Running Head: PROCESSING, PITCH, AND PROFICIENCY

Processing, Pitch, and Proficiency: An Examination of the Development of Auditory Processing Skills and its Potential Correlation to Pitch Discrimination Proficiency in Students in Grades Kindergarten through Grade Two

By

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Abstract

This study was designed using a Mixed Methods approach to investigate the nature of pitch proficiency development of children in grades Kindergarten through Grade Two. The goal of this research was to determine if pitch proficiency improves as children progress through the stages of auditory development, which reaches full maturation around the age of nine. The study’s findings offer insight for music educators to utilize when shaping their teaching methodologies in regard to pitch proficiency as well as suggestions for considerations in its assessment.
Table of Contents

Introduction ................................................................................................................................. 1

Purpose Statement ..................................................................................................................... 1

Importance of the Study ............................................................................................................. 2

Definition of Terms .................................................................................................................... 2

Chapter II: Review of Related Literature .................................................................................. 5

Pitch Development ..................................................................................................................... 6

Hearing Development ................................................................................................................. 8

Studies Related to Hearing Ability ............................................................................................ 11

Chapter III: Design and Methodology ...................................................................................... 15

Process ........................................................................................................................................ 15

Participants ............................................................................................................................... 16

Mixed Methods Research ......................................................................................................... 16

Data Collection .......................................................................................................................... 17

Approach Analysis ..................................................................................................................... 19

Table 1 ......................................................................................................................................... 21

Table 2 ......................................................................................................................................... 22

Table 3 ......................................................................................................................................... 22

Table 4 ......................................................................................................................................... 23

Chapter IV: Findings ................................................................................................................... 24
Chapter I: Introduction

Introduction

The dual rationales for the importance of this topic are both personal and professional. On a personal level, intrigue concerning pitch proficiency development originates from my own hearing complications from tinnitus. My diagnosis of this condition dates back almost 12 years ago to when I was involved in a serious car accident. Not long after this event, I began to perceive a constant ringing sound in both ears. Unfortunately, there is no treatment or cure for this disorder. However, it brought to my attention more acutely that there may be different factors that affect pitch proficiency that I had not previously considered.

Professionally, my attentiveness to this subject arose early in my years of teaching elementary general music. There, I observed that my students often confuse the concepts of ‘high and low’ with ‘loud and soft.’ Many times, they believe ‘high’ and ‘loud’ are the same as ‘low’ and ‘soft.’ From there, I became curious as to whether this issue was a result of my teaching methodologies, or if there was a developmental component.

Purpose Statement

The purpose of this thesis is to examine lesser-known potential factors that can affect children’s development in pitch proficiency, to share suggestions for adaptations to assessment of pitch proficiency at the elementary school level, and to provide data findings to inform future research of this topic. The specific research question this thesis seeks to answer is: Is a child’s ability to discriminate pitch affected by their age, and can their proficiency improve over time?
Importance of the Study

The information in this thesis will be of value to general music educators at the elementary level as well as early childhood specialists, as it offers details outside of their area of expertise that are of significance in the musical development of their students.

Definition of Terms

The following terms used in this thesis are defined below for the better understanding of the reader.

Acute Acoustic Trauma: a condition in which instantaneous, continuous hearing loss prevails after the occurrence of an explosive noise (Axelsson & Hamernik, 1987).

Amusics: Persons who do not possess the ability to differentiate musical pitches.

Amusia: a condition in which the sufferer is unable to recognize musical tones or to reproduce them. This condition is more often referred to in modern culture as “tone deafness” (Definition of amusia, n.d.).

Auditory brainstem: a succession of “spatially separate nuclei” that process auditory signals received from the acoustic nerve “as [they] enter the neocortex” (Johnson, K. L., et al., 2008).

Auditory streaming: is thought to be the expression of the human ability to “analyze an auditory scene” or assign incoming sound stimuli to specific “sound generating entities” (Barniv & Nelken, 2015).

Binaural unmasking: A phenomenon in which the brain synthesizes information received from both ears to enhance the listener’s signal detection as well as their noise identification ability.
Bisectional task: a situation in which a subject is offered two choices for responding, such as “two levers to press for rats or two keys to press on a keyboard for humans” (Cheng & Crystal, 2008).

Electrophysiological techniques: examine electrical and chemical signals by “measuring electrical activity” (Carter & Shieh, 2010).

English Language Learner (ELL): a student who is currently unable to communicate fluently in English and usually requires modified instruction to succeed in their academic classes. ELL students often come from households and backgrounds where English is not the primary language spoken within the home (English-language learner definition, 2013).

Family Education Rights and Privacy Act (FERPA): a federal law that grants parents authority to obtain access to their children’s education records as well the privilege to request that those records be amended. Additionally, FERPA extends to parents the liberty to exert a certain amount of control over divulgence of any personally identifiable information from their children’s education records (What is Ferpa?, n.d.).

IEP (Individualized Education Program): is a legal document that maps an individualized program consisting of specialized instruction, supports, and services that qualified students require in order to succeed in their educational environment. IEPs are enforced by the Individuals with Disabilities Education Act (IDEA) (What is an IEP?, 2019).

Latency: the time that lapses between the onset of a sound and the response of the listener.

Mental rotation task: an undertaking in which the subject is to imagine what a presented stimulus would look like if it were rotated (Mental rotation task, n.d.).

Noise induced hearing loss (NIHL): results from damage to the inner ear structures and nerves that respond to sound. NIHL is usually caused by exposure to exceedingly loud sounds
PITCH, PROCESSING, AND PROFICIENCY

either from a single exposure, or over an extended period of time and cannot be corrected surgically or through any other medical means (Preventing noise-induced hearing loss, 2020).

Otolaryngology: a medical area of expertise that studies the ear, nose, and throat as well as related parts of the head and neck (Definition of otolaryngology, n.d.).

In conclusion, in Chapter One I gave information on the purpose of this study, my research question, the importance of the study, and a definition of key terms. In Chapter Two I will provide my review of literature related to this study.
Chapter II: Review of Related Literature

In the previous chapter, I introduced this study regarding pitch proficiency in students in Kindergarten, First Grade, and Second Grade, and gave some information as to why I began the study. Here, in Chapter Two, I will review the literature related to my study of pitch proficiency amongst early elementary music students.

Many scholars in both the music world and the world of auditory development agree that pitch proficiency acquisition is important:

“Imagine hearing the song “Happy Birthday to You” played quickly on a piccolo or played slowly on a tuba. These imagery tasks (Halpern, 1992) are relatively easy because adults know—usually implicitly—that melodies are abstractions defined on the basis of pitch and temporal relations between consecutive tones. However, when in development are melodies processed primarily as abstractions? This question motivated us in the present investigation, and we focused specifically on pitch perception. Relative pitch, the ability to process pitch in terms of intervals (i.e., distances in pitch between tones), is fundamental to music cognition. Virtually all adults perceive and represent pitch relatively (except amusics; Peretz, 2008), either explicitly or implicitly” (Stalinski & Schellenberg, 2010).

Scholars also agree that pitch proficiency is developed at different rates: “There is evidence that all aspects of music pitch processing are affected by learning and experience but, given a normal auditory environment in which to develop, the more complex culturally specific aspects appear to be more dependent on experience” (Trainor & Unrau, 2012, p. 248).

Additionally, the general consensus among researchers is that auditory development is usually completed by age nine (Werner, 2007).
I have organized my review of the literature into the following sections: 1) Pitch Development, 2) Hearing Development, and 3) Studies Related to Hearing Ability. On the topic of pitch development, I will include scholars who discuss the process in which children develop pitch proficiency (Stalinski et al., 2008; Ting Tan et al., 2014; Trehub et al., 2008). In the second section on hearing development, I will introduce scholarship concerning how children develop hearing in stages (Litovsky, 2015; Moore, 2002; Skoe et al., 2015). In the last section, I will discuss other studies related to hearing ability (Centers for Disease Control and Prevention, 2019; Szibor et al., 2017; Tillmann et al., 2010).

**Pitch Development**

In this section, I will present information from scholars who study the development of pitch proficiency (Stalinski et al., 2008), from other scholars regarding the manifestation of music ability (Ting Tan et al., 2014) as well as other researchers who study hearing and music (Trehub et al., 2008). The literature highlights the struggles that children often experience before their auditory development is complete, suggest that proficiency in pitch may have a genetic basis, and explore the possibility of cultural perspective playing a role in pitch perception.

Research has shown that pitch perception is difficult for many children to master. Stephanie Stalinski and her colleagues in the Department of Psychology at University of Toronto at Mississauga in Canada noted known difficulties many elementary students struggle with in terms of pitch development in their 2008 study. They describe how children younger than seven struggle to comprehend musical concepts like “high and low or up and down in relation to pitch” (Stalinski, 2008, p. 1759). Another important concept mentioned in this study is that the English language uses “multiple meanings of the terms high and low” which can contribute to confusion in young children’s understandings of pitch relationships (Stalinski, 2008, p. 1759).
Pitch perception is not just a learned skill, but may also have a genetic component. Dr. Yi Ting Tan, a faculty member of the Melbourne Conservatorium of Music, along with her research team members, authored an article in 2014 that examined the genetic basis for musical ability. They noted, based on the collective results of previous studies by other researchers, that “these findings suggest that all humans are endowed with an intrinsic form of musicality, and that genetic factors may play a role in its manifestation” (Ting Tan et al., 2014, p. 10). In the specific area of music perception, individual participants’ results suggest that the level of ease at which auditory skills are acquired imply that there are “predisposed differences in auditory ability” (Ting Tan et al., 2014, p. 10). Within one study they mentioned, participants were stratified as “slow or fast learners in an auditory discrimination training task” (Ting Tan et al., 2014, p. 10). Their results signify that genetic variance in brain functioning may have an impact on abilities in the area of music perception and aptitude for attaining music skills.

Not only could there be a genetic component for pitch perception, but cultural perspectives may play a role as well. Trehub et al., (2008) explored the cross-cultural perspectives on pitch memory. In two separate experiments, one involving Canadian children aged five to ten years old with a wide range of exposure to music lessons, and the other involving Japanese children aged five to six years old who, like the children in Experiment One, had a spectrum of experiences in their participation in music lessons. While their results were inconsistent with findings of other related studies, they maintain that “cultural differences in exposure to music may have both general cognitive and specific musical consequences. If Japanese children’s exposure to music at school generates overall increases in music proficiency relative to same-age Canadian children, it may have implications for the processing of both nonmusical and musical stimuli. For example, musicians exhibit more faithful and more robust
encoding of linguistic pitch (i.e., lexical tones) than do nonmusicians (Wong, Skoe, Russo, Dees, & Kraus, 2007)” (Trehub et al., 2008, p. 50).

**Hearing Development**

This section examines literature concerning hearing development from scholars who research this topic at great length (Litovsky, 2015; Moore 2002; Skoe et al., 2015). In this section, I will present a brief overview of the existing literature on Hearing Development as it pertains to auditory and non-auditory stimuli, lifelong hearing development abilities, and the role of experience in auditory development.

Hearing development not only involves auditory stimuli, but also non-auditory stimuli. Litovsky determined that not only are certain auditory abilities well-developed by birth, but also provided evidence that “there is a clear prolonged maturation of auditory development well into the teenage years” (Litovsky, 2015, p. 1). They go on to explain that non-auditory developments in the brain, such as cognition, attention and memory, “play an important role in auditory development” (Litovsky, 2015, p. 1).

During the early years of auditory development, children experience sound in a multitude of different environments: home, school, theaters, and other various public spaces. In these surroundings, a large amount of stimuli is presented, often simultaneously, for the listener to process, and that stimuli “varies in content, location, identity of the source, frequency, intensity, and other; these features are also typically dynamic rather than static, thus they are likely to change over time.” The child is then left to manage and assimilate this input into meaningful information “so that the child can learn about his or her environment, attain language capacity, and master numerous abilities that rely on auditory-based communication” (Litovsky, 2015, p. 8). This shapes their schema for their personal auditory perception.
The beginning phases of auditory perception include mastery in recognizing and differentiating sounds. In later stages, the ability to decide which sounds “belong together” and which “do not belong together” is developed. “This issue is not so much about categorization, but rather this is ultimately about identification of sounds and extraction of meaning from sound sources,” which is an important skill that could possibly affect the development of a child’s pitch proficiency (Litovsky, 2015, p. 8).

Another important stage of auditory perception involves the different experiences in auditory streaming. Auditory streaming can be explained as the presentation of two tone sequences that contain a variety of frequencies. The greater the similarity of the frequencies, “the more likely it is that listeners will perceive a single, coherent auditory image. Auditory stream formation appears to depend on acoustic parameters, including frequency, spatial locations, sex of the talker, spectrum, and common temporal onsets/offsets (Bregman, 1990; Yost, 1997)” (Litovsky, 2015, p. 10.). It is noted that younger children necessitate a larger difference in frequency in order to perceptually “segregate” the two tones. Older children and adults require small differences.

While hearing development reaches adult maturation by age eight or nine, there are still developments that continue to occur throughout an individual’s lifespan. In a 2015 article, Dr. Erika Skoe of the University of Connecticut along with their research team discussed the topic of “Stability and Plasticity of Auditory Brainstem Function Across the Lifespan.” They found that the results of their study performed well in “challenging the well-entrenched idea that the auditory brainstem matures early in life” (Skoe et al., 2015, p. 1419), and suggests the existence of numerous developmental trajectories within the auditory brainstem. Their research included
586 participants ranging in ages from three months to 72.4 years old and from there were categorized into 12 different age groups.

The research team utilized electrophysiological techniques to collect their data. They were surprised to find that participants who were between the ages of five and eight had remarkably shorter latencies. Latency is the amount of time (measured in milliseconds) that lapses between the onset of the sound stimuli to the response of the listener. These findings suggest that “that the response undergoes further maturational changes beyond age five. In further support of a protracted development of the auditory brainstem, the eight to eleven year-old group also differs from the adults in the latencies of peaks [of clicks] V and A, with trends observed for [clicks] D and E” (Skoe et al., 2015, p. 1418). In summary, the researchers were able to record subtle nuances in auditory brainstem responses that typically appear over a person’s lifetime.

The simple element of time allows for additional auditory developments than were previously thought, and experience could play a role in this as well. Moore (2002) explained that while the human ear is considered mature on a functional level shortly after birth, the central auditory system will continue to develop for at least the first ten years of a person’s life. “Current interest focuses on the relation between the very late developing aspects of hearing and other aspects of cognition and behaviour. While active neural input to the brain is essential during the very early stages of development, auditory experience is now thought to be a powerful influence on central function throughout an individual’s lifespan” (p. 171). Moore utilizes the findings from various studies along with his own expertise and combines them to present how two contrasting types of experiences can influence auditory development: good auditory experiences and bad auditory experiences.
While there are certainly sensitive periods during which negative auditory experiences can have a higher impact, there is evidence that suggests “some aspects of the brain’s susceptibility to experience-dependent plasticity are maintained throughout life” (Moore, 2002, p. 176). An example of a negative auditory experience would be the extended use of ear plugging. The result of this experience is poor development in sound localization as well as decreased ability to recognize sounds in noisy environments (binaural unmasking).

Examples of good auditory experiences would be the reclamation of auditory ability after hearing loss and the presence of improved functioning after participating in auditory training. A therapeutic tool, referred to as “enhanced auditory experience” has proven to be a practical resource. Candidates who engage in psychoacoustic and/or other sensory activities improve function with practice. The results of this practice have been utilized in assisting in the development of listening skills in children who have been diagnosed with language delays and the outcome of this subsequent practice have reported significant results.

**Studies Related to Hearing Ability**

This section explores literature concerning studies related to Hearing Ability. Here I will present publications that present important information about congenital amusia, (Tillmann et al., 2010) and noise-induced hearing loss (Centers for Disease Control and Prevention, 2019; Szibor et al., 2017).

Researcher Barbara Tillman (2010) of the Lyon Neuroscience Research Center in France, and her team assess participants who suffer from congenital amusia. Congenital amusia is more commonly referred to as ‘tone deafness’ and affects 4% of the population (who are sometimes referred to as “amusics”). While the term ‘tone deafness’ has been discussed in pop culture, its clinical definition differentiates from the information that has been transmitted through media
PITCH, PROCESSING, AND PROFICIENCY

platforms. Congenital amusia is a condition in which the affected population experiences severe deficiencies in music perception, especially in the area of processing variations in pitch. Outside of music, the affected persons usually present with normative hearing development, normative cognitive functions, and normative exposure to music in general. Because pitch perception is a key foundation of musical structure, it is thought that there is a connection between the pitch perception deficit and a potential spatial processing deficit.

Tillmann and their research team conducted a study to investigate this hypothesis. The study included two experiments: one relating to accuracy in bisectional tasks, and the other a mental rotation task. Their findings from the bisectional tasks experiment show “that [people suffering from amusia] do not exhibit less precise mid-point estimations than [those of normative auditory development], which suggests they are not subject to a degraded spatial representation in comparison to normal controls” (Tillman, et al., 2010, p. 3). The second experiment also failed to find evidence to demonstrate a spatial deficit in amusia sufferers. Because of these results, Tillman and her team conclude that the pitch processing deficit that is present in amusia does not coincide with an additional deficit in spatial processing.

Some hearing disorders, like amusia, are congenital, but there are some that are induced by the actions of the listener, as is the case with most noise-induced hearing loss (NIHL). Historically, NIHL was a problem limited to the area of occupational health where workers were exposed to dangerously high noise levels (i.e., military employees). Fortunately, the successful implementation of occupational hearing protection programs has all but eradicated the severe traumas that occur as a result of subjection to hazardous noise levels in the work environment.

The biggest culprit today of NIHL arises from noise exposure experienced during leisure time. “Adolescents and teenagers often expose themselves to loud music and excessive noise
levels during social and music events: noise levels between 104 and 112 dB can be measured in nightclubs and discos” (Szibor et al., 2017, p. 21). To put these numbers into context, the CDC recognizes that prolonged exposure to sounds less than 70 decibels typically do not cause any hearing damage. Sounds of about 85 decibels, such as lawnmowers or car horns, can cause hearing damage within two hours. More concerning, though, is that the decibel level at which personal listening devices are played (85-110 decibels) can cause hearing loss in just five minutes (Centers for Disease Control and Prevention, 2019).

A study conducted in Finland by researchers from the Ear Institute of Helsinki and staff members from the Department of Otolaryngology at the University of Helsinki and Helsinki Hospital found that “music can cause an acute acoustic trauma with subsequent various degrees of hearing dysfunction, above all tinnitus” (Szibor et al., 2017, p. 23). Tinnitus is a hearing disorder in which sufferers often perceive a sound they describe as constant ringing in their ears, although some sufferers have described the sound differently: buzzing, clicking, etc. It should be noted that not all tinnitus diagnoses are made as a result of exposure to loud noise. Head trauma, even a mild concussion, can induce tinnitus temporarily and sometimes, permanently.

In conclusion, Chapter Two reviews scholarship concerning Pitch Development, Hearing Development, and Studies Related to Hearing Ability. To better understand the development of auditory skills and its potential relationship to pitch proficiency, it is important to research both auditory and pitch development in order to know more about the potential for a relationship between a child’s age and their proficiency in pitch development. The literature included here creates the foundation of my research because it helps to better examine my research question: Is a child’s ability to discriminate pitch affected by their age, and can their proficiency improve over time?
Moreover, in this chapter, Chapter Two, I presented the literature related to this study focused on Pitch Development, Hearing Ability, and Studies Related to Hearing Ability. Next, in Chapter Three, I will describe the methodology I used to address my research question and the design of the study as well as the procedures used for analysis.
Chapter III: Design and Methodology

Last chapter, I reviewed the preexisting literature about Pitch Development, Hearing Development, and Studies Related to Hearing Ability. In Chapter Three, I will explain how I designed this research project and share my analysis methods. I have created the following subsections for the ease and understanding of the reader: Process, Participants, Mixed Methods Research, Data Collection, and Analysis. As I noted in Chapter One, the research question driving this study is: Is a child’s ability to discriminate pitch affected by their age, and can their proficiency improve over time?

**Process**

My process for conducting this research began with attempting to understand why my younger elementary students struggled with identifying ‘high’ and ‘low,’ sometimes even confusing that concept with ‘loud’ and ‘soft.’ I knew I needed to first discuss the issue with my district colleagues to ascertain whether this problem was localized to my own classroom, or if it was an obstacle for other elementary general music teachers as well. After reaching out to them via email, online video meetings, and through face-to-face discussions, I was able to determine that pitch discrimination was a problematic issue for my peers as well.

I then designed an experiment geared toward testing the pitch discrimination proficiency of my students in Kindergarten, First Grade, and Second Grade over the course of their regular ‘high/low’ unit in music class. I limited the testing to these grades because, in general, auditory development reaches adult maturation by the age of nine. In this experiment, I played two separate prompts on the electric piano: C5 for ‘high,’ and A4 for ‘low.’ To minimize risk, all students responded to these prompts by identifying if a pitch that I played was ‘high’ or ‘low’ in
small groups, regardless of their participation authorization status. The participant responses recorded in my data sheet were de-identified and then analyzed.

**Participants**

My participants were selected using purposive and convenience sampling. Sampling methods are used in research to gain information about a population based on the results of a subgroup of that population. This avoids the extensive undertaking of having to test every individual of that population. Due to the fact that I was trying to understand pitch development, I used purposive sampling. “A purposive sample is a non-probability sample that is selected based on characteristics of a population at the objective of the study” (Crossman, 2020). For the sake of answering questions about pitch development, I needed students who had not yet reached maturation in their auditory development, and additionally, these students needed to experience their regular grade-level music lesson content concerning ‘high and low.’ Once these criterions were established, my pool to select from was clear. Because I already have an established relationship with the students and families in my district, using convenience sampling, I chose to research each Kindergarten, First Grade, and Second Grade class I was assigned to teach during the 2021-2022 school year and reached out to the parents of the students in each of these classes via a permission letter along with an Informed Consent Document (See Appendix A). The students whose parents gave authorization to participate in the study by way of returning the signed Informed Consent Document to me were the students from which data was collected.

**Mixed Methods Research**

This study uses Mixed Methods research. Mixed Methods research design is defined as “a procedure for collecting, analyzing, and ‘mixing’ both quantitative and qualitative research and methods in a single study to understand a research problem” (Terrell, 2012). Quantitative
research examines data that is concrete and can be measured using numbers. Results are conclusive and non-subjective. The quantitative research in this study involved my collection of observational data recording the accuracy of my students’ responses involving pitch proficiency.

My qualitative research concerned the analysis of my collected data and the consideration of participants who had experienced a self-declared issue with hearing at some point in their childhood. Qualitative research allows for the investigator to categorize their data based on “properties, attributes, labels, and other identifiers” (Pickell, 2021). The qualitative research in this study is informed by phenomenology, in which “the researcher describes the lived experiences of individuals about a phenomenon as described by participants” (Creswell, 2014, p. 14). Implementing a mixed methods research design allowed me to focus on answering a specific question (quantitative) as well as use data and observations to look for themes (qualitative). Together, these methodologies provide for a much more comprehensive understanding of the research being conducted.

**Data Collection**

My research design required me to select participants under the age of nine, but who were also old enough to respond appropriately to prompts regarding high and low pitches. Because I am an elementary general music educator, my candidates were limited to Kindergarteners, First Graders, and Second Graders. To obtain consent for their participation, I provided all parents and guardians of my 193 Kindergarten, First, and Second Grade students with both a permission letter (See Appendices B and C) and a required district FERPA (Family Education Rights and Privacy Act) form in September 2021. Parents of Spanish bilingual students were provided forms that were translated into Spanish. All parents were provided with two copies of both the
permission letter and the FERPA documents so that they were able to sign and keep a copy for their own personal records.

Within the permission letter, I provided parents with the option to voluntarily disclose any hearing issues their child may have experienced at any point, including, but not limited to chronic ear infections, ear tubes, or a diagnosed hearing disorder. This information did not factor directly into my data analysis, but it did provide important qualitative insight into individual students’ hearing circumstances, which may or may not affect their capacity to accurately distinguish high pitches from low pitches. These details provided documentation that can potentially contribute to future research design concerning pitch perception in students who are still within the stages of auditory development.

Of the 193 potential student participants, 117 obtained the necessary permission to take part in this research: 39 Kindergarteners, 25 First Graders, and 53 Second Graders. In October 2021, I taught my regular instructional unit covering high and low sounds to assist students in their developmental understanding of the difference between high and low. This was taught to all students in every class I was assigned to in Kindergarten, First Grade, and Second Grade regardless of participation in the study. During class periods within the unit, I played a prompt set of two sounds. The high sound was pitch C5 and the low sound was pitch A4. As a normal part of the classroom routine, and without singling any students out, I played the prompt three times on the electric piano, and each student had the opportunity to respond in small groups. I recorded in my spreadsheet an observation of whether each student identified high and low correctly based on the prompt from the electric piano in the classroom. To maintain anonymity, I utilized numbers to identify students on my spreadsheet and omitted any students whose parents have elected not to have them participate in the study as well as those who simply did not return
the permission form at all. The students were not aware of who was participating and who was not. I next noted on the spreadsheet whether the students were in Kindergarten, First Grade, or Second Grade (to determine if age is a factor to be considered). The collected data was analyzed during the months of November and December of 2021. My findings were then organized into a presentation in slideshow form and introduced at the AIME professional music conference at the University of Wisconsin-Stevens Point in January 2022.

**Approach Analysis**

My data analysis plan began by creating a quantitative database using an *Excel* spreadsheet and then implementing descriptive statistical analysis to look for trends in the data. First, I identified trends that would help me begin to answer my main research question: Is a child’s ability to discriminate pitch affected by their age, and can their proficiency improve over time? The trends I initially wished to identify included how students performed by grade-level, biological age, and gender. I then looked for trends amongst students with both general and specific parent-identified hearing disorders. Next, I considered whether the results showed better pitch proficiency with each subsequent recorded response opportunity. Additionally, I planned to examine if the results demonstrated better pitch proficiency in the following scenarios: during the morning classes versus the afternoon classes and/or at different times during the class period (specifically, the beginning, middle, and end).

The next step in my data analysis plan involved developing both inclusion and exclusion criteria. Regarding inclusion criteria, I established that the data should only include children who were assigned to me in Kindergarten, First Grade, or Second Grade who are under nine years of age but also old enough to understand what is being asked of them by the researcher. Additionally, I determined that data should only be recorded for students who have signed
permission (consent) from their parent/guardian on file and had also given verbal assent to the researcher on their own.

My exclusion criteria determined that data should not be collected for students aged nine or older or at an age that was too young for them to understand what was being asked of them by the researcher. Additionally, it entailed that data collection did not include students who were taught by the school’s other music teacher, students who did not have a signed consent form from a parent/guardian on file, or students who had parental permission but did not give verbal assent when asked to participate in the research.

After my inclusion and exclusion criteria were finalized, I then determined the variables to be used in my analysis, which included: age, gender, grade level, and the three individually recorded responses to the pitch prompts, the number of correct responses overall, the point in the class period (beginning, middle, or end), and the point in the unit (pre-instruction, mid-instruction, or post-instruction) in which data collection took place, as well as the time of day that data was collected for each response. Each variable was assigned its own unique code and is illustrated below in Table 1.
Table 1

Variable Codes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Assigned Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Identification Number</td>
<td>Randomized 3-digit numbers ranging from 101-199</td>
</tr>
<tr>
<td>Gender</td>
<td>M, F</td>
</tr>
<tr>
<td>Grade</td>
<td>K, 1, 2</td>
</tr>
<tr>
<td>Birthdate</td>
<td>MM/DD/YYYY</td>
</tr>
<tr>
<td>Age</td>
<td>Y.MM (ex: 5 years, 1 month = 5.01)</td>
</tr>
<tr>
<td>Response One</td>
<td>C, IN, ABS</td>
</tr>
<tr>
<td>Response Two</td>
<td>C, IN, ABS</td>
</tr>
<tr>
<td>Response Three</td>
<td>C, IN, ABS</td>
</tr>
<tr>
<td>Time of day</td>
<td>AM, PM</td>
</tr>
<tr>
<td>Number of correct responses</td>
<td>0, 1, 2, 3</td>
</tr>
<tr>
<td>Chronic ear infections</td>
<td>X, (blank)</td>
</tr>
<tr>
<td>Ear tubes</td>
<td>X, (blank)</td>
</tr>
</tbody>
</table>

In Table 1, above, gender was identified by parents/guardians as either male (M) or female (F). Grade was marked as Kindergarten (K), First Grade (1), or Second Grade (2). Each of the students’ three responses during data collection were coded as correct (C), incorrect (IN), or absent (ABS). Time of day referred to before noon (AM) or after noon (PM). Parents supplied information about whether a student had a history of chronic ear infections or ear tube placement. Those students identified were marked with an X, all others were left blank.

Next, I created descriptive statistics to consider the variability of students who had achieved pitch proficiency and those who had not. I calculated the distribution and central tendency for various groups of students. My measures for dispersion are listed below in Table 2.
Table 2

Measures for Dispersion

<table>
<thead>
<tr>
<th>Measure for Dispersion</th>
<th>Actual Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum age of participants</td>
<td>5 years, 0 months</td>
</tr>
<tr>
<td>Maximum age of participants</td>
<td>8 years, 3 months</td>
</tr>
<tr>
<td>Range of age of participants</td>
<td>5 years, 0 months – 8 years, 3 months</td>
</tr>
<tr>
<td>Average (mean) age of participants</td>
<td>6 years, 2.3 months</td>
</tr>
<tr>
<td>Range of correct responses</td>
<td>0, 1, 2, 3</td>
</tr>
<tr>
<td>Range of grade-levels of participants</td>
<td>Kindergarten, 1, 2</td>
</tr>
</tbody>
</table>

Additionally, I generated a list to test the relationship between two or three variables. The combinations of 2-Variable Relationships tested are listed below in Table 3. The combinations of 3-Variable Relationships are illustrated in Table 4.

Table 3

2-Variable Relationships

<table>
<thead>
<tr>
<th>Variable 1</th>
<th>Variable 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of correct responses</td>
<td>Grade</td>
</tr>
<tr>
<td>Percentage of correct responses</td>
<td>Age range</td>
</tr>
<tr>
<td>Total number of correct responses</td>
<td>Gender (*parent-identified)</td>
</tr>
<tr>
<td>Total number of correct responses</td>
<td>Response One, Response Two, Response Three</td>
</tr>
<tr>
<td>Time of day of data collection</td>
<td>Response One, Response Two, Response Three</td>
</tr>
<tr>
<td>Total number of correct responses</td>
<td>Participants who have experienced chronic ear infections</td>
</tr>
<tr>
<td>Total number of correct responses</td>
<td>Participants who have experienced ear tube placement</td>
</tr>
<tr>
<td>Point of unit (pre-instruction, mid-unit, post-unit)</td>
<td>Total number of correct responses</td>
</tr>
<tr>
<td>Point of class period in which data was collected (beginning, middle, end)</td>
<td>Total number of correct responses</td>
</tr>
</tbody>
</table>

22
Table 4

3-Variable Relationships

<table>
<thead>
<tr>
<th>Variable 1</th>
<th>Variable 2</th>
<th>Variable 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant grade-level</td>
<td>Participant gender (*parent-identified)</td>
<td>Total number of correct responses</td>
</tr>
<tr>
<td>Participant grade-level</td>
<td>Time of day of data collection</td>
<td>Response One, Response Two, Response Three</td>
</tr>
</tbody>
</table>

Here, in Chapter Three, I described how I designed this research project. I then explained each step of my data collection process and shared my method of analysis. Next, in Chapter Four I will report my findings.
Chapter IV: Findings

The data collected in this study sought to answer the main research question: Is a child’s ability to discriminate pitch affected by their age, and can their proficiency improve over time? The 117 student participants in this research study ranged in age from 5 years, 0 months to 8 years, 3 months and were in Kindergarten, First Grade, or Second Grade.

In the previous three chapters, I introduced this study about pitch discrimination proficiency, gave a review of literature related to the study, and provided a description of the methodology and my approach to analysis. Here, in Chapter Four, I will report my findings.

As described in Chapter Three, the data collection process involved playing a prompt set of two pitches on the electric piano. The high pitch was C5 and the low pitch was A3. As a normal part of the classroom routine, I played the prompt three times, and each student had the opportunity to respond in small groups. In my Excel spreadsheet, I recorded an observation as to whether each student identified high and low correctly, based on the prompt from the electric piano in the classroom. This procedure was conducted on three separate occasions: once before the students’ curricular unit about high and low sounds, once mid-unit, and once post-unit. The results of the collected data are described in Table 5 and Table 6 on the following pages.
Table 5

Population Percentages of Total Number of Correct Responses

<table>
<thead>
<tr>
<th>Baseline Characteristic</th>
<th>Total Number of Participants</th>
<th>Three Correct Responses</th>
<th>Two Correct Responses</th>
<th>One Correct Response</th>
<th>Zero Correct Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Grade Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindergarten</td>
<td>39</td>
<td>8</td>
<td>20.5</td>
<td>17</td>
<td>43.6</td>
</tr>
<tr>
<td>First Grade</td>
<td>25</td>
<td>1</td>
<td>4</td>
<td>17</td>
<td>68</td>
</tr>
<tr>
<td>Second Grade</td>
<td>53</td>
<td>9</td>
<td>17</td>
<td>24</td>
<td>45.3</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>60</td>
<td>9</td>
<td>15</td>
<td>29</td>
<td>48.3</td>
</tr>
<tr>
<td>Female</td>
<td>57</td>
<td>9</td>
<td>15.8</td>
<td>29</td>
<td>50.9</td>
</tr>
<tr>
<td>Grade/Gender Females</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindergarten</td>
<td>17</td>
<td>5</td>
<td>29.4</td>
<td>8</td>
<td>47.1</td>
</tr>
<tr>
<td>First Grade</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>68.8</td>
</tr>
<tr>
<td>Second Grade</td>
<td>24</td>
<td>4</td>
<td>16.7</td>
<td>10</td>
<td>41.7</td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindergarten</td>
<td>22</td>
<td>3</td>
<td>13.6</td>
<td>9</td>
<td>40.9</td>
</tr>
<tr>
<td>First Grade</td>
<td>9</td>
<td>1</td>
<td>11.1</td>
<td>6</td>
<td>66.7</td>
</tr>
<tr>
<td>Second Grade</td>
<td>29</td>
<td>5</td>
<td>17.2</td>
<td>14</td>
<td>48.3</td>
</tr>
<tr>
<td>Time of Day</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>69</td>
<td>10</td>
<td>14.5</td>
<td>35</td>
<td>50.7</td>
</tr>
<tr>
<td>PM</td>
<td>48</td>
<td>8</td>
<td>16.7</td>
<td>23</td>
<td>47.9</td>
</tr>
</tbody>
</table>
### Table 6

*Population Percentages of Correct Responses, Incorrect Responses, and Absences*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Number of Participants</th>
<th>Correct Responses</th>
<th>Incorrect Responses</th>
<th>Absences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( N )</td>
<td>( n )</td>
<td>( n )</td>
<td>( n )</td>
</tr>
<tr>
<td>Response One</td>
<td>117</td>
<td>72</td>
<td>61.5</td>
<td>30</td>
</tr>
<tr>
<td>Response Two</td>
<td>117</td>
<td>73</td>
<td>62.4</td>
<td>33</td>
</tr>
<tr>
<td>Response Three</td>
<td>117</td>
<td>59</td>
<td>50.4</td>
<td>39</td>
</tr>
<tr>
<td><strong>Grade</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response One: Kindergarten</td>
<td>39</td>
<td>26</td>
<td>66.7</td>
<td>4</td>
</tr>
<tr>
<td>Response One: First Grade</td>
<td>25</td>
<td>12</td>
<td>48</td>
<td>12</td>
</tr>
<tr>
<td>Response One: Second Grade</td>
<td>53</td>
<td>34</td>
<td>64.2</td>
<td>14</td>
</tr>
<tr>
<td>Response Two: Kindergarten</td>
<td>39</td>
<td>23</td>
<td>59</td>
<td>10</td>
</tr>
<tr>
<td>Response Two: First Grade</td>
<td>25</td>
<td>16</td>
<td>64</td>
<td>7</td>
</tr>
<tr>
<td>Response Two: Second Grade</td>
<td>53</td>
<td>34</td>
<td>64.2</td>
<td>16</td>
</tr>
<tr>
<td>Response Three: Kindergarten</td>
<td>39</td>
<td>20</td>
<td>51.3</td>
<td>15</td>
</tr>
<tr>
<td>Response Three: First Grade</td>
<td>25</td>
<td>13</td>
<td>52</td>
<td>8</td>
</tr>
<tr>
<td>Response Three: Second Grade</td>
<td>53</td>
<td>26</td>
<td>49.1</td>
<td>16</td>
</tr>
<tr>
<td><strong>Time of Day</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response One: AM</td>
<td>69</td>
<td>41</td>
<td>59.4</td>
<td>23</td>
</tr>
<tr>
<td>Response Two: AM</td>
<td>69</td>
<td>46</td>
<td>66.7</td>
<td>19</td>
</tr>
<tr>
<td>Response Three: AM</td>
<td>69</td>
<td>34</td>
<td>44.9</td>
<td>21</td>
</tr>
<tr>
<td>Response One: PM</td>
<td>48</td>
<td>31</td>
<td>64.6</td>
<td>7</td>
</tr>
<tr>
<td>Response Two: PM</td>
<td>48</td>
<td>27</td>
<td>56.3</td>
<td>14</td>
</tr>
<tr>
<td>Response Three: PM</td>
<td>48</td>
<td>25</td>
<td>52.1</td>
<td>18</td>
</tr>
<tr>
<td><strong>Ear Tubes &amp; Chronic Ear</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ear Tubes/Chronic Ear Infections</td>
<td>12</td>
<td>4</td>
<td>33.3</td>
<td>5</td>
</tr>
<tr>
<td>Ear Tubes</td>
<td>9</td>
<td>6</td>
<td>66.7</td>
<td>2</td>
</tr>
<tr>
<td><strong>Point of Unit Instruction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Unit</td>
<td>117</td>
<td>72</td>
<td>61.5</td>
<td>30</td>
</tr>
<tr>
<td>Mid-Unit</td>
<td>117</td>
<td>73</td>
<td>62.4</td>
<td>33</td>
</tr>
<tr>
<td>Post-Unit</td>
<td>117</td>
<td>59</td>
<td>50.4</td>
<td>39</td>
</tr>
<tr>
<td><strong>Point of Class Period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beginning</td>
<td>117</td>
<td>72</td>
<td>61.5</td>
<td>30</td>
</tr>
<tr>
<td>Middle</td>
<td>117</td>
<td>59</td>
<td>50.4</td>
<td>39</td>
</tr>
<tr>
<td>End</td>
<td>117</td>
<td>73</td>
<td>62.4</td>
<td>33</td>
</tr>
<tr>
<td><strong>First Grade/Time of Day</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response One: AM</td>
<td>16</td>
<td>7</td>
<td>43.8</td>
<td>9</td>
</tr>
<tr>
<td>Response Two: AM</td>
<td>16</td>
<td>12</td>
<td>75</td>
<td>3</td>
</tr>
<tr>
<td>Response Three: AM</td>
<td>16</td>
<td>8</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>Response One: PM</td>
<td>9</td>
<td>5</td>
<td>55.6</td>
<td>3</td>
</tr>
<tr>
<td>Response Two: PM</td>
<td>9</td>
<td>4</td>
<td>44.4</td>
<td>4</td>
</tr>
<tr>
<td>Response Three: PM</td>
<td>9</td>
<td>5</td>
<td>55.6</td>
<td>3</td>
</tr>
</tbody>
</table>
The data displayed in Table 6 indicate that there were circumstances in which students achieved a total of zero correct responses. In the overall male population, there were four students in Kindergarten and Second Grade who matched this description. It should be noted that one of those students was absent for all three response opportunities, two were absent for two response opportunities, and one was absent during one response opportunity. There were no male students in First Grade who had zero total correct responses.

As for the female student population, there were a total of three students with zero total correct responses. These students were in First Grade and two of them were absent for one response opportunity. There were no female students in Kindergarten or Second Grade who achieved zero total correct responses.

Each recorded response (Response One, Response Two, and Response Three) was additionally coded as either ‘AM’ (collected between the hours of 12:00 AM and 11:59 AM) or ‘PM’ (collected between the hours of 12:00 PM and 11:59 PM). Kindergarteners’ responses were only collected in the ‘PM’ due to their class schedules, and Second Graders’ responses were only collected in the ‘AM’ for that same reason. First Grade was the only population whose responses were collected in both the ‘AM’ and ‘PM’.

Out of all participants in the study, First Grade was the only grade-level that met both in the ‘AM’ (between 12:00 AM and 11:59 AM) and ‘PM’ (between 12:00 PM and 11:59 PM). Because of this factor, First Grade was the only grade-level chosen for comparison between each response opportunity and the time of day in which it was collected.

For all students identified to have experienced ear tube placement, six of nine response opportunities were answered correctly. For students who have had both ear tubes and suffered from chronic ear infections, four of 12 response opportunities were answered correctly. It should
be noted in this scenario, however, that three of 12 response opportunities were recorded as ‘absent.’

One Kindergarten male who both had ear tubes AND suffered from chronic ear infections had experienced hearing loss on two occasions prior to the insertion of their ear tubes. Their response rate was one correct response, one incorrect response, and one absence. One First Grade female who had ear tubes and endured chronic ear infections had a history of passing all hearing exams. Their response rate was two correct responses and one incorrect response.

**Percentage of Total Responses Coded as Absent (ABS)**

Because each of the 117 participants engaged in three response opportunities, there were a total of 351 responses overall. Of these 351 responses, 45 were coded as ‘ABS,’ meaning that they were absent. Essentially, 12.8% of the total responses were missing data.

**Percentage of Correct Responses/Age-Range**

The total number of correct responses in the study were broken down into age ranges of the participants. Although the ages of participants had originally been coded by years and months (Y.MM), the graph in Figure 2 illustrates the participants' ages by years, and then the months were calculated as a decimal point value of one year (12 months), rounded to the nearest hundredth (ex: 5 years, 7 months = 5.58). Of the total number of correct responses produced amongst all 117 participants, 44.2% of came from participants who were 7.08 to 8.0 years of age. The percentage of the total number of correct responses and participant age ranges are pictured in Figure 1.
Figure 1

Percentage of Total Number of Correct Responses and Participant Age-Ranges

SPSS Analysis

All collected data was also analyzed separately using the Statistical Package for the Social Sciences (SPSS) software using only responses that were coded as “C” or “IN.” All “ABS” data was considered missing and was eliminated from the analysis. None of the performed analyses showed a significant difference between the selected variables. Results of the analysis can be viewed in Table 7.
Table 7

Level of Significance Between Variables Using SPSS Analysis

<table>
<thead>
<tr>
<th>Variable 1</th>
<th>Variable 2</th>
<th>Total number of Participants</th>
<th>Value of $\chi^2$</th>
<th>Value of df</th>
<th>Value of p</th>
<th>Cramer’s V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response One</td>
<td>Grade</td>
<td>102</td>
<td>8.64</td>
<td>2</td>
<td>0.013</td>
<td>0.013</td>
</tr>
<tr>
<td>Response Two</td>
<td>Grade</td>
<td>106</td>
<td>0.033</td>
<td>2</td>
<td>0.018</td>
<td>0.018</td>
</tr>
<tr>
<td>Response Three</td>
<td>Grade</td>
<td>98</td>
<td>0.213</td>
<td>2</td>
<td>0.047</td>
<td>0.047</td>
</tr>
<tr>
<td>Response One</td>
<td>Gender</td>
<td>102</td>
<td>0.094</td>
<td>1</td>
<td>0.759</td>
<td>0.030</td>
</tr>
<tr>
<td>Response Two</td>
<td>Gender</td>
<td>106</td>
<td>0.044</td>
<td>1</td>
<td>0.020</td>
<td>0.020</td>
</tr>
<tr>
<td>Response Three</td>
<td>Gender</td>
<td>98</td>
<td>0.137</td>
<td>1</td>
<td>-0.037</td>
<td>0.037</td>
</tr>
<tr>
<td>Response One</td>
<td>Age (YM)</td>
<td>102</td>
<td>12.194</td>
<td>6</td>
<td>0.346</td>
<td>0.346</td>
</tr>
<tr>
<td>Response Two</td>
<td>Age (YM)</td>
<td>106</td>
<td>1.052</td>
<td>6</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Response Three</td>
<td>Age (YM)</td>
<td>98</td>
<td>3.546</td>
<td>6</td>
<td>0.19</td>
<td>0.19</td>
</tr>
<tr>
<td>Response One</td>
<td>Time of day</td>
<td>102</td>
<td>3.524</td>
<td>1</td>
<td>0.186</td>
<td>0.186</td>
</tr>
<tr>
<td>Response Two</td>
<td>Time of day</td>
<td>106</td>
<td>0.283</td>
<td>1</td>
<td>-0.052</td>
<td>0.052</td>
</tr>
<tr>
<td>Response Three</td>
<td>Time of day</td>
<td>98</td>
<td>0.136</td>
<td>1</td>
<td>-0.037</td>
<td>0.037</td>
</tr>
</tbody>
</table>

In this chapter, I explained the entirety of my collected data using the 2-Variable and 3-Variable relationships laid out in Tables 3 and 4 from Chapter Three. In the next chapter, I will present a discussion of my findings and implications for music educators, students, and future researchers.
Chapter V: Discussion and Implications

In the previous chapters, I provided a review of literature, and explained my methodology on this study on pitch proficiency amongst students in primary grades. In the prior chapter, I illustrated the data I collected for my research. In this chapter, I will present a discussion of my findings and the implications they hold for music educators, students, and future researchers.

Discussion of the Data Findings

When looking strictly at the number of correct responses for each data collection point, the results were surprising. Response One (which was collected pre-instruction of the participants’ curricular high/low unit) and Response Two (which was conducted mid-unit instruction) both yielded a similar number of correct and incorrect responses, but Response Three (which took place post-instruction of the students’ curricular high/low unit) provided some unexpected results. One would naturally assume that Response Three would present a higher number of correct responses than the first two response opportunities, especially given that the data in question was collected post-unit instruction, however, that was not the case here. Response One displays a total of 72 correct responses, but there were only 59 correct responses in Response Three. I have a few theories that may explain these unpredicted results, which I will discuss below.

Response Three was collected during the week leading up to Halloween and the day after Halloween. During this timeframe, participants took part in a multitude of themed dress-up days, which most likely caused distraction and affected the participants’ ability to focus on the response task. Additionally, Response Three was collected in the middle of the class period, which might have caused an abrupt transition for the students.
Lastly, the highest number of absences took place during Response Three, which most likely affected the potential for a higher number of correct responses. Overall, these results suggest that mid-class period is not an optimal time to plan assessments with students, and to, perhaps, avoid intense focus-based tasks during dress-up themed instructional days.

I was also curious if the time of day that the data was collected might affect the participants’ total number of correct responses. This comparison was ineffective using the tools in this study because the student’s times of day of data collection were not spread evenly across the grade levels. Due to their set class schedules, Kindergarten data was only collected in the afternoon, whereas Second Grade data was only collected in the morning. Second Grade contained the highest number of participants to begin with, so this skewed the number of total correct responses to favor the morning’s totals. The specific comparison of the total number of correct responses collected in the ‘AM’ versus the total number of correct responses gathered in the ‘PM’ did not necessarily provide me with useful information for this research endeavor, however, I felt it was still a curiosity worth mentioning in the case of future research in this area.

All research data was collected amid the COVID-19 pandemic, which meant that there was a higher-than-usual rate of student absences, as compared to non-pandemic instructional years. These absences were due to a multitude of factors, including: participants affected directly by positive COVID test results, participants who experienced household close contact with COVID-19, student needing to quarantine or isolate as per district COVID guidelines, and other miscellaneous non-COVID reasons.

Thus, 12.8% of the total responses amongst all 117 participants were recorded as absences. While an absence is not considered an incorrect response, it prohibits the opportunity for a participant to provide a potential correct response. These ‘absence’ recordings could hold
the prospective for a much higher number of correct responses (or, possibly, incorrect responses) and therefore, provide a much richer and comprehensive data set to analyze.

While I have already provided results for a comparison between all female participants’ total number of correct responses and all male participants’ total number of correct responses in Figures 4 and 5 in Chapter Four, I felt it was important to additionally break the gender results down by grade levels to examine the information at a deeper level. While the majority of each sub-population had two correct responses, it is the number of zero correct responses for each that is noteworthy. Kindergarten females had no participants with zero correct responses and Kindergarten males had three participants with zero correct responses. One of the male Kindergarten participants who achieved zero correct responses was absent for all three response opportunities, and two other Kindergarten male participants who achieved zero correct responses were absent for two of the three response opportunities. Absences played a significant role in the response outcomes for the males in this sub-population.

When analyzing the data for First Grade females and First Grade males, I noticed that the majority of each sub-population produced two total correct responses. Additionally, the percentages of each sub-population producing two correct responses were remarkably similar. Unlike the results of the Kindergarten male data and Kindergarten female data, the First Grade males contained no students with zero correct responses and contained students who achieved three correct responses. The females in First Grade had no participants with three correct responses and three students with zero correct responses. While absences played a role in the results for First Grade females, these absences did not affect results to the extent that it affected the results of the Kindergarten males.
The data collected from the Second Grade female and Second Grade male participants each show similar percentages for two correct responses and three correct responses. Second Grade females contained no students with zero correct responses, and only one Second Grade male had zero correct responses, but it should be noted that that participant was absent for one of the three response opportunities. While not conclusive, these results suggest that as children age and progress through the final stages of auditory development, they will provide a higher rate of correct responses in discerning high sounds from low sounds than they did in the lower elementary grades when they were in the early-to-mid stages of auditory development.

As confirmed earlier, the data collected for Response One was recorded before the participants’ curricular high/low unit. Unlike Kindergarten and Second Grade, less than half of the students in First Grade responded correctly. It is important to mention that not all First Grade students this year were my students when they were in Kindergarten last year, which could have affected the rate of accuracy in their responses. Our school’s student population is large enough that it requires the need for a traveling music teacher to teach any and all classes that exceed my maximum case load of 22 sections. The traveling music teacher personnel changes each school year based on district enrollment, which creates some inconsistencies in their music instruction.

Additionally, the months of September 2020 through February 2021 of last school year were taught exclusively in a 100% virtual setting when this year’s current First Grade students were in Kindergarten. Out of all my classes last school year, across all grade-levels, Kindergarten music easily had the lowest attendance rate during this time due to a plethora of reasons, including: students without anyone at home to help them log on to their Zoom meets and/or students lacking an older sibling or adult to remind them to attend each of their classes. Their scarce attendance rate may even have been due to the fact that music was scheduled at the
very end of the students’ instructional day from 2:40 PM - 3:10 PM during their months spent in virtual learning. These hours already create a lengthy school day for a Kindergarten student participating in face-to-face instruction. These scheduled times of instruction feel substantially longer for a Kindergarten student participating in a 100% virtual learning environment. I feel that the low attendance rate (which was about 50% of students per class most school days) during their months of virtual instruction could have influenced the First Graders’ lower ‘correct’ response numbers for Response One.

The recorded responses for Response Two were collected mid-instruction in the participants’ curricular unit on high/low. First Grade saw a large increase in the number of students who answered correctly from Response One to Response Two, whereas the Kindergarteners’ population percentage for correct responses decreased between Response One and Response Two. The Second Grade population percentages for correct answers for Response One and Response Two are the same, although, their absence percentage was lower in Response Two. Because of this lowered absence rate in Response Two, the Second Grade population percentage for incorrect answers actually increases from Response One to Response Two. All three grades (Kindergarten, First Grade, and Second Grade) had similar population percentages for incorrect answers in Response Two, and Kindergarten had the largest grade-level population percentage of ‘absent’ recorded responses for both Response One and Response Two.

Response Three was conducted post-instruction of the participants’ curricular high/low unit. All three grades (Kindergarten, First Grade, and Second Grade) had similar population percentages for both ‘correct’ and ‘incorrect’ answers for Response Three. Unlike Response One and Response Two, Kindergarten had the smallest percentage of absences of all three grades in Response Three, whereas Second Grade had the highest population percentage of absences this
time, coming in at 20.8% of their total population being recorded as ‘absent’ for this response opportunity. From Response One to Response Three, the population percentage of Kindergarten and Second Grade students who answered correctly decreased by 15 percentage points. From Response One to Response Three, the population percentage in First Grade of participants who answered correctly increased by four percentage points, which is interesting considering the fact that First Grade had the lowest population percentage of correct answers in Response One amongst all grade levels in the study.

In Chapter Four, Figure 2 the data results show that 45.9% of the total number of correct responses gathered from the study participants came from students between the ages of 7.08 and 8.25 years old. This intrigued me at first because it seemingly offered evidence to answering my research question: Is a child’s ability to discriminate pitch affected by their age, and can their proficiency improve over time? However, upon further reflection, I realized that almost half of the study participants were identified as being a part of this age range, so the high number of correct responses was more likely due to the large population size, not their age.

Within the parent permission form that the participants’ parents signed at the beginning of the study, an option was provided for them to voluntarily disclose whether or not their child had ear tubes at some point in their life and/or have suffered from chronic ear infections. Out of 117 participants, seven were electively identified as having one or both conditions during some point in their childhood. It is likely that there are a larger number of participants in the study who have also had ear tubes and/or chronic ear infections at some point, but their parents may not have felt comfortable disclosing that information for a variety of unknown personal reasons.

Of the seven students identified, three had experiences with just ear tubes and four participants had both ear tubes and chronic ear infections at some point in their childhood. One
Kindergarten male who both had ear tubes and suffered from chronic ear infections had experienced hearing loss on two occasions prior to the insertion of their ear tubes. Their response rate was one correct response, one incorrect response, and one absence. One First Grade female who had ear tubes and endured chronic ear infections always passed all of their hearing tests. Their response rate was two correct responses and one incorrect response. For all students who identified as having ear tubes at some point, six of nine response opportunities were answered correctly. For students who have had both ear tubes and suffered from chronic ear infections, four of 12 response opportunities were answered correctly. It should be noted in this scenario, however, that three of 12 response opportunities were recorded as ‘absent.’

Because this sub-population sample is so small, it’s difficult to draw conclusions from the results, but it does offer some insight into the participants’ personal experiences with hearing and could serve as an interesting factor to include in other research.

**Implications for Future Music Education Practices**

While inconclusive, the results of this research provides “food for thought” with which we can take the time to consider and examine both current and past practices in the scope of how we, as music educators, shape and develop a student’s pitch proficiency. Additionally, it encourages discussion as to how we can measure that growth. While it may be a debatable approach, I, personally, am not recommending formal or summative assessment of a student’s pitch proficiency at these specific ages at this moment in time because of the effects of COVID on our student’s learning progress across all subject areas. I also feel it would be unethical to try to clearly define the parameters for mastery in this area at a child’s stage of overall development at these ages. Furthermore, it is simply impractical to authentically assess the number of children we teach, given that pitch proficiency is only one piece, albeit an important one, that contributes
to their overall understanding of music and musicianship development. I instruct a total of 201 students at the Kindergarten, First Grade, and Second Grade levels alone, making it impossible to adequately assess every area of their individual musical progress, despite my best efforts.

One solution to this issue could be to focus on measuring the students’ growth instead. Using quick ‘check-ins’ such as the ones conducted in this research, over the course of the school year and over the course of multiple school years, would be much a much easier way to track students’ development in pitch proficiency and inform future instruction.

The outcome of this research prompted another related question to examine: Is what we’re asking of students (in regard to pitch proficiency) developmentally appropriate? If we look to the National Core Arts Standards to establish an idea of what is to be universally expected in each area at each grade level, you will find that a developmental trajectory for this skill is not directly addressed. The most closely related standard to this skill, at the Pre-Kindergarten level, states that students should be able to, “with substantial guidance, explore and demonstrate awareness of musical contrasts” and that in Kindergarten, children should be able to, “with guidance, explore and demonstrate awareness of music contrasts (such as high/low, loud/soft, same/different) in a variety of music selected for performance” (Music at a Glance, 2014). Furthermore, in First Grade, it specifies students should be able to, “with limited guidance, demonstrate knowledge of music concepts (such as beat and melodic contour) in music from a variety of cultures selected for performance” (Music at a Glance, 2014).

If each us, as music educators, look to our own district’s Kindergarten through Fifth Grade general music curriculum for guidance in what to expect of student development in pitch proficiency, the answer may still be just as unclear. In my district, according to our official elementary general music curriculum, high/low pitch distinction is considered to be a developing
skill at the pre-Kindergarten level, and that students should achieve proficiency in distinguishing high from low by the end of Kindergarten. Unfortunately, none of our students receive formal music instruction at the pre-Kindergarten level, making it impossible to bring students to a ‘developing’ level of proficiency at that age. This implies that this skill must be both introduced and mastered within their Kindergarten year, creating a puzzling dichotomy for the music educator to interpret. Altogether, these contradictions present a clear example that demonstrates the aphorism that veteran teachers are quite familiar with: Just because it’s stated in the curriculum doesn’t mean it’s correct, or developmentally appropriate, or makes any sense.

Results from this study can assist in influencing, adjusting, and improving our curricular decisions regarding pitch discrimination skill development. For example, if a music educator is required by their district to grade a student in pitch proficiency on a report card, they can use the information gained from this study to reevaluate when students should be assessed within the duration of their time spent in elementary school. If a music educator’s district already has a trajectory in place for assessing pitch proficiency, they could offer suggestions for adjustments and query their curricular team to review alternate expectations that are both more developmentally appropriate and clearly stated as to when mastery in pitch proficiency should be achieved.

**Implications for Future Research**

The research performed in this study was driven by the question: Is a child’s ability to discriminate pitch affected by their age, and can their proficiency improve over time? The answer, based on the results of this study, is: likely, but uncertain. Any future research on this topic should occur over a longer timeframe during students’ crucial years of auditory
development to truly answer the question of whether this skill can improve over time and what factors can affect pitch development besides a student’s age.

Subsequent research studies concerning pitch development should be designed to utilize more detailed, individualized student information than was approved for in this study, such as: the participants’ special education status, Individualized Education Program (IEP) information (if applicable), English Language Learner (ELL) status, definitive background of experience with any and all auditory issues, and whether or not the student receives speech and language services, to name a few.

Lastly, the results of this study present related questions to consider in future research regarding factors that could influence a student’s development in pitch proficiency. One question, for example, might be: Does the fact that today’s students are inundated with mostly impure instrumental sounds (i.e. generated and/or manipulated through modes of technology) affect how musical sound is perceived by them?

In conclusion, pitch proficiency is a principal skill in our students’ musical development and we can see that there are many different factors that can influence our students’ aptitude in this capacity. Armed with an awareness of these components, we, as music educators, can adjust our teaching practices to be more cognizant of the many nuanced facets that influence our students’ musical growth through our assessment efforts.
Resources


**PITCH, PROCESSING, AND PROFICIENCY**


Appendix A

INFORMED CONSENT DOCUMENT

Informed Consent to Participate in Human Subjects Research

Mrs. Megan Willis and Dr. Rachel Brashier, Director of Music Education at the University of Wisconsin-Stevens Point would appreciate your child’s participation in a research study designed to understand whether or not there is a relationship between a child’s age and their ability to discriminate musical pitches.

During the month of October 2021, your child would be asked to participate in normal music classroom instruction while confidential data is collected regarding their ability to discriminate high pitches from low pitches. Your participation is completely voluntary. The benefit of this study is to provide insight into the music learning of children with normative and non-normative hearing development and the relationship of this to pitch discrimination in the primary grades. Approximately 270 students across grades K-2 will be participating in the study. We anticipate no risk to your child as a result of their participation in this study other than the potential to feel uncomfortable being observed.

If we are able to gain insight into the students’ age and its relationship to pitch perception, elementary music educators can then informatively adjust their practices and/or curriculum to meet the students where they are at developmentally. This not only benefits music educators pedagogically but our students as well as they will receive a more comprehensive music education experience from the study's findings and the resulting recalibration of our teaching practices.

This information can only be achieved through observation. You may choose not to have your child participate as an alternative. Confidential spreadsheet data will be kept in a locked
drawer in my office and only seen by the 2 researchers listed on this IRB, and analysis will only be stored on my UWSP OneDrive account.

Your participation in this study is completely voluntary. If you want your child to withdraw from the study, at any time, you may do so without any negative repercussions. Only confidential information provided will be retained. All identifiable information will be removed from the study and destroyed or deleted. In the event of a computer glitch, the investigator may withdraw the confidential participant results from the gathered data.

Once the study is completed, confidential results will be published in Megan Willis’ master’s thesis and presented at a professional conference.

If you have any complaints about your treatment as a participant in this study or believe that you have been harmed in some way by your participation, please call or write:

David Barry, PhD
IRB Chair
Associate Professor, Sociology
2100 Main St.
Old Main 208
University of Wisconsin, Stevens Point and Extension
Stevens Point, WI 54481
715.346.3799
irb@uwsp.edu
Although Dr. Barry will ask your name, all complaints are kept in confidence.

Thanks so much for your consideration.

Sincerely,

Mrs. Megan Willis & Dr. Rachel Brashier

mewillis@gbaps.org rbrashie@uwsp.edu

Please return the signed portion of this document with your student to turn into the school secretary in the main office.

“I have read and understand the information provided to me; that my participation is voluntary and I may withdraw at any time.”

Student Name: _____________________________________

Parent Signature: _____________________________________

Date: _______________________________________________
Appendix B

Parent Permission Letter

Dear Parent/Guardian:

Greetings! My name is Megan Willis, and I am your child’s music teacher at Baird Elementary. I am completing my Masters of Music Education degree from UW-Stevens Point and I am in the research phase of my studies. The reason for this letter is to kindly request your permission to allow me to use the data I collect during class on your child’s progress on hearing various pitches.

I will be delivering lesson content and an assessment that is a part of the regular music curriculum, approved by the Board of Education. In these observations, which will take place in September and October. I will play two pitches, asking the students to answer-whether the second pitch was “higher” or “lower” than the first pitch. My goal is to see if there is a relationship between a child’s age and their ability to tell the difference between high and low pitches. The data I collect is completely anonymous, plays no part in a student’s grade in the class, and will better allow me to meet students at their developmental stage as I learn more about their musical development.

The analyzed data results, which will include no names or identities, will be organized into my written masters thesis. I plan to present the study results at a professional conference of music educators from Wisconsin. The data collected from this research is important because the results of the research can help inform music teachers about student pitch development and the potential need to adjust their teaching practices.

All students will be participating in the lessons and assessment as they are a part of the normal music curriculum. They shouldn’t experience any discomfort beyond what they normally
experience in music class. Granting permission for me to use the data collected is completely voluntary. There will be no negative repercussions for declining to participate. I will only use this information for my thesis and conference presentation to other music teachers. Data will only be collected from students whose parents provide permission.

This is a minimal risk study. I will simply be recording student responses to the pitches I play in class. I will only analyze the answers for those students whose parents have agreed for them to participate in this study. All student identities will remain confidential and known only by me. Whatever you decide on his form, you are also welcome to change your mind at any time.

On the following page, please indicate below your choice for me to use the data collected for your child in my research thesis and conference presentation. Please sign and date and include your child’s first and last name. If, later on, you decide to not allow me to use the data collected on your child and you would like to revoke your permission, please email me at: mewillis@gbaps.org. You can return the form by sending it back in your child’s classroom take-home folder.

Additionally, and optionally, if you would be willing to disclose any past hearing difficulties your student has experienced, it would inform my research even further. Thank you for your time and consideration.

Sincerely,

Megan E. Willey
Appendix C

Research Data Use Permission Form

Mrs. Willis

Baird Elementary

Research Data Use Permission Form

September 2021

_____ I DO allow (consent) for the data collected during music class about my child’s ability to hear high and low pitches to be used for the graduate research thesis and conference presentation

_____ I DO NOT allow (consent) for the data collected during music class about my child’s ability to hear high and low pitches to be used for the graduate research thesis and conference presentation

Optional – Below, please mark a check next to any hearing difficulties your child has experienced:

This information will remain strictly confidential to me only as the researcher and your child’s music teacher. I am only asking in order to help understand your child’s specific needs.

______Chronic ear infections

______Ear tubes

______Diagnosed hearing disorder

______Other

_______________________________________ Parent Signature

_______________________________________ Date

_______________________________________ Student first and last name
Appendix D

Graphs Depicting Collected Data

Population Percentage of Total Number of Correct Responses: Kindergarten

Population Percentage of Total Number of Correct Responses: Second Grade

Population Percentage of Total Number of Correct Responses: First Grade

Population Percentage of Total Number of Correct Responses: Males
Population Percentage of Total Number of Correct Responses: Females

Number of Correct Responses, Incorrect Responses, and Absences for Response One

Number of Correct Responses, Incorrect Responses, and Absences for Response Two

Number of Correct Responses, Incorrect Responses, and Absences for Response Three
Individual Participants’ Total Number of Correct Responses Collected During AM Hours

Individual Participants’ Total Number of Correct Responses Collected During PM Hours

Percentage of Total Responses Recorded as ‘ABS’ or Absent

Population Percentage of Total Number of Correct Responses: Kindergarten Females
Population Percentage of Total Number of Correct Responses: Kindergarten Males

Population Percentage of Total Number of Correct Responses: First Grade Females

Population Percentage of Total Number of Correct Responses: First Grade Males

Population Percentage of Total Number of Correct Responses: Second Grade Females
Population Percentage of Total Number of Correct Responses: Second Grade Males

Population Percentage of Recorded Responses for Response One: Kindergarten

Population Percentage of Recorded Responses for Response One: First Grade

Population Percentage of Recorded Responses for Response One: Second Grade
Population Percentage of Recorded Responses for Response Two: Kindergarten

Population Percentage of Recorded Responses for Response Two: First Grade

Population Percentage of Recorded Responses for Response Three: Kindergarten

Population Percentage of Recorded Responses for Response Three: First Grade
Population Percentage of Recorded Responses
for Response Three: Second Grade

Population Percentage of Recorded Responses
for Response One: AM

Population Percentage of Recorded Responses
for Response One: PM

Population Percentage of Recorded Responses
for Response Two: AM
Population Percentage of Recorded Responses for Response Two: PM

- Correct: 56.3%
- Incorrect: 29.2%
- Absent: 14.6%

Population Percentage of Recorded Responses for Response Three: AM

- Correct: 44.9%
- Incorrect: 34.8%
- Absent: 20.3%

Population Percentage of Recorded Responses for Response Three: PM

- Correct: 52.1%
- Incorrect: 37.5%
- Absent: 10.4%

Total Number of Correct, Incorrect, and Absent Responses for Students Identified As Having A History of Both Ear Tubes and Chronic Ear Infections

- Correct: 3
- Incorrect: 4
- Absent: 5
Total Number of Correct, Incorrect, and Absent Responses for Students Identified as Having a History of Ear Tubes

Total Number of Correct, Incorrect, and Absent Responses Collected Before Introducing High/Low Curricular Unit

Total Number of Correct, Incorrect, and Absent Responses Collected Mid-Point of High/Low Curricular Unit

Total Number of Correct, Incorrect, and Absent Responses Collected Post-Instruction of High/Low Curricular Unit
Total Number of Correct, Incorrect, and Absent Responses Collected At the Beginning of the Participants’ Class Period

Total Number of Correct, Incorrect, and Absent Responses Collected in the Middle of the Participants’ Class Period

Total Number of Correct, Incorrect, and Absent Responses Collected at the End of the Participants’ Class Period

Total Number of Correct, Incorrect, and Absent Responses Recorded in the ‘AM’ for First Grade Participants for Response One
<table>
<thead>
<tr>
<th>Description</th>
<th>Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Number of Correct, Incorrect, and Absent Responses Recorded in the ‘AM’ for First Grade Participants for Response Two</td>
<td><img src="image1.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Total Number of Correct, Incorrect, and Absent Responses Recorded in the ‘PM’ for First Grade Participants for Response One</td>
<td><img src="image2.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Total Number of Correct, Incorrect, and Absent Responses Recorded in the ‘AM’ for First Grade Participants for Response Three</td>
<td><img src="image3.png" alt="Pie Chart" /></td>
</tr>
<tr>
<td>Total Number of Correct, Incorrect, and Absent Responses Recorded in the ‘PM’ for First Grade Participants for Response Two</td>
<td><img src="image4.png" alt="Pie Chart" /></td>
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Total Number of Correct, Incorrect, and Absent Responses Recorded in the ‘PM’ for First Grade Participants for Response Three