DEVELOPMENT OF MUSICIANSHIP AND EXECUTIVE FUNCTIONING AMONG CHILDREN PARTICIPATING IN A MUSIC PROGRAM

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ABSTRACT

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Music programs may contribute to children's musical and behavioral development. This study investigated the development of musical skills and behaviors associated with executive functioning among students in one urban elementary school, across one academic year of participation in an intensive after-school music program. This study provides evidence that music programs may be particularly well-suited to helping children develop executive functioning skills important to success in school and life. This type of evidence may support the existence of music programs, particularly those that serve underprivileged children.

The first research question asked to what extent children participating in a music program demonstrate musical development as indicated by measures of developmental music aptitude and performance. Music program participants demonstrated significant growth across the year in tonal developmental music aptitude. The music program seemed to have a greater effect on students' tonal music aptitude than their rhythmic music aptitude, but rhythmic music aptitude scores were high at both time-points. There is also evidence that students' tonal and rhythmic performance skills increased across the year.

The second research question asked how music instruction activities differ in the extent to which they provide opportunities for children to practice behaviors associated with executive functioning (shifting, inhibition, updating and attention) and in students' rates of active vs. passive engagement and off-task behavior. Many music activities afford and constrain the use of attention, inhibition, updating and shifting, and provide frequent feedback to students and

teachers. Musical tasks differed in levels of executive functioning affordances and constraints. Overall the music activities observed in this study were associated with high levels of student engagement, particularly active engagement, and low levels of off-task behavior. These levels differed significantly by activity. Further analyses revealed some relationships between executive functioning affordances and constraints and students' levels of engagement and off-task behavior. When students are actively engaged in music class, they are more likely to be practicing the important skills of attending, inhibiting, updating and shifting. Good music instruction can teach us about ways to engage students with any kind of instructional material.

The third research asked to what extent students participating in a music program demonstrate, over time, improved behaviors associated with executive functioning in the general education classroom compared to students not participating in a music program. Music students' behaviors associated with executive functioning, as rated by classroom teachers, did not improve relative to control students. In fact, music students showed increasing difficulties in the areas of inhibition and shifting. This study did not find evidence of the executive functioning skills practiced in the music program generalizing or transferring to the general education setting. Sensitivity of behavior to environmental context, teacher bias and the short timeframe may also have contributed to lack of support for the hypothesis.

The fourth research question asked, for students participating in a music program, whether musical development correlates with development of executive-functioning-related behaviors in the general education classroom. Overall, data trended toward supporting the hypothesis that music and executive functioning skills develop together. More research is needed to better understand the extent to which the relationship between expert musicians and high executive functioning skills is due to a reciprocal developmental process or selection.

DEDICATION

I dedicate this dissertation to my wonderful family. Especially to my inspiring mom, Nancy, who made me who I am and encouraged me to pursue this topic. And to my supportive husband, David, who is the joy of my life. Without their love and belief in me, this dissertation could not have been written.

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CHAPTER I:

INTRODUCTION

Problem Statement

The effect of today's educational climate on student access to school music programs. As a result of legislation such as No Child Left Behind (2001), schools have become increasingly accountable for the academic achievements of all students, regardless of race, socio-economic status, language or disability (Ysseldyke et al., 2006). Positive effects of this legislation may include greater exposure to the regular education curriculum for students with disabilities as well as better alignment between students' individualized education programs and the regular education curriculum (Merrell, Ervin & Gimpel, 2006). However, along with these benefits might come some unintended consequences. Increased academic performance pressure may lead schools to focus solely on "core academics," ignoring other important aspects of child development. Narrowing of the curriculum may also be contributing to fine arts programs being cut from schools. In many US schools, music programs are being cut despite potential benefits to children. For example, in California, the percentage of students involved in music education declined by 50% and the number of music teachers declined by 27% between the years 1999-2000 to 2003-2004 (Music for All Foundation, 2004). As school districts face increasing financial difficulties, music education programs are often cut. In some cases, gifted programs or magnet schools are established, but these often neglect the music education needs of average students (Gordon, 2007). While today's increased emphasis on core academic areas such as reading and math is essential to improve student outcomes, school psychologists should also be thoughtful about what schools are doing to support other important areas of child development.

Urgent need to understand the impact of music study on child development. School psychologists do not seek to promote academic skills alone; we also work to enhance the development of students' wellness, social skills, mental health and life competencies by building the capacities of systems to meet children's needs at the universal, targeted and intensive level (Ysseldyke et al., 2006). Within the field of school psychology there is a focus on meeting the needs of all students through prevention strategies that lead to positive behavior, social-emotional learning and high academic achievement. As school psychologists with the goal of promoting children's academic and social-emotional success in school and in life, we should be aware of the trend of music programs being cut and understand the ways this trend may impact children, for better or worse. To understand this we need to gather evidence about whether and how music programs actually benefit children. As schools and communities are strapped for resources and having to make difficult funding decisions, music programs are being cut. Therefore, it is particularly critical and urgent that we have empirical evidence to understand how music programs may benefit children. This data and insight could inform the programming choices and funding decisions of schools and communities. This urgent need for data forms the rationale for this study. This study will examine the existing theoretical and research basis to support providing high-quality music programs to schoolchildren and will seek to deepen our understanding of the impact of music programs on child development.

Extra-musical benefits of music study. Within the music education and music therapy literature there is a substantial amount of theory and research into extra-musical benefits of participation in a music program. Much of this research has investigated the relationship between music and enhanced academic outcomes. Students involved in music have, on average,

higher SAT scores, more academic honors, higher grades, and higher achievement scores in math and reading (MENC, 2000; Catterall, Chapleau, & Iwanaga, 1999; Butzlaff, 2000).

In addition to the research on academic outcomes of music students outlined in the Introduction, there are many other important areas of research into the extra-musical benefits of music study. Some researchers argue that because music is an inherently social activity, music programs afford the opportunity to enhance children's social skills, as well as leadership and cooperation (Gooding, 2009). One way that music education may contribute to children's development of social skills might be through participation in a caring classroom community. Children do not necessarily have a healthy social network at home. Schools can provide healthy social communities that give children the opportunity to develop into psychologically healthy members and contributors to society. Music education may be uniquely positioned to provide children with a healthy community experience. During participation in a music ensemble children collaborate with one another to contribute to a greater whole. Their voice is an important part of the whole group. Their collaborative efforts are rewarded through the creation of something beautiful and moving. They can learn what it is like to experience a shared emotion. The shared musical experience may lead the children to care for other members of their musical community because they have shared a meaningful life experience.

Other potential benefits of music study include increasing children's self-esteem and providing another venue for children to experience success at school (Kokotsaki & Hallam, 2007). Music study could foster aesthetic appreciation and creative expression. Levitin (2006) writes that music is a human activity that all people are wired to participate in. Others argue that music brings opportunities for enjoyment and personal growth (O'Byrne, 2009; Peterson & Seligman, 2004). Some researchers aim to show that "music makes you smarter," (e.g.

Rauscher, 1998; Schellenberg, 2006, 2004). Gordon (2007) argues that music provides unique cognitive challenges.

Some music programs explicitly seek to promote general ways of thinking that are not discipline-specific but are shared among many disciplines. Burton, Horowitz, and Abeles (2000) used teacher interview, classroom observation and review of existing research to identify and classify outcomes of school-based arts education and arts partnership programs that are both central to arts learning experiences and widely applicable within other domains of learning. They classified these outcomes into three broad categories: cognitive capacities, socio-cultural capacities, and personal learning capacities. Cognitive capacities include expression of ideas and feelings, focused perception, making connections, seeing multiple perspectives, imagining new possibilities, sensory learning, layered relationships and the construction and organization of meaning. Socio-cultural capacities include cooperative learning, compassion and empathy. Personal learning capacities include risk-taking, confidence and competence.

Additionally, students with high arts involvement outperform students with low arts involvement on academic measures; this effect holds true among students with low SES backgrounds (Catterall et al., 1999). Because most of this research on the link between music study and academic achievement is correlational, we do not know whether music causes increased academic achievement. It is possible that the reason for the observed correlation is that children of privilege/high SES backgrounds are more likely to participate in music programs and that their background advantages, rather than the music study, lead to higher levels of academic achievement. While it is true that economically disadvantaged students have less access to music and other arts programming, arts participation is associated with higher achievement even among economically disadvantaged youth (Catterall et al., 1999). There is a need for research

examining *how* music study may lead to school success. For example, a question that follows from these academic outcome studies is: what is the underlying mechanism for how music study leads to school success?

Executive functioning, school success and at-risk students. Executive functioning, a collection of processes that guide, direct and manage our cognition, emotions and behavior, makes an important contribution to academic success (Gioia et al., 2000). Executive functions are crucial for success in school and in life. According to Meltzer (2007), academic success requires students to plan their time, organize and prioritize materials and information, distinguish main idea from details, shift approaches flexibly, monitor their own progress, and reflect on their work.

Children from economically disadvantaged backgrounds are more likely to face certain challenges in school and in life, including behavioral difficulties associated with executive functioning skills (Ackerman, Kogos, Youngstrom, Schoff, & Izard, 1999; Randolph, Koblinsky, Beemer, Roberts, & Letiecq, 2000; Noble, McCandliss, & Farah, 2007). These students are sometimes labeled "at-risk". According to Croninger and Lee (2001) students labeled at-risk are often those who belong to a disadvantaged group or experience difficulty in academic or social domains. What these individuals are at risk for is usually considered to be academic failure, dropout, diminished prospects for future gainful employment, substance abuse or criminal activity. (Croninger and Lee stress that "risk" is only a matter of probability, not certainty. In itself the label does not help us intervene, and it may lead to a self-fulfilling prophecy of low expectations.) These children are less likely to succeed in school due to higher rates of behavioral, emotional, social and learning difficulties, and they are more likely to demonstrate difficulties at school such as ability deficits, poor academic achievement, grade-retention, drop-

out, problematic peer relationships, conduct problems and deliquent behavior (Ackerman et al.). Behavior difficulties of at-risk children may include impulsivity, poor self-regulation, poor self-control and inattention, skills associated with executive functioning. Parents' educational level has been found to correlate significantly with children's executive functioning skills (Ardila, Roselli, Matute, & Guajardo, S., 2005). Furthermore, Noble et al. (2007) found that socio-economic status is associated with children's neurocognitive abilities, including executive functioning skills. Since at-risk students tend to struggle with these important executive functioning skills, programming that helps them to practice and develop these skills might be especially worthwhile for them.

Music programs and at-risk populations. There is evidence that children from economically disadvantaged backgrounds involved in music and other arts, show greater resilience, self-regulation, and general habits of practice, focus and discipline within the regular classroom (Oreck, Baum, and McCartney, 1999). Research has shown that minority students in particular tend to look to music teachers as positive role models (Hamann & Walker, 1993). Furthermore, genetics research indicates that environmental influences (as opposed to genetic influences) are especially salient for children of disadvantaged backgrounds (Pennington et al., 2009). It seems likely that exposure to the enriching environment provided by a high-quality music program could be particularly beneficial and influential for the development of at-risk students.

Unfortunately, in the US, children with low SES backgrounds are less likely to have opportunities for intensive music study compared to their peers. They are less likely to take private lessons on an instrument or participate in a music ensemble than their higher-SES peers. In part, this may be because purchasing or renting an instrument and paying for lessons is

expensive. Unfortunately, music programs in public schools are most likely to be cut in districts serving under-privileged children, particularly in urban districts serving minority students where budgets are especially tight (Renfro, 2003). Some research indicates that these are the children that have the potential to benefit most from this kind of program, but there is a need to further investigate the ways in which a music program could benefit underprivileged children. This type of information could support the existence of music programs that serve needy children.

There is a movement afoot within the global classical music scene aimed at bringing music instruction into the lives of societies' neediest children. In the US there is an ever-increasing implementation of community music and other arts programs targeting at-risk children (Weitz, 1996). These programs seek to benefit children in many ways, including fostering cooperation, academic success, self-esteem, creativity, self-expression, and community pride. Some of these efforts are inspired by the fantastically successful "*El Sistema*," the National System of Youth and Children's Orchestras of Venezuela (Waleson, 2008; Crease, 2008). *El Sistema* aims to serve society by bringing music into the lives of Venezuela's neediest children. While these community programs are certainly well-intended, highly acclaimed and internationally celebrated, there has been little empirical investigation of the impact that the music programs have on child development. One potential benefit of music programs for at-risk students could be the development of executive functioning, a set of behaviors and skills that many at-risk students need to support to develop.

Relationship between executive functioning and musical training. Research indicates that trained musicians have better executive functioning skills than the general population (Bialystock & DePape, 2009). However, it is unclear whether music study causes executive functioning skills to develop or whether pre-existing executive functioning strengths lead to

success in music. There is reason to suspect that intensive music study could lead to the development of cognitive skills and behaviors associated with executive functioning. Important aspects of executive functioning include selective attention, shifting strategies, behavioral inhibition, holding representations in working memory, and sustaining attention on the task at hand. Musicians often have to attend selectively to visual and auditory information. Through experience, musicians learn to hone in on particular qualities of music, such as form, tonality, harmony, phrasing, tempo, rhythm and so forth. A musician playing in an ensemble needs to selectively attend to specific stimuli in order to play together with the other musicians. Musicians also need to shift strategies flexibly. For example a cellist might find that a certain fingering is creating difficult string crossings, so he might try an alternative fingering. Musicians also frequently have to inhibit behavioral responses. An orchestral musician may have to resist the urge to play when the conductor cues the person next to her, and a child holding a percussion instrument in music class may have the urge to start playing right away but inhibit that action until the teacher indicates it is time to play. Musicians also hold relevant rhythmic and tonal patterns in mind (in working memory) in order to compare and predict. For example, a musician might compare what he just heard with internal representations of what he would like to hear, and adjust his playing accordingly. Furthermore, musicians often sustain their attention for long periods of time when they are listening to, playing or singing musical works.

One way to find out if music study leads to development of executive functioning would be to examine the behavior development over time of children engaged in a music program. But this alone wound not shed light on *how* music study may lead executive functioning to develop. The question of what about a music program may help children develop executive functioning related skills calls for greater investigation of the executive functioning demands of various

musical activities. It might also be enlightening to search for behavioral evidence that executive-functioning skills are developing during various musical activities, by examining the extent to which children are practicing such skills as sustained/selective attention, and behavioral inhibition.

Purpose Statement

The purpose of the study is to investigate the potential for a music program to contribute toward children's healthy psychological development, musical development and school success. Specifically, this study will investigate the development of musical skills and executive functioning among first and second grade students in one urban elementary school, across one academic year of participation in an intensive music program.

Research Questions and Hypotheses

1. To what extent do children participating in a music program demonstrate musical development as indicated by measures of developmental music aptitude and performance?

Hypothesis: Students participating in a music program will demonstrate significant improvement over time in measures of developmental music aptitude and performance.

2. How do music instruction activities differ in the extent to which they provide opportunities for children to practice behaviors associated with executive functioning (shifting, inhibition, updating and attention) and in students' rates of active vs. passive engagement and off-task behavior?

Hypothesis: Music instruction activities will differ from one another in the frequency of opportunities they provide to practice shifting, inhibition, updating and sustained attention, and students' rates of active vs. passive engagement and off-task behavior will differ depending on the activity.

3. To what extent do students participating in a music program demonstrate, over time, improved behaviors associated with executive functioning (shifting, inhibition, updating and attention) in the general education classroom compared to students not participating in a music program?

Hypothesis: Students participating in a music program will demonstrate in the general education classroom more improvement over time in behaviors associated with shifting, inhibition, updating and attention, than students not participating in a music program.

4. For students participating in a music program, does musical development correlate with development of executive-functioning-related behaviors in the general education classroom?

Hypothesis: Measures of musical development will correlate positively with measures of shifting, inhibition, updating and attention in the general education classroom.

CHAPTER II:

REVIEW OF THE LITERATURE

Brief Summary of Problem and Purpose

Before delving into an investigation of the development of music skills and executive functioning among children participating in a music program, it is necessary to understand the underlying cognitive processes. Accordingly, the review of literature addresses existing research in the following areas: a) components of executive functioning and their development, b) development of music audiation and music aptitude through participation in a music program, c) how participation in a music program might contribute to the development of executive functioning skills.

Components of Executive Functioning and Their Development

Definitions and scope of executive functioning. Executive functioning is defined as the mental capacity to engage successfully in independent, purposeful, goal-oriented problem-solving behavior (Gioia, Isquith, Guy & Kenworthy, 2000). Executive functions include many types of self-control: cognitive control, regulatory control of emotional response, and control of behavior. Executive functioning skills include planning, cognitive flexibility, response inhibition, organization and working memory (Semrud-Clikeman & Ellison, 2009). Executive processes include the following regulatory and management functions (Meltzer, 2007; Nadel, 2003; Gioia, Isquith, Guy & Kenworthy, 2000): 1) initiate behavior, 2) focus attention on relevant information and processes while inhibiting irrelevant ones (inhibit competing stimuli), 3) sustain and redirect attention, 4) schedule processes in complex tasks while switching attention between tasks, select task goals, 5) plan and organize a sequence of tasks to solve a problem/accomplish a complex goal, 6) update and check the contents of working memory to

determine the next step in a sequence of tasks, 7) inhibit inappropriate behavioral and emotional responses, 8) flexibly switch among problem-solving strategies when needed, and 9) monitor, adjust and evaluate one's own behavior.

Shifting, updating and inhibition. Using confirmatory factor analysis, Miyake et al. (2000) identified three separable but correlated executive functions: shifting, updating and inhibition. "Shifting" is also referred to as "attention switching" or "task switching" and involves shifting among various tasks, operations or mental sets (Monsell, 1996). "Updating" refers to the updating and monitoring of representations in working memory. This involves coding incoming information for relevance to the task, and replacing information that is no longer relevant. This updating process may involve "temporal tagging" (Jonides & Smith, 1997) to help determine whether information is new or old and no longer relevant. "Inhibition" refers to the ability to intentionally inhibit automatic or prepotent responses.

Inhibition as building block of attention and working memory. The notion of inhibition deserves additional discussion, given that its meaning can vary depending on the study and it is considered a building block of other executive functions. The term inhibition is used on the neurological level to refer to the role of the frontal lobes in modulating the salience of perceptual signals by inhibiting unattended information (Posner & Rothbart, 2007; Gazzaniga et al., 2009). In other studies it refers to the deliberate suppression of certain prepotent behaviors or overt actions (Miyake et al., 2000). Inhibition of action occurs when we are about to take an action, but decide not to. It is thought that individuals with frontal lobe damage may exhibit socially inappropriate behavior due to loss of inhibitory control (Gazzaniga, Ivry, & Mangun, 2009). The fact that patients with frontal lobe lesions often have difficulty aborting an action, provides evidence that the frontal lobes are involved in the inhibition of actions. Inhibitory

control refers to the regulation of actions through active inhibition of certain responses that may be habitual, automatic or dictated by environmental cues.

Researchers believe that inhibitory functions serve as a basis for the development of more complex forms of attention and executive functioning (Barkley, 1997). For example, inhibition is necessary for selective attention. Selective attention is defined as the ability to concentrate on a specific subset of sensory input, thoughts or actions while intentionally ignoring others (Gazzaniga et al., 2009). In life we are bombarded with sensory information, and it pays to focus on some of that information while repressing attention to other extraneous stimuli. For example, a child may perform better in the classroom by focusing attention on the teacher's voice rather than the buzzing noise of the radiator. Furthermore, the child needs to attend to the content of what the teacher is saying and focus on the most important or salient points. Top-down control allows us to purposefully attend to and process information that is relevant to the task at hand. This is accomplished in two ways. First, particular information can be accentuated, such as information coming from a certain location. Alternatively, we can selectively control the information we process by excluding irrelevant information (Gazzaniga et al., 2009). Additionally, when complex information is coming from the same source or location, we can focus in on particular aspects of that information and tune out other less relevant aspects.

Inhibition is also necessary in order for working memory to succeed in holding information. Working memory is defined as transient representations of information relevant to the task at hand (Gazzaniga et al., 2009). These representations may be brought up from long-term memory, or the representations could be related to a current or recent environmental stimulus. To recall information in working memory an individual must ignore distractions and sustain the representation. That is, we must *inhibit* our attention to extraneous stimuli in order to

hold the relevant representations in mind. If we fail to block out distractions, working memory fails. For patients with frontal lobe damage, the inability to inhibit attention to incoming stimuli can lead to working memory problems.

Relevance to school. Executive functioning skills are reflected in children's behavior and academic success at school. Executive functioning is an umbrella term for the complex cognitive processes that drive goal-directed behavior (Meltzer, 2007). Thus, executive functioning skills are critical for success in school and in life. According to Meltzer (2007), academic success requires students to plan their time, organize and prioritize materials and information, distinguish main idea from details, shift approaches flexibly, monitor their own progress, and reflect on their work. The executive functioning skills of shifting, inhibition, updating and attention are reflected in children's behavior in the classroom. Students demonstrate shifting in their ability to move freely from one situation to another, transition among activities, problem-solve flexibly, and switch attention or focus as required by the task. Students with difficulty shifting may demonstrate perseveration, rigidity, inflexibility, or trying the wrong approach over and over again. Children with inhibition difficulties may be overly physically active in the classroom, have a tendency to interrupt others and disrupt group activities (Gioia et al., 2000). Children with better inhibitory control will stop their behavior at the appropriate time. Students demonstrate difficulty in updating (holding relevant information in working memory) when they have difficulty remembering things even for a minute, difficulty following directions, lose track of what they are working on, and struggle with tasks that involve mental manipulation of information (e.g. reverse digit span). Working memory is closely related to attention because working memory is necessary in order to sustain performance and attention. Because of this interdependence, the behavioral outcomes of working memory

problems and attention problems are difficult to distinguish. Children demonstrate attention in the classroom when they concentrate for sustained periods of time on the task at hand. Children demonstrate attention problems when they are frequently distracted from the task at hand and do not concentrate on the task more than momentarily.

Attention-Deficit Hyperactivity Disorder (ADHD) and executive functioning. School psychologists often serve students with ADHD or related difficulties and may use assessment dand intervention for executive functioning deficits in this context. Attention problems, including inattentiveness, distractibility, poor concentration, impulsivity and hyperactivity, are widely thought to reflect deficits in executive functioning (Friedman et al., 2007). Children with deficits in executive functioning are often diagnosed with Attention-Deficit Hyperactivity Disorder (ADHD), a disorder closely linked to deficits in executive functioning. According to the *Diagnostic and Statistical Manual of Mental Disorders, fourth edition, text revision (DSM-IV-TR),* Attention-Deficit/Hyperactivity Disorder (ADHD) is defined as a persistent pattern of inattention and/or hyperactivity-impulsivity that is more severe than in other individuals of a similar developmental level (American Psychiatric Association, 2000). These children have difficulty regulating their behavior and emotions, sustaining attention during activities, staying on-task, organizing tasks and activities, transitioning and waiting for their turn; they tend to make careless mistakes and act impulsively. Clearly ADHD overlaps with the construct of executive functioning skills, which includes the ability to sustain and redirect attention, inhibit inappropriate behavioral and emotional responses, plan strategies for future behavior and flexibly switch among problem-solving strategies. Among scientists there are two predominant views of this relationship. Some researchers argue that some but not all individuals diagnosed with ADHD suffer impairments in executive functioning. Other researchers argue that all individuals

with ADHD suffer deficits in executive functioning; in fact, many researchers believe that ADHD is above all, a developmental impairment of executive functioning (Brown, 2006). Friedman et al. (2007) write that ADHD is the extreme end of the executive functioning skill continuum.

Behavior observations of active engagement, passive engagement and off-task behavior for students with ADHD/executive functioning deficits. Behavior observations of children in academic settings are an important part of an evaluation of executive functioning or when considering an ADHD diagnosis. Evaluators and researchers often measure the percentage of class-time that students spend engaged in an academic activity vs. percentage of time off-task. Vile Junod et al. (2006) measured active engaged time, passive engaged time and off-task behavior among children with and without ADHD in the classroom setting. When children are actively engaged in an academic task they are attending and responding (e.g. reading aloud, writing, talking to a peer or a teacher about the topic). When children are passively engaged they are passively attending to the academic task (e.g. listening to the teacher, silently reading, examining a worksheet). Vile Junod et al. break off-task behavior down into three components: off-task verbal behavior (e.g. having a side-conversation off-topic with a peer), off-task motor behavior (e.g. out of seat at the inappropriate time) and off-task passive behavior (e.g. sitting and staring into space).

Development of executive functioning.

Social and linguistic influences. There is also a long tradition in the field of considering social and linguistic influences on the development of executive functioning. Luria was among the first researchers to examine the development of attention and executive functioning, though he used the terms "voluntary attention" and "verbal regulation." Luria (1961; 1973) thought that

the constructs of attention and executive functions were closely related and change across development. Young children attend to interesting environmental stimuli and react impulsively. Verbal information in the form of rules or commands that are in conflict with the child's behavioral impulses have little influence on the child's behavior. The ability to control one's attention and actions develops through interaction with adults. Early on, adults control children's behavior through signals and words, but gradually the child internalizes rules and motives that govern their behavior (Luria, as cited in Korkman, 2004).

Both Vygotsky and Luria emphasized the role of language and symbol systems, learned and maintained through social interaction, that allow individuals to gain self-control through access to higher cognitive processes such as inhibition, planning and working memory (Lewis & Carpendale, 2009). Social interactions and conventions provide a way for humans, as Vygotsky said, "to control their behavior from the outside." Research on the development of self-regulation focuses on the relationship between a child and his caregiver. It is possible that peer-interactions facilitate the development of executive functioning as well, given that children who attend daycare have been found to score higher on tests of executive functioning than children raised solely at home (Gerstadt, Hong, and Diamond, 1994). Socio-economic-status correlates with executive functioning skills (Noble, McCandliss, & Farah, 2007). Lewis and Carpendale postulate that social interaction influences children's executive functioning through adult scaffolding of children's performance. This scaffolding can be quite complex because as the adult is trying to scaffold the child's cognition, the child is also contributing to the interaction. Perhaps this scaffolding allows children to acquire symbols that help them distance themselves from a reward, allowing them to override direct impulses to respond prepotently (without thought). This perspective gets at the motivational perspective behind self-regulation. Through

interaction with the child's social environment, the child comes to internalize scripts, rules, cues and prompts. This is how the process of socialization occurs. But just as the environment exerts influence on a child's brain and behavior, so too does the child gradually become more autonomous in his ability to shape his environment and to engage in goal-oriented problem-solving.

Neuropsychology of executive functioning development. Today, much of the research on executive functioning examines neuropsychological pathways. Executive functioning, as evidenced by changes in the capacity for self-regulation and planful behavior, starts to develop in infancy and does not reach maturity until adolescence or even beyond (Melzer, 2007). The development of executive functioning is not so much about maturation of any one brain area; rather, the process involves assembly, integration, and refinement of functional networks (Johnson & Munakata, 2005). Dramatic changes in executive abilities over the course of development may reflect the ongoing process of establishing new neural networks. Myelination of white matter tracts in the prefrontal lobes continues even past adolescence (Paus et al. 2000), providing humans with a huge window of time in which to tune their brains to complex social contexts and environmental demands. According to a study examining the development of attention and executive functions among 400 Finnish children aged 3-12 years, development of executive functioning follows a sequential pattern. First, relative maturity in the capacity to inhibit impulsive reactions develops around the age of 6, followed by selective visual and auditory attention at age 10, with fluency continuing to develop into adolescence (Kelenberg, Korkman & Lahti-Nuuttila, 2001).

The human brain has a great capacity to adapt to the demands of the environment through a high level of sensitivity and responsivity to contextual variables. In particular, the brain's

executive system is highly adaptable, allowing the brain to more efficiently cope with the demands of the environment. Executive functioning is not preprogrammed; rather, it develops in response to interaction with the environment. Executive capacities are highly contextual; they may be thought of as the interface between a person and the social and physical environment in which that person interacts (Bernstein & Waber, 2007). The executive system allows for the organization and reorganization of attention (through control of sensory input), intention (through control of behavioral output) and thought (through control of memory and processing). This control allows the individual to integrate past experiences with present situations to guide behavior. The brain's frontal circuitry and the systems it supports are shaped bidirectionally by contextual factors internal and external to the individual, meaning that the brain both influences and is influenced by its environment (Bernstein & Waber, 2007). Neural circuitry in the brain develops through interaction between the brain and the context. As the neural circuitry of the brain matures, an individual becomes better able to select with precision from among an array of response options within the environment. As the brain interacts with the environment, it develops neural circuitry that is progressively more and more adaptive to the given context. Over time the brain becomes better able to differentiate contextual variables, leading to increased neural differentiation. The human capacity for language greatly expands the contextual variables to which humans learn to adapt (Bernstein & Waber, 2007). It seems logical then that contextual demands of music would lead the brain to adapt as well.

Influence of socio-economic status. Noble, McCandliss, & Farah (2007) found that socio-economic status is associated with children's neurocognitive abilities, including executive functioning skills. SES accounted for significant amounts of variance in both working memory and cognitive control composites. However, home literacy environment, daycare/preschool

attendance, and elementary school quality also mediated the relationship between executive functioning and working memory scores. The authors suggest that these factors could be targeted to potentially impact children's ability to manipulate online information in working memory. In contrast, language abilities, especially receptive vocabulary, accounted for the relationship between cognitive control and working memory. So it is possible that SES influences language development, which in turn affects cognitive control.

Interventions to develop executive functioning. Intervention for executive functioning is a relatively new area of research inquiry. McCloskey, Perkins and Van Divner's book *Assessment and Intervention for Executive Function Difficulties* (2009) provides an excellent overview of this emerging topic. Most of the existing research on executive functioning interventions comes from practical research on the effectiveness of various strategies for children with executive functioning deficits. McCloskey et al. write that "the ultimate goal of any intervention designed to address executive function difficulties should be to increase the child's capacity for internally directed self-regulation." Strategies for intervening to develop executive functioning fall into two categories: strategies for developing internal control and strategies for maintaining external control. Internal control strategies include increasing student awareness, modeling appropriate use of executive functions, teaching routines, use of verbal mediation, use of verbal and non-verbal labeling, and teaching use of internal feedback and self- reinforcement. Many of the internal control strategies grew out of the Cognitive Behavioral Therapy (CBT) literature (e.g. Mennuti, Freeman, & Christner, 2006). External control strategies include pharmacological treatment, structuring the environment, structuring time, providing processing cues, providing feedback, providing reinforcement/rewards, and aligning external demands with

the student's desires/interests. These external control strategies come primarily from the ADHD literature (e.g. Barkley, 2006).

ADHD is often conceptualized as a deficit in executive functioning, in terms of a developmental delay in the self-regulation of behavior by internal means of representing information through working memory and motivating goal-oriented behavior (Smith, Barkley & Shapiro, 2006). Behavioral interventions for this deficit in self-regulation include providing externally represented information to prompt and guide behavior. It is also suggested to provide these children with increased density of external consequences to enhance motivation. The behavioral feedback should be immediate in timing. Such programs should be implemented over long time-intervals. Children with ADHD diagnoses might have difficulty generalizing behavior regulation skills across situations or if stimulus prompts and motivational systems are removed. From this perspective children's failure to self-regulate is viewed as a motivational issue rather than a deficit in skills or knowledge.

Usually, a balance of internal and external approaches are recommended. The adult delivering the executive functioning intervention can foster development of executive functioning through a combination of both types of strategies. For example, the adult can model appropriate use of executive functioning skills and provide a structured consistent environment in which the child can practice her skills. McCloskey et al. (2009) suggest six guidelines to follow in designing an intervention plan for a child with executive function difficulties:

1) Provide the child with a rich executive function environment, with skilled adults to model proper use of executive functions and provide the child needed support and structure.

2) First try to activate existing executive capacities, taking the stance that the child has the executive capacities but is unaware that she is not using them.

3) Make the student aware of the executive skills necessary to reach behavior goals, and teach the child when and how to activate use of the executive skill so that the child can internalize self-regulation routines.

4) Use interventions that provide external control, and gradually withdraw the external supports so that the child can demonstrate internal control.

5) Model perseverance and patience with intervention efforts.

6) Help other adults around the child to adopt reasonable behavior expectations and sensible consequences for unacceptable behavior.

Summary of executive functioning and its development. Executive functioning appears to be a complex process that is diffuse across the brain, characterized by spurts of change and involving differentiation and integration rather than a clear linear developmental pattern. Miyake et al. identified three related but separable components of executive functioning: shifting, updating and inhibition. Inhibition is particularly important because it is necessary for working memory and selective attention. Behaviors associated with executive functioning are critical for school success and can be observed in the classroom. The diagnosis of ADHD is closely aligned with the construct of poor executive functioning skills. Behaviors associated with ADHD are often assessed in schools using rating-scales and direct behavior observations of engagement and off-task behavior. There is some research to provide clues about how executive functioning skills develop. The neuropsychology literature explains that dramatic changes in skill occur from infancy through adolescence due to myelination, assembly, integration, and refinement of functional networks. Inhibition of impulses develops before selective attention. Executive functioning neural networks are highly plastic and develop as an individual interacts with the contextual demands of his environment. In addition to these

neuropsychological perspectives, other researchers consider the influence of social and linguistic factors in the development of executive functioning. The language children accrue through social interaction provides them an external structure for regulating their emotions and behavior. Adults provide scaffolding support to help children learn to self-regulate. SES is another social influence that correlates positively with the development of executive functioning skills. Receptive language deficits impact children's cognitive control, providing evidence for the role of language in helping executive functions to develop.

Interventions for developing executive functioning seek to increase the child's capacity for internally directed self-regulation through the use of internal control and external control strategies. The CBT and ADHD literatures contribute to our understanding of this emerging area. Specific strategies that contribute to the development of executive functioning skills include: increasing student awareness, modeling appropriate use of executive functions, externally represented information to guide behavior, highly structured environment and time, routines, verbal and non-verbal labeling, teaching use of internal feedback, providing processing cues, providing immediate feedback, and increasing density of external consequences (e.g. reinforcement/rewards) for use of executive functions. Activities that incorporate these characteristics might be expected to help students develop executive functions.

Development of Music Audiation Skills and Music Aptitude Through Participation in a Music Program

Gordon's Music Learning Theory. Gordon (1986; 2007) defines music aptitude as an individual's potential or capacity to learn music. This is related to but distinct from the concept of music achievement, what has actually been learned. Aptitude is necessary for musical achievement but not everyone with high aptitude displays high achievement. Aptitude is the

result of nature and nurture influences. According to Gordon (2007), everyone is born with a certain level of music aptitude which decreases unless it is stimulated. One's music aptitude develops during the formative years beginning at birth (or possibly before birth) and stabilizes around age 9. Up until age 9, one's level of music aptitude changes with the quality of one's formal and informal musical environment. While people can certainly continue to learn music after age 9, Gordon asserts that one's potential to achieve in music stabilizes. This is evidenced by aptitude percentile ranks remaining relatively stable after age 9. This points to the importance of early musical experiences, both in terms of formal music instruction and informal music exposure.

Music aptitude is defined as one's potential to achieve in music and is measured by behavioral signs that predict later competencies (Lehmann, Sloboda & Woody, 2007). According to Gordon, an individual's music aptitude is commensurate with one's musical audiation skills. Audiation is one's mental representation of music and involves thinking about or "hearing" music in one's head when the music is not physically present. One can also be audiating while listening to music. According to Gordon (2007), "thought is to language what audiation is to music." Gordon also writes that sound, in itself, is not music. Rather, sound becomes music through the process of audiation, when one translates sound in one's mind and gives it meaning. This is similar to the way the mind processes language. People derive meaning from music through audiation, by comparing a mental representation of what one has just heard with referential music material (music that has been heard before, what one expects to hear, what one would like to hear, etc.). Gordon (1997) writes,

> Although music is not a language, the process is the same for audiating and giving meaning to music as for thinking and giving meaning to speech. When you are listening

> to speech, you are giving meaning to what was just said by recalling and making connections with what you have heard on earlier occasions. At the same time, you are anticipating or predicting what you will be hearing next, based on your experience and understanding. Similarly, when you are listening to music, you are giving meaning to what you just heard by recalling what you have heard on earlier occasions. At the same time, you are anticipating or predicting what you are hearing next, based on your musical achievement. In other words, when you are audiating as you are listening to music, you are summarizing and generalizing from the specific music patterns you have just heard as a way to anticipate or predict what will follow. Every action becomes an interaction. What you are audiating depends on what you have already audiated. As audiation develops, the broader and deeper it becomes and thus the more it is able to reflect on itself. Members of an audience who are not audiating usually do not know when a piece of unfamiliar, or even familiar, music is nearing its end. They may applaud at any time, or not at all, unless they receive clues from others in the audience who are audiating. Through the process of audiation, we sing and move in our minds, without ever having to sing and move physically. (pp. 5-6)

Audiation involves concentrating on one set of musical sounds while simultaneously attending to or performing one or more other sets of musical sounds (Gordon, 2007). Capable musicians audiate what they expect to hear or perform before they actually hear or perform. The most common type of audiation occurs when we listen to familiar or unfamiliar music. When we listen to music, we hear familiar and unfamiliar tonal and rhythmic patterns; we give meaning to what we hear by sequencing, recalling, anticipating, and predicting these tonal and rhythmic patterns through audiation. Tonal patterns and rhythmic patterns are of particular importance to

audiation because they are the content that establishes musical function and gives contextual meaning to music.

Gordon (2007) theorizes that as we audiate while listening to familiar or unfamiliar music, we go through the following six music-processing steps: First, auditory information is momentarily retained in sensory memory (in response to sound). The second step requires audiating tonal and rhythmic patterns and identifying a tonal center and macrobeats. The third step involves audiating musical context through the mental establishment of tonality and meter. Fourth, rhythmic and tonal patterns are organized and retained. Fifth, previously audiated patterns are recalled. Finally, the sixth step involves anticipating and predicting tonal and rhythmic patterns. These steps occur in continuous cycles. Gordon asserts that the more one engages in formal/informal music instruction and musical activities that place music processing demands on the brain, the more audiation skills will develop.

Audiation skills are the foundation for the development of musicianship. Gordon (2007) argues that audiation is necessary to understand and therefore to truly appreciate music. He writes that "to capture music in audiation is to experience an aesthetic response." Basic tonal and metric audiation skills (e.g. ability to hear and comprehend sameness and difference in music), established in childhood, are the building blocks of musicianship. After an internal sense of tonality and meter are established, people may, with appropriate instruction, learn to audiate more advanced aspects of music, such as style, form, expression, dynamics, timbre and harmonic progressions. In adults, many types of stabilized music aptitude have been identified; tonal aptitudes include melody and harmony, rhythm aptitudes include tempo and meter, and preference aptitudes include phrasing, balance and style. In young children, only two developmental music aptitudes have been identified: tonal and rhythm. Gordon (2007) attributes

this to children being at a developmental level when they are not yet interested in preference aspects; children seem to be more interested in how music is made than in how music is expressed, and this is developmentally appropriate. Expressive sensitivity can develop after basic audiation skills are in place.

One's music aptitude is determined by both hereditary and environmental factors (Vinkhuyzen, Van Der Sluis, Posthuma, & Boomsma, 2009). However, regardless of an individual's genetic make-up, the environment plays a crucial role in the development of musical aptitude. Gordon (2007) asserts that informal music learning at home and preschool as well as formal music instruction in early grades will directly influence children's levels of developmental music aptitude, which ultimately has a profound impact on their music achievement in life. Therefore, music-learning experiences in early childhood have more impact on an individual's ultimate musical achievement than experiences in high school or even college. According to Gordon (1986; 2007), environmental influences that promote development of music aptitude include opportunities to listen to, audiate, and perform music. Young children should have opportunities to listen to many styles of music with varying rhythm, dynamics and timbre. Children should have opportunities to rhythmically respond to what they hear and to sing familiar and made-up songs. Gordon emphasizes that exploration and experimentation are more important to the development of audiation than accuracy. Informal instruction is appropriate for pre-school-aged children. Children in Kindergarten through grade 3 should receive both informal and formal instruction. Formal instruction is most appropriate for children beyond third grade.

Gordon's Music Learning Theory sheds light on what parents and teachers can do to promote development of music aptitude and audiation (Gordon, 2001; 2007). Informal music

instruction typically happens in home or pre-school settings. Similar to the development of language, when young children are exposed to music, they unconsciously absorb it without necessarily understanding it. This exposure promotes readiness for later conscious listening and comprehension of music. Musical development also parallels language development in that the most crucial time for exposure to music is before age 3. Just as a child experiments with verbal language early in development, so does a child play with music through singing and rhythmic movement. According to Gordon, the quality and quantity of a child's early music participation is directly related to the quality and quantity of his music participation later in development. Adults should hum and sing to the child. Spontaneous child singing should be encouraged without attempting to correct the child. Children should also be encouraged to experiment freely with rhythm. Activities that promote development of rhythmic aptitude include: moving freely to music, chant (non-rigid), experimentation with percussion instruments, dancing, swinging, galloping, marching, etc.

Furthermore, according to Gordon's Music Learning Theory (Gordon, 2001; 2007) children also need structured opportunities to practice. Children need to experience success through scaffolding, and have appropriate behavior modeled. Formal music instruction for young children should include singing. Singing in groups and alone helps the child to develop the audiation and vocal skill necessary to sing in tune. An effective teaching strategy is to have a student echo a pattern sung by the teacher or a peer, and then for the student to engage in musical dialogue, improvising responses to a given pattern. These experiences in audiation and singing alone help the child to develop a sense of tonality. Formal music instruction should also include teaching songs to children. To promote audiation, it is important for the teacher to sing the song for the children at least one time before they try to sing it. The teacher can also prepare the

children to audiate by establishing the tonality, key, and meter before the children sing. As in any learning arena, it is important to scaffold music instruction to promote student success and sense of musical competence. In Music Learning Theory (Gordon, 2003), the musical skills, rhythmic and tonal content are carefully sequenced, so that new material builds on previously acquired skills. Much of Gordon's theory is devoted to sequencing these skills and content. Gordon's learning sequences in the areas of skill, tonal content, and rhythm content can be viewed in Appendix A (Gordon, 2003).

Research that builds on and challenges Gordon's assertions. Gordon's Music Learning Theory has been very influential in the field of music education, contributing to our understanding of developmental changes in the way people perceive, produce and perform music (Hargreaves, North, & Tarrant, M., 2006). Much research has centered on applying his theories to improve music teaching. For example, Garner (2009) built on Gordon's theories to outline ways to improve students' music listening through movement and voice. Taggart has built on and applied Gordon's work to improve music instruction and develop curricular materials (e.g. Taggart, Bolton, Reynolds, Valerio, & Gordon, 2006). Some researchers challenge Gordon's theories. Woodford (1996) asserts that Gordon's Music Learning Theory is not so much a learning theory as a "taxonomy of musical preconditions for critical thinking," including musical knowledge and skills. Woodford feels that Gordon's theory does not explain how students learn to think for themselves.

Other theoretical approaches to music learning. While Gordon's theory of music learning is considered by many to be the gold standard in the development of musical skill within the field of music education, some researchers focus more on children's verbal, visual and kinesthetic responses to music as an important part of the music learning process (Kercher, 2000;

Cohen, 1997). These approaches focus more on children's perceptual and affective responses to music and their ability to talk about their experiences. As children get older they develop more sophisticated ways of thinking about, reacting to and describing music. Kerchner (2000) found that fifth graders showed more affective and aesthetic responses to music than younger children. She also found that visual and kinesthetic ways of responding to music tend to draw out more differentiated descriptions of musical events compared to just responding verbally to the music. Cohen (1997) developed an innovative way to teach children musical schemas (mental organizers) without the need for talking about the music. She teaches her students the way she organizes music in her mind by developing and performing kinesthetic interpretations of the music that communicate such aspects of the music as: grouping, closure, hierarchy of groupings, direction of musical movement, and the expectation and gratification of expectation. Then after students observe her movements a few times, they mirror her. She feels that this allows them to enter into her musical thought processes and provides a way of teaching the music holistically, in its totality. She noticed that children learned the mirrors almost instantly, and children demonstrated better memory for pieces they had been taught in this way.

Overview of music education programs and methodologies. One would expect that children engaged in a music program would develop musical skills and demonstrate achievement in music, but this is not a given. Music programs for children vary in quality and intensity. Consider a music program based on the *National Standards for Music Education*. In such a program children would 1) sing alone and with others, a varied repertoire of music, 2) perform on instruments alone and with others, a varied repertoire of music, 3) improvise melodies, variations and accompaniments, 4) compose and arrange music with specific guidelines, 5) read and notate music, 6) listen to, analyze and describe music, 7) evaluate music and musical

performances, 8) understand relationships between music, other arts and other disciplines, and 9) understand music in relation to history and culture (www.menc.org). Then consider a music program that does not provide the varied opportunities to interact with music as outlined in the standards. It seems logical to expect that these programs would differ greatly in their effectiveness in helping children develop musical skills. Therefore, one cannot assume that all music programs are equal in quality; nor can one assume that all music programs would lead to development of musical skills and achievement.

Within the field of music education, several methodologies have become well established and researched. Many music programs for children today, including the music program described in this study, are rooted in the Gordon Method described above but also incorporate elements of various methodologies. The Dalcroze Method emphasizes learning musical concepts through movement, or eurhythmics, encouraging students to physicalize and feel the music in their bodies. This method also uses solfege, a pedagogical technique for teaching tonal syntax whereby each note is assigned a syllable (e.g. in moveable-do solfege, tonic is "do" and dominant is "sol") (Ely & Rashkin, 2005). This method helps children develop a sense of pitch and tonal function. The Kodaly Method is based on the idea that all children should learn music through singing and moving to folk songs of their culture (Ely & Rashkin, 2005). The Kodaly Method incorporates practices from other methods, including solfege and a system of syllables to help children learn rhythm and rhythmic notation. In the Kodaly Method, learning is carefully scaffolded; for example, pentatonic scale degrees are introduced before leading tones.

Formal music instruction for children can also include learning to play instruments. For example, in the Orff Schulwerk method, children explore making music with easy to play instruments like the xylophone and the marimba, after rhythmic foundations have been laid. The

Orff method focuses on teaching children rhythm, progressing from imitation to experimentation to creation (Ely & Rashkin, 2005). The Suzuki Method involves intensive study of a specific instrument such as the violin or piano. This method emphasizes learning music the way we learn language, with emphasis on listening to recordings and learning to play by ear, particularly in the early stages of development. Students learn through observation, imitation and repetition, gradually developing intellectual awareness (Ely & Rashkin, 2005).

So, in a music program that follows guidelines of best practices in the field of music education research and theory, the following activities and instructional techniques might occur (all of the following occur in the music program described in this study):

- Opportunities to listen to, audiate, and perform music (Gordon)
- Listening to music
    - Of many styles, with varying rhythm, dynamics and timbre (Gordon)
    - Repeated listening in order to learn to play an instrument by ear (Suzuki)
- Movement
    - Opportunities to move freely and rhythmically respond to what they hear (Orff, Dalcroze, Gordon)
    - Exploration and experimentation with movement and sound (Gordon, Orff)
    - Learning musical concepts through movement, or eurhythmics, encouraging students to physicalize and feel the music in their bodies (Dalcroze)
- Scaffolding of music instruction (Gordon, Kodaly, Dalcroze, Suzuki)
    - To promote student success and sense of musical competence.

    - Careful sequencing of musical skills, rhythmic and tonal content taught, so that new material builds on previously acquired skills
- Appropriate musical behavior modeled (Gordon, Kodaly, Dalcroze, Suzuki)
    - For example, teacher sings the song for the children at least one time before they try to sing it
- Singing in groups and alone (Gordon, Kodaly, Dalcroze, Suzuki)
    - Sing familiar and made-up songs
    - Teacher prepares the children to audiate by establishing the tonality, key, and meter before the children sing
- Dialogue/Improvisation
    - Echoing of patterns sung by the teacher or a peer (Gordon, Orff)
    - Engaging in musical dialogue, improvising responses to a given pattern (Gordon, Orff)
- Syntax of Music
    - Solfege (Gordon)
    - Rhythmic Syllables (Gordon)
- Playing Instruments
    - Orff Instruments (Orff)
    - Intensive study of an instrument such as violin, cello or piano (Suzuki)

How Participation in a Music Program Might Contribute to the Development of Executive Functioning Skills

Trained musicians tend to have strong executive functioning skills. There is some direct evidence for a relationship between music processing and the development of executive

functions. Bialystok and DePape (2009) found that musical training and practice enhances executive control, even on tasks that bear no obvious relationship to music (when no auditory processing is required). Their study included bilinguals, a group known to have enhanced executive functioning probably resulting from the constant need to manage attention and switch consciously between two language systems. The study compared the performance of bilinguals, monolinguals and musicians on various measures of executive functioning. Bilinguals and musicians both outperformed monolinguals on a spatial conflict task (switching attention between a symbol and its position). Musicians outperformed both monolinguals and bilinguals on an auditory Stroop task that required subjects to switch attention between words and pitch. The authors conclude that the effect of experience can generalize to other domains, but the effect remains strongest for tasks more closely related to one's realm of experience (i.e. selective auditory processing of pitch, for musicians). This study contributes evidence that intensive music training can promote the development of selective attention, with both domain specific and domain general effects. A limitation of this study is its correlational design, leaving the question of whether music study causes improvement in executive function unanswered. It is possible that people with strong pre-existing executive functioning skills (inhibition, shifting, attention, and updating working memory) are better suited to music and more likely to pursue and persist with music study in the first place. While this study provides evidence that executive functioning skills and musical training are related, it does not shed light on *how* they are related. To understand how executive functioning and music training are related, we will next explore the executive functioning skills involved in musical tasks.

The executive functioning demands of music. The specific music processing steps described by Gordon (2007) involve general cognitive processes that comprise executive

functioning, including: working memory, shifting, inhibition, updating, selective attention, monitoring and planning. Table 1 shows the steps of music processing and the corresponding executive functioning skills involved at each step.

Table 1

Steps of Music Processing and the Corresponding Executive Functioning Skills Involved

Gordon's Music Processing Steps (2007)	Executive Functioning Skills Involved
1. Momentary retention of auditory information.	Attention to irrelevant stimuli is inhibited and selective attention is given to relevant auditory information. Auditory information is held in working memory.
2. Audiating tonal and rhythmic patterns and identifying tonal center and macrobeats.	Tonal and rhythmic patterns are held in working memory. Selective attention to particular aspects of the patterns allow for identification of tonal center and macrobeats.
3. Audiating tonal context by establishing tonality and meter.	Working memory continues to hold patterns in mind while simultaneously updating working memory with the relevant tonal and metrical context.
4. Organizing and retaining patterns.	Working memory holds onto important patterns and inhibits attention to less relevant details.

Table 1 (cont'd)

5. Recalling patterns previously audiated.	Task shifts to include retrieval and comparison to previously audiated material. Working memory holds tonal and rhythmic patterns, along with their tonal and metrical context and the previously audiated material retrieved from working memory.
6. Anticipating/predicting tonal and rhythmic patterns.	Task shifts attention to thinking about what tonal and rhythmic patterns are likely to occur next given current and past information. Attention is sustained through the music to see if predictions are satisfied. Working memory is updated with new material, and the cycle repeats.

Music demands on working memory. Working memory is necessary in order to hold a musical phrase in mind so that it can be compared to other music previously heard. Working memory is essential to music processing. By definition, audiation requires that musical stimuli be held in mind and compared to previously audiated material (Gordon, 2007). By holding representations in mind of what has just been heard, along with representations of remembered material retrieved from long-term storage, we are able to make critical judgments about the music we are hearing. This allows musicians to make comparisons and adjustments. Furthermore, when we listen to music with present and past representations in mind, we are able make predictions about what we are about to hear. Expectation brings pleasure to the experience of music (Huron, 2006). Without working memory, listening to music would be devoid of meaning. Because music places demands on working memory, some researchers argue that

music therapy can improve working memory or stave off age-related declines. Bugos et al. (2007) found that older adults who participated in individualized piano instruction demonstrated improvement over time on measures of working memory compared to controls. The authors attributed the effects to the complex processing required by musical tasks. They write that the distribution of task demands across multiple cognitive domains may contribute to the facilitation of top-down processing.

Music demands on inhibition and selective attention. Inhibition and selective attention are inextricably linked, and both are critical skills in music processing. Musicians need to inhibit in order to selectively attend to auditory and visual information. Musicians are often bombarded with a large amount of complex auditory information. To make sense and meaning of the cacophony, musicians need to selectively attend to certain aspects of the music and inhibit attention to irrelevant information. Satoh, Takeda, Nagata, Hatazawa and Kuzuhara (2001) found that musicians listening to motets activated different brain regions when attending selectively to the harmony or to the alto line. Through experience, musicians learn to hone in on particular qualities of music, such as form, tonality, harmony, phrasing, tempo, rhythm and so forth. A musician playing in an ensemble needs to selectively attend to specific stimuli in order to play together with other musicians. For example, in order to know when to play, a musician must attend to tempo and rhythm. This might involve selectively listening for the timpani playing on the beat, rather than the cellos sustaining long notes. That is, the musician might need to inhibit the stimulus coming from the cello and enhance the stimulus coming from the timpani. Specific visual cues also help a musician know when to play. An example of this is the need to watch the conductor and hone in on gestures that are intended for you. Alternatively, if a musician wants to concentrate on intonation, he might selectively attend to pitch and temporarily

ignore rhythm. The task becomes even more complex and demanding when musicians are reading music; in this case musicians must decode symbols on the page that tell them when, what and how to play while also attending to other visual and auditory cues.

Inhibition of action is also important for musicians. For example, an orchestra musician might need to restrain the urge to play when the conductor cues the person beside him. Or the written music might tell a musician to wait for the offbeat to come in. The musician might need to override the tendency to come in on the beat along with other players. A child holding a percussion instrument in music class may have the urge to start playing right away but inhibit that action until the teacher indicates it is time to play. Thus, being involved in music might give an individual many opportunities to practice inhibition of actions. When a music student is successful at appropriately inhibiting his actions, he might experience positive reinforcement for his successful behavior inhibition in a couple of ways. When musicians wait and play together, they might be rewarded by the music itself sounding as it was intended. The musician might also be socially rewarded for action inhibition by the pleasure of fitting in with the people around him, experiencing social acceptance, and contributing to a greater whole.

Music demands on shifting. Music frequently requires that individuals shift among mental-sets or actions. For example, an orchestral musician might shift from listening and counting rests, to playing. It is critical that the musician shifts effectively and at the right time or he may miss his entrance. Likewise, a singer in a choir might shift from singing a harmony line to singing a solo melody. In this case the necessary shift might involve altering the volume of the voice, going from harmony to melody, and changing register. Again this shift needs to happen effectively and at the right time in the music. Another type of shift may happen when the music changes tempo, meter or dynamics.

Music provides external demands that may shape development of executive functions. It is known that external demands shape the development of executive functioning. For example, language systems are one type of external demand that shape executive functioning. Research shows that receptive language deficits impact children's cognitive control, providing evidence for the role of language in helping executive functions to develop (Noble et al., 2007). Like language, music is another uniquely human practice or "context" that challenges the executive system and leads it to adapt. Scaffolding, structure, provision of externally represented information to guide behavior, and increased density and immediacy of external consequences/feedback to motivate behavior are all strategies that may promote development of executive functioning. Music itself is often extremely structured, and a music performer's specific actions are dictated by the demands of the music. Additionally, music instruction may provide scaffolding and structure if, for example, music teachers carefully plan out learning activities so that students can build on what they already know. Likewise, a music program may provide external guides for how to behave in the form of teacher demonstrations, classroom set-up, and musical notation. It also seems possible that a music lesson could provide frequent opportunities for students to receive immediate feedback on their behavior. If children are attending to their musical performances, the sound itself may provide frequent and immediate feedback about whether it sounds in tune and in rhythm with the rest of the group. The teacher can also provide immediate reinforcement or correction for students' playing and singing.

Musical activities that provide immediate feedback/reinforcement might be highly motivating and engaging for children and help them to develop important executive functioning skills. Instructional activities that ensure students are actively engaged are considered the gold-standard in teaching and are referred to as high-access instruction (Feldman & Denti, 2004).

High-access instruction involves teaching strategies that actively engage all learners, maximize student participation, and ensure all learners focus on the critical concepts (Kameenui & Carnine, 1998). Research suggests that when teachers use strategies that actively engage all students, students of all skill levels make gains (Pressley, Hogan, Wharton-McDonald, & Mistretta, 1996). Therefore it would be interesting to investigate opportunities for feedback and students' level of engagement, both active and passive, during various musical activities. This might shed light on the kind of musical activities that most contribute toward children's development of executive functioning related behaviors.

Potential for generalization and transfer of executive functioning skills across settings. Executive functioning is conceptualized as a domain-general mechanism, so specific experiences that engage executive control may also lead to domain-general effects on executive functioning that generalize to other task-settings. Music processing is diffuse across the brain, involving many systems of the brain working in parallel and in communication (Levitin, 2006; Tramo, 2001). Elliott (1995) writes that performing music engages an individual's entire system of conscious powers, including: attention, awareness, cognition, emotion, intention and memory. Because music study demands high levels of cognitive control through the need for concentration, selective attention and inhibition, switching, updating and monitoring, musical experience may contribute to the development of general executive functioning (Bialystok & DePape, 2009). For example, a person playing the piano might focus his attention on different aspects of his playing. He could selectively attend to rhythmic accuracy, dynamics, phrasing, expression or balance. He might compare his own sound to what he would like it to sound like based on previous learning and stylistic knowledge. This requires the audiation of relevant musical representations held in working memory. The pianist also engages in problem solving;

if he comes across a passage that is difficult to play, a trained pianist selects from among strategies for mastering the passage. These skills might then transfer to improved cognitive skills and behaviors important for school success, such as moving flexibly among various strategies to solve a difficult math problem. Music study can promote self-regulated learning, and in fact music learning may require more self-regulated learning than do most other academic domains (Baum, Owen & Oreck, 1997; McPherson & Zimmerman, 2002).

Music instruction may afford and constrain use of executive functioning skills. The particular qualities of music instruction may offer affordances and constraints that support the use of specific executive functioning skills. In his argument that the environment supports cognitive activity, Gibson defined affordances as features of the environment that contribute to interactions and constraints as dependency relations between situation types (Greeno, 1994; Gibson, 1977). Music activities are intrinsically engaging and captivating for many children and may have qualities that afford the use of sustained attention and focus. Likewise, certain music activities may afford the skill of inhibition and constrain disinhibition, in that it is not possible to be successful in the musical task without inhibiting. Structured environment and clear expectations may also help children to develop internal behavior regulation, a component of executive functioning. Music study may provide many opportunities to develop executive functioning through continuous visual and auditory feedback about one's own performance, alone and in relation to others. For example, children engaged in musical activities might imagine the sounds they want to make, be attuned to the movements and sounds they are making (continuous feedback), and frequently be making needed adjustments. It would be interesting to examine the extent to which various music instruction activities provide opportunities for students to practice reacting to feedback, shifting, inhibiting, updating and sustaining attention.

Music therapy. Further evidence that music involvement may contribute to the development of executive functioning comes from the music therapy literature. Music therapy techniques are sometimes used in the treatment of children with ADHD. As was discussed earlier, ADHD is sometimes described in the literature as a deficit in executive functioning skills. Music therapy researchers have found that children often demonstrate highly sustained attention and concentration when engaged in individual and small group music therapy (Bunt, 2006). Jackson (2003) surveyed music therapists who treat children with diagnoses of ADHD. Music therapists were asked to identify the most common methods they use to treat children with ADHD. The most common method, cited by 74% of therapists, was music and movement, followed by instrumental improvisation (67%), musical play (63%), group singing (55%), and instrumental instruction (47%). Therapists also identified specific treatment goals, with 94% naming behavior goals, 89% naming psychosocial goals and 69% naming cognitive goals. A limitation of the study was that effectiveness was only measured by therapists' ratings. In addition to providing their own estimate of effectiveness, therapists were also asked to estimate the responses of other professionals, teachers, parents and children receiving therapy. Having therapists rate the effectiveness of their own treatment leaves room for potential bias. Almost all ratings were "effective" or "very effective." Some music therapists provided comments on why they felt the treatment was effective. Some mentioned that the music therapy increases on-task behavior, attention span, positive behaviors, and self-esteem. One therapist commented that "group music is effective because of its demands and its ability to motivate," and another mentioned that music therapy "provides structure that helps children 'get organized'." Despite the methodological limitations of this study, it does indicate that music therapists perceive

various musical activities to be effective in helping children regulate their behavior, sustain attention, and get organized, all important components of executive functioning.

There is a need for more empirical investigation into the potential for various music instruction activities to help children learn to regulate their behavior. How do children's rates of engagement and off-task behavior differ depending on the type of musical activity? This may shed light on the types of music activities that best promote the development of executive functioning (shifting, updating, behavior inhibition and attention).

Conceptual Framework

The review of literature has led to the following overarching conceptual framework (see Figure 1). Participation in an intensive high-quality music program incorporates such activities as listening to music, singing alone and in groups, playing instruments alone and in groups, waiting for a turn to play, imitation, call and response and improvisation. Participation in these musical activities involves cognitive music processing. Music processing involves six steps (Gordon, 2007). First, auditory information is momentarily retained in sensory memory (in response to sound). The second step requires audiating tonal and rhythmic patterns and identifying a tonal center and macrobeats. The third step involves audiating musical context through the mental establishment of tonality and meter. Fourth, rhythmic and tonal patterns are organized and retained. Fifth, previously audiated patterns are recalled. Finally, the sixth step involves anticipating and predicting tonal and rhythmic patterns. These steps occur in continuous cycles. The more one engages in formal/informal music instruction and musical activities that place music processing demands on the brain, the more musicianship and audiation skills will develop (as demonstrated by increased developmental music aptitude scores and improved performance over time).

Participation in music instruction activities and music processing create cognitive and behavioral demands that are related to executive functioning, including switching attention and transitioning, inhibition of prepotent responses, updating working memory and sustaining attention. For example, playing instruments in groups might require students to switch attention and transition. The teacher might direct the students to play a rhythm off the blackboard and then listen to the people around them to play together. In this case the child has to switch attention from visual input of the notation on the blackboard to the auditory and visual input of the people around him. Children have to inhibit prepotent responses when they wait for their turn to play. Children are updating working memory as they go through the music processing steps, such as organizing and retaining tonal and rhythmic patterns (step 4). And children have to sustain attention to sing a song all the way through.

It is hypothesized that various music instruction activities differ in the extent to which they demand and allow students to practice switching attention and transitioning, inhibition of prepotent responses, updating working memory and sustaining attention. As students practice these skills in the music program, behaviors associated with improved executive functioning may become evident in the general education classroom. Specifically, it is hypothesized that students will demonstrate improved behaviors associated with shifting, inhibition, updating working memory, and attention in the general classroom setting over the course of a year's participation in a music program. Because music instruction activities and music processing allow children to practice switching, inhibition, updating and sustaining attention, it is possible that music skills and executive functioning skills might develop together in a synergistic manner. In this way, participation in a music program may lead to development of both musical and executive functioning skills.

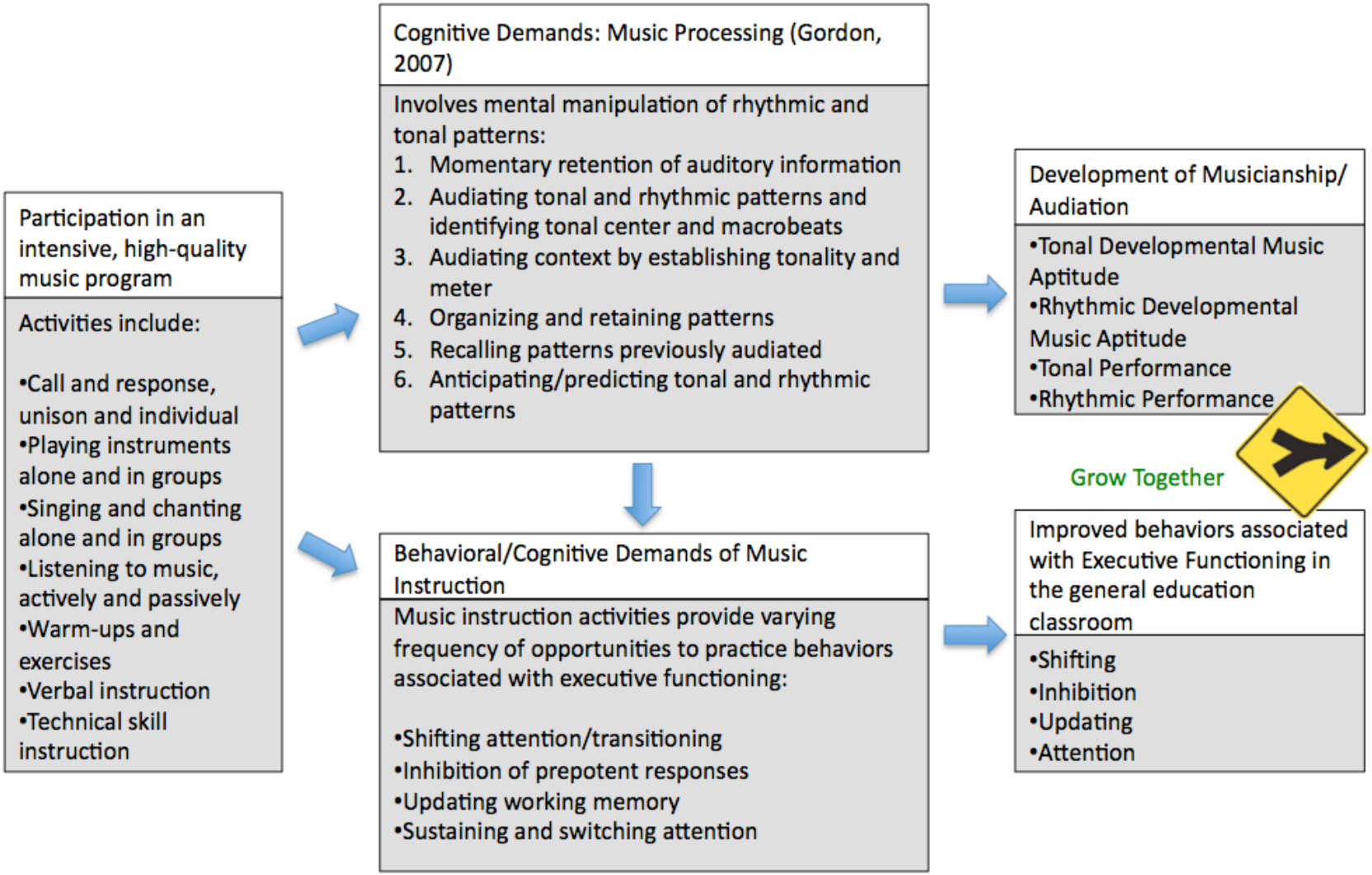

Figure 1. Conceptual Framework (For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation.)

Relevance to the Research Problem

The review of literature identified some gaps in existing empirical research. The relationship between participation in a music program and development of audiation has not yet been documented among urban minority low-SES populations. This study will build on emerging literature suggesting that experienced musicians have particular executive functioning skills superior to those of non-musicians (Bialystok & DePape, 2009). This correlation is suggestive but not indicative of a causal relationship between music study and the development of particular executive functioning skills. The present study seeks to catch musicianship and executive functioning early as they are developing among beginning music students. A control group of students who are not in a music program will allow for comparison in growth of executive-functioning-related behaviors to children who are participating in a music program. The quasi-experimental design in this study may provide more convincing evidence that the relationship may indeed by causal. Another way in which the present study departs from the work of Bialystock and DePape, is that the present study focuses on behavioral manifestations of executive functioning. Therefore the methods of measuring executive functioning in this study center on direct observation and teaching-ratings, rather than individually administered neuropsychological assessments. Furthermore, existing research has not examined the potential for intensive music programs to promote the executive functioning development of urban minority children who are considered at-risk for executive functioning deficits (e.g. ADHD-related behaviors) and school failure. It is hoped that the present study will shed light on some of these gaps in the literature.

Research Questions and Hypotheses

1. To what extent do children participating in a music program demonstrate musical development as demonstrated by measures of developmental music aptitude and performance?

Hypothesis: Students participating in a music program will demonstrate significant improvement over time in measures of developmental music aptitude and performance.

2. How do music instruction activities differ in the extent to which they provide opportunities for children to practice behaviors associated with executive functioning (shifting, inhibition, updating and attention) and in students' rates of active vs. passive engagement and off-task behavior?

Hypothesis: Music instruction activities will differ from one another in the frequency of opportunities they provide to practice shifting, inhibition, updating and sustained attention, and students' rates of active vs. passive engagement and off-task behavior will differ depending on the activity.

3. To what extent do students participating in a music program demonstrate, over time, improved behaviors associated with executive functioning (shifting, inhibition, updating and attention) in the general education classroom compared to students not participating in a music program?

Hypothesis: Students participating in a music program will demonstrate in the general education classroom more improvement over time in behaviors associated with shifting, inhibition, updating and attention, than students not participating in a music program.

4. For students participating in a music program, does musical development correlate with development of executive-functioning-related behaviors in the general education classroom?

Hypothesis: Measures of musical development will correlate positively with measures of shifting, inhibition, updating and attention in the general education classroom.

CHAPTER III:

METHOD

Participants

The population of interest in this study was children participating in intensive high-quality music program (intensive in that the students participated in the music program 3-4 times per week for more than one hour; high-quality in that the instructors were certified highly-qualified music educators and instruction followed the *National Standards for Music Education*; www.menc.org). Children not participating in intensive music programs but receiving general music education in the school setting were also of interest for the purposes of comparison. The sample for this study consisted of 117 children in grades one and two within one urban elementary school in Maryland. All of these children participated in general music education classes that were part of the standard curriculum at the school for 30 minutes once per week. Because the general music education classes were not investigated in this study, it is not known how they differed from the afterschool music program other than in intensity (30 minutes once per week vs. 4 plus hours). Of the 117 children in the sample, 78 participated additionally in an afterschool music program offered at the school (the other 39 did not participate in the afterschool program). The sample was 100% African American with a high percentage of children from low SES backgrounds. The demographics of the overall student population at the school where the sample was drawn from was 99.0% African American, 0.6% American Indian/Alaskan Native, and 0.3% Asian/Pacific Islander. At the school, 90.7% of the student population received free or reduced lunch during the 2009/10 academic year.

Description of the Program

The afterschool music program from which the sample was drawn took place at one urban elementary school in Maryland. The program was sponsored by numerous community partnerships and affiliated with a local symphony. The goal of the program was to provide intensive music education, instruments and mentorship to inner-city school children. This program was chosen for this study because of the underprivileged demographic served as well as the intensity, frequency and high quality of the music instruction offered. The program was intensive in that the students received music instruction 3-4 times per week for more than one hour each time. This program served children in pre-kindergarten, kindergarten, first grade and second grade in an inner-city school. The program was based on current best practices within the field of music education, incorporating elements of Gordon's *Jump Right In*, Kodaly Method, Dalcroze Method, Orff Schulwerk, and The Suzuki Method. Music instruction was provided by qualified professional music teachers. The program was high-quality in that the instructors were certified highly-trained music educators and instruction followed the *National Standards for Music Education* (www.menc.org). Frequent performing for peers, teachers, families and the community was part of the culture of the program. Students performed regularly in various contexts including individual and group lessons, rehearsals, impromptu performances for visitors, peers, and staff, and formal concerts for large audiences of peers, staff, family and community members.

During the 2008/09 school year, approximately 25 first-grade students participated in a pilot program. The pilot program was held after school three days per week, and consisted of music instruction and activities aimed at improving musicianship, as well as other enrichment activities. These students continued to participate in the program across the 2009/10 academic

year, with the exception of a few students who moved out of the district. During the 2009/10 academic year, additional students in Pre-Kindergarten, Kindergarten, first grade and second grade participated in the program. Thus there was one cohort of second grade students in their second year in the program, plus additional cohorts of beginning students going into their first year in the program. In this study, these cohorts are referred to as Veterans, Second Grade Beginners, and First Grade Beginners. The pre-Kindergarten and Kindergarten students were collapsed into one cohort. The pre-Kindergarten and Kindergarten students were not included in most analyses because their music program was less frequent and less intense (consisting of music instruction during school hours twice a week for 45 minute segments).

The First and Second Grade Beginners participated in the after-school music program three times per week for 2.5 hours each session (this included time for snack, supervised homework session, music instruction and enrichment activities). The musical focus was on singing alone and with others, performing on recorders, recognizing orchestral instruments by sound, and listening and moving to various styles of music. The Veterans participated in the afterschool music program four times per week for 2.5 hours each session. The musical focus included understanding music in relation to history, performing on an orchestral instrument (violin, cello, bass, flute, clarinet or trumpet), practicing alone and with others, performing in small ensembles, as well as listening and speaking about music. Music program participants also attended some classes and events during the school day. They were pulled from their classrooms during the day to attend a weekly 45-minute musicianship class, and they attended occasional field trips during the school day.

Researcher Role

The researcher served as an unpaid consultant to this music program during the 2009/10 school year. Prior to the beginning of the year, the researcher met with program staff to develop a plan for data collection and program evaluation. Areas targeted for evaluation included 1) musical skills and knowledge, 2) student attitudes, self-perceptions and predictions, 3) academic achievement and attendance, 4) social-emotional and behavioral development, and 5) adult feedback. The researcher continued to consult with program staff throughout the year as they collected data. During the summer of 2010, the researcher compiled all of the data that had been collected and provided the music program with a program evaluation report for the 2009/10 school year.

This research study was a separate but parallel project to the program evaluation. The researcher obtained approval from the Michigan State University Institutional Review Board to use de-identified data that were collected as part of the program evaluation for the purposes of addressing the specific research questions posed in this study. The music program gave permission for the research study using de-identified data and signed a data use agreement

Variables and Measures

Table 2 summarizes the research questions and corresponding outcome variables and data sources.

Table 2

Research Questions, Outcome Variables and Data Sources

Research Questions	Outcome Variables	Data Sources
1. To what extent do children participating in a music program demonstrate musical development as demonstrated by measures of developmental music aptitude and performance?	• Developmental Musical Aptitude o Overall o Tonal o Rhythm • Performance Achievement	PMMA Composite Score Tonal Subscore Rhythm Subscore Performance Ratings
2. How do music instruction activities differ in the extent to which they provide opportunities for children to practice behaviors associated with executive functioning (shifting, inhibition, updating and attention) and in students' rates of active vs. passive engagement and off-task behavior?	• Detailed description of music activities. • Active-Engaged Time • Passive-Engaged Time • Off-Task Time	Direct Observation Videotape
3. To what extent do students participating in a music program demonstrate, over time, improved behaviors associated with executive functioning (shifting, inhibition, updating and attention) in the general education classroom compared to students not participating in a music program?	• Executive Functioning o Shifting o Inhibition o Updating o Sustained Attention	BRIEF Teacher Rating Scales Shift Scale Inhibit Scale Working Memory Scale BASC-2 Teacher Rating Scale Attention Problems Scale

Table 2 (cont'd)

4. For students participating in a music program, does musical development correlate with development of executive-functioning-related behaviors in the general education classroom?	Look for correlations between music development variables (developmental music aptitude and performance achievement) and executive functioning variables (shifting, inhibition, updating and sustained attention).	See musicianship and executive functioning data sources above.

Outcome Variables (Operational Definitions of Key Terms)

Developmental music aptitude. Music aptitude is defined as an individual's potential to learn music (Gordon, 1986). Up until age nine, music aptitude is considered developmental and changes in response to environmental demands. In this study, a subject's music aptitude was operationally defined by three scores on the *Primary Measures of Music Audiation (PMMA):* Rhythmic Aptitude Subscore, Tonal Aptitude Subscore and Music Aptitude Composite Subscore (Gordon, 1986).

Performance achievement. Participants' musical development was also measured by having expert musicians rate their performances at Time 1 and Time 2 in terms of rhythmic and tonal accuracy. Doctoral students in music education were trained to rate individual singing clips using the Music Performance Rating Scale (Appendix B).

Executive functioning affordances and constraints. Executive Functioning Affordances and Constraints for specific music activities were determined by using the Executive Functioning Affordances and Constraints rating scale (Table 15).

Time active-engaged, passive-engaged and off-task. Engaged Time refers to the percentage of time on average students spent focused on the task at hand during any given music instruction activity. Active-engaged time refers to active participation such as playing an

instrument, singing, or clapping a rhythm. Passive-engaged time might be listening to a peer or teacher perform, listening to a recording, or holding an instrument and waiting to play. The definition of off-task behavior depended somewhat on the activity, but did include being out of seat at the wrong time, sitting and staring off into space, yelling or crying, or talking to a peer.

Executive functioning. In this study, executive functioning was operationally defined by a child's profile of scores derived from BRIEF teacher rating-scales (Gioia, Isquith, Guy & Kenworthy, 2000) and the BASC-2 teacher rating-scales (Reynolds & Kamphaus, 2004). Scores included the BRIEF scales Shift, Inhibit and Working Memory, as well as the BASC-2 Attention Problems scale.

Measures

Primary Measures of Music Audiation (PMMA). The *Primary Measures of Music Audiation (PMMA)* is a standardized assessment tool used to evaluate tonal and rhythmic developmental music aptitude of individual children in Kindergarten, grade one, grade two and grade three (Gordon, 1986). Music aptitude tests are designed to measure the personal inferential processes by which a particular student synthesizes what is being heard as music (Gordon, 2007). The PMMA consists of two tests: Tonal and Rhythm. Each test contains 40 items and practice items, and each test takes about 20 minutes to administer. Stimuli are presented aurally from cassette tapes. Each item consists of two musical phrases that are either the same or different. The children respond individually, indicating whether the phrases were the same or different by circling faces on an answer sheet. This test does not involve reading language, numbers or musical notation. Stimuli are provided without musical context of melody or harmony because the test is measuring the ability to audiate context subjectively. The PMMA can be administered to children as a group or individually. In essence, this test measures "how

well one can derive immediate musical impressions and make intuitive responses in audiation," (Gordon, 1986). The PMMA yields a tonal subtest score, a rhythmic subtext score, and a composite score. Raw scores can be converted to percentile ranks. The norms sample for the PMMA is fairly small, consisting of 873 children in Kindergarten through grade 3. Gordon argues that local norms are also a good way of comparing children's relative performance on the PMMA.

Reliability coefficients for the PMMA range from .66 to .92. Gordon found that the rhythmic and tonal subtests share only 25% of the variance, establishing that the subtests are indeed measuring unique dimensions of music aptitude. Within the field of music education, the PMMA is considered to be one of the most valid measures of music aptitude for this age group. This test focuses on tonal and rhythmic dimensions of aptitude. These constructs are theoretically central to music aptitude, and research indicates that these dimensions can be measured with confidence. Test items were carefully constructed based on knowledge of children's rhythmic and tonal development and theory of audiation. The PMMA is valid in that scores tend to reflect the quantity and quality of children's music exposure (Gordon, 1980). Compared to teacher ratings of children's music aptitude, the PMMA has been found to be more predictive of the intonation, rhythm and musical expression quality of children's musical performance (Gordon, 1984). In summary, the PMMA is technically one of the best measures of music aptitude and development and is highly accepted among music researchers.

Performance ratings. Individual students were recorded singing short melodic patterns and chanting short rhythmic patterns at two time-points (December, 2009, and May, 2010). The teacher vocally provided melodic and rhythmic stimuli, and the children were asked to do their best to imitate the teacher's examples. Figures 2 and 3 show the tonal stimuli that were provided

to first grade students at time 1 and time 2. Major tonal patterns were used. The teacher sang three notes, and then each student repeated the same three notes. Then the teacher sang another three notes, which were repeated by the student. There are some differences in the stimuli between time 1 and 2 because the teacher designed the stimuli to reflect and inform instruction. Some of these differences increase difficulty of the task, reflecting students' musical development across the year. At time 1, the text consisted of neutral syllables, but at time 2, solfege syllables were used. At time 1, only an arpeggiated major tonic (I) triad was used. In contrast, at time 2, both an arpeggiated major tonic (I) triad and an arpeggiated major subdominant (IV) triad were used. Also adding to the increased difficulty of the task at time 2, was the descending motion of arpeggiation and the first inversion of the tonic triad (I^6).

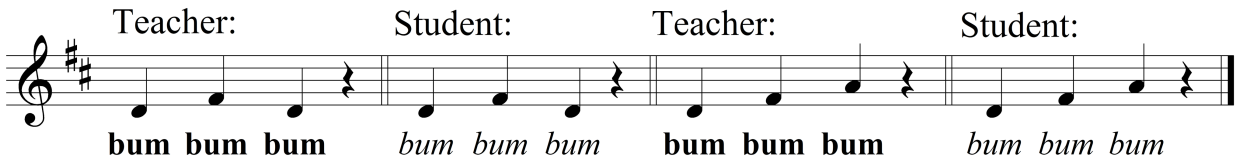

Figure 2. First Grade Tonal Time 1

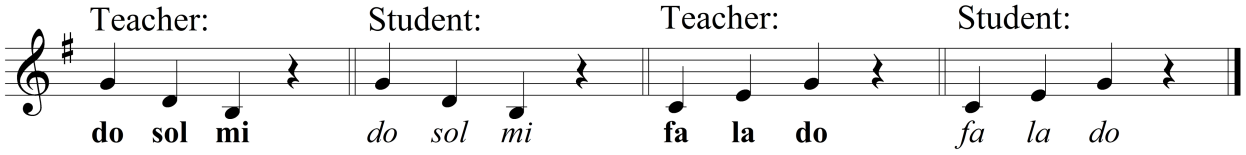

Figure 3. First Grade Tonal Time 2

Figures 4 and 5 show the tonal stimuli and responses of second grade students at time 1 and time 2. These stimuli are more difficult than the stimuli provided to first graders at time 1 (Figure 2). At time 1 the teacher gave each second grade student one of the 4 examples in Figure 4. Most students were given either example 1 or 2; these are similar stimuli arpeggiating a major tonic triad. A few students were given either example 3, an ascending arpeggiation of a

subdominant (IV) triad, or example 4, a descending arpeggiation of a dominant (V) triad. At time 2, second graders were given two 3-note patterns to imitate, corresponding exactly to examples 1 and 3 at time 1.

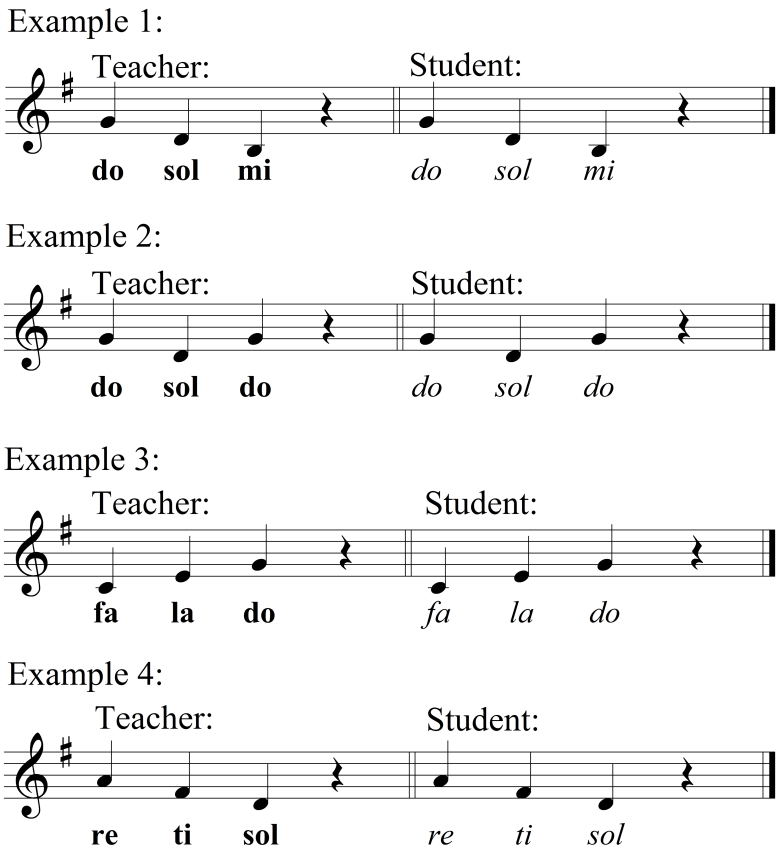

Figure 4. Second Grade Tonal Time 1

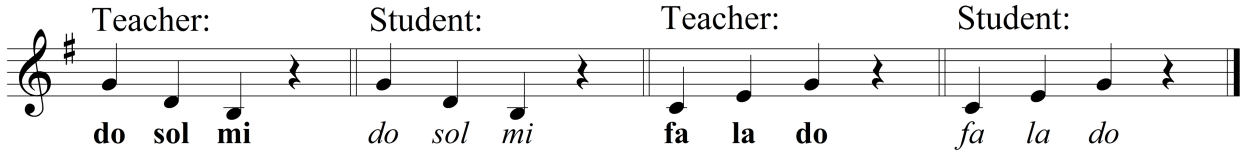

Figure 5. Second Grade Tonal Time 2

Figures 6 and 7 show the rhythm stimuli that were presented to first graders at times 1 and 2. At time 1, the teacher presented students with either Example 1, Example 2, or a very similar variation. In all cases, the first three beats were some mix of eighth and sixteenth notes, and forth beat was always a quarter note. At time 1, students were given varied stimuli, whereas

at time 2, students were all given the same stimuli. At time 1, students were only given one 4-beat pattern to imitate, while at time 2, students were given two 4-beat rhythmic patterns. Also, a neutral syllable was used at time 1, while Gordon rhythmic syllables were used at time 2. Rhythmic content was similar between the two time-points in that some combination of quarter notes, eighth notes and sixteenth notes were used within a common-time meter.

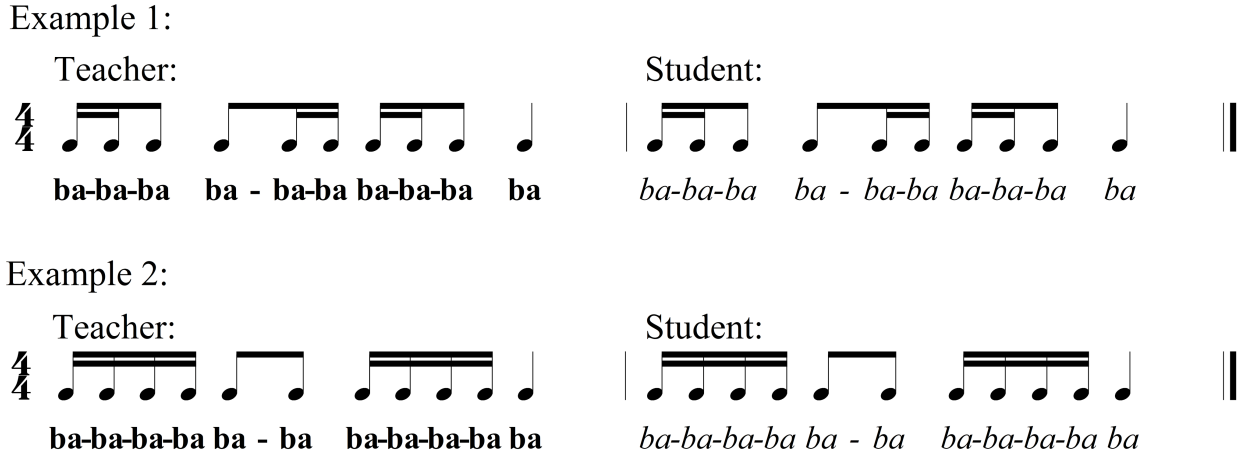

Figure 6. First Grade Rhythm Time 1

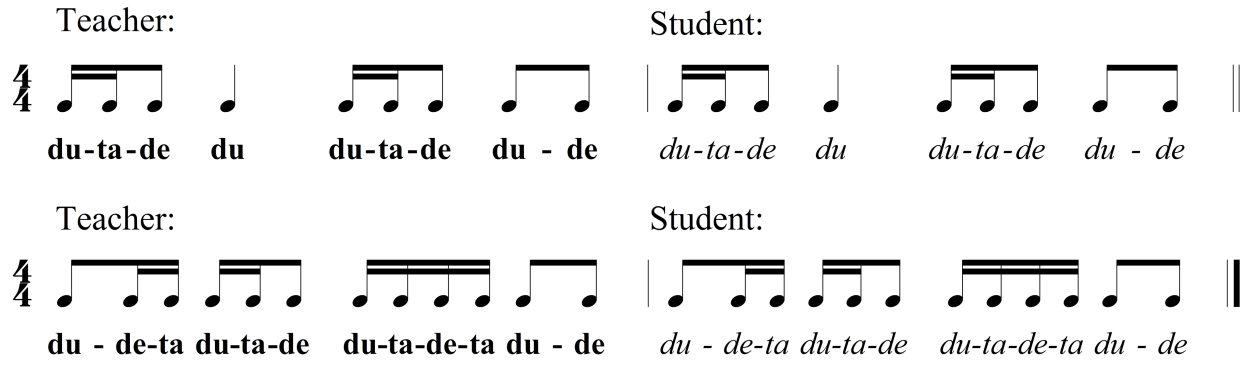

Figure 7. First Grade Rhythm Time 2

Figures 8 and 9 show rhythmic patterns that were provided to second grade students at times 1 and 2. At time 1 stimuli consisted of 4 beats of quarter notes, eighth notes and sixteenth notes in common time (4/4), and the teacher presented slight variations of rhythm to each student (see Figure 8, examples 1 and 2). The time 2 rhythm stimuli were more challenging. First the

teacher presented 4 beats similar to time 1. Then the teacher presented 4 beats in a new triple meter (12/8), holding the beat tempo constant. The student had to go from hearing and performing a duple division, immediately into hearing and performing a triple division.

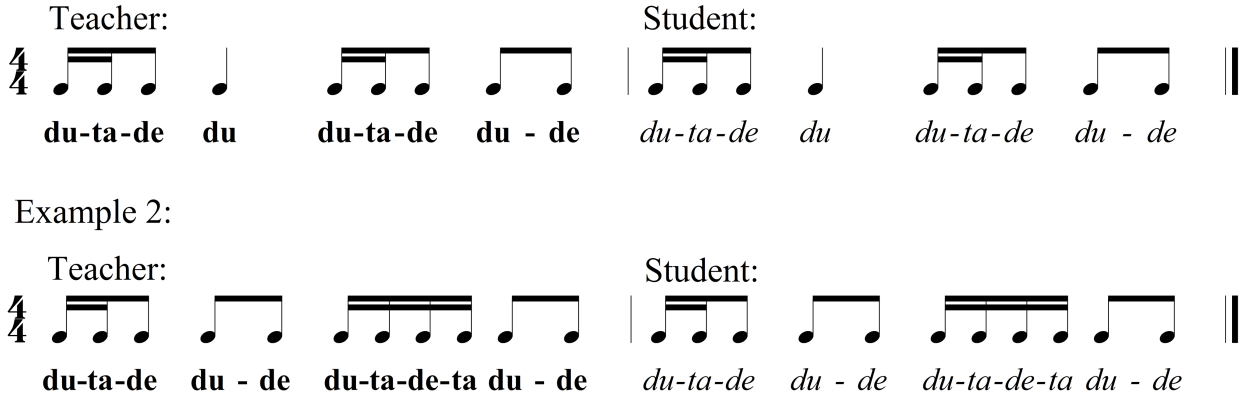

Figure 8. Second Grade Rhythm Time 1

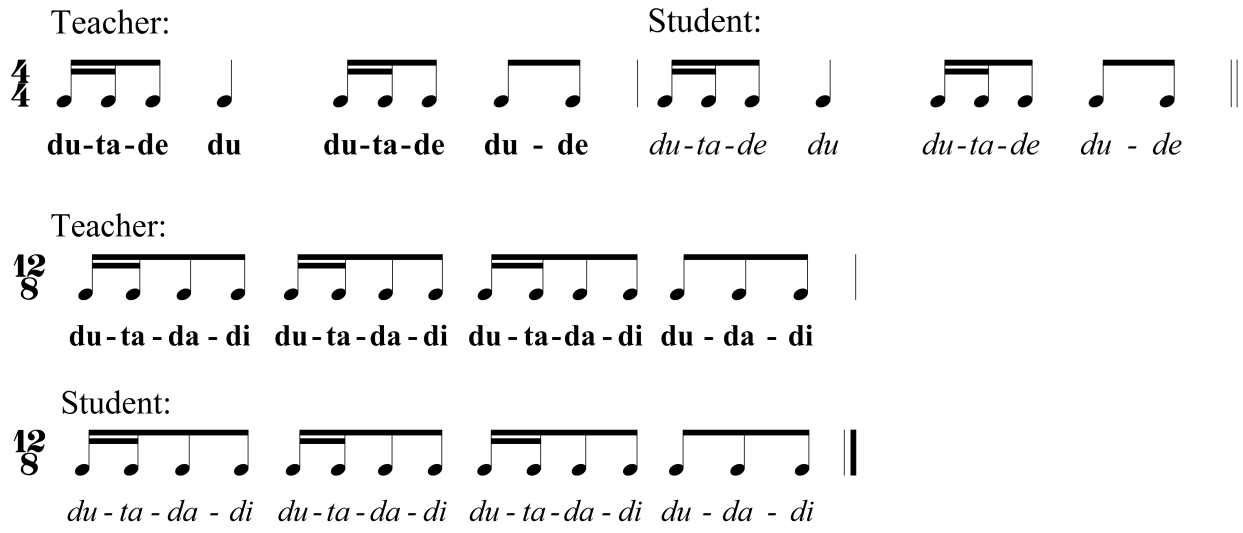

Figure 9. Second Grade Rhythm Time 2

These performances were rated for rhythmic and tonal accuracy by expert musicians (doctoral students in music education) who were blind to the order in which the recordings were made and blind to the overall purpose of the study. First the raters were trained to use the rating scale (see Appendix B). A representative selection of tonal and rhythmic performances were

used for the raters to practice. Raters discussed precise interpretation of the rating scale for clarification, and made some decisions about how to apply the rating scale to students' performances. For example, the raters decided that 1 or 2 pitches slightly out of tune would still earn a score of 4. The raters practiced until they reached a level of at least 80% agreement.

Then the raters were presented with the students' tonal and rhythmic performances in random order. The raters worked independently scoring each performance. Afterwards the raters' scores were compared. Raters agreed (came up with the exact same rating) on 81.4% of the tonal performances and 89.7% of the rhythmic performances. For performances where there was disagreement between raters, the raters listened to those particular performances again, discussed their interpretation, and came to an ultimate agreement on a score.

Direct observation of student behavior across settings. Music instruction was videotaped across several days in April, May and June, 2010. A broad range of settings and activities were videotaped in order to capture a representative sample of the musical activities that take place within the program. Settings included Musicianship Class, Small Group Instrumental Lesson (brass, cello, violin, flute), Private Instrumental Lesson (string bass) and Large Group Ensemble Rehearsal (choir, orchestra, jazz band, or combined). Some performances/concerts were also captured. This broad sample of video was then divided up into short video clips, each capturing a type of musical activity. Doctoral students in school psychology who were blind to the research questions and purpose of the study were trained to code student behavior using a momentary time-sampling technique. Each momentary observation of a specific student was coded as either Active Engaged, Passive Engaged, Off-Task Motor, Off-Task Verbal, or Off-Task Passive.

Executive Functioning Affordances and Constraints Rating Scale. This 5-point rating scale was developed for this study, for the purpose of rating music activities according to the extent to which they afford and constrain use of particular executive functioning skills. The rating scale incorporates the frequency of affordances and constraints, ranging from little to none up to continuous/almost always. The scale also incorporates likelihood that the skill would be used during the activity, and the frequency of consequences and/or feedback for using or not using the skill. Though developed for the purposes of this study, this rating scale is valid in its similarity to the Executive Functioning Classroom Observation Form developed by McCloskey, Van Divner and Perkins (2009), a tool designed to assess the instructional environment for the presence of self-regulation executive functioning demands. The tool developed by McCloskey et al. requires the observer to 1) consider several aspects of executive functioning such as inhibit, sustain, shift and manipulate information held in working memory, 2) take notes on the types of executive functioning prompts observed within the classroom environment for each aspect of executive functioning, and 3) tally the number of prompts observed for each executive functioning skill. The tool used in this study, the Executive Functioning Affordances and Constraints Rating Scale, also assesses the frequency of environmental prompts, conceptualized in this study using the language of affordances, constraints and feedback.

The Behavior Rating Inventory of Executive Functioning (BRIEF). The BRIEF is a psychometrically sound (adequately reliable and valid) tool that is used to measure executive functioning abilities (Gioia, Isquith, Guy, & Kenworthy, 2000). The BRIEF consists of a parent and a teacher rating form, each containing 86 items. Normative data based on a nationally representative sample provide a way to compare a child's behavior to other children of the same age and gender. The BRIEF produces a Global Executive Composite Score as well as a

Behavioral Regulation Index (scales: Inhibit, Shift, Emotional Control) and a Metacognition Index (scales: Initiate, Working Memory, Plan/Organize, Organization of Materials, Monitor).

The normative data are based on child ratings form 1419 parents and 720 teachers, reflecting 1999 US census data. The BRIEF is sensitive to developmental changes over time. Pre- and post-rating scales are often used in studies that measure the effectiveness of social-emotional interventions in promoting competencies (e.g. social skills) and reducing problems (e.g. aggression) (for example, Taub, 2002). The BRIEF has a high level of ecological validity, by providing insight into a child's behavior in the home and school setting. The BRIEF is rooted in current theory of executive functioning, and provides a comprehensive sample of behaviors associated with many aspects of executive functioning. The BRIEF includes an inconsistency scale and a negativity scale to help ensure that an individual's ratings are valid. Convergent validity is established through correlations with other measures of inattention, impulsivity and learning skills. The BRIEF has a high level of internal consistency, with alphas ranging from .80 to .98. Test-retest reliability alphas are .82 for parents and .88 for teachers. Teacher and parent ratings of child behavior correlate moderately.

Behavior Assessment System for Children, Second Edition (BASC-2). The *Behavior Assessment System for Children, second edition* (BASC-2) is a multi-dimensional and multi-method system for assessing the behavior and self-perceptions of individuals ranging in age from 2 to 25 years (Reynolds & Kamphaus, 2004). The *BASC-2* consists of a teacher rating scale (TRS), a parent rating scale, a self-report scale, a Structured Developmental History form, and a classroom observation form. There are Preschool, Child and Adolescent versions of each form. In this study, one scale from the Teacher Rating Scale (TRS) Child Form was utilized. The Attention Problems scale on the BASC-2 was used to measure teachers' ratings of children's

attention in the general education classroom. This subscale includes items measuring the inability to maintain attention and the tendency for students to become easily distracted during tasks that require attention. Based on the General norm sample, internal consistency coefficient alphas for the Child Attention Problems TRS subscale range from .94 to .95. Measures of test-retest reliability for the Child Attention Problems TRS yielded a coefficient alpha of .90. This indicates that teacher ratings of attention problems tend to be fairly stable over time, even taking into account natural fluctuation and growth in child behavior. Interrater reliability was measured by having two different teachers rate the behavior of the same children. Measures of interrater reliability for the Child Attention Problems TRS yielded a coefficient alpha of .59 (Reynolds & Kamphaus, 2004). This indicates that the relationship between different teachers' ratings on the Attention Problems subscale is weaker than the relationship between the same teacher's ratings over time. There are several potential explanations for this lower level of interrater reliability: teachers may interpret the items differently, teachers may perceive the intensity of behaviors differently, or children's behavior may vary across environments and with different adults.

Data Collection Procedure

Data collection occurred in two waves across the 2009/10 school year. Music teachers from the program administered the PMMA in November, 2009, and May, 2010. Some of the Second Year Veterans also took the PMMA during the previous academic year, in Fall, 2008. Performance samples were collected for First and Second Grade Beginners at two time-points (December, 2009, and May, 2010), but no performance data were collected for Second Year Veterans. Individual students were recorded singing short melodic patterns and chanting short rhythmic patterns. The teacher vocally provided melodic and rhythmic stimuli, and the children were asked to do their best to imitate the teacher's examples. General education teachers filled

out items from the BRIEF and BASC-2 rating scales for each music student and non-music student in the sample in the fall of 2009 and again in the spring of 2010 near the end of the school year. The BRIEF and BASC-2 are sensitive to developmental changes over time, so by administering the rating-scales at the beginning and at the end of the 09/10 academic year, growth in several key areas of executive functioning could potentially have been detected. Items from the BRIEF and BASC-2 rating scales took about 10 minutes for teachers to complete for each student. Teachers were compensated for their time with gift cards. Each teacher was familiar with each child for at least one month before filling out the rating scale.

Music instruction was videotaped across several days in April, May and June, 2010. A broad range of settings and activities were videotaped in order to capture a representative sample of the musical activities that take place within the program. Settings included Musicianship Class, Small Group Instrumental Lesson (brass, cello, violin, flute), Private Instrumental Lesson (string bass) and Large Group Ensemble Rehearsal (choir, orchestra, jazz band, or combined). Some performances/concerts were also captured. In all, approximately 6 hours of music instruction were captured on video.

Data Analysis

Research question 1. The first research question asks to what extent children's musical development increases over the course of participation in an intensive music program. The two measures of music development in this study are developmental music aptitude (PMMA scores) and performance ratings. This research question calls for analysis of PMMA tonal and rhythmic aptitude data collected at two time-points. Students' scores on the PMMA at time 1 were compared to their PMMA scores at time 2 using Paired Samples T-test. This analysis facilitated comparison of means and identification of potential statistical significance of any differences

found. Furthermore, at time 1, comparison was made between PMMA scores of the second grade cohort in their first year of the program and PMMA scores of the second grade cohort in their second year in the program. Expert ratings of children's singing performances at time 1 and time 2 yielded an overall performance achievement score, a rhythmic performance achievement score and a tonal performance achievement score. Paired Samples T-tests were used to compare performance scores at time 1 with performance scores at time 2, and to identify statistical significance of any differences found. Again, at time 1, comparison was made between performance ratings of second-grade children in their first year in the program and ratings of second-grade children in their second year in the program.

Research question 2. The second research question asks how music instruction activities differ in the extent to which they provide opportunities for children to practice behaviors associated with executive functioning (shifting, inhibition, updating and attention) and in students' rates of active vs. passive engagement and off-task behavior. To address this question, first the broad sample of video was divided up into short video clips, each capturing a type of musical activity, such as singing a song, teacher lecture, call and response, etc. This process involved splitting the video into a new separate clip each time the activity changed. The length of each clip was determined by the length of the specific activity.

From the representative sample of music instruction videotaped, main types of musical activities were identified. The process of identifying music activities began by sorting the short video clips into categories (through the assignment of number codes) according to similarity of what the teacher and students were doing in the clips. Clips involving the same activity were grouped together (coded with the same number) and identified by a category name. Sometimes, two or more mini-categories were combined into one category because of the underlying

similarity of the activity (see Results for specific examples of this process). From this process of sorting and categorizing, ten main types of musical activities that cut across musical settings emerged. The total amount of time devoted to each type of activity was tallied, as well as the percentage of total video time devoted to each activity.

Next, each type of musical activity was analyzed to determine the extent to which it affords and constrains attention, inhibition, updating and shifting. For each musical activity, a numerical rating and a qualitative description/explanation of the executive functioning affordances and constraints are provided in the results section. The author used the Executive Functioning Affordances and Constraints Rating Scale to rate the levels of executive affordances and constraints for each musical activity. For each rating assigned to each activity, rationale is provided through explanation of the ways in which the activity affords and constrains the particular executive functioning skill. This includes consideration of consequences, frequency of feedback, and reinforcement for using or not using the skill. For each music activity, attention, inhibition, updating and shifting scores were added to create an Executive Functioning Affordances and Constraints Composite Score (EF Comp).

The second part of research question 2 asks how music instruction activities differ in students' rates of active vs. passive engagement and off-task behavior. This question was addressed through analysis of video coding data gathered from raters' direct observation of student behavior using a momentary time-sampling technique with one observation occurring every 15 seconds. Raters, doctoral students in school psychology blind to the purpose of the study and specific research questions, coded 1-3 students in each of the 249 video clips, yielding a total of 3664 discrete observations. Some video shots only contained one, two or three students; in these cases all students present were coded. In other videos, large groups of students

were visible. In these cases, 3 clearly visible students were selected at random for observation. With each new clip, a different set of 3 students was observed. A broad sample of students were observed in the videos and a large number of discrete observations were made in order to maximize representativeness of the data. Of the 3664 total observations, 28.6% were coded by both raters. Interrater reliability was 79.7% perfect agreement. All instances of disagreement were reviewed and final coding decisions were made by the researcher.

An example of active-engaged time might be playing an instrument, singing, or clapping a rhythm. Passive engaged time might be listening to a peer or teacher perform, listening to a recording, or holding an instrument and waiting to play. The definition of off-task behavior depended somewhat on the activity, but did include being out of seat at the wrong time, sitting and staring off into space, yelling or crying, or talking to a peer. For each activity, the percentage of observations that were Active Engaged, Passive Engaged, Off-Task Motor, Off-Task Verbal, and Off-Task Passive was calculated by dividing the number of each type of observation by the total number of observations for that activity and them multiplying by 100%. A one-way analysis of variance was conducted to see if levels of student levels of Active Engagement, Passive Engagement, Off-Task Motor, Off-Task Verbal, and Off-Task Passive differed significantly among activities.

Finally, in order to explore whether there were any relationships between levels of executive functioning affordances and constraints and students' levels of engagement and off-task behavior, a series of Pearson correlation coefficients were calculated.

Research question 3. The third research question asks to what extent students participating in an intense music program demonstrate, over time, improved behaviors associated with executive functioning (shifting, inhibition, updating and attention) in the general education

classroom compared to students not participating in an intense music program. This question was addressed by comparison of BRIEF and BASC-2 teacher rating-scale data at time 1 and time 2 using Paired Samples T-tests. Separate analyses were carried out for the Shift, Inhibit, and Working Memory scales as well as the BASC-2 Attention Problems subscale. Mixed between-within subjects analysis of variance (ANOVA) was used to compare growth of students in the afterschool music program to growth of students who were not in the afterschool music program. This allowed for main effects and any potential interactions to be potentially detected.

Research question 4. The fourth research question asks whether evidence exists that musicianship and executive functioning develop together as evidenced by the presence of a correlation between musical development and the development of executive-functioning-related behaviors in the general education classroom. In other words, do children who demonstrate more growth in musicianship also demonstrate more growth in executive functioning? The goal was to find evidence that supports or refutes that these abilities develop together. To address this question, growth in developmental music aptitude between time 1 and time 2 was correlated with growth in measures of shifting, inhibition, updating and attention in the general education classroom. Change over time in music performance ratings was also correlated with growth in specific areas of executive functioning. To set up the analyses, change scores (time 2 minus time 1) for each variable were calculated. Then a number of simple bivariate correlations were carried out in order to describe the strength and direction of the relationship between the variables. Pearson correlation coefficients for all combinations of musicianship and executive functioning variables were displayed in a matrix.

CHAPTER IV:

RESULTS

Research Question 1

To what extent do children participating in a music program demonstrate musical development as demonstrated by measures of developmental music aptitude and performance?

Summary of research question 1 results. First and Second Grade Beginners' PMMA Tonal scores increased significantly from time 1 (fall 2009) to time 2 (spring 2010). Grade 1 Beginners made approximately 1.5 year's of growth in six months' time, and Grade 2 Beginners made close to 1 year's growth in six month's time (see Figure 10). First and Second Grade Beginners' PMMA Rhythm scores did not increase significantly from time 1 to time 2. However, students' PMMA Rhythm scores were well above the standardization sample mean at both time-points (see Figure 11). First and Second Grade Beginners' PMMA Composite scores increased significantly from time 1 to time 2 (see Figure 12). Second Year Veterans' PMMA Composite scores also increased significantly from time 1 (fall 2008) to time 2 (fall 2009), with PMMA Tonal scores increasing marginally and PMMA Rhythm scores increasing significantly (see Tables 6, 8 and 10). Tonal Performance scores increased for First Grade Beginners and decreased for Second Grade Beginners. First Grade Beginners' Rhythm Performance scores stayed the same from time 1 to time 2, while Second Grade Beginners' Rhythm Performance scores increased marginally (see Figures 13 and 14). Performance scores should be interpreted in light of the increasing difficulty of the tasks from time 1 to time 2 (see Discussion).

Developmental music aptitude as measured by the PMMA. Table 3 shows the number of First Grade Beginners, Second Grade Beginners and Second Year Veterans who took the PMMA at each time-point. While 15 First Grade Beginners took the PMMA in the Fall, only

10 First Grade Beginners took the PMMA in the Spring. A total of 10 First Grade Beginners were present in the sample at both time-points. Likewise for Second Grade Beginners, 18 took the PMMA in the fall but only 10 took the PMMA in the spring. These 10 students were present in the sample at both time-points. A total of 14 Second Year Veterans took the PMMA at the Fall, 2009, time-point, but this group did not take the PMMA in Spring, 2010. However, 8 of them took the PMMA in December, 2008, during their first year in the program. These 8 Second Year Veterans were tested at both time-points. A total of 28 students took the PMMA at two time points.

Table 3

Number of students included in the PMMA sample

	Fall 2008	Fall 2009	Spring 2010	Number of students tested at two time-points
First Grade Beginners	-	15	10	10
Second Grade Beginners	-	18	10	10
Second Year Veterans	8	14	-	8

Table 4 displays average PMMA scores for those First and Second Grade Beginners who were tested at both Time 1 (fall, 2009) and Time 2 (spring, 2010) along with average PMMA scores from the standardization sample for comparison. (For average PMMA scores including all students tested at each time point, refer to Appendix C.) Figures 10, 11 and 12 graphically represent mean PMMA scores for students across time-points and grade-levels as well as average PMMA scores within the standardization sample. Growth rates can be compared for PMMA

Tonal scores (Figure 10), PMMA Rhythm scores (Figure 11), and PMMA Composite scores (Figure 12).

Table 4

Average PMMA Scores Within the Standardization Sample and for First and Second Grade Beginners

	PMMA Test	Standardization Sample Fall Average Score**	First and Second Grade Beginners Fall Average Score	First and Second Grade Beginners Spring Average Score
Grade 1	Tonal	29.8	30.4	34.0
	Rhythm	25.8	31.3	31.7
	Composite	55.6	61.7	65.7
Grade 2	Tonal	32.0	33.2	35.2
	Rhythm	27.7	32.5	31.9
	Composite	59.7	65.7	67.1
Grade 3	Tonal	34.6	-	-
	Rhythm	29.4	-	-
	Composite	64.0	-	-

**Children in the PMMA standardization sample were tested in the fall months of October and November; therefore no spring scores are available.

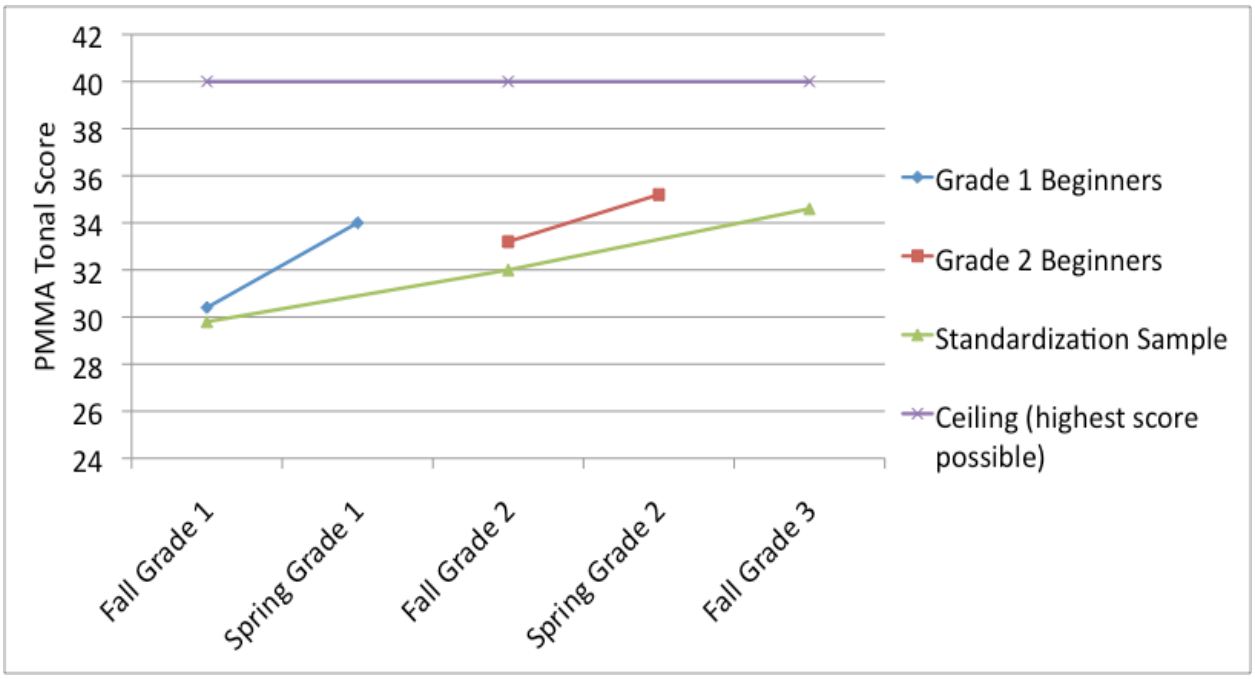

Figure 10. Students' Average PMMA Tonal Scores in Fall and Spring Compared to the Standardization Sample Mean

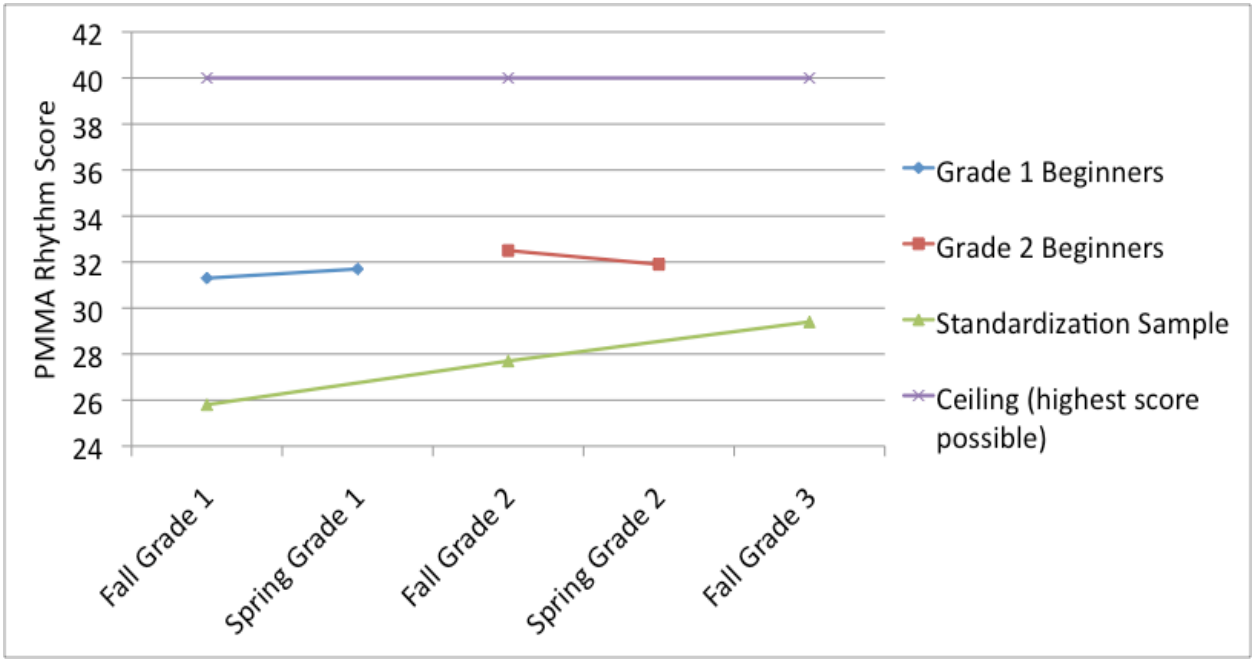

Figure 11. Students' Average PMMA Rhythm Scores in Fall and Spring Compared to the Standardization Sample Mean

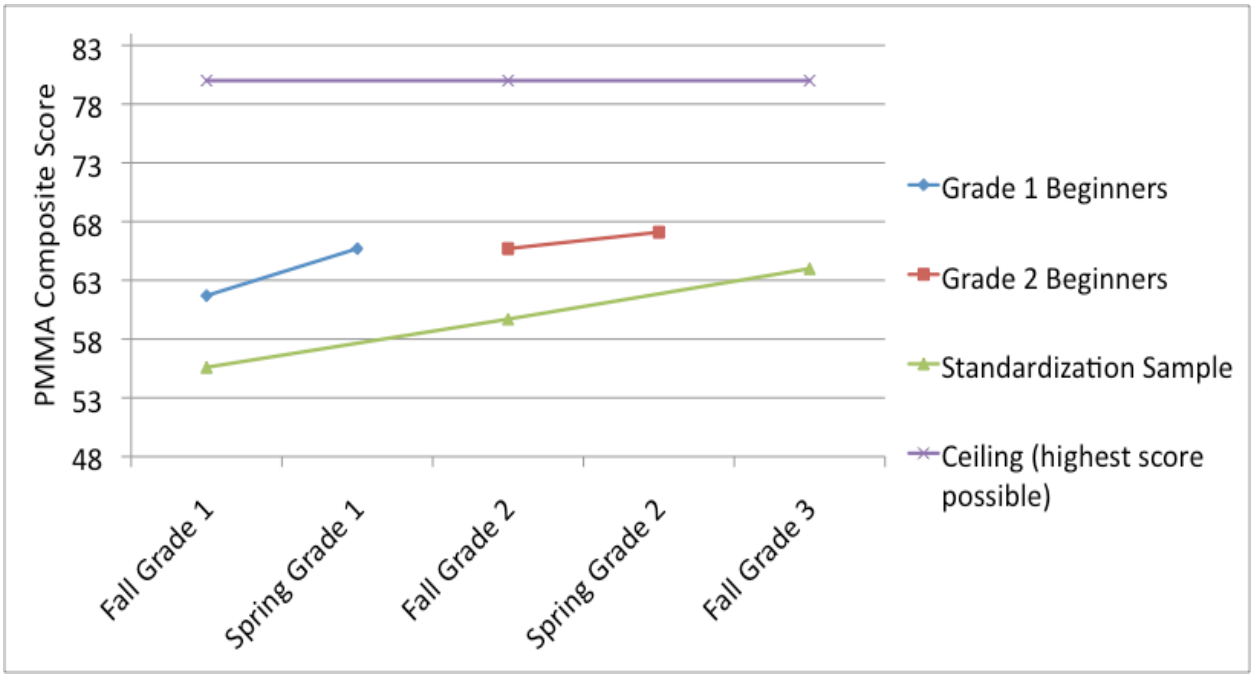

Figure 12. Students' Average PMMA Composite Scores in Fall and Spring Compared to the Standardization Sample Mean

PMMA Tonal scores. Possible scores on the PMMA Tonal test range from 0 (low) to 40 (high). Grade 1 Beginners' average fall Tonal score (30.4) was close to the standardization sample mean (29.8). By the spring, Grade 1 Beginners' average Tonal scores had increased to 34.0, an average growth of 3.6 points. Grade 2 Beginners' average fall Tonal score (33.2) was about 1 point above the standardization sample mean (32.0). By spring Grade 2 Beginners' average Tonal score (35.2) had increased by an average growth of 4.5 points. In Figure 10 we see that the growth rate for both Grade 1 and Grade 2 Beginners is steeper than the typical growth rate as represented by the standardization sample line. In fact, Grade 1 Beginners made approximately 1.5 year's of growth in six months' time, and Grade 2 Beginners made close to 1 year's growth in six month's time.

For the purposes of analyzing significance of growth over time, a mixed between-within subjects analysis of variance (ANOVA) was conducted to compare change in PMMA Tonal scores for Grade 1 Beginners and Grade 2 Beginners. The means and standard deviations are presented in Table 5. There was a significant effect for time, the within-subject variable [$F(1,18)=6.78$, $p<.05$] and the effect size is large [multivariate partial eta-squared=.274]. There was no statistically significant main effect for group, the between-subject variable, and there was no significant interaction between time and group. Because groups are not significantly different, it is acceptable to collapse First and Second Grade Beginners into one group for interpretation.

Table 5

Descriptive Statistics for PMMA Tonal Scores at Time 1 and Time 2 for First and Second Grade Beginners

	Student subgroup	Mean	Standard deviation	N
PMMA Tonal Time 1	First Grade Beginners	30.40	5.93	10
(Fall, 2009)	Second Grade Beginners	33.20	3.29	10
	Total	31.80	4.88	20
PMMA Tonal Time 2	First Grade Beginners	34.00	3.68	10
(Spring, 2009)	Second Grade Beginners	35.20	3.12	10
Total		34.60	3.38	20

A paired-samples (repeated measures) t-test was conducted in order to examine growth over time in PMMA Tonal scores for Second Year Veterans. Means and standard deviations are

shown in Table 6. Average PMMA Tonal Scores for Second Year Veterans increased from Fall 2008 (M=32.78, SD=4.60) to Fall 2009 (M=33.78, SD=4.71). This growth is close to a level of statistical significance (p=.081).

Table 6

Descriptive statistics for PMMA Tonal Scores at Time 1 and Time 2 for Second Year Veterans

	Mean	Standard deviation	N
PMMA Tonal Time 1 (Fall, 2008)	32.78	4.60	9
PMMA Tonal Time 2 (Fall, 2009)	33.78	4.71	9

PMMA Rhythm scores. Possible scores on the PMMA Rhythm test range from 0 (low) to 40 (high). Grade 1 Beginners' average fall Rhythm score (31.3) was already 5.5 points higher than the standardization sample mean (25.8). Grade 1 Beginners' average Rhythm score increased slightly (by 0.4 points) across the school year, with an average score of 31.7 in the spring. Similarly, Grade 2 Beginners' average fall Rhythm score (32.5) was already 4.8 points higher than the standardization sample mean (27.7). Grade 2 Beginners' average Rhythm score was slightly lower in the spring (31.9). Figure 11 shows that students' average scores were well above the standardization average in both the fall and the spring. While Grade 1 Beginners show a rate of growth parallel to the standardization sample, Grade 2 Beginners' scores decreased slightly, on average, from fall to spring.

For the purposes of analyzing significance of growth in PMMA Rhythm scores over time, a mixed between-within subjects analysis of variance (ANOVA) was conducted to compare change in PMMA Rhythm scores for Grade 1 Beginners and Grade 2 Beginners. The means and standard deviations are presented in Table 7. There was no significant effect for time, the within-subjects variable ($p=0.87$), there was no statistically significant main effect for group, the between-subjects variable ($p=0.66$), and there is no significant interaction between time and group ($p=0.42$). Because groups are not significantly different, it is acceptable to collapse First and Second Grade Beginners into one group for interpretation.

Table 7

Descriptive statistics for PMMA Rhythm scores at Time 1 and Time 2 for First and Second Grade Beginners

	Student subgroup	Mean	Standard deviation	N
PMMA Rhythm Time 1	First Grade Beginners	31.30	4.47	10
(Fall, 2009)	Second Grade Beginners	32.50	2.27	10
	Total	31.90	3.51	20
PMMA Tonal Time 2	First Grade Beginners	31.70	4.81	10
(Spring, 2009)	Second Grade Beginners	31.90	2.77	10
Total		31.80	3.82	20

A paired-samples (repeated measures) t-test was conducted in order to examine growth over time in PMMA Rhythm scores for Second Year Veterans. Means and standard deviations are shown in Table 8. There was a statistically significant increase in PMMA Rhythm Scores for

Second Year Veterans from Fall 2008 (M=29.89, SD=3.48) to Fall 2009 (M=32.89, SD=2.32, $t(8)=-3.18$, $p<.05$).

Table 8

Descriptive statistics for PMMA Rhythm Scores at Time 1 and Time 2 for Second Year Veterans

	Mean	Standard deviation	N
PMMA Rhythm Time 1 (Fall, 2008)	29.89	3.48	9
PMMA Rhythm Time 2 (Fall, 2009)	32.89	2.32	9

PMMA Composite scores. The PMMA Composite is a combination of the Tonal and Rhythm tests, with possible scores ranging from 0 (low) to 80 (high). In the fall, Grade 1 Beginners earned an average Composite score of 61.7, 6.1 points higher than the standardization average of 55.6. By spring, Grade 1 Beginners' average Composite score increased by 4.0 points to 65.7. Grade 2 Beginners earned an average Composite score of 65.7 in the fall, 6.0 points higher than the standardization average of 59.7. By spring, Grade 2 Beginners' average Composite score increased by 1.4 points to 67.1. Examination of Figure 12 shows that, Grade 1 Beginners' PMMA Composite scores were already above average in the fall, and by spring this gap had increased. In other words, students' rate of growth was steeper than the typical rate of growth represented by the standardization sample. Grade 2 Beginners' average PMMA Composite score was already well above the standardization sample in the fall and were even

higher in the spring, though the rate of growth for Grade 2 Beginners' was less steep than the standardization sample.

For the purposes of analyzing significance of growth in PMMA Composite scores over time, a mixed between-within subjects analysis of variance (ANOVA) was conducted to compare change in PMMA Composite scores for Grade 1 Beginners and Grade 2 Beginners. The means and standard deviations are presented in Table 9. There was a significant effect for time, the within-subject variable, [$F(1,18)=5.58$, $p<.05$] and the effect size is large [multivariate partial eta-squared=.237]. There is no statistically significant main effect for group, the between-subject variable ($p=.327$), and there is no significant interaction between time and group ($p=.270$). Because the groups are not significantly different, it is acceptable to collapse First and Second Grade Beginners into one group for interpretation.

Table 9

Descriptive statistics for PMMA Composite scores at Time 1 and Time 2 for First and Second Grade Beginners

	Student subgroup	Mean	Standard deviation	N
PMMA Composite Time 1 (Fall, 2009)	First Grade Beginners	61.70	7.69	10
	Second Grade Beginners	65.70	4.24	10
	Total	63.70	6.38	20
PMMA Composite Time 2 (Spring, 2009)	First Grade Beginners	65.70	8.21	10
	Second Grade Beginners	67.10	5.02	10
Total		66.40	6.66	20

A paired-samples (repeated measures) t-test was conducted in order to examine growth over time in PMMA Composite scores for Second Year Veterans. Means and standard deviations are shown in Table 10. There was a statistically significant increase in PMMA Composite Scores for Second Year Veterans from Fall 2008 (M=63.75, SD=6.27) to Fall 2009 (M=68.25, SD=4.65, $t(7)=-4.28$, $p<.005$).

Table 10

Descriptive statistics for PMMA Composite Scores at Time 1 and Time 2 for Second Year Veterans

	Mean	Standard deviation	N
PMMA Composite Time 1 (Fall, 2008)	63.75	6.27	8
PMMA Composite Time 2 (Fall, 2009)	68.25	4.65	8

Performance achievement as measured by performance ratings. Two trained musical experts rated audio-taped singing performances of First and Second Grade Beginners across two time-points (Fall 2009 and Spring 2010). Raters were blind to the purpose of the study and blind to condition (time 1 vs. time 2). Levels of inter-rater reliability were 81.4% perfect agreement for tonal performances and 89.7% perfect agreement for rhythmic performances. For performances where there was disagreement between raters, the raters listened to those particular performances again, discussed their interpretation, and came to an ultimate agreement on a score. Table 11 shows the number of First Grade Beginners and Second Grade Beginners whose performances were recorded at each time-point. While a total of 25 students were recorded in

Fall 2009 and 33 in Spring 2010, only 18 students were recorded at both time-points. No data were collected for Second Year Veterans' performance achievement.

Table 11

Number of students included in the Performance sample

	Fall 2009	Spring 2010	Number of students tested at two time-points
First Grade Beginners	6	15	5
Second Grade Beginners	19	18	13
Total Students	25	33	18

Tables 12 and 13 display average Tonal Performance scores for First Grade Beginners and Second Grade Beginners who were recorded at both Time 1 (fall, 2009) and Time 2 (spring, 2010). Figures 13 and 14 graphically represent mean Tonal and Rhythm Performance scores for students across time-points and grade-levels. Growth rates can be compared for Tonal Performance scores (Figure 13) and the Rhythm Performance scores (Figure 14).

Table 12

Tonal Performance Score Means and Standard Deviations for First and Second Grade Beginners

		Time 1 Score (Fall 2009)	Time 2 Score (Spring 2010)	N
First Grade Beginners	mean	2.60	3.80	5
	standard deviation	1.14	0.45	
Second Grade Beginners	mean	3.31	2.85	13
	standard deviation	1.49	1.14	
Combined	mean	3.11	3.11	18
	standard deviation	1.41	1.08	

Table 13

Rhythm Performance Score Means and Standard Deviations for First and Second Grade Beginners

		Time 1 Score (Fall 2009)	Time 2 Score (Spring 2010)	N
First Grade Beginners	mean	4.40	4.40	5
	standard deviation	0.89	0.89	
Second Grade Beginners	mean	4.08	4.54	13
Total	standard deviation	1.19	0.78	
Combined	mean	4.17	4.50	18
	standard deviation	1.10	0.79	

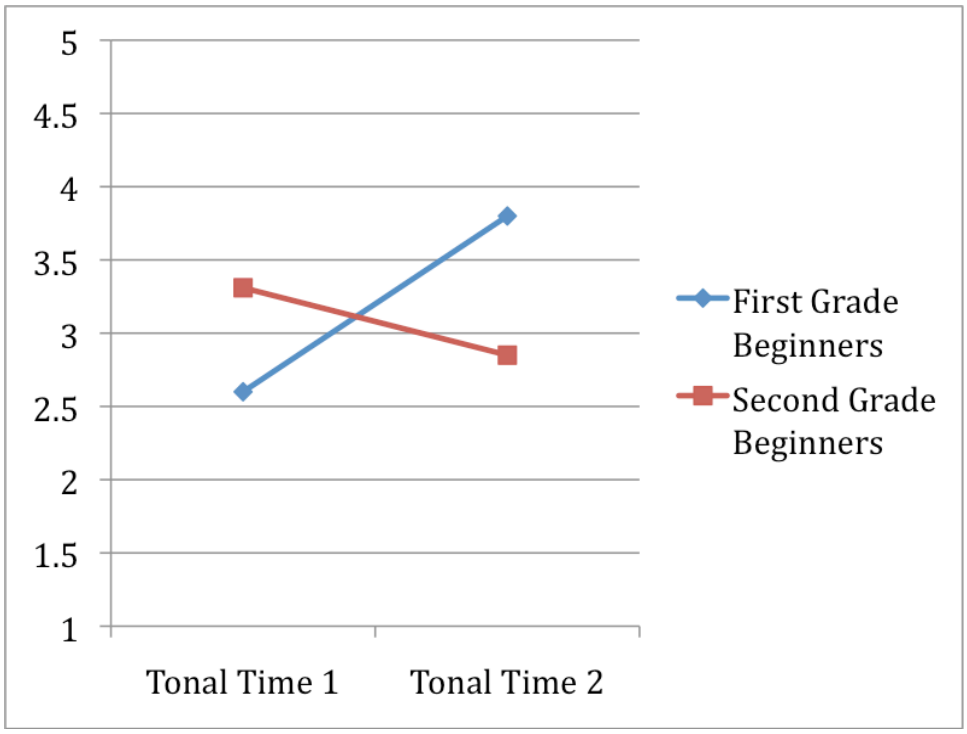

Figure 13. Average Tonal Performance Scores for First and Second Grade Beginners

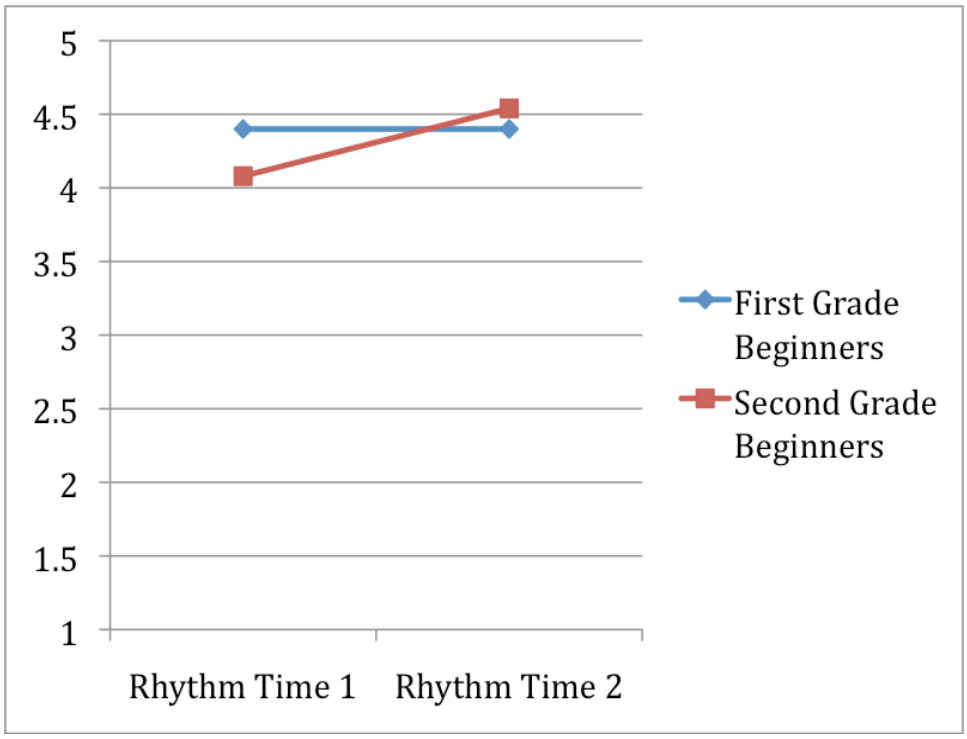

Figure 14. Average Rhythm Performance Scores for First and Second Grade Beginners

Tonal Performance scores. Possible scores on the Tonal Performance test range from 1 (low) to 5 (high). First Grade Beginners' scores increased from 2.60 in the fall to 3.80 in the spring. In contrast, Second Grade Beginners' scores decreased from 3.31 in the fall to 2.85 in the spring. Figure 13 shows that the lines cross, indicating a potential interaction between time and grade.

In order to analyze significance of change over time, a mixed between-within subjects analysis of variance (ANOVA) was conducted to compare change in Tonal Performance scores for Grade 1 Beginners and Grade 2 Beginners. The means and standard deviations are presented in Table 12. There was no significant effect for time, the within-subject variable ($p=.249$), and there was no statistically significant main effect for group, the between-subject variable ($p=.884$). However, there was a significant interaction between time and group [Wilks' Lambda=.688, $F=7.24$, $p<.05$] and the effect size was large [multivariate partial eta-squared=.312].

Rhythm Performance scores. Possible scores on the Rhythm Performance test range from 1 (low) to 5 (high). First Grade Beginners' average scores stayed at 4.40 at both time-points. In contrast, Second Grade Beginners' scores increased from 4.08 in the fall to 4.54 in the spring.

In order to analyze significance of change over time, only those students recorded at both time-points were included in the analysis. A mixed between-within subjects analysis of variance (ANOVA) was conducted to compare change in Rhythm Performance scores for Grade 1 Beginners and Grade 2 Beginners. The means and standard deviations are presented in Table 13. There was no significant effect for time, the within-subject variable ($p=.477$), or for group, the

between-subject variable (p=.823). There was no significant interaction between time and group (p=.477).

Research Question 2

How do music instruction activities differ in the extent to which they provide opportunities for children to practice behaviors associated with executive functioning (shifting, inhibition, updating and attention) and in students' rates of active vs. passive engagement and off-task behavior?

Summary of research question 2 results. Ten music activities that cut across settings were identified through a process of coding and sorting similar videoclips into categories. Musical activities differed in levels of executive functioning affordances and constraints (see Table 16). The two music activities with the highest Executive Functioning Composite (EFC) scores were playing, singing or chanting a piece of music in parts and student performing a solo. The lowest EFC scores went to passive music listening and teacher verbal instruction. Activities differed significantly in levels of students' active engagement, passive engagement, and off-task passive behavior. Activities with the highest levels of active engagement included active music listening and student performing solo (see Table 17). Activities with the lowest levels of active engagement and the highest rates of off-task behavior were passive music listening and teacher verbal instruction. Overall the music activities observed in this study were associated with high levels of student engagement, particularly active engagement, and low levels of off-task behavior. Further analyses revealed some relationships between executive functioning affordances and constraints and students' levels of engagement and off-task behavior (see Table 19). During activities that did more to afford and constrain the use of attending, inhibiting, updating and shifting, students were more likely to be actively engaged. Likewise, during

activities that did less to support the use of executive functioning skills, students were less likely to be actively engaged, and more likely to be passively engaged or off-task.

Identification of music activities. The broad sample of video was divided up into short video clips, each capturing a type of musical activity, such as singing a song, teacher lecture, call and response, etc. This process involved splitting the video into a new separate clip each time the activity changed. This process yielded a total of 255 clips, ranging in length from as short as 9 seconds, to as long as 428 seconds (7 minutes, 8 seconds). The average clip length was 83 seconds.

From the representative sample of music instruction videotaped, 10 main types of musical activities were identified. The process of identifying music activities began by sorting the short video clips into categories (through the assignment of number codes) according to similarity of what the teacher and students were doing in the clips. For example, many clips involved the teacher singing a phrase followed by the students repeating the phrase in unison. These clips were grouped together (coded with the same number) and identified by the category name "Call and Response Unison." Sometimes, two or more mini-categories were combined into one category because of the underlying similarity of the activity. For example, some clips involved students singing through a piece in unison, while other clips involved students chanting a piece in unison or playing a piece in unison on instruments. These clips were all assigned to the category "Playing, singing or chanting a piece of music in unison." Although the sub-categories differed in type of instrument used (singing voice, speaking voice, cello, etc.), they all shared the underlying commonality that students were performing a piece in unison with other students. From this process of sorting and categorizing, 10 main types of music activities

emerged. These activities characterize the music program in that they occurred frequently and cut across settings. The activities are listed and defined below.

Ten main activities that characterize this music program.

1. *Call and response, unison.* During this activity the teacher would sing, chant or play short phrases, and students would repeat the phrases in unison. Usually the teacher provided the stimulus, but sometimes a student provided the stimulus and other students echoed.
2. *Call and response, individual.* Teacher would sing, chant or play short phrases, and students would take turns repeating a phrase individually.
3. *Playing, singing or chanting a piece of music in unison.* Students would play, sing or chant, sometimes while reading music, sometimes without reading music. The singing included singing of words, neutral syllables, solfege syllables or roots.
4. *Playing or singing a piece of music in parts.* Similar to number 3 above, except that students did not all play/sing a unison line; rather, they were split into different parts.
5. *Active music listening.* Students would move their bodies while listening and reacting to music (scarves, fingering, hand signals, gestures). This category includes listening to a recording or a live performance.
6. *Passive music listening.* Students would listen to a piece of music, either a live performance (e.g. teacher singing) or a recording, while keeping their bodies relatively still. Sometimes students were waiting to play or sing while listening.
7. *Warm-ups.* Warm-ups are exercises that prepare the voice and body for music-making. This category includes physical (e.g. stretching), vocal, breathing and instrumental exercises. Usually the teacher led this activity and students warmed-up in unison or near-unison.

8. *Teacher verbal instruction.* This category includes times when the teacher was mostly just talking. Examples include giving directions, corrections, teaching vocabulary, writing on the board, lecturing about music history, discussing an upcoming performance, etc. Sometimes the teacher included brief singing or playing in the lecture. Sometimes the teacher asked a question about the music and asked for students to raise hands or show their response with hand gestures. Sometimes the teacher called on individual students one at a time to give a verbal answer.
9. *Student performing a solo.* This category includes both improvised and non-improvised solos. The context for solo playing varied. Sometimes a student played through a piece with no one else playing, and other times there was accompaniment by the jazz ensemble, including other students and instructors. Sometimes students took turns improvising solos during jazz ensemble. The settings and audiences for solos included: 1) playing for the teacher during a private lesson, 2) playing for the teacher and a small group of peers during a group lesson, 3) playing for a large group of peers and teachers in an informal rehearsal or impromptu performance setting, and 4) playing in a formal concert setting for a large audience including peers, program staff, family and community members. There were not enough video clips to separate out these different solo contexts into discreet categories for analysis, so they are considered together.
10. *One-on-one technical instrumental instruction.* Sometimes the teacher worked with a single student on his/her instrumental technique. This included physically making adjustments to position/posture, or making verbal corrections or suggestions. Almost always, instruction was provided by a teacher, but sometimes, a more advanced student was teaching a less advanced student.

A few additional types of musical activities occurred rarely, and did not fit well into the 10 main categories. Examples include, a student talking about music, teachers handing out instruments, and students getting their instruments ready to play. Six clips were not included in the analysis for this reason (Other category). Table 14 shows the number of seconds devoted to each type of activity across all of the video clips, as well as the percentage of total video time devoted to each activity.

Table 14

Percentage of videotaped instructional time devoted to each activity

Activity	Total Seconds	Percentage (out of 21191 seconds)	Prevalence Rank
1. Call and Response, Unison	2971	14.0%	3
2. Call and Response, Individual	723	3.4%	9
3. Playing, singing or chanting a piece of music in unison	4930	23.3%	1
4. Playing, singing or chanting a piece of music in parts	1564	7.4%	6
5. Active Music Listening	1030	4.9%	7
6. Passive Music Listening	935	4.4%	8
7. Warm-ups	1677	7.9%	5
8. Teacher Verbal Instruction	4836	22.8%	2
9. Student Performing Solo	76	0.36%	10
10. One-on-one Technical Instrumental Instruction	2042	9.6%	4
Other	*407*	*1.9%*	-

Analysis of executive functioning affordances and constraints. This first part of this research question asks how music instruction activities differ in the extent to which they provide opportunities for children to practice behaviors associated with executive functioning (shifting, inhibition, updating and attention). For the purpose of this analysis, attention, inhibition, updating and shifting are operationally defined as follows:

Attention: Attention is operationally defined as purposeful focus on and processing of information that is relevant to the task at hand. Selective attention is defined as the ability to concentrate on a specific subset of sensory input, thoughts or actions while intentionally ignoring others. Relevant information (or aspects of information) is accentuated, while irrelevant information is excluded (Gazzaniga et al., 2009).

Inhibition: Inhibition refers to intentionally suppressing/overriding automatic or prepotent responses. These responses can be overt (actions/behaviors) or covert (thoughts/information processing).

Updating: Updating refers to the refreshing and monitoring of representations in working memory. This involves coding incoming information for relevance to the task, and replacing information that is no longer relevant.

Shifting: Shifting is also referred to as "attention switching" or "task switching" and involves switching among various tasks, operations or mental sets (Monsell, 1996).

The researcher analyzed each type of musical activity to determine the extent to which it affords and constrains attention, inhibition, updating and shifting. For each musical activity, a numerical rating and a qualitative description of the executive functioning affordances and constraints are provided. The Executive Functioning Affordances and Constraints Rating Scale (see Table 15 below) was used to rate the levels of executive affordances and constraints for each

musical activity. This rating scale was developed for the purposes of this study. It is valid in its similarity to the Executive Functioning Classroom Observation Form developed by McCloskey, Van Divner and Perkins (2009), a tool designed to assess the instructional environment for the presence of self-regulation executive functioning demands (for more information, see Measures in Method Section). Ratings for each music activity are displayed in Table 16. For each music activity, attention, inhibition, updating and shifting scores were added to create an Executive Functioning Affordances and Constraints Composite Score (EF Comp), displayed in the far right column. The two music activities with the highest Executive Functioning Composite scores (14) were Playing, Singing or Chanting a Piece of Music in Parts and Student Performing a Solo. The lowest EF Composite scores went to Passive Music Listening, with an EF Composite rating of 4, and Teacher Verbal Instruction, with an EF Composite rating of 5. Following Table 16, rationale is provided for the ratings assigned to each musical activity, through descriptive analysis of the executive functioning affordances and constraints inherent in each activity.

Table 15

Executive Functioning Affordances and Constraints Rating Scale

Rating	Description
0	Little to no affordances and constraints. The executive functioning skill is not likely to be used and there are few if any consequences for using or not using the skill.
1	Some affordances and constraints, less than half the time, only once in a while. The executive functioning skill is likely to be used only sometimes, or there are usually few or vague consequences for using or not using the skill.
2	Regular affordances and constraints, about half the time. Students are probably using the executive functioning skill about half of the time. Consequences and feedback for using or not using the skill are likely about half of the time.

Table 15 (cont'd)

3	Frequent affordances and constraints, more than half the time, or every few seconds. The task demands that students use the executive functioning skill frequently, or more than half of the time. Consequences and feedback for using or not using the skill are frequent.
4	Continuous affordances and constraints, almost always. Executive functioning skill is highly likely to occur almost all of the time. Consequences and feedback for effective vs. ineffective use of the skill are nearly continuous.

Table 16

Levels of Executive Functioning Affordances and Constraints for Each Musical Activity

Type of Activity	Executive Functioning Affordances and Constraints Ratings				
	Attention	Inhibition	Updating	Shifting	EF Comp
1 Call and Response Unison	4	2	3	3	12
2 Call and Response Individual	1	3	1	1	6
3 Playing, singing or chanting a piece of music in unison	4	1	4	1	10
4 Playing, singing or chanting a piece of music in parts	4	4	4	2	14
5 Active music listening	4	2	4	2	12
6 Passive music listening	1	1	1	1	4
7 Warm-ups	4	2	2	2	10
8 Teacher verbal instruction	1	2	1	1	5
9 Student performing solo	4	3	4	3	14
10 One-on-one Technical Instrumental Instruction	3	4	1	1	9

Activity 1: Call and response, unison.

Attention Rating: 4. Call and response affords attention (makes attention likely to occur) in that constant attention is necessary in order to be successful in the task. In order to repeat the phrase accurately, students must attend carefully to the stimuli provided by the teacher and sustain their focus throughout repeating the phrase. Likewise, attending to what peers are singing or playing provides valuable feedback on one's own performance. Students can immediately hear whether they are fitting it in with their peers, and this feedback allows students to make adjustments. Fitting in harmoniously could be reinforcing of student attention to teacher, self and peers. Call and response also affords attention because the stimuli changes frequently, and students have frequent and regular opportunities to respond during the activity. The activity constrains inattention (makes inattention less likely to occur) in that students would be unable to repeat the phrase without carefully attending to the stimulus provided by the teacher. Consequences of not attending are visible and audible to peers and teacher; without attending, the child might not sing, try to fake it, or sing the phrase incorrectly, any of which could be detected by the teacher and peers.

Inhibition Rating: 2. Call and response unison affords inhibition by requiring students to wait for their turn to sing. Students must hold back from singing while the teacher is singing. Inhibition is reinforced because inhibiting the urge to sing while the teacher is presenting the stimulus allows the students to repeat the stimulus correctly and fit in with their peers. The activity also constrains disinhibited behavior, such as blurting out at the wrong time. Such behavior is not likely to occur during this activity because students cannot be blurting out and be successful at the task. Being successful at this activity requires inhibiting oneself vocally (not blurting out at the wrong time). Consequences of not inhibiting, such as singing/playing at the

wrong time or not being able to repeat the phrase correctly, would be visible and audible to the child, peers and teacher.

Updating Rating: 3. Call and response affords frequent updating, every time the teacher sings a new phrase. This occurs about every 4 seconds, depending on the length and tempo of the stimulus phrase. The students must let go of the previous phrase in order to free up cognitive space to focus on the current phrase. This activity constrains failure to update in a timely manner, in that students will be unable to do the task without updating.

Shifting Rating: 3. This activity affords frequent shifting from a listening task to a responding task (playing/singing). First students must listen carefully to the teacher sing a phrase, then they must repeat the phrase by singing or playing. One limitation of the demands on shifting, is that this activity is repetitive, and only includes predictable, regular shifting between two types of tasks. Appropriate, timely shifting will be reinforced by success at the task and musically fitting in with others. The activity constrains not shifting; if students do not shift from listening to singing and back at the right time, they will not be able to do the task. Because the activity includes frequent audible and visible responding, failure to shift may be immediately apparent to the student, teacher and peers.

Activity 2: Call and response, individual.

Attention Rating: 1. This activity differs from call and response unison, in that students only need to be attending when it is their turn to respond. This activity has far fewer opportunities to respond to stimuli provided by the teacher. While students are waiting for their turn to respond, it is less apparent whether they are attending to the activity or not. The activity does little to constrain inattention while students are waiting for a turn; students could zone out with little feedback or consequence. However, when a student does have a turn to repeat a

phrase, it is even more apparent to the teacher whether or not the student is attending to the stimulus, because that student is singing/playing alone. Another way that this activity differs from call and response unison, is that when a student is singing, she does not have her peers singing simultaneously for comparative feedback. The student need only attend to her own performance and that of the teacher.

Inhibition Rating: 3. Call and response individual affords inhibition by requiring students to sit quietly for long periods of time and wait for their turn to sing or play. This activity constrains disinhibition such as blurting out or singing/playing at the wrong time. These behaviors would make the student stand out and may lead to teacher redirection. While these behaviors are prohibited by the activity, for some students this teacher/peer attention could be reinforcing. It would be easy for students to zone out during this activity with little consequence. The activity does little to support inhibition of covert off-task thinking.

Updating Rating: 1. While students are waiting for a turn to respond, they may or may not be updating their working memory with each new stimuli being provided by the teacher. When it is a student's turn to respond, she only gets a chance to demonstrate success in updating working memory with one or two stimuli. For most students, most of the time, there is little feedback on whether or not they are successfully updating. There are no immediate consequences for failing to update when it is not one's turn to respond.

Shifting Rating: 1. This activity does little to afford shifting. Most of the time, students are passively listening, rather than actively shifting from one type of task to another. When it is a student's turn to respond, she only gets a couple opportunities to demonstrate success in shifting from listening to responding. This activity does little to constrain not shifting when students are waiting for a turn.

Activity 3: Playing, singing or chanting a piece of music in unison.

Attention Rating: 4. Playing, singing or chanting a piece in unison affords attention (makes attention likely to occur) by requiring continuous attention to many aspects of the piece such as rhythm, pitches, and/or phrasing. As this activity is almost always led by a teacher/conductor, students need to attend to that person in order to know when and how to sing, play or chant. Continuous attention to one's own sound and others' sound is necessary to gauge whether one is fitting in with the music. Fitting in with the music and contributing to the group ensemble is naturally reinforcing. The activity constrains inattention in that without attending, a student will not be contributing to the piece. A student's inattention can be immediately detected by the teacher and peers if the student is singing, playing, or chanting the incorrect pitches and/or rhythm. If the inattentive student is quiet and not moving, the teacher and peers may not notice this right away, particularly if the ensemble is large.

Inhibition Rating: 1. This activity does little to afford inhibition because students are almost continuously active in singing, playing or chanting. However, students do have to inhibit going ahead in the music while sustaining a note or during a rest. While playing, singing or chanting a piece, students may be inhibiting thinking about other music or thinking about earlier parts of the music.

Updating Rating: 4. This activity affords almost continuous updating. As students move through the music, certain aspects of the music are constantly changing. The rhythm, meter, words, pitches, harmony, dynamics and phrasing may be different from moment to moment during the piece. Students need to continuously update working memory according to where they are in the piece. Thinking about what happened already in the music is likely less important. In order to execute the piece accurately, students need to replace this old information with

information about what is happening in the music now and what is about to happen next.

Shifting Rating: 1. This activity does little to afford shifting because students are doing one type of activity throughout (either playing, singing, or chanting). Certain elements of the music may change, such as meter, harmony, but most of the time students are doing the same kind of task.

Activity 4: Playing, singing or chanting a piece of music in parts.

Attention Rating: 4. All of the attention affordances mentioned above for playing, singing or chanting a piece in unison are also relevant here. The added element of singing, playing or chanting in parts, creates another attentional demand. In some pieces, attending to the other parts is necessary in order to sing, play or chant one's own part correctly.

Inhibition Rating: 4. While playing, singing or chanting in parts, students must focus on their own part and inhibit playing/singing/chanting the other parts even though they may be aware of them and even partially attending to them.

Updating Rating: 4. All of the updating affordances mentioned above for playing, singing or chanting a piece in unison are also relevant here. The presence of other parts adds another aspect of the music that must be updated as the music proceeds.

Shifting Rating: 2. Sometimes playing, singing or chanting a piece in parts affords shifting. Switching parts (e.g. from melody to harmony, or from singing to playing a drum) is an example of this. However, many times, students stick with one part through the entire piece.

Activity 5: Active music listening.

Attention Rating: 4. Music listening affords attending because the music itself is frequently changing (e.g. in harmony, phrasing, rhythm, dynamics, etc.). Tonal music follows predictable rules, such as how dissonances are resolved, and sometimes composers play with our

expectations through delay or by resolving harmonies in unexpected ways (Huron, 2006). These expectations are linked to the emotional experience of listening to music (e.g. feelings of tension, longing, excitement). Successful predictions evoke positive feelings, while musical surprises can lead to feelings of awe and interest. Attention to the music allows the listener to experience expectation and surprise, as well as the emotions associated with these. Forms of active music listening, such as physical movement and dance, afford attending to the music in order to be able to respond physically in an appropriate way, to make movements that fit in with the musical environment. When the teacher is leading the movements, continuous attending to the teacher is afforded in order to move in sync with others. During active music listening, consequences of not attending to the music include not moving in sync with others and in sync with the music. This will be visible to the teacher, peers and listener.

Inhibition Rating: 2. Active music listening does little to afford inhibition because students are almost continuously moving in response to the music or teacher. However, a student might inhibit moving in the wrong way at the wrong time. For example, if the music is calm and slow, the student might inhibit the urge to run and jump. Inhibiting these movements would allow the student to fit in with the music and peers. Not inhibiting such movements would be apparent to the teacher and peers. If the active music listening is free form, students may be able to move in almost any way whether it fits the music or not. The teacher is more likely to notice and correct inappropriate movements during teacher-led active music listening.

Updating Rating: 4. Similar to playing, singing or chanting a piece of music, music listening affords continuous updating because certain aspects of the music are constantly changing. When one is listening to music, the rhythm, meter, words, pitches, harmony, dynamics and phrasing change from moment to moment and are continually being updated in

working memory. During active music listening, updating is made visible as students respond to changing qualities of the music. For example, if the music starts to slow down, updating to the new tempo would allow students to adjust their movements accordingly. Consequences of not updating could be that a student's movements would not fit with the music or with peers.

Shifting Rating: 2. During this activity, the task tends to stay more or less the same: students are responding physically to the music they hear. When active music listening is teacher-led, the teacher sometimes incorporates shifting among types of active listening tasks. For example, movements could reflect dynamics and then switch to reflecting the meter.

Activity 6: Passive music listening.

Attention Rating: 1. Passive music listening affords attending in some of the same ways that active music listening does. Successful predictions evoke positive feelings, while musical surprises can lead to feelings of awe and interest. Attention to the music allows the listener to experience expectation and surprise, as well as the emotions associated with these. However, the consequences of not attending during a passive music listening activity are not as readily apparent to the listener, teacher or peers. A student could zone out without any immediate consequences, and it is difficult to tell whether a student is attending to the music or not.

Inhibition Rating: 1. Passive music listening does little to afford inhibition. The activity involves sitting quietly and still throughout, so there is little impetus to respond. Since no motion or sound-making is involved, there is no behavioral momentum that must be inhibited. Students do have to inhibit themselves from talking, singing, and moving around the room. Students might also inhibit thinking about other things, but daydreaming is not readily apparent and there are few consequences.

Updating Rating: 1. Similar to active music listening, passive music listening affords

updating in that certain aspects of the music, such as rhythm, meter, words, pitches, harmony, dynamics and phrasing, are constantly changing. In contrast however, the consequences of not updating during passive listening are not visible or immediate. It would be hard for anyone to detect whether a student is still thinking about the last musical phrase rather than the current one.

Shifting Rating: 1. While passively listening to music, students are engaging in the same kind of task rather than switching among tasks. There may be some covert shifting that goes on if students attend to certain aspects of the music (e.g. meter) and shift to focusing on other aspects of the music (e.g. harmony). However, any shifting that may be going on is covert and not visible to the teacher. There are few consequences for shifting one's focus among different aspects of the music.

Activity 7: Warm-ups.

Attention Rating: 4. Warm-ups are teacher-led and students usually warm-up in unison. Warm-ups afford attention to such technical aspects as breath control, intonation, sound-quality, posture, and range. The activity of warming-up requires students to sustain their attention continuously. Warm-ups constrain inattention in that if students are not attending to the specific focus of the warm-ups, the consequences are visible and audible. The student may not be using correct posture, singing in the right range, controlling breath in order to sustain pitches, etc.

Inhibition Rating: 2. Warm-ups do little to afford inhibition because students are almost continuously active in singing, playing, moving, stretching, breathing, etc. On the other hand, warm-ups can demand high levels of effort and concentration to stay on-task because they are often repetitive and not as interesting as actual music. Students have to follow the teacher and inhibit themselves from off-task activities (e.g. playing through a song rather than playing the scale the teacher is leading). In this way failure to inhibit could be visible and audible.

Updating Rating: 2. Warm-ups afford updating when the particular warm-up activity changes over time. For example, students may be singing a pattern that is transposed a half-step higher each time it is repeated. In that case, students need to update to the new key for each repetition of the phrase. Sometimes warm-ups are more monotonous, such as a breath control activity that involves playing a repeated staccato note on the trumpet for one minute.

Shifting Rating: 2. Sometimes the teacher has students switch frequently among warm-up tasks. For example, the teacher may have students practice taking deep breaths, then release breath in controlled ways (e.g. hiss), then make various types of vocalizations like an owl sound and a puppy sound. At other times the type of task stays the same across time, such as playing a scale.

Activity 8: Teacher verbal instruction.

Attention Rating: 1. This activity provides few affordances and constrains to encourage attention and discourage inattention. This activity does not provide very much feedback about or reinforcement for attentiveness. While the teacher is talking or lecturing, there is little need for students to be attentive. Also in this case it is hard to know whether the students are attending and processing the information or not. Likewise, when the teacher asks a question and students raise their hands to be called on individually, the students who are not called on may disengage or focus on something else (Marzano, Pickering, & Heflebower, 2011). Hand-raising is one way to see if students are attending, but students may be responding thoughtfully or simply following along with peers. In a large group, there is little chance of being called on to speak, so feedback on one's understanding of the material is limited. Consequences of inattention, such as not learning the concept being taught, are not immediate.

Inhibition Rating: 2. This activity affords inhibition to a certain extent, but does little to

constrain disinhibition. During this activity students are expected to remain seated and quiet. They are expected to raise their hands to speak rather than blurting out. However, there is little feedback built into this activity to afford students' inhibition of thought. They can easily get away with day-dreaming and receive little reinforcement for inhibiting irrelevant thoughts.

Updating Rating: 1. In order to follow what the teacher is telling them and asking them, students need to frequently update the contents of working memory at the rate that the teacher presents ideas and questions. Good updating affords understanding the concepts the teacher is talking about. There is some reinforcement for updating: students get to raise their hand and have the chance to be called on by the teacher. However, the stakes for updating versus not updating are not very great in this activity. The student could be focused on a previous idea and "lost in thought" without much consequence or feedback.

Shifting Rating: 1. This activity does little to afford shifting among types of tasks or mental sets. The tasks shift somewhat during this activity. Students go from listening to the teacher to thinking of answers to her question to raising their hand, etc. However, the difference between these tasks is minimal and there is little opportunity to get feedback on one's shifting. Furthermore, the tasks are not musical tasks.

Activity 9: Student performing solo.

*Attention Rating: 4***.** Performing a solo affords continuous attention to many aspects of the piece such as rhythm, pitches, and/or phrasing. Because the student's sound is exposed, any lapse in attention to these important aspects will be audible to the people listening and the student. Solo performers attend to their own sound and compare it to what they want it to sound like (internal representation). Solo performers playing with accompaniment also attend to the

other players so that their part fits in (e.g. temporally, tonally, etc.). When soloists are improvising, they need to attend to the underlying harmony and play notes that fit in.

Inhibition Rating: 3. While performing a solo without accompaniment, a student must inhibit thinking about all the people listening to him. Because the student is playing alone, the activity does not require inhibiting attention to other music/sound. However, students do have to inhibit going ahead in the music while sustaining a note or during a rest. When performing a solo with accompaniment, students must focus on their own part and inhibit singing or playing the other parts even though they may be aware of them and even partially attending to them.

Updating Rating: 4. Performing a solo affords almost continuous updating. As the soloist moves through the music, certain aspects of the music, such as harmony and phrasing, are constantly changing. The precise technical demands of the solo (e.g. fingerings, shifting, breath pressure, embouchure) may also change from moment to moment. Therefore the soloist needs to be continually updating working memory. In order to execute the piece accurately, students need to replace old information with information about what is happening in the music now and what is about to happen next. When a soloist is improvising during a jazz piece, he must attend to the underlying harmony and select notes that fit in with the harmony of the moment. Without frequent updating, the soloist may have difficulty performing the piece accurately and fitting in with the other musicians.

Shifting Rating: 3. In one sense, performing a solo does little to afford shifting because the soloist is doing one main type of activity throughout (e.g. playing a piece on an instrument). On the other hand, certain elements of the music such as dynamics and harmony may be changing continually, and the soloist may shift among techniques such as from arco to pizzicato or from legato to staccato articulation. The soloist might also shift attention in response to what

she is hearing. If the soloist senses that she is out of tune she may focus on intonation and then switch her attention to rhythm if she hears that she is not quite together with the ensemble.

Activity 10: One-on-one technical instrumental instruction.

Attention Rating: 3. One-on-one technical instrumental instruction affords frequent attention because the teacher is continually watching and listening to the student and providing immediate feedback. For example, a teacher might show a student how to hold her instrument with correct posture by modeling, commenting on the student's posture and making manual adjustments. Or a teacher might show the student how to get a good sound out of the instrument by blowing a certain way or drawing the bow across the strings in a certain way. Again, the teacher might use comments, modeling and physical adjustments. The teacher is continuously aware of whether the student is attending or not. Inattention is constrained because if a student is not attending, he will not be able to make the precise adjustments being asked of him. Sometimes, one-on-one technical instrumental instruction occurs in the context of a group lesson; in this case, a teacher might provide technical instruction to the whole group at once or alternate her focus from one student to another. When a teacher is focusing her instruction on one particular student, there are fewer affordances and constraints for the other students to attend.

Inhibition Rating: 4. One-on-one technical instrumental instruction affords inhibition almost continuously because the teacher controls when and what the student plays. For most people, technical work such as posture, intonation and shifting, are not as enjoyable as playing actual music. During this kind of technical work, students must usually inhibit themselves from experimenting freely on their instrument or playing through a piece. The teacher might have the student practice a difficult shift many times before the student can go on in the piece. When the

teacher is modeling a technique, the students must inhibit from playing until it is their turn. When the teacher adjusts a student's cello posture, the student must inhibit the desire to slouch or squirm.

Updating Rating: 1. The one-on-one technical instruction observed in this study tended to be rather repetitive. Repetition is a key aspect of instrumental practice, and is necessary for solidifying technique. For example, the teacher might have the student practice blowing into the flute to make a good tone, and this activity might go on for several minutes. While slight precise adjustments are made during this type of activity and this does require some updating of working memory, for the most part the contents of working memory stays constant while the students are focused on a specific aspect of their technique.

Shifting Rating: 1. As was mentioned above, the technical instrumental instruction observed in this study tended to be repetitive, with sustained focus on a particular aspect of technique rather than frequent shifting among tasks. Therefore, this activity does not frequently afford or constrain shifting. Sometimes technical instruction requires a student to switch from watching the teacher model a technique to practicing a technique oneself. Likewise, a teacher might sometimes direct a student to focus on one technical aspect and then shift focus to another aspect (e.g. from intonation to posture), but this type of task switching was not frequently observed.

Analysis of levels of student engagement and off-task behavior. The second part of this research question asks how music instruction activities differ in students' rates of active vs. passive engagement and off-task behavior. This question was addressed through analysis of video coding data gathered from raters' direct observation of student behavior using a momentary time-sampling technique. Raters coded 1-3 students in each of the 249 video clips,

yielding a total of 3664 discrete observations. Of these observations, 28.6% were coded by both raters. Interrater reliability was 79.7% perfect agreement. All instances of disagreement were reviewed and final coding decisions were made by the researcher. For each activity, the percentage of observations that were Active Engaged, Passive Engaged, Off-Task Motor, Off-Task Verbal, and Off-Task Passive was calculated by dividing the number of each type of observation by the total number of observations for that activity (see Table 17 below). Active music listening had the highest levels of active engagement (76.7%), followed by student performing solo (75%). The following activities also had high rates of active engagement (about 50% of the time): playing, singing or chanting a piece of music in unison; warm-ups; playing, singing or chanting a piece of music in parts; one-on-one technical instrumental music instruction; and call and response, unison. The following activities had the lowest levels of active engagement: passive music listening (7.4%), teacher verbal instruction (19.1%), and call and response individual (27.0%).

One-way analysis of variance revealed that the activities differed significantly in levels of Active Engagement, Passive Engagement, and Off-Task Passive ($p<.001$). Off-Task Motor and Off-Task Verbal did not vary significantly among activities. The far-right column of Table 17 shows the overall ratio of engaged (active and passive) to off-task (motor, verbal and passive) for each music activity. Students were off-task most (about one third of the time) during passive music listening and teacher verbal instruction. Figure 15 shows the percentage of observations that were coded as active engaged, passive engaged and off-task, for each music activity. For ease of interpretation all of the off-task categories (motor, verbal and passive) are collapsed into one.

Table 17

Levels of engagement and off-task behavior by activity: number and percent of observations

Activity	Active Engaged	Passive Engaged	Off-Task Motor	Off-Task Verbal	Off-Task Passive	Ratio of %Engaged to %Off-Task
1. Call and Response, Unison	40.1 228/569	36.4 207/569	8.1 46/569	1.9 11/569	13.5 77/569	76.4/23.6
2. Call and Response, Individual	27.0 37/137	56.9 78/137	5.8 8/137	2.9 4/137	7.3 10/137	83.9/16.1
3. Playing, singing or chanting a piece of music in unison	52.3 474/906	21.6 196/906	10.6 96/906	1.4 13/906	14.0 127/906	74.0/26.0
4. Playing, singing or chanting a piece of music in parts	49.8 145/291	30.9 90/291	6.2 18/291	5.5 16/291	7.6 22/291	80.8/19.2
5. Active Music Listening	76.7 112/146	8.2 12/146	4.8 7/146	4.1 6/146	6.2 9/146	84.9/15.1
6. Passive Music Listening	7.4 12/162	59.3 96/162	14.2 23/162	0 0/162	19.1 31/162	66.7/33.3
7. Warm-ups	51.5 152/295	33.2 98/295	4.4 13/295	5.1 15/295	5.8 17/295	84.7/15.3

Table 17 (cont'd)

8. Teacher Verbal Instruction	19.1 155/811	47.1 382/811	15.9 129/811	3.3 27/811	14.5 118/811	66.2/33.8
9. Student Performing Solo	75.0 12/16	25.0 4/16	0 0/16	0 0/16	0 0/16	100/0
10. One-on-one Technical Instrumental Instruction	49.5 164/331	30.5 101/331	11.2 37/331	4.2 14/331	4.5 15/331	80.1/19.9

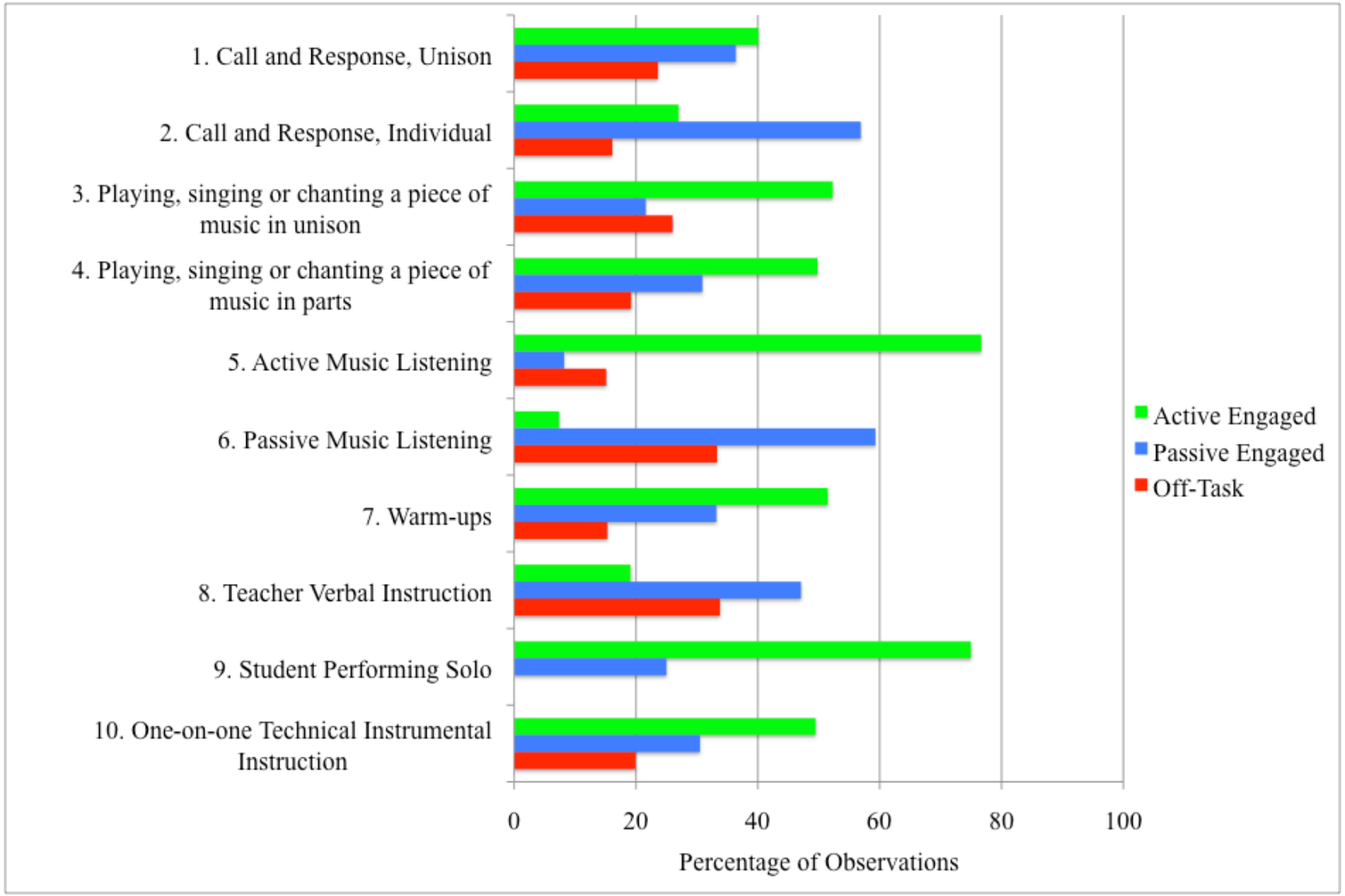

Figure 15. Percentage of Observations Coded Active Engaged, Passive Engaged and Off-Task, for Each Music Activity

Table 18

Executive Function Affordances and Constraints Ratings Compared to Student Average % of Time Engaged and Off-Task

Type of Activity	Executive Functioning Affordances and Constraints Ratings					Percentage of Observations				
	Attention	Inhibition	Updating	Shifting	EF Comp	Active Engaged	Passive Engaged	Off-Task Motor	Off-Task Verbal	Off-Task Passive
1 Call and Response Unison	4	2	3	3	12	40.1	36.4	8.1	1.9	13.5
2 Call and Response Individual	1	3	1	1	6	27.0	56.9	5.8	2.9	7.3
3 Playing, singing or chanting a piece of music in unison	4	1	4	1	10	52.3	21.6	10.6	1.4	14.0
4 Playing, singing or chanting a piece of music in parts	4	4	4	2	14	49.8	30.9	6.2	5.5	7.6
5 Active music listening	4	2	4	2	12	76.7	8.2	4.8	4.1	6.2
6 Passive music listening	1	1	1	1	4	7.4	59.3	14.2	0	19.1
7 Warm-ups	4	2	2	2	10	51.5	33.2	4.4	5.1	5.8
8 Teacher verbal instruction	1	2	1	1	5	19.1	47.1	15.9	3.3	14.5
9 Student performing solo	4	3	4	3	14	75.0	25.0	0	0	0
10 One-on-one Technical Instrumental Instruction	3	4	1	1	9	49.5	30.5	11.2	4.2	4.5

Relationships between executive functioning affordance and student engagement.

Table 18 above summarizes the results for both parts of research question 2, displaying both the levels of executive functioning affordances and constraints (attention, inhibition, updating and shifting) and the percentages of observations coded active engaged, passive engaged, off-task motor, off-task verbal and off-task passive. This is a comparison of qualities of the instruction and qualities of student response. In order to explore whether there were any relationships between levels of executive functioning affordances and constraints and students' levels of engagement and off-task behavior, a series of Pearson correlation coefficients where calculated. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. Table 19 (below) shows all of the Pearson correlation coefficients in a matrix; significant correlations are marked with asterisks. Attention affordances and constraints were strongly positively correlated with student active engagement ($r=.84$, $n=10$, $p<.005$) and strongly negatively correlated with student passive engagement ($r=-.85$, $n=10$, $p<.005$). Inhibition affordances and constraints were strongly negatively correlated with student off-task passive behavior ($r=-.69$, $n=10$, $p<.05$). Updating affordances and constraints were strongly positively correlated with student active engagement ($r=.77$, $n=10$, $p=.01$) and strongly negatively correlated with student passive engagement ($r=-.79$, $n=10$, $p<.01$). Shifting affordances and constraints were strongly negatively correlated with student off-task motor behavior ($r=-.70$, n=1-, $p<.05$). Finally, the Executive Functioning Affordances and Constraints Composite scores had a strong positive relationship with student active engagement ($r=.85$, $n=10$, $p<.005$), a strong negative relationship with student passive engagement ($r=-.78$, $n=10$, $p<.01$), a strong negative relationship with student off-task motor behavior ($r=-.74$, $n=10$, $p<.05$),

and a strong negative relationship with student off-task behavior collapsed together (r=-.68, n=10, p<.05).

Table 19

Pearson Correlation Matrix among Levels of Executive Functioning Affordances and Constraints Assigned to the 10 Music Activities and Students' Average Levels of Engagement and Off-Task Behavior During the 10 Music Activities

	Active Engaged	Passive Engaged	Off-Task Motor	Off-Task Verbal	Off-Task Passive	Off-Task Collapsed
Attention	.840**	-.850**	-.609	.223	-.471	-.535
Inhibition	.285	-.103	-.354	.501	-.690*	-.481
Updating	.766**	-.786**	-.580	-.028	-.302	-.471
Shifting	.571	-.420	-.700*	-.095	-.424	-.612
EF Comp	.852**	-.775**	-.737*	.205	-.609	-.682*

*p<0.05, ** p<0.01

Research Question 3.

To what extent do students participating in a music program demonstrate, over time, improved behaviors associated with executive functioning (shifting, inhibition, updating and attention) in the general education classroom compared to students not participating in a music program?

Summary of research question 3 results. Music students' behaviors associated with executive functioning, as rated by classroom teachers, did not improve relative to control students. In fact, music students showed increasing difficulties in some areas. Music students' BRIEF Shift scores increased marginally, and their BRIEF Inhibit scores increased significantly,

indicating increased difficulties from time 1 to time 2. Control students' BRIEF Shift and Inhibit scores did not change significantly (see Figures 17 and 18). BASC-2 Attention Problems scores did not change significantly for music students or control students and their were no significant differences between groups (see Figure 16). BRIEF Working Memory scores revealed a marginal interaction, with music students' scores getting slightly worse and control students' scores getting slightly better (see Figure 19). However, there were no significant effects for group or time. BRIEF Global Executive Composite scores showed a similar pattern, with music students' scores increasing significantly, indicating increasing difficulties with executive functioning (see Figure 20). Control students showing no significant change, but there was a significant group by time interaction. This study did not find evidence of the executive functioning skills practiced in the music program generalizing or transferring to the general education setting.

Defining groups. Before analyses could be conducted, groups had to be defined. For the purposes of the following analyses, only students who participated in the music program across the entire year were included in the Music Program Participants group (N=78). Students who never participated in the music program or participated in the music program for less than 2 months, were included in the Control group (N=39). Students who were dismissed from the program due to behavior problems were not included in the analysis. Furthermore, only students who were included in the dataset at both time points could be included in the analyses.

Table 20

Total number of Music Program Participants and Control Students measured with the BRIEF and BASC-2 at both time-points and included in the analyses

	Music Program Participants	Control Students
BASC-2	32	15
BRIEF	43	18

BASC-2 Teacher Rating Scale.

Attention Problems Scale. Table 21 displays mean scores on the Attention Problems Scale for Music Program Participants and Control Students. Higher scores indicate more attention problems reported by the teacher. Repeated Measures Analysis of Variance showed no statistically significant time effects, $F(1, 45)=1.27$, $p=.267$, no significant main effects of group $F(1, 45)=.26$, $p=.610$ and no interaction effect $F(1, 45)=.13$, $p=.718$. Follow-up t-tests showed no significant differences. Groups did not differ significantly at either time point, and neither groups' scores changed significantly from Time 1 to Time 2.

Table 21

Mean BASC-2 Attention Problems Scale Scores at Time 1 and Time 2 for Music Program Participants and Control Students

		Time 1	Time 2
Music Program Participants	mean	50.34	53.34
	standard deviation	11.47	13.96
Control Students	mean	53.00	54.53
	standard deviation	13.63	16.73

Note: Higher scores are associated with greater difficulties in the area of attention problems.

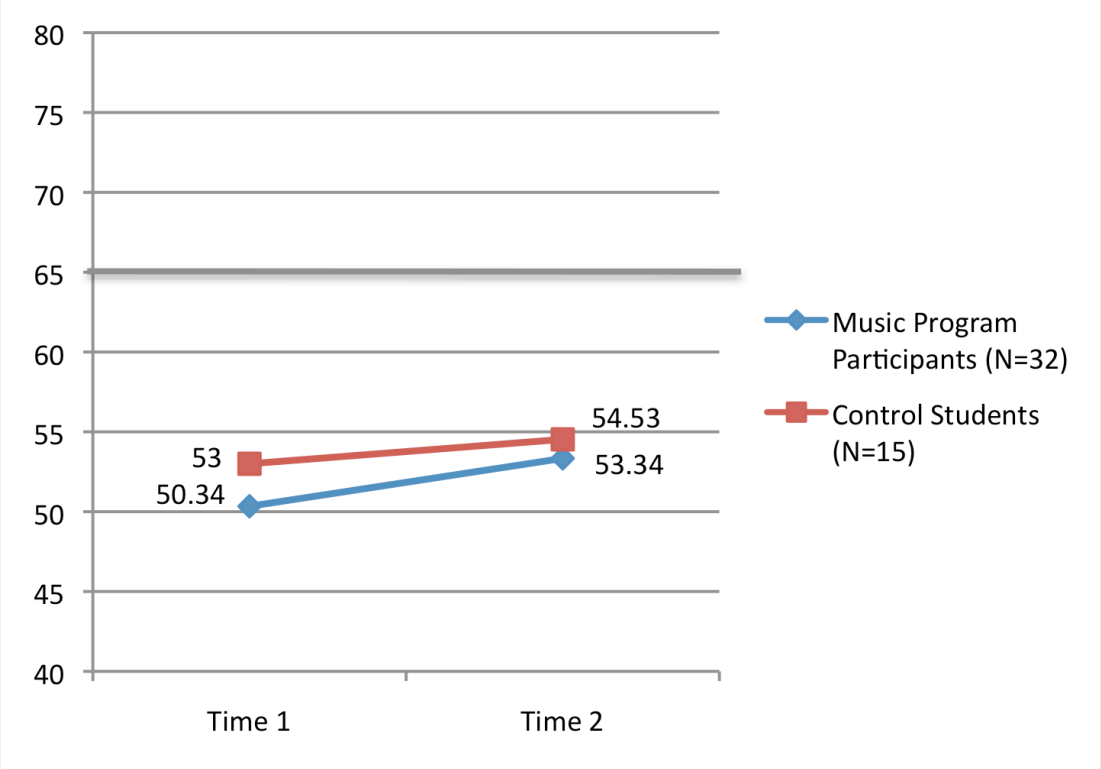

Figure 16. Mean BASC-2 Attention Problems Scale T-Scores

BRIEF Teacher Rating Scales. BRIEF scores presented are T-Scores, where 50 is the average score of the distribution. A score of 65 or higher is 1.5 standard deviation above the mean and is considered abnormally elevated.

Shift Scale. Table 22 displays mean scores on the BRIEF Shift Scale for Music Program Participants and Control Students. Repeated Measures Analysis of Variance showed no statistically significant time effects, $F(1, 59)=.156$, $p=.694$, no significant main effects of group $F(1, 59)=.062$, $p=.804$ and no interaction effect $F(1, 59)=2.46$, $p=.122$. Follow-up independent samples t-test showed no significant differences between groups at either time point. Paired samples t-test found no significant differences from Time 1 to Time 2 for either group; however, Music Program Participants' change in BRIEF Shift scores over time had a marginal effect ($p=.057$).

Table 22

Mean BRIEF Shift Scale Scores at Time 1 and Time 2 for Music Program Participants and Control Students

		Time 1	Time 2
Music Program Participants	mean	58.07	62.81
	standard deviation	16.60	17.87
Control Students	mean	60.78	57.94
	standard deviation	19.04	18.41

Note: Higher scores are associated with greater difficulties in the area of shifting.

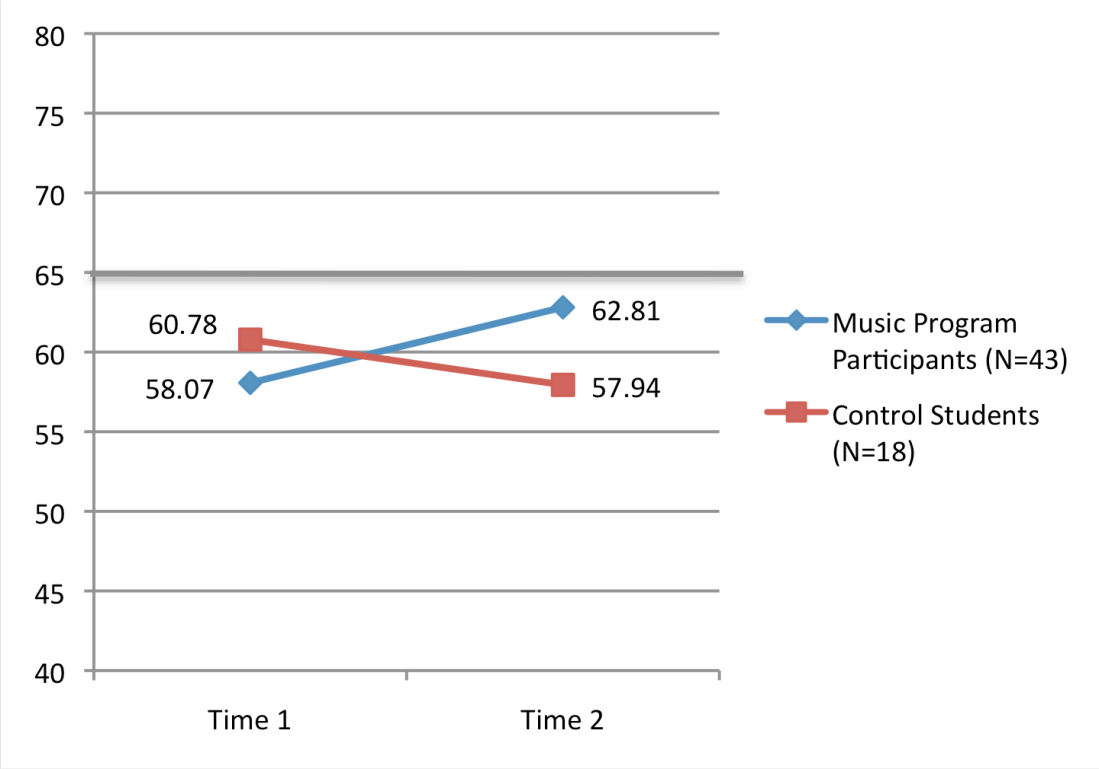

Figure 17. Mean BRIEF Shift T-Scores

Inhibit Scale. Table 23 displays mean scores on the BRIEF Inhibit Scale for Music Program Participants and Control Students. Higher scores indicate more attention problems reported by the teacher. Repeated Measures Analysis of Variance showed no statistically significant time effects, $F(1, 59)=0.38$, $p=.540$, no significant main effects of group $F(1, 59)=0.04$, $p=.840$ and no interaction effect $F(1, 59)=3.08$, $p=.084$. Follow-up independent samples t-test showed no significant differences between groups at Time 1 or Time 2. However, follow-up paired-samples t-test revealed that scores of Music Program Participants' BRIEF Inhibit Scale scores increased significantly from a mean of 52.74 at Time 1 to a mean of 56.91 at Time 2, reflecting teachers' report of increased difficulties with inhibition in the classroom ($p<.05$). Control students' scores did not change significantly over time.

Table 23

Mean BRIEF Inhibit Scale Scores at Time 1 and Time 2 for Music Program Participants and Control Students

		Time 1	Time 2
Music Program Participants	mean	52.74	56.91
	standard deviation	11.37	13.46
Control Students	mean	56.50	54.50
	standard deviation	17.65	13.11

Note: Higher scores are associated with greater difficulties in the area of inhibition.

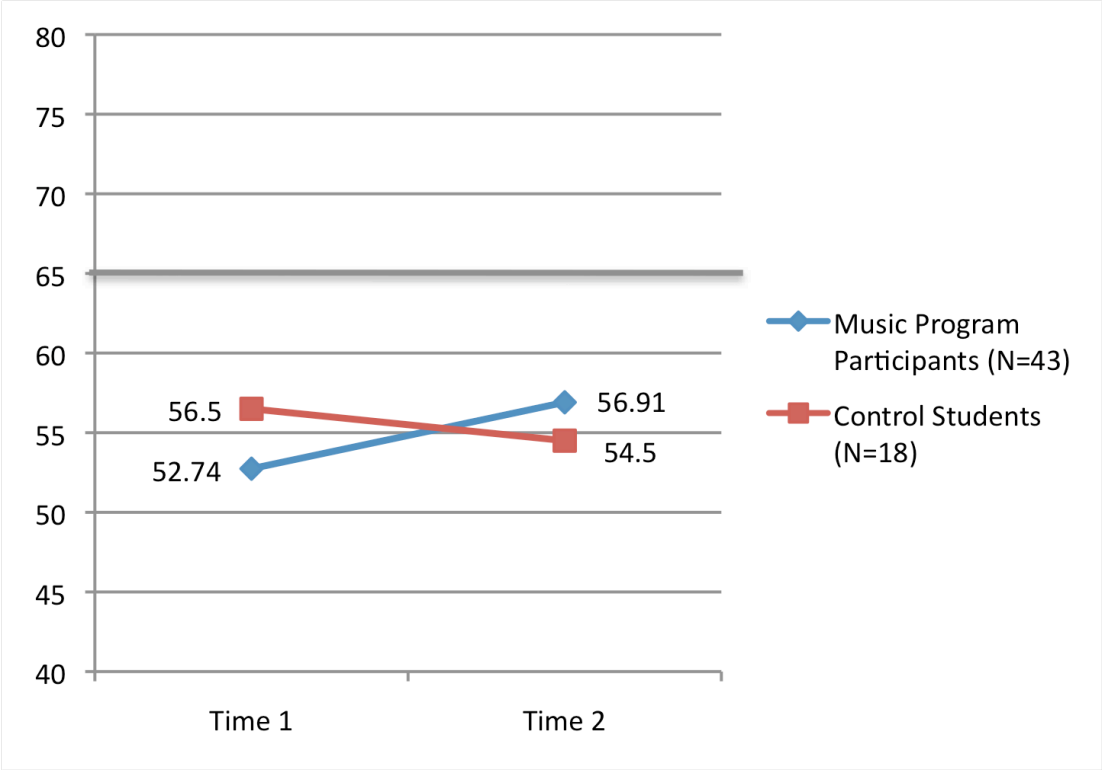

Figure 18. Mean BRIEF Inhibit T-Scores

Working Memory Scale. Table 24 displays mean scores on the BRIEF Working Memory Scale for Music Program Participants and Control Students. Repeated Measures Analysis of Variance showed no statistically significant time effects, $F(1, 59)=.344$, $p=.560$, no significant main effects of group $F(1, 59)=.012$, $p=.913$ and a marginal interaction effect $F(1, 59)=3.675$, $p=.060$. Follow-up independent samples t-test showed no significant differences between groups at Time 1 or Time 2, and follow-up paired-samples t-test showed no significant change in BRIEF Working Memory scores over time for either group.

Table 24

Mean BRIEF Working Memory Scale Scores at Time 1 and Time 2 for Music Program Participants and Control Students

		Time 1	Time 2
Music Program Participants	mean	51.33	53.63
	standard deviation	12.35	13.53
Control Students	mean	55.00	50.67
	standard deviation	15.67	10.90

Note: Higher scores are associated with greater difficulties in the area of working memory.

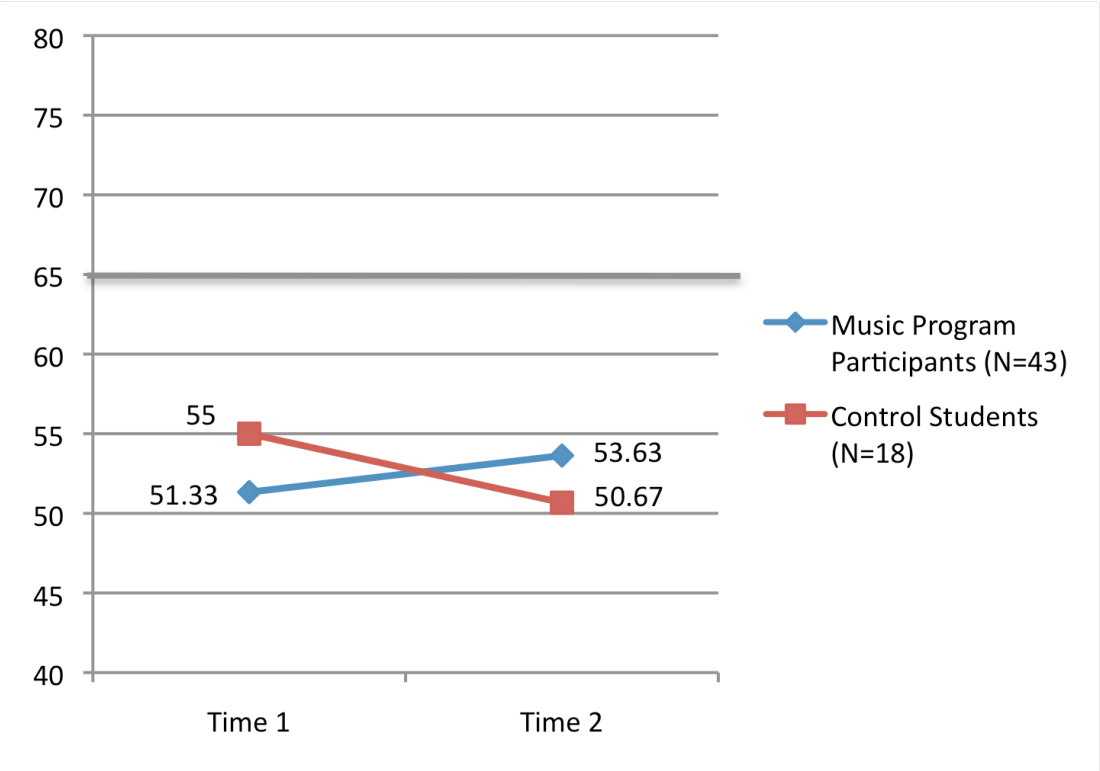

Figure 19. BRIEF Working Memory T-Scores

Global Executive Composite (GEC). Table 25 displays mean scores on the BRIEF Global Executive Composite for Music Program Participants and Control Students. Repeated Measures Analysis of Variance showed no statistically significant time effects, $F(1, 59)=.003$, $p=.958$, and no significant main effects of group $F(1, 59)=.048$, $p=.828$. However, there was a significant interaction effect $F(1, 59)=4.208$, $p<.05$. Follow-up independent samples t-test showed no significant differences between groups at either time-point. Paired-samples t-test showed that Music Program Participants' BRIEF Global Executive Composite scores increased significantly between Time 1 and Time 2 ($p<.05$), while Control Students' scores did not change significantly.

Table 25

Mean BRIEF Global Executive Composite Scores at Time 1 and Time 2 for Music Program Participants and Control Students

		Time 1	Time 2
Music Program Participants	mean	53.74	57.86
	standard deviation	14.19	15.49
Control Students	mean	58.83	54.50
	standard deviation	20.66	15.29

Note: Higher scores are associated with greater executive functioning difficulties.

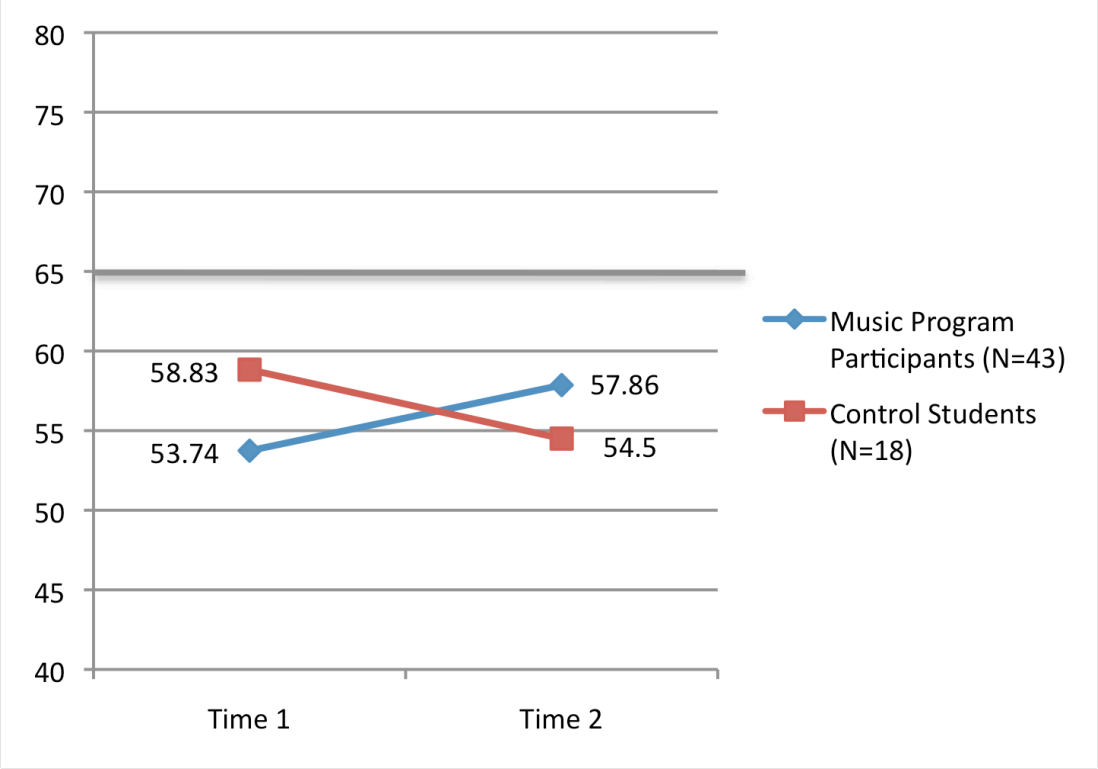

Figure 20. BRIEF Global Executive Composite Scores

Research Question 4.

For students participating in a music program, does musical development correlate with development of executive-functioning-related behaviors in the general education classroom?

Summary of research question 4 results. Negative correlations between executive functioning change scores and music performance change scores, may indicate that these skills grow together. Of the 30 correlations in the matrix, 21 (70%) are negative (see Table 26). However, only 3 (10%) of the correlations were statistically significant. The significance of these 3 correlations may have been due to chance alone and should therefore be interpreted with some caution. Performance Tonal change scores had a strong negative relationship with BRIEF Working Memory change scores, BRIEF Shift change scores, and BRIEF Global Executive Composite change scores.

Calculation of change variables and correlation coefficients. To answer this question, change variables first had to be calculated for music development variables (developmental music aptitude and performance achievement) and executive functioning variables (shifting, inhibition, updating and sustained attention). Students' Time 1 scores were subtracted from their Time 2 scores, yielding change scores for each variable. In order to explore whether there were any relationships between music development and executive functioning development, a series of Pearson correlation coefficients were calculated between music change scores and executive functioning change scores. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. Table 26 shows all of the Pearson correlation coefficients in a matrix; significant correlations are marked with asterisks.

Table 26

Pearson Correlation Matrix among Executive Functioning Rating Scale Change Scores and Music Development Change Scores

	PMMA			Performance		
	Tonal	Rhythm	Composite	Tonal	Rhythm	Composite
BASC-2 Attention	.150 N=16	-.272 N=16	-.036 N=16	-.287 N=13	.248 N=13	-.119 N=13
BRIEF Inhibit	-.083 N=19	-.147 N=19	-.143 N=19	-.306 N=17	.261 N=17	-.057 N=17
BRIEF Working Memory	.119 N=19	-.268 N=19	-.019 N=19	-.540* N=17	.444 N=17	-.121 N=17
BRIEF Shift	.105 N=19	-.365 N=19	-.078 N=19	-.647** N=17	.338 N=17	-.380 N=17
BRIEF GEC	.021 N=19	-.323 N=19	-.133 N=19	-.547* N=17	.395 N=17	-.190 N=17

*p<0.05, ** p<0.1

Keeping in mind that decreasing scores on the BRIEF are associated with improvement in executive functioning and increasing performance scores are associated with musical growth, we would expect to find negative correlations if indeed executive functioning and music skills grow together. Of the 30 correlations in the matrix, 21 (70%) are negative. However, only 3 (10%) of the correlations were statistically significant. Because of the large number of correlations, the significance of these 3 correlations may have been due to chance alone and should therefore be interpreted with some caution. Performance Tonal change scores had a

strong negative relationship with BRIEF Working Memory change scores (r=-.54, N=17, p<.05), BRIEF Shift change scores (r=-.65, N=17, p<.01), and BRIEF Global Executive Composite change scores (r=-.55, N=17, p<.05). Scatter plots for these three significant correlations are shown below in Figures 21, 22 and 23. Each point on the scatterplot represents a student. The scatterplots provide visual representation of the significant negative relationships; as students' performance scores increase, their BRIEF scores tend to decrease (indicating improved executive functioning skills).

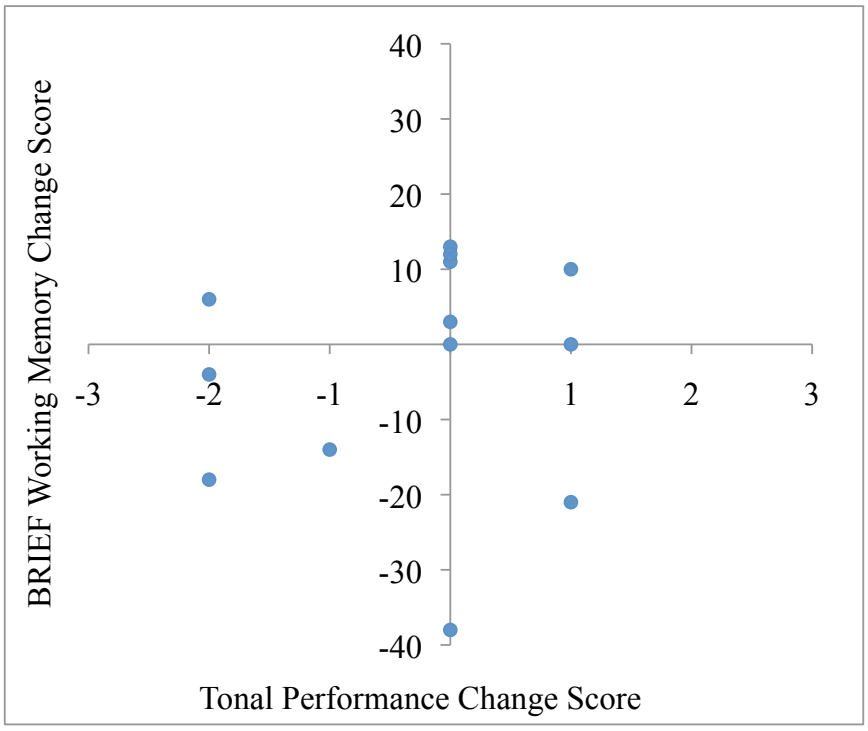

Figure 21. Scatterplot for Tonal Performance Change Score and BRIEF Working Memory Change Score

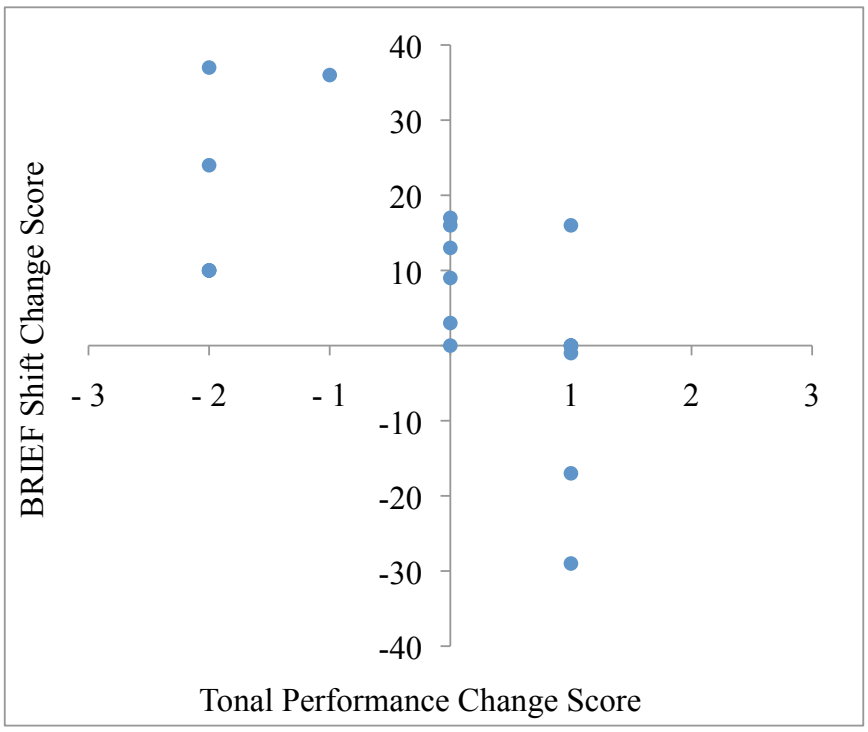

Figure 22. Scatterplot for Tonal Performance Change Score and BRIEF Shift Change Score

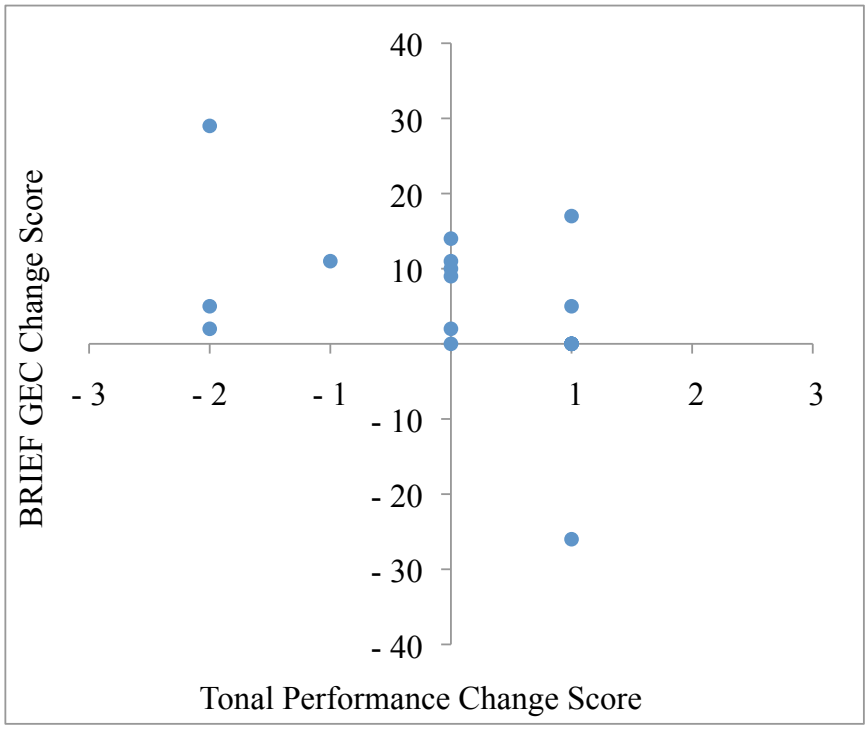

Figure 23. Scatterplot for Tonal Performance Change Score and BRIEF Global Executive Composite Change Score

CHAPTER V:

DISCUSSION

Research Question 1

To what extent do children participating in a music program demonstrate musical development as demonstrated by measures of developmental music aptitude and performance?

Summary of main discussion points.

- Students' tonal music aptitude increased more than their rhythmic music aptitude, indicating that the music program may have had a greater effect on students' tonal music aptitude than their rhythmic music aptitude.
    - Tonal emphasis of instruction
    - Rhythm scores high at time 1
    - Previous learning
- Increasing difficulty of performance stimuli provides further evidence of growth
- Small sample size limits power to detect performance growth

The music program may have had a greater effect on students' tonal music aptitude than their rhythmic music aptitude. Both the PMMA and the performance ratings indicate that students made greater gains in tonal development (see Figures 10 and 13) than in rhythmic development (see Figures 11 and 14) across the year. Program participants' PMMA Tonal scores increased significantly from fall to spring (see Figure 10). At both timepoints, students performed above the standardization sample. On average, students made more than one year's growth in half a year in the area of tonal music aptitude. When looking at the PMMA Composite scores, we see that average scores increased significantly across the year, and students' average scores were above the standardization sample at both timepoints (see Figure 12).

Tonal emphasis of instruction. One potential reason why the program seemed to have a greater effect on students' tonal music aptitude than their rhythmic music aptitude may be the emphasis of the instruction students received. The musicianship class teacher was trained in the Gordon Method, and flooded students with opportunities to audiate tonal context. For example, he often played the same song for children in different modalities (major, minor, dorian, mixolydian, etc.). Furthermore, the teacher gave students frequent opportunities to manipulate these tonal factors by having students select a known song and a modality for the class to sing while the teacher accompanied on the piano. Another example of the musicianship teacher directly teaching students to audiate tonal context was in the use of words, signs, and physical movements to label/represent different harmonic functions. For example, while playing a song at the piano, the teacher frequently sang along with the children the word "no" on the dominant root (scale degree 5) during dominant function, "yes" on the tonic root (scale degree 1) during tonic function, and "maybe" on the subdominant root (scale degree 4) during subdominant function. These various harmonic functions also have different hand signs/physical motions associated with them, such as hands up and hands down. These activities were intended to help children learn to differentiate among various harmonic functions underlying music, and eventually to be able to identify and label the functions and to be able to audiate the harmonic functions independently, with or without music being physically present. The music teacher also did parallel activities focused on developing students' rhythmic audiation skills. One such activity involved having children select a song and either a duple of triple meter for singing it. The teacher also had students perform various rhythms on percussion instruments. In one example, the teacher had half the class play a duple pattern while the other half of the class played a triple pattern, and the students switched patterns. While students had many

opportunities to practice both tonal and rhythmic audiation during musicianship class, observation of the classroom indicated that the teacher may have put a greater emphasis on tonal audiation, with more direct instruction in the tonal domain and more time devoted to activities focused on tonal differentiation. The teacher may have chosen this emphasis because students had a greater need for tonal development. In the fall, average PMMA Tonal scores were slightly above average relative to the standardization sample, whereas average PMMA Rhythm scores were well above average (see Figures 10 and 11).

Rhythm scores high at time 1. For both PMMA and Performance, students' rhythm scores were already quite high at Time 1. This brings us to another potential reason that Rhythm scores did not show as much growth as Tonal scores; students had more room to grow in the tonal domain. Students were already demonstrating well above average levels of Rhythmic aptitude in the fall. By time 2, tonal skills seemed to catch up with rhythmic skills, which increased slightly or held steady across the year.

Previous or other learning. It is possible that students' rhythmic aptitude had already grown between the time they started the music program in August/September and the time they were tested in November/December. Any growth that occurred earlier in the fall was not captured. It is also possible that, prior to starting the music program, these students had already been exposed to music and experiences that contributed to the development of rhythmic aptitude, and less exposure to music and experiences that would help them develop tonal aptitude. As we know, formal music training is not the only experience that impacts developmental music aptitude. Exposure to music in any context, including informal music learning experiences, contributes greatly to children's levels of developmental music aptitude (Gordon, 2007). As part of the program evaluation, children were surveyed about the kind of music they like to listen to.

In the fall, the majority of students surveyed mentioned that they like to listen to pop, hip-hop and rap musicians. Pop, hip-hop and rap was also popular among students surveyed in the spring, but a few students also mentioned certain jazz and classical musicians and composers as well in the spring. It is possible that the music children in this population had been primarily exposed to prior to participation in the music program, was in the pop, hip-hop and rap genres. These genres of music are more rhythmically complex than they are tonally complex, leading to greater development of rhythmic as opposed to tonal aptitude and audiation skills. It appears that once exposed to direct instruction in tonal audiation as well as more tonally-complex forms of music (jazz and classical), the students' levels of tonal aptitude increased dramatically. The differences in tonal and rhythmic aptitude growth could also be partly attributable to the general music program at the school.

Increasing difficulty of performance stimuli provides further evidence of growth. The music teacher used performance stimuli that reflected instructional content and the increasing developmental level of the students. Therefore, performance stimuli tended to increase in difficulty across the year. If the difficulty of performance stimuli increased, and students' performance ratings stayed consistent, that may reflect improvement in students' ability to perform tonal and rhythmic patterns. Furthermore, if the difficulty of performance stimuli increased and students' performance ratings also increased, then we can be even more confident that students' ability to perform tonal and rhythmic patterns improved. In cases where students' performance ratings decreased across the year, it is difficult to interpret whether any student improvement did or did not occur.

In the area of Tonal Performance there were no significant differences overall for time or group (see Figure 13). However, when data were broken down by First and Second Grade

Beginners, there was a significant interaction for time by group. First Grade Beginners' tonal performance scores increased while Second Grade Beginners' tonal performance scores decreased. In interpreting these scores, is it important to examine the stimuli provided the students at each timepoint. First Grade Beginners' tonal performance stimuli increased in difficulty from Time 1 to Time 2. Use of solfege syllables, changing harmonic function, and descending motion of arpeggiation all contribute to making the time 2 stimuli more advanced and challenging than the time 1 tonal stimuli. The fact that First Grade Beginners' scores improved while the task increased in difficulty, increases confidence that their tonal performance skills improved over time. For Second Grade Beginners, tonal stimuli also increased in difficulty from Time 1 to Time 2. At Time 2, each student was given two 3-note patterns to imitate, each outlining a different chord and harmonic function. At time 2, the stimuli was more harmonically complex and included twice as many notes as the Time 1, when students sang only one arpeggiated triad. The increasing difficulty of the stimuli coupled with Second Grade Beginning students' slightly decreasing scores, makes it difficult to draw conclusions about tonal performance development for Second Grade Beginners. In summary, we can be confident that First Grade Beginners' Tonal Performance skills improved across the year, but it is unclear whether Second Grade Beginners' Tonal Performance Skills improved or not.

In the area of Rhythmic Performance, no significant differences were found. Average Rhythmic Performance scores were high at both timepoints, rated 4 and above (see Figure 14). This indicates that on average, students maintained a steady beat and performed the rhythmic patterns with little to no flaws in accuracy. First Grade Beginners' average Rhythmic Performance scores were exactly the same at both timepoints (see Figure 14). First Grade Beginners' rhythmic stimuli increased somewhat in difficulty, in that at time 1, students were

only given one 4-beat pattern to imitate, while at time 2, students were given two 4-beat patterns. Also contributing to an increasing difficulty level, neutral syllables were used at Time 1 and Gordon rhythmic syllables were used at Time 2. The complexity of the rhythmic content stayed pretty consistent. First Grade Beginners' consistent performance coupled with an increase in difficulty level, may indicate that students' rhythmic performance skills increased slightly across the year. Second Grade Beginners' scores improved on average by about half of a point on the rating scale (see Figure 14). Also, the complexity of rhythmic stimuli provided to Second Grade Beginners increased across the year. At time 2, students were given two 4-beat patterns to imitate, rather than just one. Additionally, the first 4-beat pattern was in a duple meter, while the second pattern was in a triple meter. The student had to go from hearing and performing a duple division, immediately into hearing and performing a triple division. Second Grade Beginners average growth of half a point combined with increasing difficulty of the rhythmic stimuli, lends confidence that students' rhythmic performance abilities improved across the year. In summary, there is a little evidence to suggest that First Grade Beginners' rhythmic performance improved across the year, and we can be more confident that Second Grade Beginners' rhythmic performance improved across the year.

Small sample size limits power to detect performance growth. Power to detect statistically significant growth in performance was limited by the small sample size. Only 18 music students had tonal and rhythmic performances recorded at both the fall and spring timepoints (see Table 11).

Research Question 2

How do music instruction activities differ in the extent to which they provide opportunities for children to practice behaviors associated with executive functioning (shifting, inhibition, updating and attention) and in students' rates of active vs. passive engagement and off-task behavior?

Summary of main discussion points.

- Music activities are characterized by affordances and constraints that support the use and development of specific executive functioning skills.
    - Frequent immediate feedback on effectiveness of executive functioning skill use
    - Reinforcement of effective executive functioning skill use
- Musical activities differ in levels of executive functioning affordances and constraints.
- Overall, music activities associated with high levels of active student engagement and low levels of off-task behavior.
- Levels of engagement and off-task behavior differ by music activity.
- Specific music activities recommended for increasing active student engagement.
- Attention affordances of activities are correlated with active student engagement.
- Music as model for engaging instruction.
- External supports and structures may lead to internalization and generalized application of skills.

Music activities are characterized by affordances and constraints that support the use and development of specific executive functioning skills. This study provides evidence that music is particularly good at developing executive functioning because of the nature of musical tasks. This adds to the existing evidence-base on the extra-musical benefits of music study (e.g.

Catterall et al., 1999; Gooding, 2009; Kokotsaki & Hallam, 2007). Many music activities afford the use of attention, inhibition, updating and shifting, and constrain not using the skills. Music activities were rated as 3 or higher on the Executive Functioning Affordances and Constraints Rating Scale (see Table 15) if they were characterized by frequent or continuous affordances and constraints, more than half the time, with frequent consequences and feedback for using or not using the particular skill. Seven out of ten music activities were rated 3 or higher for attention, meaning that the music activities afforded the use of attention, constrained inattention, and provided frequent feedback and consequences in response to levels of attention most of the time or continually (see Table 16). Eight out of ten music activities were rated as affording inhibition, constraining disinhibition, and providing consequences at least half of the time. Five out of ten music activities were rated 3 or higher for updating, indicating that half of the music activities frequently or continuously afford updating, constrain failure to update and provide feedback and consequences. And five out of ten music activities were rated as affording shifting, constraining failure to shift, and providing feedback and consequences half the time or more.

In many cases, constant attention, inhibition of impulses, updating working memory, and shifting among tasks are necessary in order to be successful in the music task. For example, during call and response, the student must attend to the stimuli provided by the teacher while inhibiting himself from blurting out at the wrong time; the student must also update and refresh the contents of working memory each time a new stimulus is provided. Likewise, many music activities constrain not using executive functioning skills because students would be unable to perform the musical task successfully without using the skills. Consequences of using a skill effectively or not tend to be immediately visible and audible to peers and teacher (not fitting in with the music rhythmically or tonally).

Frequent immediate feedback on effectiveness of executive functioning skill use. Music activities also afford executive functioning skills by providing frequent or continuous feedback to students and teachers about whether students are or are not attending, inhibiting, updating and shifting. During an activity that involves singing, playing or chanting with others, attending to what peers are singing or playing provides valuable feedback on one's own performance. Students can immediately hear whether they are fitting it in with their peers, and this feedback allows students to make adjustments. For example, a student singing in a choir who is not shifting from soft to loud or from duple to triple meter along with the group, will stand out from her peers. This lack of fitting in provides the student with immediate feedback on her use of executive functioning skills and prompts the student to make adjustments. The teacher is also likely to notice and provide feedback to the student on her performance. This frequent feedback would not be possible if students did not have frequent opportunities to respond during music activities. Frequent opportunities to respond are also reflected in high levels of active engagement.

Reinforcement of effective executive functioning skill use. Being successful in a musical task is rewarding in that students fit in harmoniously with those around them and experience the satisfaction of expectation and the interest of surprise inherent in the music. Because successful participation in music is inherently rewarding and requires the use of attention, inhibition, updating and shifting, the effective use of these executive functioning skills is reinforced.

Music also inherently affords use of executive functioning skills in that music changes frequently; such aspects as rhythm, meter, words, pitches, harmony, dynamics and phrasing change from moment to moment. This adds interest and also demands attention to many changing qualities and continual updating of musical representations in working memory.

Musical activities differ in levels of executive functioning affordances and constraints.

Overall, the results of this study show that music activities do much to afford and constrain use of executive functioning skills (attention, inhibition, updating and shifting). However, the results of this study also indicate that musical tasks differ in the extent to which they afford the use of executive functioning skills and constrain not using these skills. The following activities were rating highest in executive functioning affordances and contraints for attention: call and response unison, playing/singing/chanting a piece of music in unison or in parts, active music listening, warm-ups, and performing a solo (see Table 16). The following activities were rated highest in affordances and constraints for inhibition: playing/singing/chanting a piece of music in parts, call and response individual, performing a solo and one-on-one technical instrumental instruction. The following activities were rated highest in affordances and constraints for updating: playing/singing/chanting a piece of music in unison or in parts, active music listening and performing a solo. And the following activities were rated highest in affordances and constraints for shifting: call and response unison, performing a solo. According to the Executive Functioning Affordances and Constraints Composite scores, these activities do the most to afford and constrain the use of executive functioning skills overall: playing/singing/chanting a piece of music in parts, student performing a solo, call and response unison and active music listening. The music activities that did the least to support the use of executive functioning skills overall were: passive music listening, teacher verbal instruction, and call and response individual. If music teachers are interested in maximizing the potential for their music instruction to contribute to children's executive functioning development, they may want to spend more instructional time on activities that do much to afford and constrain executive functioning and less time of activities that do not.

Overall, music activities associated with high levels of active student engagement and low levels of off-task behavior. While the first part of this research question involved examination of affordances and constraints inherent in the music instruction activities, the second part of the question involved examination of how students responded to the various activities in terms of engagement and off-task behavior. Overall the music activities observed in this study were associated with high levels of student engagement, particularly active engagement, and low levels of off-task behavior. During six out of ten music activities, students were rated as actively engaged about half or more of the time (see Table 17 and Figure 15). For two of the activities (active music listening and performing a solo), students were rated as actively engaged about 75% of the time. For six out of ten music activities, students were rated as off-task less than 20% of the time. Instructional strategies that ensure students are actively engaged are considered the gold-standard in teaching and are referred to as high-access instruction (Feldman & Denti, 2004). High-access instruction involves teaching strategies that actively engage all learners, maximize student participation, and ensure all learners focus on the critical concepts (Kameenui & Carnine, 1998). Research suggests that when teachers use strategies that actively engage all students, students of all skill levels make gains (Pressley, Hogan, Wharton-McDonald, & Mistretta, 1996). Because music activities are associated with such high levels of active student engagement, music instruction may be a good model for highly engaging and effective teaching in general.

Levels of engagement and off-task behavior differed by music activity. Music activities differed significantly from one another in three areas: levels of active engagement, passive engagement and off-task passive behavior. Music activities with the highest levels of active engagement include active music listening (76.7%) and student performing a solo (75%), while

music activities with the lowest levels of active engagement were passive music listening (7.4%), teacher verbal instruction (19.1%), and call and response individual (27.0%). Passive engagement was highest during passive music listening (59.3%), call and response individual (56.9%), and teacher verbal instruction (47.1%) and lowest during active music listening (8.2%). Passive music listening had the highest rate of off-task passive behavior (19.1%) and student performing a solo had the lowest rate of off-task passive behavior (0%). Levels of off-task motor and off-task verbal behavior may not have differed significantly among activities because they were so low; for all activities, student rates of off-task motor behavior was less than16%, and off-task verbal rates were below 6% across the board.

Specific music activities recommended for increasing active student engagement. If music teachers want to increase levels of active engagement in their classrooms, it is recommended that they increase instructional time devoted to active music listening, playing/singing/chanting a piece of music in unison and in parts, warm-ups, and call and response unison. Interestingly, choral responding (similar to call and response unison) is also considered a high-access instructional strategy associated with high levels of active engagement in the general classroom (Feldman & Denti, 2004). Some activities, such as performing a solo and one-on-one technical instrumental instruction, are very actively engaging for the student performing or receiving the instruction, but with a larger group of students, many of the students would not be actively engaged during these activities. It is also recommended that teachers be thoughtful in their use of passive music listening, teacher verbal instruction and call and response individual. While these activities can be very valuable to students' music learning, students do not tend to be actively engaged during these activities. This makes it hard for teachers to gauge whether students are engaged with the instructional material or off-task, in short, whether they

are processing the material and learning. Because students tend to sit passively during these activities with little feedback, it is also hard to tell whether they are engaging executive functioning skills. Strategies that incorporate more opportunities to respond and receive feedback during these activities may increase student engagement and teachers' ability to gauge levels of engagement. Examples of potential strategies to incorporate during music listening, teacher verbal instruction and call and response individual, include: physical movement, signaling, partner-sharing, student writing and drawing (Marzano, 2011).

Attention affordances of activities are correlated with active student engagement.

Further analyses revealed relationships between executive functioning affordances and constraints and students' levels of engagement and off-task behavior (see Table 19). Specifically, a significant strong positive correlation was found between attention affordances and constraints and students' active engagement. In other words, activities that do more to afford attention, constrain inattention and provide feedback/consequences for attending, are associated with significantly higher levels of active student engagement. Similarly, activities with high levels of attention affordances and constraints were associated with significantly lower levels of passive engagement, and vice versa. When an activity encouraged and supported the use of attention, students were less passively engaged. Perhaps activities that do more to afford attention, also provide more opportunities for students to actively respond. A significant negative relationship was also detected between inhibition affordances and constraints, and students' off-task passive behavior. When an activity did more to encourage students to inhibit responses, students were less likely to be zoning out. Updating affordances and constraints had a significant strong positive relationship with active engagement and a negative relationship with passive engagement. During music activities that support and encourage the use of updating,

students tend to be actively rather than passively engaged. There was a strong negative correlation between shifting affordances and constraints and student off-task motor behavior. Students are less likely to be physically off-task during music activities that involve frequent alternation between different types of tasks. This makes sense; because the activity keeps students busy with new tasks, they are less likely to resort to a new off-task activity to do. Finally, the overall executive functioning affordances and constraints composite scores were positively correlated with active engagement, and negatively correlated with passive engagement, off-task motor behavior, and off-task behavior in general. These relationships all indicate that music activities with higher levels of active engagement do more to afford and constrain the use of executive functioning skills. When students are actively engaged in music class, they are more likely to be practicing the important skills of attending, inhibiting, updating and shifting.

Music as model for engaging instruction. Good music instruction has much to teach us about ways to engage students with any kind of instructional material. During many music activities, students are actively engaged much of the time and they receive frequent or continuous feedback. Music provides the structure for frequent meaningful interactions between the student and teacher, between the student and other students, and between the student and the music. If we agree that good instruction engages all students and makes thinking visible, then music instruction might have much to teach us about good instruction in general.

External supports and structures may lead to internalization and generalized application of skills. Executive functioning capacities are highly contextual and develop in response to interaction with the environment. As the brain interacts with the environment, it develops neural circuitry that is progressively more and more adaptive to the given context. The

human capacity for language greatly expands the contextual variables to which humans learn to adapt (Bernstein & Waber, 2007). It seems logical then that the contextual demands of music would lead the brain to adapt as well. Vygotsky (1978) believed that children develop self-regulation through the gradual internalization of external rules and structures. Research-based interventions for developing executive functioning include use of routines, verbal and non-verbal labeling, structuring the environment, structuring time, providing processing cues, providing feedback, and providing reinforcement/rewards (McCloskey, Perkins & Van Divner, 2009). By providing a highly structured environment that supports students' practicing of executive functioning skills within a meaningful context, music programs over time may help students to internalize executive functioning skills and develop the capacity to apply them in other settings.

Research Question 3

To what extent do students participating in a music program demonstrate, over time, improved behaviors associated with executive functioning (shifting, inhibition, updating and attention) in the general education classroom compared to students not participating in a music program?

Summary of main discussion points.

- Unexpected findings: teacher ratings of music students' executive functioning skills did not improve relative to controls.
- Executive functioning skills practiced in music may not necessarily transfer to the general classroom.
    - Influence of environmental context on child behavior.
    - Importance of consistent behavior support: Positive Behavior Intervention Support (PBIS) recommended.

- Potential teacher bias.
- Longitudinal study design may be more sensitive to development of executive functioning among music students.

Unexpected findings: teacher ratings of music students' executive functioning skills did not improve relative to controls. Overall, the results did not support the hypothesis that music students' executive functioning skills would improve across a year of participation in the music program relative to non-participants. Music students' behaviors associated with executive functioning, as rated by classroom teachers, did not improve relative to control students. In fact, music students' scores showed a significant increase in inhibition difficulties (see Figure 18) and a marginal increase in shifting difficulties (see Figure 17).

Classroom teachers did not report improvements in music students' ability to maintain attention and avoid distractions in the general classroom from Time 1 to Time 2. On the BASC-2 Attention Problems scale, music program participants' attention in the general education classroom appeared to be slightly better than control students, on average, though both groups' attention problems in the classroom seemed to increase slightly across the year (see Figure 16). However, there were no significant differences over time or between groups. It should also be noted that students' mean scores fell within the average range relative to the normative sample at both timepoints.

Classroom teachers also did not report improvements in music students' inhibitory control or ability to stop their behavior at the right time (e.g. interrupting, blurting out, being out of seat or talking at the wrong time). On the BRIEF Inhibit scale, music program participants' scores increased significantly, indicating that teachers reported music students showed increasing difficulties inhibiting their behavior in the classroom across the year (see Figure 18). However,

there were no significant effects for time, group, or interaction. It should also be noted that students' mean scores fell within the average range relative to the normative sample at both timepoints.

Classroom teachers did not report improvement in music students' working memory skills, or the capacity to hold information in mind for the purposes of completing a task. Working memory manifests itself in classroom behavior in carrying out multi-step activities, remembering what to do, staying on-task and following instructions. On the BRIEF Working Memory scale, music program participants appeared to demonstrate increasing difficulties across the year while control students appeared to demonstrate slightly decreased difficulties with working memory (see Figure 19). However, there were no statistically significant differences for time, group or interaction. Students' mean scores at both time-points were within the average range relative to the normative sample.

Likewise, classroom teachers did not report improvement in music students' ability to transition and shift flexibly from one activity, situation or aspect of a problem to another as the context demands. On the BRIEF Shift scale, music program participants' scores increased marginally, indicating that teachers reported music students showed some increasing difficulties shifting and transitioning among tasks in the classroom across the year (see Figure 17). However, there were no significant effects for time, group, or interaction.

Executive functioning skills practiced in music may not necessarily transfer to the general classroom. This study did not find evidence of the executive functioning skills practiced in the music program generalizing or transferring to the general education setting.

Influence of environmental context on child behavior. As executive functioning skills are just developing in children, the application of these skills is highly sensitive to the environmental

context (Borkowski & Muthukrishna, 1995). A child might be able to self-regulate well in one setting and not in another, perhaps more chaotic, setting. To activate executive functioning skills, the environment needs to support (afford and constrain) their use. It seems that the children in this study were able to sustain their attention, inhibit behavioral responses, update working memory and shift among tasks within the highly structured and engaging setting of music instruction. Perhaps without the environmental context of music, the children were not able to apply these skills. This finding is congruent with the work of Baum, Owen and Oreck (1997), who found that many students who were self-regulated during their arts lessons (i.e. dance, music and theater) demonstrated few self-regulation skills in the academic environment. The authors point to differences in context and environment between the two settings. The arts classes were characterized by 1) a physical and emotional climate conducive to learning, 2) collaborative goal-setting, 3) instructional process that emphasizes active participation, and 4) teacher expectations and frequent specific feedback. It is possible that the music program context in this study was similarly supportive of students' behavioral self-regulation.

Importance of consistent behavior support: Positive Behavior Intervention Support (PBIS) recommended. A greater level of congruence between behavioral expectations in the music program and behavioral expectations in the school might have improved music students' ability to behave appropriately (including attending, inhibiting, shifting, and updating) in both settings. Positive Behavior Intervention Support (PBIS) was not in place within the music program or the school, but implementation of PBIS was recommended in the program evaluation report (see Method, Researcher Role). PBIS is a prevention-oriented process of implementing evidence-based practices that maximize students' social and academic behavior (www.pbis.org). The PBIS movement stresses the importance of consistent school-wide expectations that are

explicitly taught to all students. Expected behavior is monitored, acknowledged and reinforced. Behavioral errors are met with a predictable continuum of consequences. System-wide behavioral data are tracked and used for decision-making and problem-solving. As it was, students may have been learning different behavioral norms and ways of interacting with adults in the music program and in the classroom. This clash may have affected music students' behavior in the classroom as well as teacher perceptions of their behavior. Furthermore, PBIS might have increased music instructional time if music teachers could have spent more time teaching music and less time addressing behavior problems in potentially ineffective ways. Increased music instructional time would have led to more time for students to be actively engaged and practicing/developing executive functioning skills. Therefore, a PBIS approach might increase the effect of music instruction on development of executive functioning.

Potential teacher bias. One limitation of this study is the reliance on teacher report to measure students' executive functioning skills. If teachers were unhappy with the program, this may have influenced their ratings of the students who participated in the program. As part of the program evaluation, the teachers filled out satisfaction surveys about the music program. Surprisingly, school staff expressed mixed feelings about the music program. While all staff agreed that the music program contributed positively to their schools, the majority of staff did not think that music program participants were better behaved at school than their peers, with 38% strongly disagreeing. While one staff member wrote that the music program provided another way to "make our school stand out from the rest in the complete education of our kids," another wrote that the music program "disrupted the school climate tremendously. It took up too much space for instruments that could have been classrooms for instruction or related services." The majority of staff surveyed were concerned about students being taken out of class and

missing important instructional time, including special education services. (Though most of the music program occurred after school, students were pulled from their classrooms during the school day weekly for musicianship class and occasionally for field trips.) Several school staff expressed concern about the behavior of students in the music program and the behavior management approach of music staff. Two school staff members expressed dislike for the way a specific music staff member spoke to the children. Another school staff member wrote that students were not properly supervised. Staff with negative perceptions of the program and negative perceptions of students participating in the program, might have been biased in filling out the executive functioning rating scales. Individually administered neuropsychological tests would eliminate the teacher bias, but would not measure behavior in the general education classroom. Future research might employ direct behavior observation of music students and non-music students in the general education classroom at the beginning and end of the year. Behavior coders would need to be blind to which students were participating in the music program.

Longitudinal study design may be more sensitive to development of executive functioning among music students. Another possible explanation for the failure to detect executive functioning growth in music students may be that the timeframe was too small to detect growth. A longitudinal study might be able to track development of executive functioning over time among students that stay in the music program. A study could look at how music students' executive functioning skills compare to their peers during their first year in a music program, and then do the same comparison again when the students have been in the program for several years. Perhaps the ability to generalize executive functioning skills practiced in music to other settings develops gradually over the years.

Research Question 4

For students participating in a music program, does musical development correlate with development of executive-functioning-related behaviors in the general education classroom?

Summary of main discussion points.

- Correlations between executive functioning measures and music measures provide some evidence that these skills may develop together.
- Missing data limited power to detect relationships.
- Correlations detected despite music students' lack of executive functioning growth overall.
- Probable overlap between music and executive functioning measures.

Correlations between executive functioning measures and music measures provide some evidence that these skills may develop together. Keeping in mind that decreasing scores on the BRIEF and BASC-2 are associated with improvement in executive functioning and increasing PMMA and performance scores are associated with musical growth, we would expect to find negative correlations if indeed executive functioning and music skills grow together. Of the 30 correlations in the matrix, 21 (70%) were negative (see Table 26). This indicates that the data are trending toward supporting the hypothesis that music and executive functioning skills develop together. However, only 3 (10%) of the correlations were statistically significant. The significance of these 3 correlations may have been due to chance alone and should therefore be interpreted with some caution. Significant negative correlations were found between Performance Tonal change scores and 3 BRIEF scores: Working Memory, Shift, and Global Executive Composite. These significant correlations provide some evidence that musical development, in this case improvement in tonal performance, is related to executive functioning

development. This finding is in alignment with the literature suggesting that the development of musical and executive functioning skills are linked (Bialystok & DePape, 2009).

Missing data limited power to detect relationships. In order to correlate change scores in executive functioning development and musical development, students needed to be included in the data set at 4 points: music measures at time 1 and 2, and executive functioning measures at time 1 and 2. If a student was absent on one of the days that data were collected, none of the data for that student could be included in the analysis. Further contributing to high rates of missing data, some students joined the program or left the program mid-year, due to such issues as behavior problems, attendance, transportation and school transfer. All 4 datapoints were present for only 13 to 19 students, depending on the specific tests analyzed. This small N could limit the power to find significant correlations among change scores. With less missing data more students could have been included in the analysis, and more significant correlations may have been detected.

Correlations detected despite music students' lack of executive functioning growth overall. It is especially encouraging to find some evidence of a correlation between musical growth and executive functioning growth among music program participants, despite the fact that music students' executive functioning did not improve overall. The overall trend of the data suggest that those students who did improve in executive functioning may have improved more in music skills than students who did not improve in executive functioning. Likewise, students whose executive functioning related behavior difficulties intensified across the year, made fewer musical gains.

Probable overlap between music and executive functioning measures. One confound that complicates this area of study, is that strong executive functioning skills may allow students

to perform better on music tests. The PMMA, for example, is likely tapping into/measuring the construct of attention in addition to tonal and rhythmic audiation skills. This points to the importance of looking at growth (change scores). More research is needed to further explore the relationship between executive functioning development and musical development.

Additional Findings of Interest

Summary of main discussion points.

- Removal of students from music program due to behavior problems.
- To what extent do music programs select for individuals with strong executive functioning skills or develop them?
- Serious fun.

Removal of students from music program due to behavior problems. An unexpected complicating factor in this study, was that students were dismissed from the program for behavior problems. It was concerning that a total of 11 students (9.4% of the total sample) were removed from the music program for behavior problems. That is almost one in ten students. This seems counter to the organization's mission to use music as a vehicle to serve the community's neediest children. Given the disadvantaged economic background of a large proportion of this population, it is not surprising to find that many of these students demonstrate behavior difficulties related to executive functioning (Ackerman, Kogos, Youngstrom, Schoff, & Izard, 1999; Randolph, Koblinsky, Beemer, Roberts, & Letiecq, 2000; Noble, McCandliss, & Farah, 2007). Yet these are the children that might have benefited most from participation in the music program. Evidence suggests that children from economically disadvantaged backgrounds have much to gain from involvement in music and other arts, including greater resilience, self-regulation, and general habits of practice, focus and discipline within the regular classroom

(Oreck, Baum, and McCartney, 1999). This further points to the need to examine current behavior management practices and consider implementing research-based strategies to support children's behavior. Implementation of PBIS would be one way to go about addressing this issue.

To what extent do music programs select for individuals with strong executive functioning skills or develop them? On a conceptual level, the fact that students were removed due to behavior problems is interesting, in that it provides some evidence that music programs may select for children who have stronger executive functioning and behavior regulation skills to start with. A selection process is an alternative explanation for the association we find between expert musicians and high executive functioning skills (Bialystok & DePape, 2009), in contrast to the notion that music study itself causes executive functioning to develop. Both explanations may have some validity, but further research is needed to understand the process. Any evidence that music programs do contribute to the development of executive functioning could add to our understanding of how music programs benefit children. This kind of evidence could help to inform programming choices and funding decisions for financially-strained schools and communities.

In efforts to investigate whether the music program in question selected for particular behavior or musical skills, it would be interesting to examine the executive functioning scores and music scores of students who were dismissed from the program and compare them to students who stayed in the program. Unfortunately, this study did not yield enough data from students who were dismissed from the program due to behavior problems for meaningful analysis. However, what data is there suggests that these students' musical aptitudes and skills were commensurate with their peers.

Serious fun. Another interesting finding that came out of the 2009/10 program evaluation, was that students absolutely loved the program and especially loved playing musical instruments. Students were surveyed at two time points during the year. In the spring, 100% of music students reported that they like to play music (compared to 98% in the fall). Music students love playing instruments and spoke glowingly about this activity. Words that music students used to describe how they feel when they play instruments include: really excited, very happy, good, proud, excellent, wonderful, etc. About playing instruments, one student said "I just want to keep playing!" and another said "I feel like, wow! Exciting! Pressing the keys is awesome!" These student perceptions of playing instruments create an interesting contrast with how students actually appeared when playing instruments. In the video, students look serious, focused and in the zone while playing instruments, not exactly how someone might picture a child who is excited, happy and having fun. Some teachers might think that students have to be wild and crazy to have fun, but this study points to the idea of "serious fun." Instruction that is hands-on, actively engaging, filled with opportunities for continuous feedback, and requires high levels of attention, inhibition, shifting and updating, can also be perceived as highly enjoyable to children.

Limitations of the Study

There were some limitations to external and internal validity within this study that are important to acknowledge. The sample was fairly homogeneous, consisting of African-American children participating in a specific afterschool music program in one inner-city school. Therefore, findings may not be generalizable to other populations and other music programs. This study also had some limitations in regard to internal validity. This study had a quasi-experimental design; students were not randomly assigned to participate in the music program or

not. Another complicating factor in the study is that not every participant received the exact same treatment. Each student in the after-school music program had a somewhat unique experience, depending upon his or her age/grade, chosen instrument, classes/ensembles and instructors.

There are some limitations related to use of the Executive Functioning Affordances and Constraints Rating Scale. This measure was developed by the author for this study for the purpose of quantifying the extent to which various musical activities afford and constrain attention, inhibition, updating and shifting. Evidence for the scale's validity is limited to comparison to the Executive Functioning Classroom Observation Form developed by McCloskey, Van Divner and Perkins (2009). Reliability is also limited by lack of multiple raters; ratings were assigned by the author based on the analysis provided in the results section for research question 2, under *analysis of executive functioning affordances and constraints*.

This study found that, overall, music instruction activities were characterized by high levels executive functioning affordances and constraints as well as high levels of active engagement. However, because no other types of instruction were analyzed, this study provides no data for comparison to other types of activities. The study suggests that music instruction is particularly good at developing executive functioning because of the nature of musical tasks, but the study did not find direct evidence of improved executive functioning skills in music students relative to control students. More research is needed to determine how music instruction compares to other types of instruction in the development of executive functioning.

A potential threat to internal validity is that students' executive functioning skills were rated by teachers, allowing the potential for teacher bias to impact the data and the conclusions drawn. However, it seemed unlikely that teachers would feel pressured to inflate students'

scores, as children's behaviors related to executive functioning are not necessarily seen as reflecting on the skill of a teacher. A potential source of teacher bias would be if the teachers had wanted to show that the program was effective. This was addressed by not telling teachers about the research design and hypotheses, and by asking teachers to be honest in their ratings.

It is also problematic that 9.4% of music program participants were removed from the program due to behavior problems. This subset of the population may have had more executive functioning difficulties than the rest of the population, and data for these students were not included in the sample. Exclusion of these students from the sample may have limited the ability to detect growth in executive functioning over time in this study.

Recommendations for Future Research

Summary of main discussion points.

- Music and executive functioning: Selection or development?
- Application of PBIS to music classrooms.
- Longitudinal study.
- Music classrooms and general education classrooms: comparison and applications.

Music and executive functioning: Selection or development? The phenomenon of students being dismissed from the music program due to behavior problems was problematic from a research perspective because data on a subset of the population with potentially more intensive executive functioning difficulties were not included the sample. This research issue might be avoided by replicating the study in schools with a high-quality general music program that is mandatory for all students.

However, the phenomenon of students being dismissed from the music program due to behavior problems is problematic for other important reasons and deserves more attention from

researchers. This study suggests that children with externalizing behavior problems are less likely than their peers to stay in music programs over the long-term. Future research might examine what factors lead children perceived to have behavior problems to discontinue music study. To what extent are the executive functioning differences we see between musicians and non-musicians a matter of behavioral selection vs. the contribution of music study to executive functioning development? It would be interesting to follow this group of students over time and see if BRIEF and BASC scores in any way predict which students will excel in music or which will persevere in music programs over time. This program dismissed students whose behavior was most difficult to manage. Might those same students have been able to stay in the music program and benefit from it had a consistent Positive Behavior Intervention Support (PBIS) system been in place?

Application of PBIS to music classrooms. Future research might study the application of PBIS to music classrooms. PBIS works to ensure that all children are successful in school; this may be a new way of thinking for some music educators. Music education may be seen by some as a privilege rather than a right for all students, particularly when provided outside of the public schools. However, if music programs truly have the mission of serving all children, they must have proactive strategies in place to prevent and address behavior problems and to support positive behaviors for all students, as well as strategies to provide additional support to children who need strategic or intensive levels of support. What do these universal, strategic and intensive levels of behavior support look like in a music classroom or a music ensemble? How can a music teacher support the behavior of a student who presents with significant behavioral difficulties in the classroom? PBIS applied to music would include defining behavior expectations in various music settings, explicitly teaching behavior expectations to music

students, monitoring student behavior, use of praise and systems of acknowledgement, addressing misbehavior with a continuum of consequences, collecting behavior data, and using behavior data to solve problems. This kind of behavior support system might allow more students to stay in music programs and benefit from them.

Longitudinal study. This study failed to detect executive functioning growth in music students relative to control students, as reflected in teacher ratings of students' classroom behavior during a year of participation in a music program. The time frame of the study, with an approximately 6-month span between time 1 and time 2, may have been insufficient to detect growth of executive functioning. A longitudinal study of executive functioning development in music students from childhood to adulthood might provide more evidence of how these areas may develop together.

Music classrooms and general education classrooms: comparison and applications. It would be interesting to compare music classrooms and general education classrooms in levels of executive functioning affordances and constraints as well as levels of student active and passive engagement and off-task behavior. While this study implied that music instruction is characterized by high levels of executive functioning affordances and constraints as well as high levels of active engagement, there were no general classroom data for comparison. There is also research to be done in applying certain characteristics of music instruction to other kinds of instruction to make them more actively engaging. Good music instruction has much to teach us about providing frequent or continuous opportunities for students to respond, receive feedback and adjust. In other words, good music instruction might be able to teach us about how to make students' thinking visible, which is essential to effective teaching and learning.

APPENDICES

Appendix A

Table 27

Music Learning Sequences (Gordon, 2003)

Levels and Sublevels of Skill Learning Sequence
Discrimination
Aural/Oral
Verbal Association
Partial Synthesis
Symbolic Association
Reading – Writing
Composite Synthesis
Reading – Writing
Inference
Generalization
Aural/Oral
Verbal
Symbolic
Reading – Writing
Creativity/Improvisation
Aural/Oral
Symbolic
Reading – Writing

Table 27 (cont'd)

Levels of Tonal Content Learning Sequence
Major and Harmonic Minor Tonalities
Tonic and Dominant Functions
Major and Harmonic Minor
Subdominant Function
Major and Harmonic Minor Tonalities
All Functions
Mixolydian Tonality
Tonic and Subtonic Functions
Dorian Tonality
Tonic, Subtonic and Subdominant
Lydian Tonality
Tonic and Supertonic Functions
Phrygian Tonality
Tonic, Supertonic and Subtonic Functions
Aeolian Tonality
Tonic and Subtonic Functions

Theoretical Understanding

Aural/Oral

Verbal

Symbolic

Reading - Writing

Table 27 (cont'd)

Levels and Sublevels of Rhythm Content Learning Sequence
Usual Duple and Triple Meters
Macro/Microbeat Function
Usual Duple and Triple Meters
Division Function
Usual Duple and Triple Meters
Division/Elongation Function
Usual Duple and Triple Meters
Elongation Function
Unusual Paired and Unpaired Meters
Macro/Microbeat Function
Usual Combined Meter
Macro/Microbeat, Division, Division/Elongation and Elongation Functions

Table 27 (cont'd)

Usual Duple, Triple and Combined Meters

All Functions

Unusual Paired Intact and Unpaired Intact Meters

Macro/Microbeat Function

Usual Paired, Unpaired, Paired Intact, and Unpaired Intact Meters

All Functions

Multimetric and Multitemporal

Monometric and Monotemporal

Polymetric and Polytemporal

Appendix B

Music Performance Rating Scale

Singing of Tonal Pattern:

1 = The student does not use singing voice
2 = The student sings the contour of the pattern on the wrong pitches, none of the notes are in tune
3 = The student sings part of the pattern on the correct pitches (including slightly off intonation) but is unable to maintain that for the entire pattern
4 = The student sings the pattern on the correct pitches with minor flaws in intonation; 1 or 2 pitches are slightly out of tune
5 = The student sings the entire pattern with accurate intonation

Chanting of Rhythmic Pattern:

1 = The student does not chant the pattern
2 = The student chants some of the pattern but it does not correspond with the beat or maintain the underlying beat
3 = The student maintains a steady beat but does not accurately chant the correct rhythmic pattern
4 = The student maintains a steady beat and performs the pattern with a small flaw in accuracy
5 = The student maintains a steady beat and performs the pattern with accuracy

Appendix C

Table 28

*Average PMMA Scores Within the Standardization Sample and for First and Second Grade Beginners, with All Students Included**

	PMMA Test	Standardization Sample Fall Average Score**	First and Second Grade Beginners Fall Average Score	First and Second Grade Beginners Spring Average Score
Grade 1	Tonal	29.8	29.9	34.0
	Rhythm	25.8	30.5	31.7
	Composite	55.6	60.3	65.7
Grade 2	Tonal	32.0	30.7	35.2
	Rhythm	27.7	31.9	31.9
	Composite	59.7	62.6	67.1
Grade 3	Tonal	34.6	-	-
	Rhythm	29.4	-	-
	Composite	64.0	-	-

*All students' scores included in these averages, not just those tested at both time-points.

**Children in the PMMA standardization sample were tested in the fall months of October and November; therefore no spring scores are available.

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