FORMAL MUSICAL EXPERIENCE IN INFANCY

EFFECTS OF FORMAL MUSICAL EXPERIENCE IN INFANCY ON MUSICAL, LINGUISTIC AND SOCIAL DEVELOPMENT

BY

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Preface

This thesis consists of studies that have been previously published or are under review for publication in scientific journals.

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Chapter 4 consists of the results of a study that has not yet been published or submitted for publication. The author of this present thesis is the primary author of this article and was responsible for experimental design and stimulus generation, data collection and analysis, and manuscript preparation.

Abstract

This thesis examines the effects of formal musical experience in infancy on musical, social and communicative development. Parents and care-givers have a wide-range of choices of activities and products for an enriched musical experience for their infants, yet prior to the studies in this thesis little was known of the effects of formal musical experience on development.

In chapter 1, I outline the introduction to my thesis. In Chapter 2, I examine the effects of Kindermusik training on rhythmic enculturation. Infants who participated in these classes demonstrated a heightened interest in rhythmic patterns but also showed a stronger preference for duple metrical patterns, indicating that musical classes for infants can accelerate the development of culture-specific metrical perception. In Chapter 3, I present results showing that infants who participate in active musical classes showed superior development of prelinguistic communicative gestures and social behaviour as compared to infants assigned to a passive musical experience. In Chapter 4 I examine the development of joint attention in infants assigned to active and passive musical experiences. Although no significant results were found, I suggest that either more sensitive measures or a longer period of study might well show differences between the groups.

Together these findings indicate that infants are able to engage in meaningful musical training when the developmentally appropriate pedagogical approach is used, and

that formal musical experience in infancy can enhance culture-specific musical acquisition as well as impact social and communication development.

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CHAPTER 1

GENERAL INTRODUCTION

Given that the human brain is most open to change early in development (Cratty, 1978; Greenough et al., 1987; Lewkowicz & Ghazanfar, 2009; Maurer & Werker, 2014; Scott et al., 2007; Striano, 1999), that infants are attracted to music (Gordon, 2003; Hannon & Trehub, 2005a; Trehub & Trainor, 1998; Trainor, 2005; Trainor & Hannon, 2007; Trainor & Hannon, 2013), and that music is an important part of the mother-infant bond (Trehub & Schellenberg, 1995; Trehub & Trainor, 1998), early directed- music classes have the potential for wide-ranging benefit. Interest in this area of music education has led to a varied range of pedagogical approaches, as well as the release of many CD and DVD projects directed at the parents of young children. Yet there is little empirical research on the effects of musical experience on infants. The purpose of this thesis is to look at the effects of different types of training on infants' development and to consider the effects of enculturation and experience on musical development, cognitive development, social development, and parent-infant bonding.

One question addresses enculturation, specifically, the effects of enriched musical experience on perceptual specialization for processing the rhythmic (Chapter 2) and pitch (Chapter 3) structures of Western music. A second question concerns the effects of formal musical experience in infancy on cognitive and social development (Chapters 3 and 4) as well as on joint attention (Chapter 4). In Chapters 3 and 4, I present results from the first empirical study with random assignment to different musical experience conditions to directly demonstrate that musical experience in infancy has effects on musical, language, cognitive, and social development.

Universals

Although there are some musical skills that require formal training, such as the ability to decipher musical notation, basic musical skills are acquired through exposure to music during everyday activities (Bigand & Poulin-Charronnat, 2006; Trainor, 2005), similarly to how language is acquired without formal instruction (Bhagwat & Casasola, 2014; Bredekamp & Copple, 1997; Elardo et al., 1977; Mehler et al., 1988; Menyuk et al., 1995). Music is an integral part of every known human society, past and present. Furthermore, every known society appears to have special songs for infants. Long before infants understand words, their mothers are communicating to them with music, calming them with lullabies and arousing them with play songs (Rock et al., 1999). Researchers have documented that adults can distinguish songs for infants from songs for adults, even when the songs are from foreign cultures (Trehub et al., 1993). In particular, songs for infants have specific characteristics such as simplicity of structure and narrow pitch range (Trehub & Trainor, 1998).

Singing to infants appears to serve important social-emotional functions. Aside from the structural characteristics of the music, mothers use a particular performance style with infants that includes a loving tone of voice and an improvisation style that is responsive to the infant's reactions (Trainor et al., 2000). Mothers sing differently to convey different emotions and caretaking goals, singing lullabies to sooth and calm infants and play songs to rouse and stimulate infants (Rock et al., 1999). Importantly, infants prefer infant-directed over non-infant-directed singing styles, particularly the high pitch and loving tone of the former (Trainor, 1996). Trehub and Nakata (2002) found that infant-directed song appears to have beneficial effects on mother-infant bonding and helps infants to distinguish their mother from other people. Thus, this shared interactive communication between mother and infant benefits social and emotional development.

Infant-parent interaction also affects language development and language acquisition appears to flourish in a rich visual and aural environment (Ingram, 1989). From birth, infants begin to recognize important sounds in their environment, such as their mother's voice (Menyuk et al., 1995). And infants become specialized for the speech sound categories of the language in their environment before one year of age (Kuhl et al., 2006; Werker & Tees, 2005).

Music is ubiquitous in the world of infants and many parents engage in infant-directed singing. Many toys aimed at infants have a musical component and there are numerous DVD and CD releases intended for use with the very young. Indeed the fast pace of contemporary life and the ready availability of media for infants may lead many parents to use recorded, synthesized music as a replacement for active musical engagement with their babies. On the other hand, there are numerous music classes for infants and their parents offered all over the world that may enhance parent-infant engagement. That infants are able to process music and that parents use music in social contexts leads to questions about the role of music in infant development and whether formal musical experience enhances musical, cognitive and social processing. It is therefore important to consider what is known about enculturation and infants' abilities to process rhythm, melody and pitch.

Rhythmic Development

The ability to process and understand rhythmic structure enables musicians to play and sing together and facilitates rhythmic movement in dance. The rhythm, defined as the sequence of sounds and silences, is given in the stimulus. However, when people listen to a musical rhythm, they also typically extract a regular beat structure, or pulse. Beats tend to fall on accented (e.g., longer or louder) notes. However, the beat is extracted by the brain and is not entirely given in the stimulus. The fact that the beat is constructed by the brain is evident in that a beat can still be felt when offbeat sounds are accented, as in syncopation. Indeed, a beat can even be felt at a point where there is actually no sound, depending on the previous context provided by the rhythm pattern. Regular beat patterns can be extracted at different related tempos, forming a metrical hierarchy. The metrical level at which one would tap in response to a musical stimulus is referred to as the *tactus*. Beats that are accented at one level (normally every second or third beat) carry on to the level below in the metrical hierarchy, such that the tempo (onset-to-onset time between beats) at the lower level is slower. Similarly, a beat at one level can be subdivided at a higher level of the hierarchy (again normally into two or three), such that the tempo at higher level is faster. Metrical structures in which accented beats at all levels are evenly spaced (whether every second or every third beat) are referred to as simple meters. Metrical structures where accented beats are not evenly spaced at one or more metrical level (e.g., where groups of two and three beats alternate) are referred to as complex meters.

Infants as young as 2 months are able to discriminate simple rhythmic patterns (Demany et al., 1977) and can discriminate the tempi of isochronous beat patterns (Baruch & Drake, 1997). By at least as young as 9-months, infants are able to detect changes in timing in sequences with strong metrical structures (Bergeson & Trehub, 2006). Infants can also distinguish metrical structures (Trainor, 2005) and they can integrate movement and auditory information in extracting the meter of ambiguous rhythms (Phillips-Silver & Trainor, 2005). Even newborns have been shown to be able to extract a regular beat structure from temporal patterns (Winkler et al., 2009).

Several recent studies have explored rhythmic abilities in non-human animals. For example, Patel et al. (2009) showed that cockatoos are able to synchronize sporadically with a beat. And Cook et al. (2013) have shown that sea lions can be trained to entrain to a beat. However, it appears that the closest genetic relatives to humans do not entrain to auditory beats (Merchant et al., 2015). Together these studies suggest that the ability to entrain movements to an auditory beat is relatively rare across species and may be restricted to vocal learning species (Patel & Iversen, 2014; Schachner, et al., 2009).

With respect to human infants, the particular metrical structures occurring in the music in the infant's environment affect the development of meter perception. Western adults, exposed predominantly to simple meters, are poor at detecting metrical changes in rhythm patterns with complex meters, whereas Macedonian adults are able to detect metrical changes in rhythm patterns with both simple and complex meters (Hannon & Trehub, 2005b). Hannon and Trehub (2005b) showed that at 6 months of age, North American infants discriminate metrical changes to music in both simple Western and complex Balkan meters, but by 12 months, infants are unable to detect changes in music with complex meters, but are able to with music in simple meters (Hannon & Trehub, 2005a, b). Thus, between 6 and 12 months of age, infants become specialized for the meters in the music of their culture. However, a period of plasticity extends beyond the point at which this perceptual narrowing or specialization for meter is seen in that brief exposure to patterns with complex meter at 12 months of age can reinstate sensitivity, whereas this is not the case for Western adults (Hannon & Trehub, 2005b). These studies underscore the powerful effects of enculturation on musical development and the fact that exposure, or lack thereof, to different metrical structures affects the development of rhythmic perception in infancy and has long-lasting effects into adulthood (Hannon & Trehub, 2005b, Hannon & Trainor, 2007).

Pitch, Melodic and Harmonic Development

Young infants develop some musical skills very early, including pitch discrimination, sensitivity to consonance, the ability to recognize melodies, and sensitivity to culture-specific scale knowledge (Trainor & Hannon, 2013; Trainor & He, 2013; Trainor & Unrau, 2012).

Pitch discrimination in infancy is important for the development of language and music skills. Even before they are able to speak, infants show sensitivity to the contours of speech that demonstrate some type of emotional meaning (Werker & McLeod, 1989). The contours of pitch also provide important clues that are helpful for discriminating vowels, (Trainor & Desjardins, 2002). Research in pre-natal development has shown that the auditory system begins to function by as early as 24 weeks (Parncutt, 2006). In terms of pitch discrimination, in the womb, it has been shown that a fetus responds to pitch changes of about an octave (Lecanuet et al., 2000). He et al. (2007) found that infants as young as 2 months of age responded to infrequent changes of a semitone in the pitch of piano tones. Two-month old infants are also able to recognize familiar melodies (Plantinga & Trainor, 2009). Somewhat older infants have been shown to be able to remember simple melodies for periods of weeks (Trainor, 2005) and to detect changes in melodic structure even when the melodies to be compared are transposed with respect to each other (Trainor & Trehub, 1992; Trehub et al., 1984).

Consonance, the musical term used to describe the agreeable effect of intervals such as an octave (1:2 ratio) or perfect fifth (2:3 ratio), is considered to be part of the foundation of Western music (Apel, 1979) and the preference for consonant as opposed to dissonant intervals could be considered a universal building block for music (Trainor et al., 2002). Although some other species such as non-human primates are able to discriminate consonance and dissonance, the fact that they do not show a preference for consonant intervals suggests that they may not have the cognitive capacity to appreciate music (McDermott & Hauser, 2007). Human infants, on the other hand, show a preference for consonant intervals over dissonant intervals from as young as 2 months of age (Trainor, Tsang, & Cheung, 2002). Because musical scales and harmonic structures are largely based on consonance principles, it is likely that this early sensitivity to consonance enables the learning of specific musical structures.

Although sensitivity to consonance and dissonance appears to develop early and to be universal across humans, different musical systems use different musical scales as the basis of their music. The basic scale pattern of Western music, the diatonic scale, consists of an arrangement of five whole tones (T; 1/6 octave) and two semitones (S; 1/12 octave): TTSTTTS. Starting on the note "C", the notes would be C D E F G A B C. This type of scale is generally known as a major scale. Minor scales are arranged using different patterns of whole tones and semitones, such as this example starting on A: TS TTTTS (e.g., A B C D E F G# A, known as "A minor harmonic"). Other types of scale patterns found in Western music include chromatic (using all twelve semitones), pentatonic (a five note scale such as C D F G A C) and whole tone (C D F# G# A# C) scales. Sensitivity to the scales used in the musical system(s) in one's culture (scale knowledge) is present by at least as young as age 4 years of age (Corrigall & Trainor, 2009, Corrigall & Trainor, 2014; Trainor, 2005). Infants were equally able to detect changes in unfamiliar Balinese and familiar Western scales (Lynch et al., 1990), whereas their parents performed better with changes in the Western scales. Lynch et al. (1990), suggest that infants are born with the potential to perceive scales from a variety of cultures but that enculturation gradually narrows and specializes this ability for the scales in the music the infant is exposed to.

A number of studies have looked at infants' understanding of melodic structure. Western adults find changed notes that go outside the key of a melody easier to detect than changes that remain in the key (Trainor & Trehub, 1992), indicating that they have implicit knowledge of Western key membership. Western infants, on the other hand, detect changed notes in a melody that remain within the key equally well as changes that go outside the key, indicating that they are not yet sensitive to Western key structure (Trainor & Trehub, 1992). Infants are also sensitive to pitch contour from an early age. For example, even when two melodies have been separated by a few seconds, infants still show the ability to detect changes in contour (Chang & Trehub, 1977). However, some intervals appear to be privileged, even for infants. For example, infants find it easier to determine whether two melodies beginning on different notes are the same or different if they are a perfect fifth apart compared to if they are a tritone apart (Schellenberg & Trehub, 1996).

The ability to process harmonic structure is a more sophisticated ability than key membership, requiring an understanding not only of key membership but also of how chords are built and the syntax of chord progressions. Trainor and Trehub (1994) showed that 7-year-olds but not 5-year-olds were able to process a melody according to its implied harmonic structure. Building on work by Schellenberg et al. (2005), Corrigall and Trainor (2009) showed that children as young as 4 years were able to rate melodic sequences ending on a tonic chord as sounding better than sequences ending on a subdominant chord. More recent work by Corrigall and Trainor (2014) found that four-year olds were sensitive to key membership and harmony suggesting that this knowledge is present in an implicit way before much formal musical experience has taken place, and suggests that investigation of how early these abilities develop would be of interest. One interesting finding with respect to early musical instruction is that young children's musical knowledge is affected by their musical experience. Corrigall and Trainor (2009) found that children taking music lessons performed significantly better than those not taking lessons, suggesting that formal musical training in pre-school children can result in improved sensitivity to harmonic structure.

Given that babies show distinct preferences for music and that they are developing culture-specific sensitivity within the first year makes it important to examine the effects and benefits of formal musical experience in infancy.

Benefits of Formal Music Training

Many studies have purported to show links between formal musical experience and non-musical skills. One distinction that needs to be made is between near and far transfer effects. Transfer in general occurs when learning in one domain enhances performance in another domain (Alexander & Murphy, 1992; Perkins & Saloman, 1992). Near transfer occurs when the two domains are similar, whereas far transfer occurs when learning in one domain affects processing in another seemingly unrelated domain. In terms of musical learning, for example, learning to recognize familiar melodic patterns could have a near transfer effect on another musical skill, such as rhythmic competency (Drake et al., 2000). On the other hand, examples of far transfer are improved discrimination of phonemes and intonation patterns in speech, or improved cognitive ability in general, as a result of musical training.

A number of studies have reported differences in cognitive ability and language development between young children taking music lessons as compared to those with no formal musical experience (Schellenberg, 2005; Trainor, 2005). Interest in the effects of music on cognitive abilities was brought to the attention of the general public in 1997 with the publication of a book on the "Mozart Effect" (Campbell, 1997). Campbell's book suggested that listening to the music of Mozart has effects on spatial- temporal reasoning, based on the results of a study by Rauscher et al. (1993). A popular conclusion of the book was that "Mozart made you smarter". Campbell marketed a popular series of recordings for parents to use with their infants. So widespread was the popularity of the ideas espoused in the book that in 1998 the governor of Georgia proposed that the state budget include a recording of classical music be provided to every child born in the state (Sack, 1998).

Since 1997 a number of researchers have questioned the "Mozart Effect" but the idea that listening to music can make you smarter still seems to be firmly entrenched in the public imagination. In some cases the "Mozart Effect" has been misinterpreted. Rauscher et al. 's (1993) study showed that the effects of listening to Mozart were temporary and not long lasting, but Campbell (1997) implied that they were long lasting. Schellenberg (2005) suggested that many reported short-term benefits of musical listening could be explained by music causing a temporary boost in mood. Lesiuk (2005) found that listening to music provided a positive mood change as well as enhanced perception during work and Twiss et al. (2006) found that older adults undergoing cardiovascular surgery suffered less anxiety if they listened to music, as compared to adults who did not. Furthermore, a recent study by Corrigall et al. (2013) found that individual differences in personality affect both who takes formal music lessons, as well as for how long. This study found that variability in personality traits are good predictors of whether a child will engage in musical training. Given these findings, it would be of interest for future research to explore these factors when studying musical training in infants and preschool-age children.

Schellenberg (2004) published the first study using random assignment to show in a causal manner that musical training could increase IQ. Specifically, he found greater increases in IQ scores in 6-year-old children taking music lessons, as compared to those taking drama lessons. These gains were found to be small but very reliable. A number of subsequent correlational studies have supported a link between musical and cognitive abilities (Franklin et al., 2008; Kang & Williamson, 2013; Schellenberg, 2005).

Some musical skills appear to be related to some language skills. For example, Kraus et al. (2014) found that preschool children who are able to entrain to a beat attain higher scores on tests of early language skills. Difficulties with beat synchronization have been linked to deficiencies in language skills (Corriveau & Goswami, 2009; Kaplan et al., 1998; Wolff, 2002). For example, Thomson and Goswami (2008) showed links between poor ability to keep a steady beat and problems with written language development in children with developmental dyslexia. Thompson et al. (2004) found that musical training appears to affect the ability to extract emotional meaning from speech prosody and studies by Magne et al. (2006) and Moreno et al. (2008) suggest that children who participate in musical activities show improvements in areas such as phonological awareness and linguistic pitch processing. Although there are fewer studies exploring links between musical training and reading ability, a study by Corrigall and Trainor (2011) found that although the length of musical training was not associated with word decoding skills, the length of training did predict reading comprehension performance, the number of hours that children spent reading each week and word decoding skills. However, earlier studies, such as those by Overy (2003) and Gromko (2005) found no effect of musical training on word-decoding ability. This is certainly an area in which further study is needed.

A common belief amongst educators is that musical ability affects mathematical skills; however, an examination of the literature shows that the link between these two areas is far from clear. A number of studies examining the link between musical training and math skills have been unable to find any support for this hypothesis (e.g., Costa-Giomi, 1999; Forgeard et al., 2008).

Other studies have looked at the relationship between early musical experience and executive function. Executive function enables the behaviour regulation, information retention and assists in problem solving. A study by Zuk et al. (2014) found that children with at least two years of private music instruction showed enhanced activation of the prefrontal cortex, reflective of differences in executive function, as compared to a group of children who did not study music. Given that other studies have shown similar links between musical training and executive function (Bugos et al., 2007; Moreno et al 2011; Skoe & Kraus, 2012), this is also an area worthy of further investigation, particularly to look at links between improved executive function and formal musical experience in infancy.

Other researchers have looked at the connection between music lessons and brain development. Gamma-band responses (30-100 Hz) reflect neuronal communication during focused attention and can be measured using electroencephalography (EEG). Gamma rhythms appear to be modulated by internal brain functions such as attention and working memory, in addition to direct sensory input (Jia & Kohn, 2011). Gamma-band activity reflects the processing of musical elements of an auditory stimulus, such as pitch and timbre (Bhattacharya, Petsche, & Pereda 2001). It has also been associated with the development of attention (Sokolov, 2002). In a study of 4 and 5-year-old children taking music lessons, Shahin et al. (2004) found that their ERP responses were similar to 6- to 8-year-old children not taking music lessons and that gamma band responses were present in the group studying music after one year of lessons. A study by Fujioka et al. (2006) found evidence of differences in auditory attention and memory processes in children engaging in formal music lessons as compared to those not involved in such experiences.

Infant Music Classes

Classes aimed at introducing infants and their parents to music can be found throughout the world. In evaluating how these classes function, it is important to remember that there is a great deal of variation in the content of the classes as well as in the quality of instruction. For example, the prerequisites required to teach these classes vary considerably, with some requiring formal musical training, others none at all. Training for some classes take place entirely on-line, others require participation in 4-5 daylong seminars. Most use a pre-packaged curriculum and support material, designed for specific age levels and are intended to be used in sessions lasting 12-15 weeks. Some of the most popular programs used in North America include Kindermusik, Music for Young Children, Musikgarten, Music Together and the Suzuki Early Childhood Education Program. We considered all of these classes in choosing the program to use in our study of the effects of early musical experience (Chapters 3 and 4).

Kindermusik was developed in Germany in the 1960's with the goal of introducing young children to music before they began formal musical instruction. The program offers structured classes from birth to age seven, and utilizes music, movement, listening and games. There are over 5,000 licensed Kindermusik instructors worldwide. The curriculum consists of 8 levels of instruction, typically presented over a 15-week term. Training for teachers is offered on-line, no previous musical training is required, and only an assessment of "vocal suitability" is required prior to beginning training. The curriculum is organized in modules that are offered in several units over the course of a term. In chapter 2 of this thesis, infants in a Kindermusik program were compared to those not taking music classes in Chapter 2 to evaluate the effects of increased exposure to simple Western rhythms (which are prominent in the music in the program) on the development of rhythm perception during infancy.

Dr. Lorna Lutz Heyge adapted and expanded upon Kindermusik curriculum, introducing it to North America in 1974, as “Musikgarten”. Teachers are licensed to use the curriculum after completing 17 hours of training. The training includes music for babies and toddlers, music for pre-school children, and group piano classes. To date there are no specific empirical research studies evaluating the effects of the program, although advertising includes a statement citing “experts” in the field of early childhood education. As with the teacher training for many of the programs, there is a strong emphasis in the workshops on demographics, marketing and business development.

Created in 1980 by Frances Balodis, “Music for Young Children” offers a curriculum that integrates keyboard, ear training, movement, music theory and composition for children ages 3-9. Prospective teachers require Royal Conservatory of Music (RCM) grade 8 piano or advanced piano skills, grade 2 RCM theory and a “natural, accurate singing voice”. Training is conducted in small groups over a 4- or 5-day period and the curriculum emphasizes that “… learning styles and needs are met through a multi-sensory approach. The understanding of music will expand into positive problem-solving skills, areas of self-expression, the growth of memory skills and will lead to excellent self-confidence and self-esteem."

Music Together has been offering classes for children from birth to age 7 since 1987. Seven teacher trainers train around 1,000 teachers each year, with an average of 20 participants per class. Classes take place over a three-day period and consist of lectures, with some smaller group work and a hands-on evaluation at the conclusion of the course. In addition to the initial training, Music Together provides skills workshops every semester, covering such topics as lesson planning, singing and dance. (Jenny Lantzer-Goings, personal communication, August 2012). Currently the only research on the program is an unpublished doctoral dissertation by Missy Strong focusing on how participating in a music program with a strong parent education component affected the families musical behaviour at home (Strong, 2012).

We rejected these programs for use in the research reported in Chapters 3 and 4 on the potential musical, cognitive and social effects of early music classes for a number of reasons, including the use of synthesized music, the lack of repetition of musical material and type of training required by the organization. It remains for future studies to examine the effectiveness of these various approaches.

We selected the Suzuki Early Childhood Education Program as the pedagogical approach to use in our test of the effects of musical training in infancy (Chapters 3 and 4). The strengths of this class include documentation of every step in learning so that parents become more aware of and engaged in the learning process, the use of high quality acoustic music, and the emphasis on the parent/teacher/infant three-way partnership. The Suzuki Early Childhood Education Program curriculum was developed by Dorothy Jones, a world renowned Suzuki specialist. Jones founded and directed a Suzuki School in London, Ontario, which was designated a world Teacher Training Centre for Suzuki Early Childhood Education (ECE) by the International Suzuki Association. Currently there are Suzuki ECE programs in Canada, the United States, Latin America, Switzerland, Australia, England, Japan, Denmark and Korea. Training is divided into several units, each lasting 5 days and consisting of 15 hours of coursework, along with observation time.

Parents and children (0-3 years of age) participate in a weekly interactive music class. Parents are encouraged to watch their infants develop rhythmic and melodic awareness, memory, and social skills. Teachers work with the parents to build a repertoire of lullabies, action songs and nursery rhymes. Parents are encouraged to use the curriculum CD at home and to repeat the songs and rhymes daily. Parents become expert observers of their own children, and the children watch the actions of the parent and teacher and gradually begin to imitate them. Desired outcomes according to Jones include increased vocabulary, development of socially acceptable behaviour and sensitive group participation at an early age (Jones, 2004). The classes are normally delivered with mixed age groups (0 to 4 years), under the assumption that older children learn sensitivity and benefit from opportunities to model for younger children, while younger children develop skills more quickly and securely with older children as models (Grilli, 1987).

Music Recordings and Musical Toys

Toys marketed at infants account for a large proportion of toy sales. According to the European Commission, in 2011, 0- to 14-year-olds made up approximately 26 % of the total global population compared to 35 % in 1980. The birth rate has declined to 19.5 per 1,000 in 2011 as compared to 21.8 in 2000. The toy industry has noted, "This trend reflects cultural and social changes towards smaller family sizes in both developed and developing markets." (European Commission Report, 2011). It appears that toy manufacturers ultimately worry that the declining numbers of children in core markets will constrain their growth prospects. Yet, in markets where the number of toys purchased has declined, the value per toy tends to be higher. One consequence of the overall downturn in birth rates in many countries is smaller household sizes and higher consumer expenditure per child, which in turn has led to more discretionary spending on non-essential products, especially toys and games. Since disposable income is a more important indicator for toy and game sales than demographics, the toy industry is looking to find growth through innovation, up-trading and pricing, especially in areas where disposable income is increasing.

A report from the United States Toy Industry Association states that world-wide sales of toys totalled $80.280 billion in 2009, with sales of over $21 billion in the U.S. alone. Sales reports for 2000 show 13% of worldwide toy sales were in the "infant/preschool" category (International Council of Toy Industries 2001). The European Commission reports that toy sales in 2009 were 15. 5 billion Euros, with sales of products aimed at infants and toddlers taking the largest percentile of the total sales at 20%. Sales figures in Canada reflect similar trends (Toy Industry Association of Canada, 2012).

The "Children's Music" genre represents a large and growing area in music sales. In 2008, the Nielsen SoundScan reports that sales of albums for babies and toddlers went from 12.3 million to 17.1 million units, a growth of 38%. Recent sales figures for digital downloads from Nielsen SoundScan show that children's music comprises 0.3 % of total sales in all genres and continues to grow. This figure may seem relatively small, but Nielsen estimates that digital downloads for this category is a growth opportunity, given that digital downloads continue to lead sales of actual "physical" units. (Nielsen, 2008). As well, high-profile artists such as *They Might Be Giants*, *Barenaked Ladies*, and *Medeski Martin & Wood* have attracted media attention with recent releases. These artists' creations for the children's market have been top sellers and in some cases have eclipsed sales of the bands' adult-oriented albums. Children's artists are recently showing up at the top of the sales charts for all music (Pampinella, 2009). A look at current Billboard magazine sales figures for "Children's Music" shows mostly albums produced by pop artists or the Walt Disney

Company. Although many of these recordings are marketed as being beneficial to children there is no research to back up this claim.

The multimedia line "Baby Einstein" produces some of the top selling CDs and DVDs that do not fit into the "pop" music category. The recordings are aimed at infants and toddlers, from birth to age 3 years, and explore classical music, art and poetry. Currently, these products are made by a division of the Walt Disney Company, which also pays a significant amount of money in royalties to the estate of Albert Einstein for the use of the name. The music albums feature renditions of works by popular classical composers that are played in a synthesized manner, without the use of musical expression or acoustic instruments. Complaints against the company in 2006 by the group "Campaign for a Commercial-Free Childhood" to the U.S. Federal Trade Commission alleged false advertising over the Disney Company's claims regarding the benefits of the Baby Einstein videos. The complaint was dismissed in 2007, after the redesign of the Baby Einstein website, which removed certain product testimonials and product descriptions, as well as the company's representations that it would take steps to ensure that any advertising claims with respect to educational and developmental value would be properly substantiated. It should be noted, however, that the websites of Baby Einstein in languages other than English are not all modified in the same way. For example, its official Chinese website still contains the product effect statement "For example, the *Baby Van Gogh* released by us can initiate your baby's interest and recognition of colors".

A study by Zimmerman et al. (2007) on the effects of television and DVD viewing on language development in children under 2 years of age found that among infants aged 8 to 16 months, exposure to "baby DVDs/videos" — such as *Baby Einstein* and *Brainy Baby* — was strongly associated with lower scores on the Communicative Development Inventory, a standardized language development test. This result was specific to baby-oriented educational videos and did not test other types of media, or effects of shared parent/child viewing. Among toddlers aged 17 to 24 months, the study found no significant effects, either negative or positive, for any of the forms of Baby Einstein media that were viewed. Parent/child daily reading and storytelling, however, were found to be associated with somewhat higher language scores, especially for toddlers. Listening to music in the absence of active participation, on the other hand, had no significant effect. A press release from the University of Washington on the study explained that "for each hour-per-day spent watching baby DVDs/videos, infants understood on average six to eight fewer words than infants who did not watch them", and recommended that "parents limit their use" (University of Washington, 2007). Following the release of the study, the Walt Disney Company demanded that the University of Washington retract the press release, a demand that was rejected by the University. A subsequent study noted that that television viewing is, "neither beneficial nor deleterious to child cognitive and language abilities" for children under 2" (Schmidt et al., 2009). In September 2009, the Walt Disney Company announced that it would offer a refund for all Baby Einstein DVDs/videos purchased between June 5, 2004 and September 4, 2009. This information on toy and music sales in North America helped me to choose what type of music would be used in the control group in Chapter 3.

Summary of Thesis Contributions

Using empirical methods to study the effects of formal musical training on infants has enabled me to make contributions to the field of music perception and cognition, as well as the field of music education.

With respect to the field of music perception and cognition, in Chapter 2, I provide evidence that formal musical training in infancy affects the perception of meter and how it is specifically biased by the choice of music. In Chapter 3, I provide evidence for effects of early musical training on the development of music, language, and social skills. In Chapter 4, I attempt to examine the social effects of early musical experience further by measuring early development of joint attention.

For the field of music education, my work provides educators with valuable information on the effects of very early musical training, and suggestions on optimal pedagogical practice.

Outline of Empirical Chapters

Chapter 2, ***Musical Experience and Enculturation to Musical Meters,*** contains a paper published in *Developmental Science* demonstrating the effects of Kindermusik classes on beat perception in 7-month-old infants (Gerry, Faux, & Trainor, 2010). This study shows how formal musical experience may accelerate the development of culture-specific metrical perception in infants.

Chapter 3, ***Effects of Musical Training in Musical, Cognitive and Social Development,*** contains a paper published in *Developmental Science* (Gerry, Unrau, & Trainor, 2012). This study was the first to show the effects of 6 months of formal musical experience on musical, language and social development using random assignment to experimental conditions.

Chapter 4 ***Formal Musical Experience and the Development of Joint Attention*** ***,*** contains a third empirical paper attempting to examine the effects of musical training in infancy on the development of joint attention. This study tested the same infants as in Chapter 3.

CHAPTER 2

Effects of Kindermusik training on infants' rhythmic enculturation

INTRODUCTION

In this chapter, I provide empirical evidence for effects of musical experience on enculturation to musical meters. This paper is published: Gerry, D. W., Faux, A. L, & Trainor, L. J. (2010). Effects of Kindermusik training on infants' rhythmic enculturation. *Developmental Science, 13*, 545-551*.*

The ability to perceive rhythmic structure and appreciate metrical structure is important for musicians to be able to perform effectively and for non-musicians to be able to appreciate music (Hannon & Trehub, 2005b). Movement has also been shown to have an important relationship with the ability to perceive rhythmic structure. Phillips-Silver and Trainor (2005) demonstrated that body movement could help infants to infer the meter of ambiguous auditory rhythmic patterns. The movement could substitute for auditory accents in the extraction of the underlying metrical structure. Sensitive periods during development across a wide range of auditory and visual stimuli, such as faces and speech sounds, ensure that perceptual narrowing (the process whereby experience and input shape perceptual abilities) results in improved perception for stimuli that are encountered frequently in the environment, and less sensitivity to stimuli not encountered frequently (Maurer & Werker, 2014). Hannon and Trehub (2005b) showed that North American infants are able to detect changes in Bulgarian, Macedonian and Western rhythmic patterns at 6 months of age, but that at 11 months North American infants are only able to detect changes in Western patterns, suggesting that there are sensitive periods for the development of rhythmic perception as well.

Here we investigate the effects of Kindermusik training on the same protocol as Phillips-Silver and Trainor and demonstrate that formal musical experience in infancy can accelerate enculturation to the metrical structure prevalent in the music they are hearing.

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Developmental Science

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PAPER

Effects of Kindermusik training on infants' rhythmic enculturation

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Abstract

Phillips-Silver and Trainor (2005) demonstrated a link between movement and the metrical interpretation of rhythm patterns in 7-month-old infants. Infants bounced on every second beat of a rhythmic pattern with no auditory accents later preferred to listen to an accented version of the pattern with accents every second beat (duple or march meter), whereas infants bounced on every third beat of the same rhythmic pattern preferred to listen to a version with accents every third beat (triple or waltz meter). The present study compared infants participating in Kindermusik classes with infants not participating in music classes. In Kindermusik classes infants receive enriched experience moving to music. Following Western musical norms, the majority of the music samples in the classes are in duple meter. During the preference test, Kindermusik infants listened longer overall, indicating heightened interest in musical rhythms. Both groups listened longer to the accented version that matched how they had been bounced, but only the Kindermusik group showed a stronger preference in the case of duple bouncing than in the case of triple bouncing. We conclude that musical classes for infants can accelerate the development of culture-specific metrical perception.

Introduction

In many domains infants are initially open to a wide variety of perceptual organizations, but through exposure to the forms of a particular culture, their perceptual organization narrows to become specialized for the forms of their culture. We refer to this process as enculturation. For example, young infants readily discriminate phonemes from categories found in any language, but before the end of the first year preferentially process the categories of the language of their culture (Werker & Tees, 2005). In the visual domain, face processing becomes better for human over animal faces, and for faces of one's own race over foreign faces (Pascalis, de Haan & Nelson, 2002; Kelly, Quinn, Slater, Lee, Ge & Pascalis, 2008).

In the musical domain, some aspects of infants' early perception are quite sophisticated (Trehub & Hannon, 2006). Infants, like adults, prefer consonant intervals over dissonant intervals (Trainor & Heinmiller, 1998; Trainor, Tsang & Cheung, 2002), remember simple melodies over days or weeks (Saffran, Loman & Robertson, 2000; Plantinga & Trainor, 2005), discriminate rhythm patterns (Demany, McKenzie & Vurpillot, 1977), recognize rhythmic patterns across variation in tempo (Trehub & Thorpe, 1989; Baruch & Drake, 1997), distinguish metrical structures (Hannon & Trehub, 2005a), and extract the meter of ambiguous rhythms through the integration of movement and auditory information (Phillips-Silver & Trainor, 2005). On the other hand, it takes considerable exposure to a musical system before enculturation occurs to the pitch structure of its scales and harmony (Trainor, 2005; Trainor & Trehub, 1992, 1994). In the present paper we investigate enculturation in rhythmic acquisition, asking whether enriched multisensory experience with Western music and movement, as found in Kindermusik training, accelerates infants' bias for preferential processing of common rhythms in Western music.

Rhythm has two components: the *rhythm pattern* itself, that is, the sequence of sound events and silences, and the *metrical structure*, or underlying beat (Lerdahl & Jackendoff, 1983; London, 2004). Metrical structure is not directly present in the stimulus, but is extracted perceptually from the rhythm pattern. Metrical structure is hierarchically organized, with accented beats typically occurring at regular intervals. For example, at one level of the hierarchy every second beat might be accented; at the next level, every fourth beat might be accented. Intuitively, the metrical structure is what you would tap your foot to and it continues in a regular way whether or not there are sound events on every beat.

A number of researchers have noted close connections between musical rhythm and movement (Brown & Parsons, 2008; Cross, 2003; Phillips-Silver & Trainor,

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2005, 2007, 2008; Todd, Cousins & Lee, 2007; Trainor, 2008; Zatorre, Chen & Penhune, 2007). Several pedagogical approaches to teaching musical rhythm are based on the belief that metrical structure must first be felt in terms of rhythmic body movements, which can then be transferred to sound perception and production. The Swiss educator Jacques Dalcroze believed that sensitivity to rhythm and beat in music could be developed by structured and improvised movement to music (Dalcroze, 1967). He developed Eurhythmics ('good rhythm') training, which promotes multisensory musical processing and an emphasis on physical awareness while experiencing music.

Western music typically uses simple metrical structures, with accents occurring either every second beat (duple rhythm), as in a march, or every third beat (triple rhythm), as in a waltz. Other traditions, including much folk music from Africa and Eastern Europe, use more complicated metrical structures consisting of 5-, 7-, or 11-beat patterns. The rhythmic structures of many musical styles including American jazz and traditional music in South America are also rich with syncopation, or accented sound events that occur between the beats of the metrical structure.

Metrical sequences with ratios of simple integers, such as 1:2 and 1:3, are more easily reproduced and remembered by Western listeners than patterns with more complex ratios, as shown in perceptual (Drake & Gerard, 1989) and in brain imaging (Janata & Grafton, 2003) studies. Within the relatively simple metrical structures of Western music, duple subdivisions are much more common than triple. Duple rhythms are also easier for Western children and adults to reproduce than triple rhythms (Drake, 1993).

In the absence of strong beat accents, perception of meter can be ambiguous and thus depend on context and individual interpretation, such that the same rhythm can be perceived in multiple ways (Repp, 2006). Regardless of the ambiguity, Western adults will impose a metrical interpretation even when a series of identical isochronous beats is presented. However, listeners are more likely to impose a binary than a ternary interpretation, as evidenced by ERP responses on subjectively, but not physically, accented beats (Brochard, Abecasis, Potter, Ragot & Drake, 2003).

There is evidence that metrical perception is affected by enculturation (Hannon & Trainor, 2007). Hannon and Trehub (2005a) showed that Bulgarian and Macedonian adults, who grew up listening to complex metrical structures in the music of their folk traditions, were able to discriminate timing alterations in music with either simple (4-beat) or complex (7-beat) metrical patterns, whereas North American adults were able to detect changes only in the simple metrical patterns. Furthermore, 6-month-old North American infants performed like Bulgarian and Macedonian adults, but by 11 months, infants only detected changes to the simple metrical structure (Hannon & Trehub, 2005b). These results suggest that enculturation plays an important role in the development of musical skills during the infancy period and that young infants appear to show greater flexibility than older infants in the organization of auditory-temporal input.

These findings raise questions about whether formal musical training at this age might accelerate the process of enculturation. Most popular pedagogical approaches are not aimed at young infants; indeed, the motor and language skill requirements of many methods preclude musical training in infancy. For example, the Orff Method integrates movement, singing and instrumental skills, but the instruments used such as xylophones and glockenspiels require fine motor control and are not suitable for use with young infants. Although some educators use the Orff approach with children as young as 3 to 4 years of age, the importance of speech-syllable pattern production to Orff precludes use of the method with pre-verbal infants. In fact, in the field of music pedagogy, most research on the acquisition of rhythmic skills is concerned with teaching methods directed toward school-aged children. For example, one of the most prominent theorists in this field, Edwin Gordon, developed a rhythm-syllabic system that only older children can use.

Recent trends, however, have been towards introducing formal musical training at increasingly younger ages (e.g. *Suzuki*, *Kindermusik*, *Musikgarten*, and *Music Together* have added programs for infants). For example, the Suzuki method, one of the most popular forms of music education today, traditionally advocates that children as young as 3 can learn to play the violin when there is an experienced teacher and a parent committed to working with the child involved in the process (Suzuki, 1983). Canadian Suzuki teacher-trainer Dorothy Jones has adapted this philosophical approach for infants with emphasis on singing, the use of rhythm instruments, as well as development of the parents' observational skills (Jones, 2004).

The *Kindermusik* program is another popular approach to music education for young children with more than one million families currently participating in 66 countries (Kindermusik, 2007). Kindermusik was initially developed for young school-aged children in Germany during the 1960s, but now includes a curriculum for newborns through to children aged 7 years. The Kindermusik approach is based on participation of the child rather than evaluative performance. One of the hallmarks of Kindermusik is that parents and children take part in activities that combine music and movement, in line with research indicating the importance of movement in learning rhythm (Phillips-Silver & Trainor, 2005) and the approach of Dalcroze. At the same time, the rhythmic character of the musical materials used in Kindermusik reflects that of Western music generally, making it a good choice with which to examine the effects of enriched musical experience on enculturation to Western rhythmic structures. We analyzed the rhythmic structures of the eight units of the infant curriculum (birth to 18 months) and found that, in line with the general bias for duple meters in Western musical structure, 71% of the 239 songs or spoken rhythms (i.e. poems, chants) in the Kindermusik repertoire were in duple meter while 29% were in triple meter, and none were in more complex meters.

In order to evaluate whether formal musical training in infancy affects the development of rhythmic enculturation, we examined the metrical processing of infants enrolled in Kindermusik in comparison to previous data on infants not enrolled in formal musical classes. Due to the emphasis on combining movement and auditory rhythm in the Kindermusik approach, we focused our testing on movement–auditory interactions.

It is generally acknowledged that music makes us want to move to the beat. A series of studies conducted by Phillips-Silver, Trainor and their colleagues (Phillips-Silver & Trainor, 2005, 2007, 2008; Trainor, Gao, Lei, Lehtovarara & Harris, 2009) show that body movement also shapes how we hear rhythm, particularly in disambiguating rhythm patterns with more than one possible metrical interpretation. Phillips-Silver and Trainor (2005) familiarized infants for 2 minutes to a repeating ambiguous (without accented beats) 6-beat rhythm pattern. During familiarization, half of the infants were bounced (moved up and down) on every second beat and the other half on every third beat. Adding intensity accents to the ambiguous auditory rhythmic pattern can create very different metrical interpretations. Accenting every second beat (duple meter) results in the perception of a march, whereas accenting every third beat (triple meter) results in the perception of a waltz. After training, infants' listening preferences were tested for these two auditory versions of the rhythm pattern. Infants chose to listen longer to the version with the accented beat pattern that matched the beats on which they were bounced, even though all infants heard the same ambiguous rhythm pattern during familiarization. This suggests that infants who were bounced on every second beat encoded the pattern in a duple meter whereas those who were bounced on every third beat encoded the pattern in a triple meter. Subsequent experiments ruled out visual cues to movement as necessary for the movement–auditory interaction, but showed that body movement was necessary. Specifically, infants who were blindfolded during familiarization were influenced by the bouncing experience whereas infants who watched the experimenter bounce, but did not participate in movement, showed no preference for either pattern. Further experiments showed that movement also affects adults' interpretation of an ambiguous rhythm pattern (Phillips-Silver & Trainor, 2007) and that the vestibular system plays a crucial role in the movement effect (Phillips-Silver & Trainor, 2008; Trainor *et al.*, 2009).

In the present study, infants enrolled in Kindermusik classes were tested on the procedure of Phillips-Silver and Trainor (2005), and the results of the infants in the present study were compared to those of the infants in the 2005 study who were not undergoing any formal musical training. We had two main hypotheses. First, because of their enriched experience with movement–auditory interactions, infants participating in Kindermusik were expected to show stronger effects of movement on auditory rhythm encoding than infants not taking formal training. Second, because of the predominance of duple meters in the Kindermusik corpus, it was hypothesized that infants in the Kindermusik group would show stronger enculturation, that is, a stronger bias for duple meters.

Method

Participants

The participants were eight infants (four males, four females), aged 6.7 to 8.2 months (average age 7.4 months) with no known hearing deficits. All were currently participating in infant Kindermusik classes in the Hamilton, Ontario area. They were compared to the 16 infants from Phillips-Silver and Trainor (2005), who were aged 6.9 to 8.2 months (average age 7.5 months), who had no formal musical training. Procedures were approved by the McMaster University Research Ethics Board, and parents gave written permission for the infants to participate.

Stimuli

All sounds were presented with a Power Macintosh 7300/180 computer, through a Denon PMA-480R amplifier, to two audiological GSI speakers located in a large Industrial Acoustics Co. sound-attenuating booth with a noise floor of 25 dB(A). The stimuli were identical to those of Phillips-Silver and Trainor (2005). For the *training*, a 6-beat metrical structure was established with a slapstick sound every 330 ms (at 50 dB) and a snare drum downbeat (at 60 dB) every 6 of these beats, using a Roland 64-Voice Synthesizer Module. After 12 repetitions of the 6-beat structure, the rhythm pattern of interest was added, consisting of four snare drum beat sounds with SOAs of 660-330-330-660 ms, presented at 60 dB (Figure 1). All sound events of the rhythm pattern were of equal duration and intensity (i.e. there were no accents present). During *testing*, the same rhythm pattern was presented, but in two different accented versions. For the *duple meter* test stimulus, sound events occurring on every second beat were presented at 60 dB, and the intervening sounds at 55 dB, which divided the rhythm into three groups of two beats. In the *triple meter* test stimulus sound events occurring on every third beat were presented at 60 dB, and the intervening sounds at 55 dB, which subdivided the rhythm pattern into two groups of three beats.

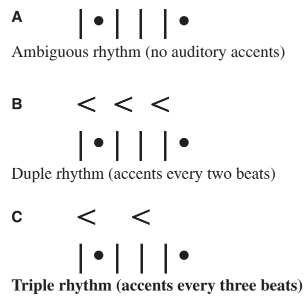

Figure 1 *Representation of the rhythmic stimuli. A. The metrically ambiguous rhythm pattern. B. The duple metrical version. C. The triple metrical version. Vertical lines represent snare drum onsets, dots represent silent beats, and arrows represent accented beats. This rhythm pattern was superimposed on a background that established the metrical structure, with a slapstick sound every beat and a snaredrum every sixth beat.*

Procedure

Prior to testing, parents were given a questionnaire to evaluate the musical background of the parents (formal musical training, years of lessons, participation in musical ensembles) as well as the number of hours music was played in the home and the styles of music listened to. Following this, the identical *training* and *testing* phases as in Phillips-Silver and Trainor (2005) were conducted.

Training

The experimenter stood between the two speakers holding the infant. The experimenter bounced up and down from the knees throughout the 2-min training phase, consisting of 60 repetitions of the training rhythm stimulus. During training, all subjects heard the same ambiguous rhythm pattern with no accents (Figure 1A), but were randomly assigned to one of two movement conditions. In the duple movement condition, infants were bounced on every second beat (beats 1, 3 and 5) and in the triple movement condition, on every third beat (beats 1 and 4).

Testing

Immediately following the training phase the parent was seated between the two loudspeakers facing the experimenter with the infant on his or her lap and a head-turn looking-time preference procedure was conducted. The experimenter and the parent wore headphones and listened to masking music for the duration of the test. Trials were presented to the infant such that the rhythm pattern was played from either the loudspeaker on the left or on the right (alternating between trials). A custom-written program running on the Power Macintosh 7300/180 computer controlled the experiment. The experimenter initiated a trial when the infant was looking forward, by pressing a button on a custom-built button box connected to the computer through a custom-built interface. On each trial, a light initially flashed on one side of the infant illuminating a toy. When the infant looked at the toy, the experimenter pressed a second button, which caused the computer to keep the light on and to play either the duple meter test stimulus (Figure 1B) or the triple meter test stimulus (Figure 1C), with trials alternating between these two. For as long as the infant looked at the light and toy, the rhythm continued to play. When the infant looked away the experimenter lifted the button, which caused the sound and light to stop, thus signaling the end of the trial. The computer kept track of how long the infant listened on each trial so that looking times, or preferences for the duple versus triple accented patterns, could be analyzed. Whether the duple or triple metrical pattern was heard on the first trial, and whether the first trial was on the right or on the left, were counterbalanced so that within each bouncing condition half of the infants heard the duple rhythm first, and half heard the triple rhythm first; as well, half heard the duple rhythm on the right and half heard it on the left. Each infant completed 20 test trials.

Results

The eight Kindermusik infants of the present study were compared to the 16 infants from Phillips-Silver and Trainor (2005), who had no formal musical training (see Figures 2 and 3).[1] An ANOVA was conducted with looking time as the dependent measure. The main variable of interest, Metrical Match, took on the value *familiar* when the bouncing experience matched the metrical accents of the test rhythm (i.e. either both duple or both triple), and *novel* when these were mismatched (i.e. one was duple and the other triple). We examined the first half of the trials separately from the last half of the trials because preferences often change from familiar to no preference to a novel

[1] These analyses were repeated comparing the eight Kindermusik infants to a randomly chosen eight infants tested in Phillips-Silver and Trainor (2005) in order to make sure that the results did not reflect the unequal sample sizes. (The infants were chosen randomly within the constraint that the following were counterbalanced: type of movement experience, whether the first stimulus in the preference test was presented on the left or on the right, and whether the first stimulus did or did not metrically match the bouncing experience.) The results of all ANOVAs were essentially the same. The only two differences across all of these analyses were that (1) the main effect of Background approached but was no longer statistically significant in the first overall ANOVA (p = .14). This effect is not crucial for the interpretation in any case as it is the interactions that tell the main story. Second, the effect of Metrical Match in the no-Kindermusik group alone for the second half only approached but did not reach significance (p = .09).

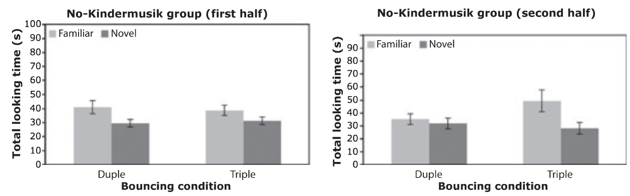

Figure 2 *Looking times for the no-Kindermusik group for the first 10 trials (left panel) and second 10 trials (right panel) for the familiar and novel rhythms across the duple and triple movement training (bouncing) conditions. Error bars reflect the standard error of the mean.*

preference with increased exposure to a stimulus (Rose, Gottfried, Melloy-Carminar & Bridger, 1982). The rate at which this change occurs can be thought of as measure of encoding efficiency. The ANOVA had Metrical Match (novel, familiar) and Half (1st 10 trials, 2nd 10 trials) as within-subjects factors and Background (Kindermusik, no-Kindermusik) and Movement Type (duple, triple) as between-subjects factors. There was a main effect of Background, $F(1, 20) = 4.80$, $p = .04$, $\eta^2 = .194$, reflecting overall longer looking times in Kindermusik than in no-Kindermusik infants. There was a main effect of Metrical Match, $F(1, 20) = 6.98$, $p = .016$, $\eta^2 = .259$, with longer looking times on familiar than on novel trials. There were interactions between Metrical Match and Test Half, $F(1, 20) = 9.01$, $p = .007$, $\eta^2 = .310$, between Metrical Match, Test Half and Movement Type, $F(1, 20) = 8.90$, $p = .007$, $\eta^2 = .308$, and between Metrical Match, Test Half and Background, $F(1, 20) = 12.57$, $p = .002$, $\eta^2 = .386$. In addition there was a trend for an interaction between Background and Movement Type, $F(1, 20) = 2.90$, $p = .10$. Because of this trend, our a priori hypothesis for group differences in enculturation, and the interaction involving background, we conducted separate analyses for the Kindermusik and no-Kindermusik groups.

For the no-Kindermusik infants, an ANOVA was conducted with Metrical Match (familiar, novel) and Test Half (1st 10 trials, 2nd 10 trials) as within-subject factors and Movement Type (duple, triple) as a between-subjects factor (see Figure 2). There was a main effect of Metrical Match, $F(1, 14) = 19.76$, $p = .001$, $\eta^2 = .585$, with longer looking times to familiar than to novel overall. There was also an interaction between Metrical Match, Test Half and Movement Type, $F(1, 14) = 4.59$, $p = .05$, $\eta^2 = .247$. To understand this interaction, we conducted separate ANOVAs for each half with Metrical Match (familiar, novel) as a within-subjects factor and Movement Type (duple, triple) as a between-subjects factor. For the first half the only significant effect was a main effect of Metrical Match, $F(1, 14) = 21.2$, $p = .001$, $\eta^2 = .602$, with longer looking times to familiar than to novel trials. For the second half, there was a significant main effect of Metrical Match, $F(1, 14) = 7.14$, $p = .02$, $\eta^2 = .338$, and the interaction between Metrical Match and Movement Type approached significance, $F(1, 14) = 3.76$, $p = .07$, $\eta^2 = .212$. As can be seen in Figure 2, right panel, the familiarity preference remained strong in the second half for infants in the triple Movement Type condition, but disappeared for those in the duple. This suggests that, in addition to effects of movement experience, the triple rhythm maintains infants' interest for longer.

Similar ANOVAs were conducted for the Kindermusik group (see Figure 3). Overall there was no main effect of Metrical Match or Test Half; however, there was an interaction between Test Half and Metrical Match, $F(1, 6) = 10.44$, $p = .018$, $\eta^2 = .635$, so we conducted separate ANOVAs for each half. For the first half, there was a significant main effect of Metrical Match, $F(1, 6) = 30.13$, $p = .002$, $\eta^2 = .834$, indicating that, as with infants with no musical training, movement affected how the Kindermusik infants interpreted the ambiguous rhythm. Also, there was an interaction between Metrical Match and Movement Type, $F(1, 6) = 6.57$, $p = .043$, $\eta^2 = .522$, reflecting a much larger familiarity preference for infants moved in duple than for infants moved in triple. This suggests that the Kindermusik training biases infants for duple meters. For the second half, there were no significant main effects or interactions, suggesting that infants in the Kindermusik group became familiar more quickly with both rhythms after the exposure of the first half.

From the questionnaire data, we extracted the number of hours per week that the Kindermusik infants listened to music at home, the number of years that their mothers had taken music lessons and the number of years that

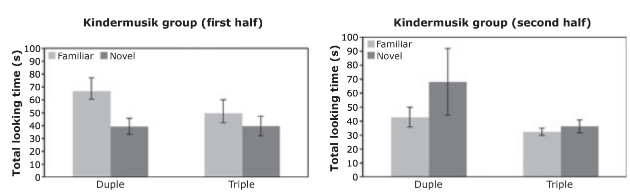

Figure 3 *Looking times for the Kindermusik group for the first 10 trials (left panel) and second 10 trials (right panel) for the familiar and novel rhythms across the duple and triple movement training (bouncing) conditions. Error bars reflect the standard error of the mean.*

their fathers had taken music lessons. None of these variables correlated with proportion of looking time to the metrical structure that matched their movement experience in either the first or second half of the trials. However, future research would need to be conducted with many more infants in order to be more certain about whether or not these environmental variables affect infant performance.

Discussion

For both groups of infants (those with Kindermusik training and those without), movement biased their metrical interpretation of the ambiguous rhythm pattern. However, we found two main differences between infants taking formal Kindermusik classes and infants not engaged in music lessons. First, infants in the Kindermusik classes showed longer looking times overall than infants without musical training. This suggests that those in Kindermusik classes found the rhythmic sequences more engaging, presumably as a result of their musical exposure. Second, those in Kindermusik who were bounced in duple meter showed a large familiarity preference in the first half, whereas those bounced in triple showed only a modest familiarity preference. This is in contrast to infants without formal musical training, who showed similar familiarity preferences whether bounced in duple or in triple. For infants bounced in triple, those not in Kindermusik classes showed larger familiarity effects (i.e. a larger preference for triple meter) than those in Kindermusik, suggesting less sensitivity to triple meter movement–auditory interactions in the Kindermusik group. Finally, there was a non-significant trend in the Kindermusik group in the second half toward a novelty preference, particularly in the case of familiarization with duple movement. In general, infants' preferences change from familiarity to novelty preferences with increased exposure to a stimulus (e.g. Rose *et al*., 1982). The novelty trend in the Kindermusik group in the second half of the trials suggests, then, that the infants in this group quickly encoded the metrical patterns, tiring of the familiar pattern more quickly than those in the no-Kindermusik group.

It is possible that the duple bias arises in the Kindermusik group from the enriched movement experience alone as the natural rhythms of human locomotion are more related to duple than triple forms. However, the measured duple bias is evident in infants' preferences for auditory rhythms, so it appears that any such effect of the movement experience alone is transferring to the auditory domain. Furthermore, previous studies suggest that young infants are readily able to encode complex rhythms and that enculturation has a strong effect on musical development. North American infants are able to detect changes in Western, Bulgarian and Macedonian rhythmic patterns at 6 months, but by 11 months are able to do so only with Western rhythms (Hannon & Trehub, 2005b). Enculturation is also seen in the pitch domain. Sensitivity to consonance emerges early in development, but more system-specific musical knowledge of scale and harmonic structure develops later (Trainor & Trehub, 1992, 1994; Trainor, 2005).

In sum, these results suggest that Kindermusik training has the effect of biasing processing for duple compared to triple rhythms. Although we did not randomly assign infants to Kindermusik classes or not, the results are consistent with an experiential effect of Kindermusik. First, the long looking times of the Kindermusik infants might well reflect a heightened interest in music developed through listening and movement. Second, the Kindermusik curriculum contains music predominantly in duple rhythms. This experience may well accelerate the bias that Western adults develop for duple rhythms. It is unlikely that infants in Kindermusik classes were genetically predisposed to preferentially process duple compared to triple meters, whereas infants not in Kindermusik classes were not. Therefore, it is reasonable to interpret the findings of the present study as evidence that formal musical training in infancy affects metrical processing.

Western music is predominantly in duple meters. The present study is the first to show accelerated culture-specific musical processing through formal training in infancy. However, Western composers in both popular and classical traditions are increasingly incorporating rhythms from around the world in their music (e.g. Ross, 2008). It is therefore essential that musicians today are versatile in their rhythmic competencies. Similarly, music listeners will have better access to the changing music of their culture, and to music from around the world, if they are adept at complex rhythmic processing. The results of the present study suggest that if one goal of musical training is to enable people to be able to both produce and appreciate more complex meters, an ideal musical training program for infants would include a variety of metrical forms.

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CHAPTER 3

Active music classes in infancy enhance musical, communicative and social development

INTRODUCTION

Previous studies have shown that formal music training can have an effect on IQ scores in 6-year-old children (Schellenberg, 2005) and that length of musical training predicts reading comprehension performance (Corrigall & Trainor, 2011). Studies have also linked musical ability and reading skills (Anvari et al., 2002, Gromko, 2005; Patel & Iverson, 2007), but little is known about the effects of formal music experience very early in development. This chapter reports a study of the effects of formal music classes before one year of age and is already published: Gerry, D., Unrau, A., & Trainor, L. J. (2012). Active music classes in infancy enhance musical, communicative and social development. *Developmental Science, 15,* 398-407.

Given that popularity of music recordings and DVDs aimed at infants may have led some parents to replace active musical engagement with their children with more passive exposure to music by using CDs and DVDs, it is important to study the potential benefits of active participation in music making early in development. In addition, there are many options available to parents who wish to participate in group music classes with their infants, and these classes vary considerably in approach and quality. Thus it is also important to begin to understand what elements might be important. In this initial study, we focused on active music making as a potentially critical element.

This chapter provides the first empirical study to show that infants who engage in active music classes with their parents before one year of age show benefits in musical, language and social development, suggesting that sound pedagogical practice and meaningful musical experience can have an effect on more than just musical development in infancy.

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PAPER

Active music classes in infancy enhance musical, communicative and social development

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Abstract

Previous studies suggest that musical training in children can positively affect various aspects of development. However, it remains unknown as to how early in development musical experience can have an effect, the nature of any such effects, and whether different types of music experience affect development differently. We found that random assignment to 6 months of active participatory musical experience beginning at 6 months of age accelerates acquisition of culture-specific knowledge of Western tonality in comparison to a similar amount of passive exposure to music. Furthermore, infants assigned to the active musical experience showed superior development of prelinguistic communicative gestures and social behaviour compared to infants assigned to the passive musical experience. These results indicate that (1) infants can engage in meaningful musical training when appropriate pedagogical approaches are used, (2) active musical participation in infancy enhances culture-specific musical acquisition, and (3) active musical participation in infancy impacts social and communication development.

Introduction

Every society appears to have special songs for infants (Trehub, 2003, 2007) and long before infants understand words, their caregivers communicate with them through music, calming them with lullabies and arousing them with playsongs (Rock, Trainor & Addison, 1999; Shenfield, Trehub & Nakata, 2003; Trehub & Trainor, 1998). Little is known about the effects of this early interactive music-making on development, but in Western societies in recent years caregivers have the option to replace it, at least in part, with passive listening to recorded music. In the present study we randomly assigned 6-month-old infants to 6 months of either active participatory music classes for infants and parents or to passive music classes where recorded music was played in the background while infants and parents engaged in various other activities. After the 6 months of passive versus active music classes, we compared infants in the two groups on their acquisition of knowledge about Western musical tonality, their social behaviours, and their use of communicative gestures.

A number of studies with older children suggest that participation in music lessons positively affects musical, linguistic and cognitive development (Corrigall & Trainor, 2009; Jentschke & Koelsch, 2009; Moreno, Marques, Santos, Santos, Castro & Besson, 2009; Schellenberg, 2011; Schlaug, Forgeard, Zhu, Norton, Norton & Winner, 2009; Trainor & Corrigall, 2010). Fujioka, Ross, Kakigi, Pantev and Trainor (2006) found that over the course of a year of music lessons, 4- to 5-year-old children showed more change in event-related potential brain responses related to attention and memory, in comparison to children engaged in other activities. Shahin, Roberts, Chau, Trainor and Miller (2008) showed that induced gamma band responses from electroencephalogram (EEG) recordings – which are related to attention, feature-binding and top-down processing – emerged after one year of musical training between 4 and 5 years of age, but remained undetectable in children not taking music lessons. Using MRI, Schlaug *et al*. (2009) found that the corpus collosum, which reflects inter-hemispheric communication, develops differently in 5- to 7-year-old children taking music lessons compared to children not taking music lessons. However, these studies did not use random assignment so it is difficult to be sure that the musical training caused the differences. Two studies using random assignment found that participation in one year of music lessons at age 6 years led to a greater increase in IQ compared to one year of participation in drama lessons (Schellenberg, 2004), and that participation in 6 months of music training at age 8 years resulted in enhanced reading and pitch discrimination skills compared to 6 months of painting training (Moreno *et al*., 2009).

Although the brain is likely most plastic early in development, controlled studies of musical training in infants have not been conducted previously. Young

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infants are sensitive to some aspects of music (Hannon & Trainor, 2007; Perani, Saccuman, Scifo, Spada, Andreolli, Rovelli, Baldoli & Koelsch, 2010; Trainor, 2005; Trainor & Corrigall, 2010; Trehub, 2003). Without formal training, young infants prefer consonant over dissonant musical intervals (Trainor, Tsang & Cheung, 2002), remember simple melodies for periods of weeks (Saffran, Loman & Robertson, 2000; Trainor, Wu & Tsang, 2004), distinguish metrical structures (Hannon & Trehub, 2005a) and integrate movement and auditory information in extracting the meter of ambiguous rhythms (Phillips-Silver & Trainor, 2005). Importantly, acquisition of musical skills continues throughout development with or without musical training. Many studies in Western adults show that even those without formal musical training have developed brain circuits that are specialized for processing Western musical structure through passive everyday exposure (Bigand & Pineau, 1997; Bigand & Poulin-Charronat, 2006; Janata, Birk, Van Horn, Leman, Tillmann & Bharucha, 2002; Koelsch, Gunter, Schröger & Friederici, 2003; Peretz, 2006; Tillman, Bigand, Escoffier & Lalitte, 2006; Tillman, Bigand & Madurell, 1998; Trainor, McDonald & Alain, 2002). Just as infants learn the particular language spoken in their environment, they also acquire sensitivity to the tonal (musical scales and harmonies) and rhythmic structure of the musical system of their culture (Hannon & Trainor, 2007; Hannon & Trehub, 2005a; Trainor, 2005; Trainor & Corrigall, 2010; Trainor & Trehub, 1992) and exposure to music and movement appears to accelerate acquisition of culture-specific rhythms (Gerry, Faux & Trainor, 2010). Such environmentally driven perceptual specialization is also found for auditory discrimination of native compared to foreign speech contrasts (Kuhl, Tsao & Liu, 2003; Werker & Tees, 1984) and visual discrimination of faces from one's own compared to a foreign race (Kelly, Quinn, Slater, Lee, Ge & Pascalis, 2007) and one's own compared to a foreign species (Pascalis, de Haan & Nelson, 2002). Thus, the natural exposure infants receive to specific faces, languages and music in their environment appears to drive perceptual skill development.

Although it is clear that infant perception becomes specialized through exposure to a particular environment, few studies have investigated the nature of learning early in development in a controlled manner by studying the effects of specific training on skill acquisition in infants using random assignment to different experiences. In the music domain, Gerry *et al*. (2010) did find that infants attending Kindermusik classes showed earlier enculturation to Western rhythms in comparison to infants not attending classes. A study of preschool children also suggests that musical training accelerates acquisition of musical harmony (Corrigall & Trainor, 2009), but neither of these studies used random assignment. A few studies suggest that specific training can affect skill acquisition in infants. Hannon and Trehub (2005b) demonstrated that 12-month-old infants exposed to music with complex metrical structures (uncommon in Western cultures) at home could distinguish rhythmic variations in other metrically complex music at test, whereas 12-month-old infants without such exposure could not. Kuhl *et al*. (2003) showed that 9-month-old English-learning infants exposed interactively to Mandarin speech, but not those with passive exposure, were able to discern phonemic differences in Mandarin. Pascalis, Scott, Kelly, Shannon, Nicholson, Coleman and Nelson (2005) found that 6- to 9-month-old infants who received training on the faces of Barbary macaque monkeys could discriminate monkey faces, whereas those who did not receive this training could not.

In the present study, infants and their parents were randomly assigned to participate in one of two types of music classes. The *active* music class employed a Suzuki-philosophy early childhood education approach in which teachers work with parents and infants using a curriculum that emphasizes movement, singing, playing percussion instruments, and building a repertoire of lullabies and action songs (Jones, 2004). Infants and parents are required to remember songs and to pay attention in order to sing, move, or play a percussion instrument at the appropriate time. Parents are active participants in the learning process; developing an awareness of their infants' progress is considered an essential component of this approach. Parents in the active music classes were encouraged to use a CD of songs from class at home and to repeat the activities on a daily basis. In the *passive* music classes, parents and infants listened to a rotating selection of music from the popular Baby Einstein™ series, the name of which implies educational benefits, featuring popular classical repertoire performed on synthesized musical instruments and without musical expression. While listening to the music, parents and infants in the passive music classes were free to interact at art, books, balls, blocks and stacking cup play stations. Participants chose a different Baby Einstein™ CD each week to play at home.

One goal of the present paper was to test whether active musical experience in infancy enhances sensitivity to Western tonality more than passive experience. To test this, we used a head-turn preference procedure in which infants controlled how long they listened to two different versions of a Sonatina by Thomas Atwood. In its original form (*tonal* version), the Sonatina conformed to the rules of Western musical structure. This tonal version was contrasted with an *atonal* version that changed key every beat. Acquisition of sensitivity to Western tonal structure was expected to lead to a preference for the tonal version. We measured amount and type of at-home musical exposure using a parent questionnaire.

A second goal of the present paper was to test whether engaging in active music-making between parents and infants promotes social, emotional and communicative development. Music is essentially a social activity and good caregiver–child interaction is essential for healthy cognitive and social development during infancy (Singer, Golinkoff & Hirsh-Pasek, 2006). Parents use singing to engage infants in social interaction and infants prefer to listen to infant-directed singing compared to singing of other types (Rock *et al*., 1999; Trainor, 1996; Trehub & Trainor, 1998). In linguistic communication, infants whose interactions with parents involve more speech and diverse vocabulary show better language outcomes later in childhood (e.g., Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991) and this environmental specificity extends to families with different socioeconomic backgrounds (Hoff, 2003). Furthermore, recent studies in children suggest that making music with other people leads to greater social cooperation. For example, Kirschner and Tomasello (2010) found that active music-making amongst 4-year-old children led to spontaneous helpful and cooperative behaviour. We measured social-emotional development with four subscales of the standardized Infant Behavior Questionnaire (IBQ): Distress to Limitations, Distress/Latency to Approach Novel Stimuli, Smiling and Laughter, and Soothability. We measured early communicative development with the standardized MacArthur-Bates Communicative Development Inventories.

Materials and methods

Participants

Infants and parents assigned to the Active Training and Passive Training groups were recruited through Ontario Early Years Centres, which are government-sponsored drop-in centres for preschool children and their families. Programmes in these centres are run in collaboration with Wesley Urban Ministries. Fifty-two infants and their parents signed up to participate for 6 months in an hour-long weekly class held at two different Ontario Early Years Centres located in areas of contrasting socioeconomic vulnerability. Music classes at each centre were offered on two different days of the week, and the class day parents were assigned dictated the type of training they and their infants received. When classes began, 49 families were attending regularly (25 in the Active Training group, and 24 in the Passive Training group). By the end of the 6 months, 38 families were still attending classes regularly (where regularly was defined as attending more than 75% of classes; 21 Active and 17 Passive) and they were asked to participate in the final round of testing at 12 months of age. Of those, 34 families (20 Active and 14 Passive) participated in all initial and final tests. The infants were 19 girls and 15 boys. In our final sample, 16 families (10 Active, 6 Passive) lived in neighbourhoods considered highly socioeconomically vulnerable for young children, according to the Neighbourhood Social Index risk factors provided by Human Resources Development Canada (Connor, 2001). The average age at the commencement of the classes was 6.49 months (SD = 0.99) and at the time of final testing in the last weeks of classes was 11.56 months (SD = 0.85). An additional control group (n = 31) of infants was recruited from the Developmental Studies Database at McMaster. Five of these infants were eliminated because they had participated in more than 4 months of parent-infant music classes, leaving 26 infants in this condition. This group received no training and completed a subset of the final tests (Measure of sensitivity to Western tonality and musical exposure questionnaire) at 12 months (average age at test was 11.41 months, SD = 0.54). All experimental procedures were approved by the McMaster Research Ethics Board (MREB), and informed consent was obtained from all parents.

Musical experience protocol

In the two active music classes, infants and their parents engaged in active music-making in Suzuki Early Childhood Education classes developed by Dorothy Jones (Jones, 2004). Parents and children participated in a weekly one-hour interactive music class. Two teachers worked with the parents and infants to build a repertoire of lullabies, action songs and nursery rhymes. Parents were encouraged to use the curriculum CD at home and to repeat the songs and rhymes daily. These participants learned a repertoire of songs and musical activities designed to develop their musical abilities through participation and observation. The class emphasized developing good singing skills and listening to acoustic music. Repetition is central to this approach, and parents were encouraged to be active participants in the learning. The curriculum emphasized singing, movement, infant/parent bonding as well as awareness of infant development.

In order to ensure that any effects were due to the Suzuki (active) music classes and not just as a result of participation in any class where parents can talk to other adults and get positive reinforcement for being with their child and listening to music, the other two groups of infants were assigned to the passive music classes (one at each centre). In these classes, infants and parents received passive exposure to recorded music in the form of a rotating series of recordings from the popular Baby Einstein™ series. This series of recordings features popular classical repertoire performed entirely on synthesized musical instruments and without musical expression. Participants chose a different CD each week for use at home. During the classes, the music played in the background, while infants and parents were free to play at five play stations including art, books, balls, building blocks and stacking cups. The curriculum did not include movement, a repertoire of memorized songs and action games, paying attention, or active parental involvement in music-making. The class was taught by a university-trained elementary education specialist, assisted by a university-trained music student.

In both types of music class, two trained teachers were present at all times and interacted with the parent–child dyads throughout the class. Parents were aware that there were multiple music classes operating over the six-month time period, but they were not told the details of the experimental manipulations. It is unlikely that there was more parent/child interaction in the active as compared to the passive music class; however, there were likely different types of interaction given the emphasis on activities involving play, creativity and discovering new objects in the passive music class, and an emphasis on active participatory music-making in the active music class. We did not measure other variables such as the amount of talking, diversity in vocabulary, smiling, or physical contact between parents and infants, but we had no reason to believe that these differed substantially between groups.

Infants in the Active Training, Passive Training, and No Training groups heard a similar amount of music per week in the classes and at home as reported by parents (Active Training average 17.9 hours/week, SE = 3.1; Passive Training average 14.8 hours/week, SE = 4.9; No Training 14.5 hours/week, SE = 3.6). The groups did not differ significantly by a one-way ANOVA, p = .75.

Measure of sensitivity to Western tonality

Two versions of an excerpt from a Sonatina by Thomas Atwood (1765–1838) were created (Figure 1). One version presented the music in its original form in the key of G major (tonal version). The other version alternated every beat between G major and G-flat major (atonal version). Both versions can be heard at http://www.psychology.mcmaster.ca/ljt/stimuli.htm. The effect of this manipulation was that the feeling of a tonal centre was lost (all 12 chromatic notes were represented) without additional sensory dissonance (each chord in isolation was equally consonant in tonal and atonal versions). Additionally, both versions had the same rhythms and phrasing.

A head-turn preference procedure was conducted with each infant individually. The infant was seated on his or her parent's lap across from the experimenter in a large sound attenuating chamber (Industrial Acoustics Co.), with a cabinet and audiological GSI speaker set up on each side of the infant. Sounds were presented at approximately 55 dB(A) over a background of 25 dB(A). To begin each trial, the experimenter attracted the infant's attention forward; when this was accomplished, the experimenter pushed a button that triggered the computer to begin flashing a light in the cabinet on one side of the infant, illuminating a toy inside. When the experimenter judged that the infant was looking toward the toy, as indicated by a head-turn of at least 45^{o} in the direction of the cabinet, the experimenter pushed another button that triggered one of the two versions of the music to begin playing. The experimenter continued pressing the button until the infant looked away. The music played for as long as the infant continued to look in the direction of the speaker, and stopped when the

Figure 1 *A. The original tonal version of the excerpt from the Sonatina by Thomas Atwood in G major. B. The atonal version of the same piece, created by lowering every note of the original version by a semitone on the second and fourth beats of every bar while not altering the notes on the first and third beats of every bar. This atonal version has the same rhythm and phrasing as the original, but is no longer in any particular key. Both versions contain the same amount of sensory consonance and dissonance as the intervals on every beat are identical between the two versions (just transposed down a semitone in the case of the second and fourth beats).*

infant looked away for 2 consecutive seconds, at which point the light in the cabinet was also extinguished. When the experimenter attracted the infant's attention forward again, the next trial was initiated, this time with a flashing light on the other side of the infant. When the infant looked in this direction the other version played in the same manner as the first. Trials of the tonal and atonal versions alternated, so that the speaker on one side of the infant always played the original tonal version, and the speaker on the opposite side always played the atonal version. The experiment continued in this fashion for a total of 20 trials. Side and version of first presentation were counterbalanced across infants. Neither the experimenter nor the parent was aware of which speaker would be playing which song, and both adults listened to masking music over headphones in order to prevent either party from hearing the sound stimuli and potentially influencing the infant's responses. The computer recorded listening times on tonal and atonal trials as a measure of preference.

In total, 60 infants were tested on this measure of tonality preference (20 Active Training, 14 Passive Training, 26 No Training). Seven infants did not complete the procedure due to fussing and crying (two Passive Training, two No Training) or parental interference (three No Training). It is potentially worth noting that all infants from the Active Training group completed the preference tests without fussing or crying. The No Training group tended to have higher looking times than the other two groups, likely because the training groups had been to the lab previously so the situation was less novel, and they had also completed multiple tests the same day. Outlier analyses were therefore completed separately for the No Training group. Data from three additional infants (two Passive Training, one No Training) were excluded for producing overall looking times that were more than 2 standard deviations from the mean resulting in a final sample of 20 Active Training, 10 Passive Training, and 20 No Training infants.

Measure of social-emotional development

In order to examine social development, both before and after the 6 months of classes, parents of infants in the two training conditions completed four subscales of the Infant Behavior Questionnaire (IBQ): Distress to Limitations, Distress/Latency to Novel Situations, Smiling and Laughter, and Soothability. The IBQ has been shown to reliably measure individual differences in infant social reactivity and regulation (Gartstein & Rothbart, 2003; Parade & Leerkes, 2008; see Rothbart, 1981, for example questions). Because the IBQ is a parent report questionnaire, we interpret IBQ data as indicating the health of the relationship between infant and parent, and were primarily interested in differences pre and post music classes. Data from 33 infants who participated in the 6 months of training (20 Active Training, 13 Passive Training) were included in the IBQ analyses. One infant from the Passive Training group was excluded for parent's failure to complete the IBQ form while the infant was still 12 months of age.

Measure of early communicative development

Parents of infants in the two training conditions completed the MacArthur-Bates Communicative Development Inventories before and after the 6 months of classes. The MacArthur-Bates is a parent report that tracks current and emerging communicative behaviours (Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994); before 1 year of age, these consist primarily of the use of gestures (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979). Data from 33 infants who participated in the 6 months of training (20 Active Training, 13 Passive Training) were included in the MacArthur-Bates analyses. One infant from the Passive Training group was excluded for parent's failure to complete the MacArthur-Bates form while the infant was still 12 months of age.

Results

Sensitivity to Western tonality

The preferences of each infant in each of the groups (Active Training, Passive Training, and No Training) for the tonal compared to atonal versions of the Atwood Sonatina were tested at 12 months of age (Figure 2). Preliminary analyses including Socioeconomic vulnerability (high, low) and SEX (female, male) as factors yielded no significant effects, and data were collapsed across these categories for further analyses. An ANOVA with Version (tonal, atonal) as a within-subject factor and TrainingGroup (Active, Passive, No) as a between-subjects factor revealed no main effect of Version, $F(1, 47)$

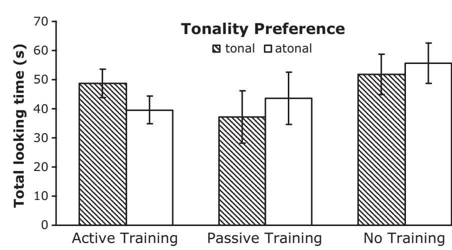

Figure 2 *Listening preferences for tonal compared to atonal versions of an excerpt from the Sonatina in G major by Atwood for infants in the Active, Passive, and No Training groups. Infants in the Active Training group prefer the tonal version, whereas infants in the Passive Training and No Training groups show no preference. Error bars represent standard error of the difference.*

< 1, p = .90, but did reveal an interaction between Version and TrainingGroup and a main effect of TrainingGroup which both approached significance, $F(2, 47)$ = 2.55, p = .09 and $F(2, 47)$ = 3.05, p = .06. The Active Training group looked longer to hear the tonal version, $F(1, 19)$ = 5.61, p = .03, but the Passive Training group did not, $F(1, 9)$ = .65, p = .44, nor did the No Training group, $F(1, 19)$ = .56, p = .46. The marginal main effect of TrainingGroup was driven by higher overall looking times in the No Training compared to Passive and Active Training groups (p = .03 and p = .06, respectively by post-hoc LSD tests) for reasons discussed in the Methods section. Because there were differences in overall looking times across groups, and because overall looking times within groups were quite variable (Active Training M = 88.3s, SE = 5.6, Passive Training M = 80.8s, SE = 9.8, No Training M = 107.4s, SE = 8.2), proportion of total looking time to the tonal version is likely a more robust measure of preference than raw looking time. A one-way ANOVA on proportion of time spent looking to hear the tonal version revealed a significant difference between the three groups, $F(2, 47)$ = 3.17, p = .05. Looking proportions were significantly different from chance (proportion of .5) for the Active Training group, M = .55, SE = .02, p = .02, but not for the Passive Training group, M = .46, SE = .05, p = .69 or the No Training group, M = .48, SE = .02, p =.41. By both measures, only infants in the Active Training group showed a preference for the tonal version. Thus, only infants who participated in the active music classes demonstrated knowledge of Western tonality.

Social-emotional development

Using scores from the four subtests of the IBQ as the dependent measures, separate ANOVAs were conducted with PrePost (6 months, 12 months) as a within-subjects factor and TrainingGroup (Active, Passive) as a between-subjects factor. Preliminary analyses including Socioeconomic vulnerability (high, low) and SEX (female, male) as factors yielded no significant effects, and data were collapsed across these categories for further analyses. For Distress to Limitations, distress generally increased between 6 and 12 months, main effect of PrePost $F(1, 31)$ = 7.7, p = .009, but more so for infants in the Passive Training group, interaction between Pre-Post and TrainingGroup, $F(1, 31)$ = 23.1, p < .001. In other words, after participation in active music classes, infants showed much lower levels of distress than after participation in passive music classes (Figure 3A). When confronted with Novel Stimuli, distress generally increased between 6 and 12 months, main effect of PrePost $F(1, 31)$ = 36.0, p < .001, but more so for infants in the Passive Training group, interaction between PrePost and TrainingGroup, $F(1, 31)$ = 19.4, p < .001 (Figure 3B). In other words, after participation in active music classes, infants showed much lower levels of distress when confronted with novel stimuli than after participation in passive music classes. There was an overall decrease in Smiling and Laughter between 6 and 12 months, $F(1, 31)$ = 4.7, p = .04, but the decrease was greater for those participating in the passive compared to active music classes, $F(1, 31)$ = 13.3, p = .001 (Figure 3C). For Soothability, infants

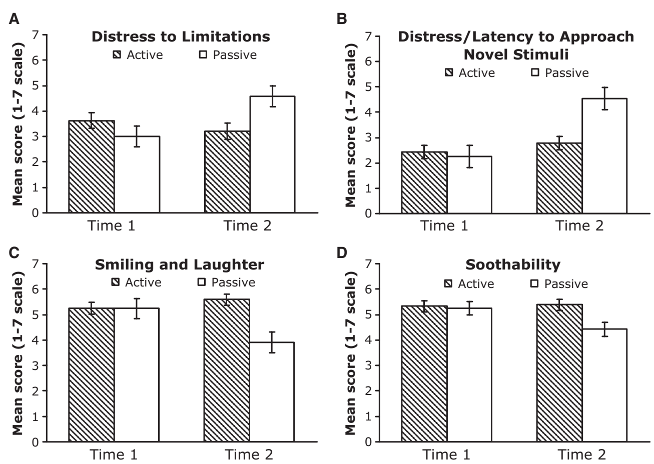

Figure 3 *IBQ scores before and after musical training. There are no differences between the Active and Passive Training groups at Time 1 before the music classes began (p > .05 in all cases), but 6 months later, compared to infants in the passive music classes, infants in the active music classes show less distress to limitations [t(31) = 3.51, p = .001] (A) and less distress/lower approach latency with novel objects [t(31) = 4.64, p < .001] (B). Infants in the active music classes also show more smiling and laughter [t(31) = -.562, p < .001] (C) and are more easily soothed [t(31) = -4.24, p < .001] (D). Error bars represent standard error of the difference.*

generally became more difficult to soothe, $F(1, 31) = 7.0$, $p = .01$, but less so for those in the active compared to passive music classes, $F(1, 31) = 9.3$, $p = .005$ (Figure 3D).

Early communicative development

Using scores from the MacArthur-Bates inventories, an ANOVA was conducted with PrePost (6 months, 12 months) as a within-subjects factor and TrainingGroup (Active, Passive) as a between-subjects factor. Preliminary analyses including Socioeconomic vulnerability (high, low) and SEX (female, male) as factors yielded no significant effects, and data were collapsed across these categories for further analyses. Use of gestures increased greatly between 6 and 12 months of age, $F(1, 31) = 139.0$, $p < .001$, but increased more so for those in the active compared to passive music classes, $F(1, 31) = 7.30$, $p = .01$ (Figure 4). It should be noted that in the case of early gestures, unlike any of the other measures tested, the groups differed initially at 6 months, $t(31) = 2.52$, $p = .007$. However, this questionnaire was designed primarily for infants 8 months and older, as 6-month-olds can only produce a small number of the gestures, so the results at 6 months are likely not reliable.

Discussion

The results indicate that when appropriate pedagogical techniques are used, active music classes for infants and parents can accelerate infants' acquisition of culture-specific musical knowledge and can positively influence communication and social interaction between parents and infants. Despite the focus in the literature on older children, the present findings suggest that the infant brain might be particularly plastic with respect to musical experience. Previous literature suggests that training in infancy with uncommon musical metrical structures, foreign languages, or foreign faces can enhance discrimination for stimuli not normally found in an infants' natural environment (Hannon & Trehub, 2005b; Kuhl *et al*., 2003; Kelly *et al*., 2007; Pascalis *et al*., 2002, 2005). The present findings indicate that enriched active musical experience can accelerate acquisition of knowledge about Western musical tonality in infancy. There is recent evidence that 5-year-olds prefer a tonal melody over an atonal melody (Corrigall & Trainor, 2011) but little was known about the development of this ability prior to 5 years of age. The present findings indicate that it is possible to see the beginnings of sensitivity to Western musical tonality as young as 12 months of age.

Furthermore, interactive musical experience appears to facilitate cognitive development in the form of earlier use of prelinguistic communicative gestures. It was previously found that the amount and nature of maternal speech input can influence later language processing in infants (Hurtado, Marchman & Fernald, 2008). The present results suggest that musical interaction may influence linguistic processing as well. Perhaps most important is that the active musical training facilitated social development. While it remains an open question as to whether the positive changes seen in the group with active musical experience on the IBQ resided exclusively in the infants' behaviour or also reflected how parents perceived their infants' behaviour, it is remarkable that 6 months of active music classes involving infants and parents led to a substantially more positive outcome than 6 months of passive music exposure also involving infants and parents.

It is clear from the present results that different types of musical experience have different effects in infancy. However, the two types of class to which infants were randomly assigned differed in several important ways. The active music class emphasized learning a small, defined repertoire of lullabies, action songs and nursery rhymes. Infants and parents actively engaged in playing percussion instruments. Parents learned to sing and played a CD at home that included versions of the musical repertoire utilized in class, sung and performed on acoustic instruments with expression. Each parent also learned to observe his or her infant's achievements and preferences in class and write a weekly journal documenting his or her infant's progress. In contrast, there was no active music-making in the passive music class and there was little repetition of the synthesized recorded music from week to week. Parents were encouraged to take a different CD home each week. In class, under the supervision of the

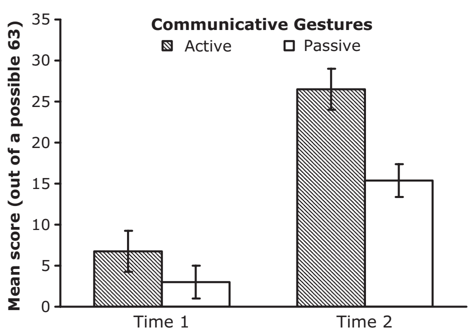

Figure 4 *Communicative gestures before and after musical training. At Time 2, when infants were 12 months of age, differences between the Active and Passive Training groups were highly significant [t(31) = 3.56, p = .001]. Groups also differed statistically at Time 1 [t(31) = 2.52, p = .007] when infants were 6 months of age, so results should be interpreted with caution. However, this questionnaire was designed for use with infants 8 months of age or older so the numbers of gestures reported at Time 1 were very small and unreliable. Furthermore, the improvement between 6 and 12 months of age was significantly greater for the Active compared to the Passive Training group [F(1, 31) = 7.30, p = .01]. Error bars represent standard error of the difference.*

teachers, the infant–parent dyads explored a variety of activities, including building blocks, simple art activities, shapes and textures, and picture books. New activities and play objects were rotated regularly. Parents worked closely with their infants during the activities in class, but they did not receive specific instructions to observe their children and journal the progress. In this first study it is not possible to be sure which factors were most important in driving the effects seen. Given the sample sizes in the training conditions, multiple regression analyses looking at associations between specific factors and outcomes were also not possible. However, differences in the overall pedagogical approach between the classes likely contributed to the differences observed.

Amount of repetition is a good candidate for future studies investigating differences between methods of musical instruction. In the active music classes, the emphasis on repetition of the songs and activities in class, as well as the encouragement to listen to the same music at home may have promoted learning in infants and developed a familiarity with activities that enabled the parents to continue to work on the material from class at home with their infants. Another candidate is the quality of the music. The active music class emphasized good singing skills and musical expression, which may have increased parental motivation and promoted parent–infant bonding, as compared to the passive music class where there was no singing and the recordings featured unexpressive synthesized music. A third candidate for future study is the role of parents' explicit observations of their infants. Such observation might increase parents' sensitivity to subtle cues from the infant, which might be particularly important for the differences observed in the parental questionnaire-based social and language scores. It will remain for future studies to test which of these factors is crucial for realizing the positive outcomes described here.

In all likelihood musical acquisition, cognitive development and social interaction do not operate as isolated systems, but affect each other. For example, positive social interactions between infants and parents likely lead to better communication and earlier acquisition of communicative gestures, which in turn lead to more positive social interactions. Shared musical activities between infants and parents likely lead to positive social interactions, and the mutual enjoyment of musical activities likely leads to earlier acquisition of culture-specific musical knowledge. Thus, for positive outcomes of early musical experience, programmes should likely incorporate stimulating musical activities and positive social interactions between parents and infants.

Music educators debate the age at which it is appropriate to begin musical training and whether there is an optimal order as to when different musical skills should be introduced. The present results suggest that when parents are actively involved and materials appropriate for infants are utilized, musical training can profitably begin early in infancy.

Toy and educational companies have created musical recordings that require virtually no parent–infant interaction and rely for the most part on inexpressive, synthesized musical sounds, sometimes marketed as being beneficial for infant development. However, one study on the effects of the popular Baby Einstein™ videos found that infants did not learn words highlighted in the videos in the absence of parental interaction (Richert, Robb, Fender & Wartella, 2010). Music media aimed at busy parents with young children have sometimes become a substitute for infant–parent interaction involving the singing of lullabies and playsongs. Our results suggest that active participation by parents and infants is likely essential for optimal learning, and our results indicate that aspects of active participation are crucial to fully realizing musical, communicative and social benefits of musical experience in early development.

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Supporting Information Online

Additional supporting information may be found in the online version of this article:

Sound example 1. The tonal original version of the excerpt from the Sonatina by Thomas Atwood.

Sound example 2. The atonal version of the excerpt from the Sonatina by Thomas Atwood (see Figure 1 for information as to how the atonal version was constructed).

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CHAPTER 4

Formal musical experience and the development of joint attention

INTRODUCTION

The process by which two people focus their attention together on an object or event is known as joint attention (Tomasello, 1995). Numerous studies have established that joint attention emerges in infancy sometime between 6 and 12 months of age, becomes well established by 18 months, and continues to develop until around three years of age (Bates et al., 1979; Mundy & Gomes, 1998; Mundy & Neal, 2001). Joint attention plays an important role in social and cognitive development.

This chapter reports a study on the development of joint attention in the infants who participated in the active or passive early childhood music classes described in Chapter 3. Although the results of the study found that participation in these classes had no significant effect on the development of joint attention, we suggest that this may because joint attention is not sufficiently established by 12 months in order to observe differences between groups. Thus more study is needed to determine whether formal musical experience might play a role in the development of joint attention

CHAPTER 4

FORMAL MUSICAL EXPERIENCE AND THE DEVELOPMENT OF JOINT ATTENTION

ABSTRACT

Joint attention has been shown through numerous studies to be of great importance in the development of social competence and cognitive development. However, no previous studies have examined the effect of formal musical experience on the development of joint attention. The present study found that participation in six months of active or passive musical classes showed no effect on this skill. Our results suggest that perhaps more study is needed, over a longer period of time and with more sensitive measures, in order to determine whether formal musical experience affects the development of joint attention.

1.0 INTRODUCTION

Little is known about the effects of early interactive music making on development in infancy but a recent study by Gerry, Trainor and Unrau (2012) showed that active participatory music classes for infants and parents not only accelerated the acquisition of culture-specific knowledge of Western tonality, but also promoted superior development of communicative gestures and social behaviour as compared to classes with passive musical exposure. Trainor (2012) also found that brain development was more advanced in the active musical group. Parents in the active musical classes engaged in directed observation, journaling and expert pedagogical practices which may have helped to increase their awareness of their infant's social and cognitive development. The data analysed in the present study was collected from the same group of infants. Here we look at the effect of formal musical experience on the development of joint attention in 12-month old infants.

1.1 Definition of Joint Attention

Joint attention is the process whereby two people focus attention together on an object or an event, often by following the gaze or pointing gestures of each other (Tomasello, 1995). The development of joint attention begins in infancy, emerging between 6 and 12 months of age and continues to develop until about three years of age, although it is well established by 18 months of age (Bates et al., 1975; Mundy & Gomes, 1998; Mundy & Neal, 2001). Joint attention is important for social and cognitive development. Joint attention is also used by infants to respond to others in social interactions (Seibert et al, 1982). Numerous studies, including those of Adamson et al.

(2004), Mundy and Sigman (2006), and Masten and Coatsworth (1998), have shown that the emergence of joint attention in infancy is of great importance to the development of social competence later in life.

The joint attention triadic relationship (i.e., parent, infant and object) involved in communicating with others about a desired object first appears in periods of play in early infancy (Bakeman & Adamson, 1984). Nelson (1973) emphasized that there are large individual differences in how parents and infants interact and that socio-economic factors and education levels of parents affect these interactions. Nonetheless, Bruner (1976) outlined a general framework for the development of communication skills and joint action in terms of the sequential development of three modes, namely a demand mode (vocalization of basic needs), an exchange mode (gestures, facial imitation) and a reciprocal mode (interactions organized around cooperative execution of a task). He emphasized that the development of these modes during the first months of an infant's life provides the framework for the development of communication skills later in life. Infants who are slow to develop the necessary skills for the "reciprocal mode" are also slower in the development of social and communication skills.

1.2 Functions of joint attention

1.2.1 Language

Awareness and sensitivity on the part of parents to the nature of early communication though joint attention plays an important role in language development. A number of studies have shown specific links between language acquisition and style of parent-infant interaction, including Nelson (1973) and Tomasello and Todd (1983). For example, a pioneering study by Tomasello and Todd (1983) of parent-infant interaction showed a positive correlation between the time spent engaged in joint attention and the infants' vocabulary size at the end of a six-month period. Children whose parents tended to be dominant and directive during periods of interaction had vocabularies that contained a smaller percentage of object-related words. And directiveness by parents during the initiation of joint attention with infants has been shown to correlate negatively with the number of object labels in a child's vocabulary (Tomasello & Todd, 1983). Tomasello and Todd (1983) concluded that how parents communicate with infants overrides what they actually say.

Empirical research in this field has also shown links between joint attention and several other areas of development including gestural and verbal skills (Namy, Acredolo & Goodwyn, 2000), social communication (Wetherby & Prizant, 1990) and early cognitive development (Vaughan et al., 2003).

1.2.2 Social Development

Other studies have shown that parent/infant interaction is also associated with social and cognitive skills (Mundy & Neal, 2001; Vaughan et al., 2003; Wetherby & Prizant, 1990) as well as self-regulatory capacity (Butterworth & Cochran, 1980; Tomasello, 1995). Carpenter et al. (1998) showed that the amount of time parents and infants spent in joint engagement, along with the parents' use of language, could predict not only early communicative skills in infants but could also predict their social development. Joint attention appears to contribute to social learning and interaction across development. For example, Tomasello (1995) suggests that the relationship between joint attention and social competence later in life is affected by an infant's understanding of their ability to influence the behaviour of other people during periods when communication is initiated. As suggested by Tomasello and Todd (1983), the style of interaction by parents during periods of joint attention activities can influence the development of joint attention in infants. Mundy and Sigman (2006) propose that measurements of joint attention can help in understanding how social competence and social attention management skills develop in childhood.

The development of shared intentions and goals through joint attention activities in infancy is a form of cultural and emotional learning that enables children to participate successfully in collaborative activities throughout their lives (Tomasello et al., 2005). And studies have shown that social competence in older children is related to the development of joint attention (Nichols, Fox, & Mundy, 2005).

1.2.3 At-risk and special needs infants

Infants born at-risk also benefit later in life from the development of joint attention in infancy. Results from a study by Smith and Ulvund (2003) in which infants who initiated non-verbal attention bids showed gains in language acquisition, supported their hypothesis that the development of joint attention is associated with later cognitive development in infants born with very low birth weight. These results also supported the findings from an earlier study (Ulvund & Smith, 1996) relating the initiation of early communicative bids such as pointing or looking between the person and the desired object with cognitive development later in life. Infants who were able to initiate joint attention bids showed gains in language and motor skills when tested between the ages of 2-5 years.

The development of joint attention in infants with autism is delayed (Naber et al., 2007). Indeed, impairments in the development of joint attention are amongst the earliest signs of autism in infants, and the development of joint attention is positively associated with language gains in this population (Charman, 2003). Studies have also shown the importance of joint attention when hearing mothers interact with deaf children (Nowakowski, M.E., Tasker, S.L., & Schmidt, L.A., 2009; Spencer, 2000).

1.3 Music

Given that social competence at 30 months of age is predicted by joint attention behaviour at 12 months (Van Hecke et al., 2007), and that communication and social interaction are important for many areas of development (Mundy & Sigman, 2006 Tomasello & Farrar, 1986), other interactive activities between parents and infants might also affect joint attention. One frequent, highly social activity involves parents singing to infants. Indeed, music plays an important role in the world of infants. It appears that every society has special songs for infants (Trehub, 2006) and that caregivers communicate with pre-verbal infants through music such as lullabies and play songs (Rock et al., 1999).

An informal review of the music education literature on the effects of joint attention on musical development revealed that music educators have largely ignored this aspect of development. Indeed, music educators in general appear unaware of the concept of joint attention and its role in development. Here we investigate the effects of 6 months of formal music experience on the development joint attention in 12 month-old infants. Data for our analyses were collected as part of a larger study on the effects of formal musical experience on social, musical and language development (Gerry et al., 2012; Trainor, 2012). For this study, infants and their parents were randomly assigned to participate in one of two types of music classes, active and passive. The active music class utilized a Suzuki- philosophy early childhood education approach emphasizing movement, singing, playing percussion instruments, and building a repertoire of lullabies and action songs (Jones, 2004). Parents actively participated in the learning process; developing an awareness of their infants' progress is considered an essential component of this approach. In the passive music classes, parents and infants listened to a rotating selection of music from the popular Baby Einstein series. During the passive class, parents and infants listened to the music, while interacting with art, books, balls, blocks and stacking cup play stations.

2.0 EXPERIMENT 1

2.1 METHOD

2.1.1 Subjects

As described in Gerry et al. (2012), infants and parents were recruited through Ontario Early Years Centres, which are drop-in centers for preschool children and their families operated by the Government of Ontario. Fifty-two infants and their parents agreed to participate for six months in an hour-long weekly class. Two different classes were held at each of two different Ontario Early Years Centres located in areas of contrasting socioeconomic vulnerability. The classes were held on two different days of the week. Parents were randomly assigned to one of the days; this assignment dictated the type of training they and their infants received. At the beginning of the classes, 49 families were attending regularly (25 in the Active Training group, and 24 in the Passive Training group). By the end of the six months, 38 families were still attending classes regularly (defined as attending more than 75% of classes; 21 in the Active and 17 in the Passive classes) and were asked to participate in the final round of testing at 12 months of age. Of these, 34 families (20 Active and 14 Passive) participated in all initial and final tests. The infants included 19 girls and 15 boys. The McMaster Research Ethics Board (MREB) approved all experimental procedures, and informed consent was obtained from all parents.

2.1.2 Experimental Protocol

These tests were administered within a few days of the tests described in Chapter 3. The experimental protocol to measure joint attention was adapted from the Early Social-Communication Scales (ESCS) developed by Peter Mundy (Mundy et al., 2003). ESCS is a videotaped structured observation measure that has been designed to provide information about individual differences in nonverbal communication skills. Although the authors of the original ESCS state that it can be administered with children 8 to 30 months, it requires 25 minutes to administer and was therefore not practical for use with infants younger than 12 months of age. We therefore modified the testing protocol, shortening some sections, eliminating the "Follows Commands", "Response to Invitation", "Book Presentation", "Plastic Jar" and "Social Imitation" tasks. We added new measures with respect to music, specifically, we added one task involving a xylophone and for the "social interaction" task, we added a song element. In addition, we added a task involving stacking cups, which reflected the experience of infants in the passive music group.

Room Set-Up

The experimenter sat across a table from a parent who held his or her infant on his or her lap. The experimenter sat slightly to the parent's right in order to allow the video camera an unobstructed view of the infant. The video camera was placed in order to enable recording a full-face view of the infant.

The objects used in the assessment were placed on the table in view of the infant but out of their reach. Two large colourful posters were hung on each side of the infant, within their view.

Test Protocol

During the test, the experimenter performed a variety of tasks with natural but minimal verbal interaction with the infant and parent. Parents were instructed that if the infant attempted to interact with them, they should acknowledge him or her but then direct the infant's attention back to the experimenter. They were also instructed not to help infants with the operation of and interaction with the toys, and to keep verbal interaction to a minimum level. Parents were also requested to assist the experimenter by preventing toys from falling from the table and picking up toys that fell on the floor.

The Tasks

A. <u>Object Spectacle Task</u>

Target behaviours: Initiating joint attention, initiating behavioural requests, responding to behavioural requests

Objects: Turtle, Crinkly toy, Top

Administration: Present each toy three times

Each toy was presented slightly out of reach of the infant. If the infant made a bid for the toy, it was presented to them. The experimenter remained silent but attentive to enable the infant to initiate joint attention bids. If the infant initiated a bid (e.g., alternating eye contact between the object and the experimenter or reached for the object), the experimenter acknowledged the response by saying "Yes, I see it". If after a brief pause (3-5 seconds) no bid was made, the object was presented again to the infant. After 5 seconds of interaction with the object, the toy was retrieved from the infant and presented again. Each object was presented three times to each infant.

B. <u>Turn-Taking Tasks</u>

Target Behaviours: Initiating and responding to social interaction.

Objects: Ball, Giraffe

Administration: Present each toy three times

The imitative toys (Rolling Giraffe and Ball) were rolled towards the infant, accompanied by a vocalization of "whee". When the infant had the object, the experimenter sat with their hands apart on the table in a posture ready to catch the object. If the infant responded by rolling the object, the experimenter would catch the toy and roll it back. If the infant did not initiate a turn within 5 seconds, the experimenter would take the object and roll it again. This was repeated three times.

C. <u>Social Interaction Task</u>

Target Behaviours: Initiating and responding to social interaction

Tasks: Song, Vocal imitation

Administration: Two repetitions of a song, presented twice in each session

The task was presented twice during each session, once near the middle and again near the end. The experimenter sang to the infant the folk song "The Honeybee" and made hand movements towards the infant culminating in a tickle. The song was repeated twice during each set. At the conclusion of the song, the experimenter paused for approximately 5 seconds. If the infant made a bid for a repetition of the song with vocalization, eye contact or hand movements, the song was immediately repeated. If no bid was made, the experimenter paused and then repeated the task.

During the vocal imitation portion, the experimenter sang the infant's name several times using the interval of a falling minor third. The experimenter paused several times during the task to allow the infant time to respond.

D. <u>Gaze Following Task</u>

Target Behaviour: Responding to joint attention

Administration: Once

The task involved a sequence of the experimenter looking and pointing at posters to the right and left of the infant. The experimenter obtained the infant's attention, then turned his entire torso and visually oriented to a poster while pointing at it. To minimize the effects of arm movement, the experimenter pointed with his elbow in contact with his side. During the pointing, the experimenter did not look at the infant but said his or her name three times, each time becoming louder and more animated.

E. <u>Musical Instrument Task</u>

Target Behaviour: Xylophone knowledge

Object: Xylophone

Administration: Once

A wooden xylophone, used in the active music classes, was placed directly in front of the infant and mallets were placed in his or her hands. Parents were instructed to hold the infant near the instrument but not to give the infant any assistance in interacting with the instrument. Infants were allowed time to interact with the instrument while the experimenter offered verbal encouragement.

F. <u>Stacking Cup Task</u>

Target Behaviour: Knowledge of stacking cups

Object: Stacking cups

Administration: Once

A set of stacking cups, a popular toy used in the passive group, was placed in front of the infant. The experimenter then waited for the infant to interact with the cups, offering verbal encouragement when appropriate.

Tasks Order

Tasks and objects were presented in the following order:

- Wind-up turtle

- Small rubber ball
- Song
- Crinkly cloth toy
- Pointing task
- Xylophone
- Vocal Imitation
- Stacking Cup
- Rolling Giraffe
- Song
- Rolling toy top

2.1.3 Coding of the video tapes

DG and LT developed the method for coding the videos. DG and a blind, independent observer coded the videos tapes from the sessions.

For the **Object Spectacle Task**, attention bids were counted for each toy.

Attention bid when the experimenter has the toy:

- Number of times infant looks at the experimenter
- Number of times infant looks at the toy
- Number of times infant looks elsewhere
- Number of times infant looks at mother or father
- Thumping the table (yes/no)
- Reaching for the toy (yes/no)

When the infant has the toy:

- Number of times infant looks at the experimenter
- Number of times infant looks at the toy
- Number of times infant looks elsewhere

When the toy is taken away, does the infant:

- Look at experimenter (yes/no)
- Vocalize upset (yes/no)
- Try to reach for toy (yes/no)
- Thump table (yes/no)
- Cry (yes/no)

For the **Turn-Taking task,** when the infant has the toy, bids were measured for:

- Number of times infant looks at the experimenter
- Number of times infant looks at the toy
- Number of times infant looks elsewhere
- Does the infant return the toy

For the **Social Interaction Task,** the following behaviours were measured:

- Smiling during the song or immediately after the song (yes/no)
- Reaching to the experimenter during the song (yes/no)
- Eye contact during the song (yes/no)
- Eye contact immediately after the song (yes/no)
- Arm movement at the end of the song (yes/no)

- Whether the first and second song sets were consistent (yes/no)
- Finger movement after song (yes/no)
- Reaction to tickling (Smile; None)
- Whether the infant did vocal imitation (yes/no)

For the **Gaze Following Task,** we measured:

- Does the infant follow the pointing gesture? (yes/no)
- Consistent for both sides? (yes/no)

For the **Musical Instrument Task,** we measured:

- Infant reaction to xylophone (positive, negative, neutral)
- Interaction with instrument (i.e., plays instrument, sucks mallets, etc.)
- Position with instrument
- Where infant looks (parent, experimenter, instrument, elsewhere)
- Reaction when instrument is taken away

For the **Stacking Cup Task,** we measured:

- Infant reaction to cups (positive, negative, neutral)
- Interaction with cups (stacks cups, throws cups, etc.)
- Where infant looks (parent, experimenter, toy, elsewhere)
- Reaction when cups taken away

2.1.4 Videotape rating

DG and the independent rater recorded the number of attention bids the infant had with the experimenter, parent and toy, as well as observations on infants' vocalizations, behaviour and temperament. An analysis of the interrater reliability showed a correlation of .85, a result that is equal to or exceeds typical standards in numerous previous studies in this area (e.g., Mundy et al., 1988; Mundy & Gomes, 1998; Sheinkopf et al., 2004).

2.2 RESULTS AND DISCUSSION

A number of exploratory analyses on the coded data revealed few differences between infants in the active and passive groups in the joint attention tasks. Due to the large number of categories coded, it was decided that, for analysis, only the results from the number of attention bids by the infant when the toys were in or out of reach would be reported, as this is the most critical test for assessing joint attention. The dependent variables were the number of times infants looked when the toy was within reach and when it was taken away. A two way mixed ANOVA was conducted with the number of looks at the experimenter when the toy was taken away versus the equivalent period before the toy was given (Pre-Post) as a within-subjects factor and Training Group (active, passive) as a between-subjects factor. There was no main effect of a group but there was a significant interaction between group and Pre-Post, $F(1, 30) = 6.49$, $p = .016$ (see Figure 1). After participation in the music classes, infants in the passive group looked less at the experimenter when the toy was taken away than infants who participated in the active group. Given that the coding results did not reveal many significant differences between active and passive groups, in Experiment 2 we approached the problem in a different way by having adults rate video clip excerpts to see whether they would rate infants differently who were in the active and passive groups.

A file showing the data analyzed in this experiment is available at www.davidgerry.ca/joint-attention.html.

3.0 EXPERIMENT 2: ADULTS RATINGS OF THE VIDEO TAPES

3.1 METHOD

3.1.1 Participants

Participants were 128 university students (93 female, 35 male), and were either recruited through McMaster Introductory Psychology classes for partial course credit, or by word of mouth. Ages ranged from 18 years to 36 years, with a mean age of 20.8 years (SD=3.2). Apart from specifying that participants should be 18 years of age or older, no special criteria were used for recruitment.

3.1.2 Procedure

Video clips were extracted from the video recordings described in Experiment 1 from the task examining infants' reactions to a novel toy stimulus (walking turtle) while in the presence of his/her parent and an experimenter. There was a total of 16 stimuli, each a video clip of a different infant. Clips ranged from 54 s to 122 s, with an average of 92.69 s (SD=19.97). Of the 16 clips, 8 infants were from the active training (experimental) condition, while the remaining 8 were from the passive condition.

Adult participants were presented the videos in pairs (two videos played back-to-back). Each combination (video pair) constituted a trial. Taking all possible pair-wise combinations between the 16 videos results in a total of 120 video pairs. Reversing the order of the two clips within each trial results in an addition 120 pairs for a total of 240 pairs.

Each participant was assigned to rate one of four attributes: sociability, intelligence, happiness, or good parent-child relationship. On each trial they made a forced-choice comparison between the clips of the two infants. They chose the infant that they perceived to better exemplify their assigned attribute by marking either "BABY A" or "BABY B" on a provided checklist. For example, if a participant was assigned the sociability attribute, on each trial they would select the infant that they believed to be more sociable.

Each participant viewed 15 trials (video pair combinations) and therefore made 15 forced-choice comparisons. Eight participants viewed each trial, with two participants assigned to each of the four attributes, providing us with two answers per attribute for every pair combination. Analyses were done separately for each attribute (sociability, intelligence, happiness, or parent-child relationship). We analyzed how each infant was rated in regards to each attribute. Every time a certain infant was selected over the other infant it was paired with, he/she was awarded a point. With all possible pair-wise combinations in both forward and reverse order, each infant video clip was seen 30 times. Furthermore, because two participants were assigned to rate each attribute per trial, each infant would be assessed a total of 60 times per attribute. Therefore, the maximum score an infant could collect was 60; in such a scenario, the infant would have been consistently chosen as better exemplifying the attribute in question across all raters.

Each of the 16 infants received four scores (out of 60): one each for sociability, intelligence, happiness, and relationship with his/her parent. Within each attribute, scores were sorted according to the group the infants belonged to: active training (experimental), or passive training (control).

3.2 RESULTS AND DISCUSSION

Each of the four attributes was analyzed separately using t-tests in Microsoft Excel to see whether there was a difference between conditions (passive training or active training). None of the four variables (sociability, intelligence, happiness, parent-child relationship) were rated as significantly different between the infants given passive training and those given active training (see Table 1 for scores). Score differences (active – passive) were 0.50, -1.25, -1.25 and -6.25 respectively for sociability, intelligence, happiness, and parent-child relationship (Table 2). None of these values reach statistical significance ($p >> 0.05$). Only the sociability attribute was seen to be slightly, though non-significantly, higher in the active musical training group. Interestingly, ratings of happiness and intelligence were correlated (Table 3), but the measures were otherwise not significantly related.

Adults' ratings showed large variability between infants in each group, which may have masked any effects of musical training condition. The highest standard deviations were reported for the passive training condition on the attributes of happiness and sociability (see Table 1). In any case, these results suggest that predispositions unrelated to the musical training are largely driving the ratings of the adult participants.

Although the data do not support the research hypothesis that active musical training affects social development, perhaps 6 months of training was not enough to show differences between the groups. It is also possible that the university students involved in rating the videos did not have enough experience with infants in order to detect subtle differences. A future experiment could use experts in the fields of music education or early childhood education to rate the videos, as they might be more sensitive to subtle differences between the infants and their parents. It would be interesting to see if results from a group of such "expert" raters differed from the results reported here.

In the initial report on this training study, Gerry et al. (2012) did report a number of differences between the active and passive groups after the musical training, including differences in social development. In Experiment 3 of the present study we examine whether our measure of joint attention relates to these variables.

4.0 FURTHER ANALYSES: RELATON TO DATA FROM PREVIOUS STUDIES

4.1 METHOD

Gerry et al. (2012) used the Infant Behavior Questionnaire (IBQ) to obtain scores of social-emotional development and the MacArthur Communicative Development Inventories (MCDI) to obtain scores for the use of early communicative gestures on the infants in the present study. They also collected a measure of infants' sensitivity to Musical Tonality, a measure of infants' esthetic understanding, and obtained an overall score of socio-economic status (SES) risk. In the present experiment, we examined relationships between these variables and our measures of joint attention used in

Experiments 1 and 2, specifically, the coded number of attention bids infants exhibited (Experiment 1) and adults' ratings of sociability, intelligence, happiness, and infant/parent bonding (Experiment 2). For the IBQ, we used separate subscores for distress, approach and smiling. Gerry et al. (2012) found that infants in the active group showed superior performance on the IBQ, MCDI and Musical Tonality tests compared to the passive group. Here we were interested in whether these variables are related to our measures of joint attention analyzed in Experiments 1 and 2.

In detail, correlations were performed using the following variables:

- Ratings of sociability, intelligence, happiness and infant/parent bonding from the adult ratings of Experiment 2
- The number of attention bids by the infant when the toy was in or out of reach from the coding data of Experiment 1
- Scores from the IBQ (distress, approach, smiling) and MCDI from Gerry et al. (2012)
- Scores from the tonality test and esthetic understanding test from Gerry et al. (2012)
- SES risk score from Gerry et al. (2012)

4.2 RESULTS AND DISCUSSION

There were no significant correlations. These results indicate that the measures of joint attention used in Experiments 1 and 2 are not related to other outcome measures (IBQ, MCDI and Musical Tonality) that differentiated the active and passive groups. This suggests that our measure of joint attention may not be very sensitive.

5.0 GENERAL DISCUSSION

Although joint attention has been reported to be present as early as 6 months (Bakeman & Adamson, 1984), most studies examine its emergence after 12 months of age (Ingsholt, 2002; Sheinkopf et al., 2004; Vaughn et al., 2003). It is generally conceded that in typically developing infants, joint attention is fully established by around 15-24 months of age (Bakeman & Adamson, 1984; Ingsholt, 2002). Taking these findings into consideration, it is probable that the lack of significant differences reported here between groups reflects the fact that joint attention is not robustly established in either group at 12 months of age.

Gerry et al. (2012) found that infant-parent bonding in the active music classes promoted not only musical learning but also increased communication skills and more even temperament in infants (Gerry et al., 2012). For instance, parents in the active music group reported that their infants used more communicative gestures and that their infants smiled more and were easier to sooth compared to parents in the passive group. This suggests that active music classes do affect social and communicative interaction. It is possible that more evidence of the development of joint attention would have been observed in the present study had the period of musical study exceeded 6 months and/or had infants been older at the time of joint attention testing. The significant interaction found in Experiment 1 reflecting different looking patterns between the active and passive infants suggests that the active music classes may have had some effect, however small. Specifically, infants in the active group looked more at the experimenter than at the toy when the toy was taken away, suggesting more sophisticated joint attention behaviour than in the passive group infants, who looked at the toy more than they engaged with the experimenter. However this result should not be over-interpreted because of the many statistical tests done this was the only one that reached significance and therefore may reflect a Type 1 error.

Experiment 3 found no significant correlations between the measures of joint attention analyzed here and the previous measures from Gerry et al. (2012) on social and communicative development that did differentiate between the active and passive groups. Again this suggests that the measure of joint attention used in the present study was not a sensitive measure of social development. And again, the most likely reason for this is that the infants were simply too young to manifest robust joint attention behaviour. It would be interesting in future studies to develop more sensitive measures of joint attention and/or precursors to joint attention that could more robustly differentiate between infants.

It would also be interesting in future studies to examine whether joint attention exercises could be more explicitly incorporated in early childhood education classes and whether this would be beneficial for infants and parents. In addition, inclusion of the topic of joint attention in early childhood music teacher training could prove beneficial for both infants and those who teach them, resulting in more optimal pedagogical approaches.

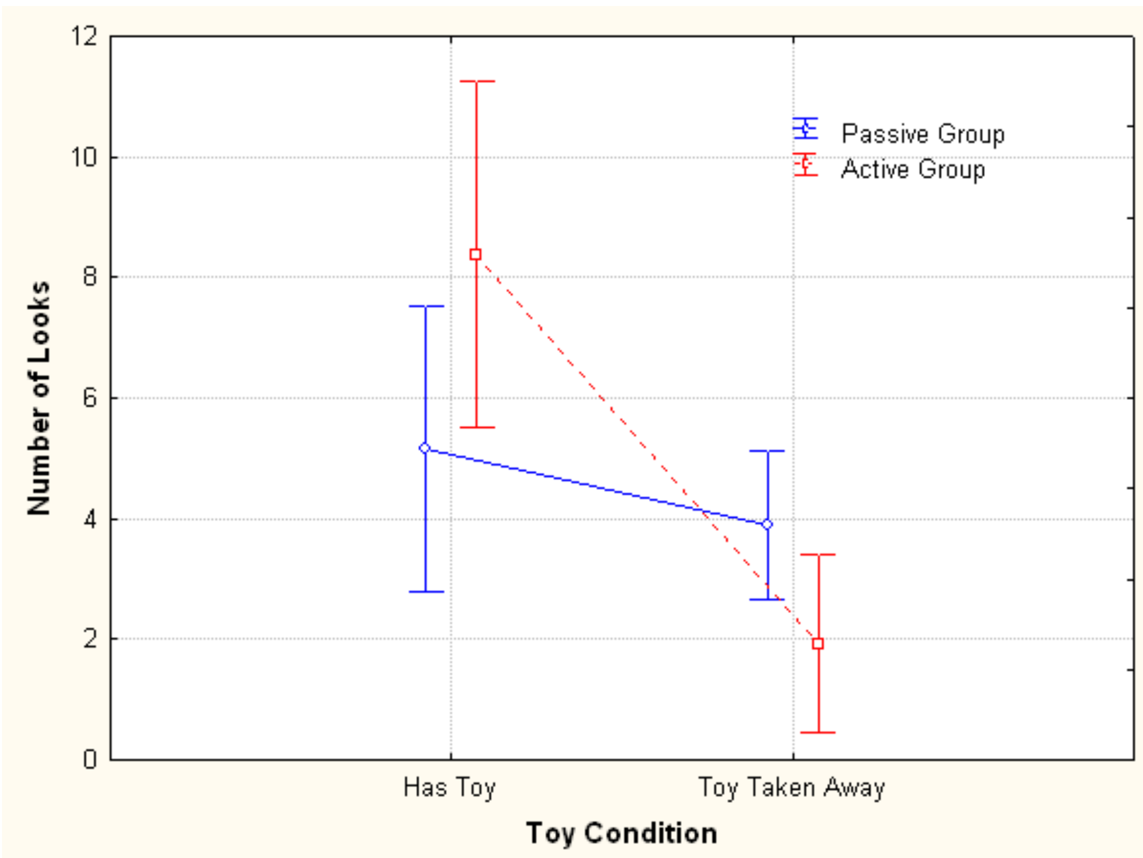

Figure 1. Comparison of infants in the active and passive training classes on joint attention. The average number of looks at the experimenter is shown for while the infant had the toy and after the toy was taken away for the active and passive groups. The interaction between toy condition and group was significant, $p = .016$.

Table 1: Mean (and SD) adult ratings of video clips in Experiment 2.

Sociability			Intelligence			Happiness			Parent-Child Bond		
Baby	Score	Mean	Baby	Score	Mean	Baby	Score	Mean	Baby	Score	Mean
Passive Training			Passive Training			Passive Training			Passive Training		
1	7		1	16		1	14		1	44	
2	21		2	28		2	22		2	46	
3	46	29.75	3	26	30.63	3	48	30.63	3	33	33.13
4	22	(SD =	4	20	(SD =	4	22	(SD =	4	9	(SD =
5	6	18.24)	5	26	11.55)	5	3	18.13)	5	43	13.02)
6	47		6	50		6	54		6	27	
7	52		7	43		7	46		7	41	
8	37		8	36		8	36		8	22	
Active Training			Active Training			Active Training			Active Training		
9	58		9	48		9	51		9	34	
10	10		10	10		10	12		10	7	
11	32	30.25	11	27	29.38	11	32	29.38	11	17	26.88
12	34	(SD =	12	21	(SD =	12	48	(SD =	12	39	(SD =
13	26	14.15)	13	33	12.06)	13	21	15.95)	13	40	11.91)
14	17		14	21		14	7		14	34	
15	33		15	39		15	26		15	26	
16	32		16	36		16	38		16	18	

Table 2: Differences between adults' ratings of infants in Active and Passive conditions in Experiment 2

	Mean Active Training Score — Mean Passive Training Score
Sociability	30.25 – 29.75 = **0.50**
Intelligence	29.38 – 30.63 = **-1.25**
Happiness	29.38 – 30.63 = **-1.25**
Parent-Child Bond	26.88 – 33.13 = **-6.25**

Table 3: Correlations between the attributes rated in Experiment 2

Variables	Sociability	Intelligence	Happiness	Parent-Child Bond
Sociability	—			
Intelligence	0.787*	—		
Happiness	0.923*	0.651*	—	
Parent-Child Bond	0.009	0.154	-0.017	—

*$p<0.05$

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CHAPTER 5

GENERAL DISCUSSION

This thesis has presented the first empirical evidence of the effects of formal musical experience in infancy. The results of Chapter 2 indicated that infants who participate in Kindermusik training show a greater bias for processing duple meter as compared to triple meter than infants not in music training. The Kindermusik infants also showed longer looking times in general, which could suggest that the musical training has resulted in increased interest in musical stimuli. The results of Chapter 3 indicated that infants who participated in Suzuki early childhood music classes with their parents showed an accelerated development of culture-specific knowledge of Western tonality, as well as advanced development of pre-linguistic communicative gestures and social behaviour compared to infants who participated in passive music classes. Although the experiment in Chapter 4 examining joint attention did not yield significant results, the findings were encouraging enough to suggest that further studies should be undertaken to investigate the development of joint attention behaviours after longer periods of formal music classes.

The results of this thesis provide an initial link between the scientific study of the development of musical, social and language skills in infancy and optimal pedagogical practice. My purpose in undertaking this study was to investigate the effects of active musical experience on infant development and determine whether parents and infants can participate in meaningful formal musical experiences together. In addition I wished to be able to make recommendations for curriculum and pedagogical practice for music educators who are interested to find optimal ways of working with young children, not only in the context of musical development, but also in the context of understanding general developmental processes.

Results from the study of infants and Kindermusik training provide some valuable suggestions for music educators. Phillips-Silver and Trainor (2005) showed the importance of multi-sensory experience for the processing of auditory rhythmic stimuli. An examination of the musical selections used in Kindermusik training reveals a predominance of duple meters. This reflects what is seen in the Western musical canon where duple meters are used more frequently than other metrical patterns. However, increasingly composers working in both popular and classical genres are incorporating more adventurous metrical patterns in their music, reflecting an increased interest in world music traditions (Ross, 2008). Thus the ability to process more complex meters is becoming more important in Western culture.

Previous research showed that North American infants are able to detect changes in Bulgarian, Macedonian and Western rhythmic patterns at 6 months, but that by 11 months infants are only able to detect changes in Western patterns, presumably as a result of exposure primarily to Western music (Hannon & Trehub, 2005b). Combined with my finding that infant music classes can accelerate this process, in the context of the incorporation of more complex rhythms into popular and classical Western music (Ross, 2008), I would suggest that it is time to reconsider the type of music utilized in infant music classes. Music educators should consider introducing music that reflects a wider range of cultural traditions in order to expose infants to a greater variety of metrical patterns. Increasingly, recording companies such as Putamaya, one of the world's largest producers of "world music" CDs, are marketing music aimed specifically at infants and toddlers. In addition, the French firm ARB is now increasing their marketing of high quality acoustic recordings featuring children from around the world singing traditional songs. Music teachers could incorporate such music in their classes. And since the multisensory experience of rhythm plays an important role in how infants encode the meter, parents should be encouraged to move with their infants while listening to music, rather than experience it in a more passive manner.

This thesis has also provided major contributions to the fields of development and early music education with the results of the first empirical study of the effects of formal musical experience on infants. Toys and recordings aimed at infants and toddlers total about 20% of worldwide sales. DVDs and CDs seem to have replaced a great deal of active musical engagement with infants. DVDs are often marketed as ways to increase vocabulary and knowledge of the world around infants, while toys may be purchased that play lullabies to sooth children at bedtime or provide an opportunity to explore musical sounds. Often these recordings and toys use synthesized musical sounds and lack musical expression.

In contrast, the Suzuki Early Childhood Music classes studied in this thesis emphasize good singing skills, the development of musical skills through learning a repertoire of songs and games, repetition of musical experiences and parental documenting of their observations of their infants' development and preferences (Jones, 2004). Parents play an important role in the classes. In addition to participating in the weekly classes with their infants, they play the recording at home and engage in daily musical activities including singing and movement. The control group, which utilized the rotation of Baby Einstein recordings and explored a variety of activities including art and free-play, is not unlike the curriculum found in any number of infant music classes commercially available. The music used in class was entirely synthesized as compared to the acoustic music in the Suzuki class. And rather than utilize repertoire that repeated every two weeks, the music played in class and by the parents at home changed on a weekly basis. The emphasis in class was on passive musical experience with no singing in class by the parent. However, parents did actively engagement in play with their infants. Although it is not possible to determine which factors led to the effects seen, it is likely that various aspects of the pedagogical approach likely played an important role.

Repetition may have been an important factor in the results seen. It plays an important role in the Suzuki curriculum, with the lullabies and playsongs chosen rotating on a bi-weekly basis and used for the duration of the classes. This was not the case for the Baby Einstein CDs played during the control group classes. Repetition of the Suzuki repertoire enables parents and infants to become familiar with the material, as they participate together in class and work on the same skills at home. Although we cannot directly determine the importance of repetition from the present study, it may have been crucial for promoting learning in the infants as they became familiar with the music and activities and their parents became able to sing the songs.

The quality of music used in the Suzuki classes may also have been important. The curriculum uses high quality, acoustic music that is always expressively sung and played, as compared to the Baby Einstein recordings where the music is synthesized and completely unexpressive. In addition, parents learned to sing confidently and expressively during the course of the classes. Parents were provided with expert modeling by the teachers during class and the recordings at home, and parents in turn provided good singing to their infants.

Awareness of infant development and preferences by the parent were also important aspects of the Suzuki class. Weekly journaling by the parents promoted explicit observation of their infants and may have contributed to greater sensitivity on the part of the parents, which have may have contributed in turn to the differences in scores between the Suzuki and Control groups on the Communicative Gestures and IBQ questionnaires. Given that this aspect of the music classes in not emphasized in most infant music programmes, future research should be done to determine its impact.

We can conclude from the research in this thesis that music experience between infants and parents when part of a music class emphasizing repetition, high-quality music, engaging activities and sensitivity to infant development leads to significant musical, prelinguistic and social effects. Future studies will be able to explore with more specificity what elements of the musical training are critical to these gains.

The development of joint attention in infancy has been well documented in the literature. Although it can emerge as early as 6 months (Bakeman & Adamson, 1984), it is generally accepted that it is not fully established until 15 to 24 months of age (Wetherby & Prizant, 1993). Here we tested infants at 12 months of age, after 6 months of music classes, and for the most part found no significant differences between groups. However, the significant interaction between group and number of attention bids suggest that future studies may be useful. Infants in the Suzuki group looked more at the experimenter when the toy was taken away, as compared to infants in the passive music condition who looked more at the toy. This suggests that perhaps with a longer training period, more differences between the groups may have been evident.

As was suggested in Chapter 4, it is also possible that 12-month-old infants lack the cognitive maturation to show that learning has taken place. Tasker and Schmidt (2008) suggest "well-timed events in the behaviour of mother-child interaction are particularly well-suited to testing joint attention as an early pre-lingual mechanism and to detecting early problems created by ineffective patterns of social behaviour". It would thus seem that the type of active engagement seen in the Suzuki music classes would provide an excellent area for future study of parent-infant interaction and its effect on the initiation of joint attention. I would also suggest that future studies in this field could also look at different methods of coding these interactions, with a particular emphasis on parental behaviour during the process. Music educators would also likely benefit from an understanding and awareness of the process of joint attention. My thesis brings this important developmental process to the attention of the music education community. Awareness and understanding of the acquisition of joint attention during development would enable educators to design curriculum with this in mind.

In Canada, the decline in funding for music education varies greatly by province. The non-profit advocacy group "People for Education" released a report in 2014 on the state of public education in Ontario. Although 85% of public schools in Eastern Canada and Quebec employ specialist music teachers, in Ontario only 43% of public elementary schools employ specialists, as compared to 2012 when 49% of those same schools utilized specialists. And they found that nearly a third of Ontario schools have no music teachers at all. Although the report did not address infant and early childhood education programmes, one could surmise that the situation within those areas is similar (People for Education, 2014).

There has always been debate amongst music educators as to what is an optimal age to commence musical training. The results from the present thesis show that formal musical training can have an effect during infancy. Considering the amount of money spent on toys, recordings and activities during infancy, as well as the wide variety of infant classes currently offered, this thesis offers some empirical evidence in support of considering optimal pedagogical practices for classes with infants. Rather than using music media as a substitute for active engagement in music activities for parents and infants, this thesis suggests that active engagement in musical activities, when combined with sound pedagogy, high-quality music, metrical variety and parental involvement may result in enhanced music, language and social skills for infants as well as optimal experiences for infant-parent bonding.

Limitations

One of the primary limitations of the research is that the classes were only offered for a period of six months It is not known if the effects found in the study were long-lasting or if the control group infants would have "caught up" and shown the some of the same effects past the six month study period. Moreover, the design of the study was such that we were only able to study two pedagogical approaches: the "active" Suzuki class and the "passive" control group. There will always be controversy when one pedagogical method is chosen over another. For the present study, we made a choice of using the Suzuki approach for early childhood music classes after careful study of curriculum, pedagogical goals and the choice of music. However, we are unable to determine exactly what factors caused the differences between the active and passive groups beyond the speculation that it was some combination of infant-parent-teacher interaction, repetition of high-quality music and choice of music used in the class.

Chapter 4 indicated that six months of formal musical experience did not have a significant effect on the development of joint attention at 12 months of age. It remains unknown as to whether the classes resulted in joint attention differences at a later age (e.g., 18 months), or whether joint attention enhancement requires more than 6 months of musical training. It is also possible that the measures used for determining differences between groups were also a limitation with respect to joint attention. More sensitive measures such as motion capture might well have been useful in determining differences between the groups.

Future Directions

It remains for future studies to determine precisely which differences between the Suzuki and control classes caused the differences between groups. It is also for future studies to determine if other popular early childhood music programmes (such as Music Together or Musikgarten) have the same effects on social and cognitive development as the Suzuki approach studied here.

In order to determine whether the effects of the early training are robust and long lasting, a longer longitudinal study would need to be done, perhaps lasting three or four years. In addition, it would be useful to study the effects of formal musical experience on school readiness for junior and senior kindergarten students, especially bearing in mind the recent implementation of full-day Kindergarten programmes in the province of Ontario, as well as the emphasis on providing the best possible start for children. These considerations could be useful for developing curriculums for children of this age.

Given the results of the study of Kindermusik, which found a bias for duple meters in infants enrolled in music classes, it is important to examine the effects of early rhythmic experience further. In order to inform early music educators, research on the amount and type of exposure to complex meters that is needed to maintain and expand sensitivity in this domain is needed. Educators who use the Suzuki approach for early childhood music classes are currently reflecting on ways to incorporate non-Western music within their curriculum. As they do so, research could be done on the effect that this has on the rhythmic skills of students who continue formal instrumental and vocal study.

Final Thoughts

My goal for this research was to use quantitative research methods to help provide answers for questions frequently posed by music educators regarding non-musical benefits derived from early music education. It is my hope that educators will use the results to help shape the type of music used in their classes—in terms of quality and variety—and to consider the effects of the pedagogical approach on learners' cognitive and social development. It is my hope that these findings, in addition to fostering an awareness of sensitive periods in development and the emergence of joint attention in early childhood, will enhance current pedagogy and perhaps inspire future curriculum development. By working more closely with music educators, the scientific community will be able to help develop more effective pedagogical approaches, from which all children may benefit.

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