable of understanding the information and has verbally provided assent to take part in this study.

_____
Name of Child (Person obtaining assent records the child's name.)

_____
Name of Person Obtaining Assent (Print)   Date

_____
Signature of Person Obtaining Assent   Date

APPENDIX F: POST-INTERVENTION QUESTIONNAIRE

1. Do you feel as though auditory-motor mapping training had a positive influence on your child's verbal output?

2. What was the difference of your child you have noticed before and after the intervention?

3. Do you feel that the use of auditory-motor mapping training has changed your perspective on bilingualism and children with autism?

4. Do you have any additional comments or questions regarding the intervention?

APPENDIX G: POST-INTERVENTION QUESTIONNAIRE RESULTS

Participant 1's Mother

1. Do you feel as though auditory-motor mapping training had a positive influence on your child's verbal output?

   – Yes. When hearing how my child speaking with you (therapist) outside of his room, I could tell that his pronunciation got much better and clearer.

2. What was the difference of your child you have noticed before and after the intervention?

   – As you know, my child has a distinct preference of what he likes or dislikes. Prior to each session, I reminded him by saying, "music teacher is coming. Music teacher is coming." He then came downstairs from his room and waited for you (therapist) to come. He seemed to like you (therapist) and enjoy music and your class. He also has a very short attention span, but I was surprised to see that he actually sat and learned the Korean words with you for such a long period of time. Normally, he spends his time watching YouTube videos or playing kids games on computer, but when I saw him learning something new from you (therapist), I thought that 'he has grown up so much and can possibly learn things.' Until now, he did not receive any therapies because I thought that he was too young and it was best not to give him stress. Yet, now I feel that it is the time for him to learn something when watching how you (therapist) and he did.

3. Do you feel that the use of auditory-motor mapping training has changed your perspective on bilingualism and children with autism?

Yes. After hearing/seeing how you (therapist) did to my child over a month, I thought that I can possibly speak more Korean to him. I was surprised to know that he understands the difference between Korean and English. I never seriously tried to teach Korean to my child with autism because he was not really verbal anyway, but now I feel that I can teach simple Korean words or phrases to him.

4. Do you have any additional comments or questions regarding the intervention?

－ Thank you for your time and effort helping my child.

Participant 2's Mother

1. Do you feel as though auditory-motor mapping training had a positive influence on your child's verbal output?

   – Yes, definitely. It is very challenging for me to teach him anything because of his irritation. However, I noticed that he not only participated well with you (therapist) but also learned to say each Korean word correctly.

2. What was the difference of your child you have noticed before and after the intervention?

   – As you know, my child had a difficulty speaking with clear intelligibility whether it's Korean or English, so I heard that his teachers and friends at school had difficulty understanding what he says. I was grateful that this auditory-motor mapping training seemed to be helpful to make my child speaking with clearer intelligibility.

3. Do you feel that the use of auditory-motor mapping training has changed your perspective on bilingualism and children with autism?

   – Yes. I cannot say that it is only because of the use of AMMT, but I think that I can teach and speak more Korean to my child after seeing how you (therapist) did. Even though I knew that my ability in English was not good, I tried my best speaking only English to my children because that is the language they use at school. However, when I saw how well my child with autism listened to you (therapist) and learned from you; I was encouraged to speak more Korean to my child and his brother. Thank you!

4. Do you have any additional comments or questions regarding the intervention?

   – I wish you (therapist) can continue doing this class with my child. Thank you!