# Do Instrumental Music Students Hear Differently? Implications for Students who have a Disability.

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Ross Walker

## Statement of Sources

This thesis contains no material that has been extracted in whole or in part from a thesis that I have submitted towards the award of any other degree or diploma in any other tertiary institution.

No other person's work has been used without due acknowledgment in the main text of the thesis.

All research procedures reported in the thesis received the approval of the relevant Ethics/Safety Committees.

**Ross Walker**

10 September 2019

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# Do Instrumental Music Students Hear Differently? Implications for Students who have a Disability.


## ABSTRACT

It should be no surprise to suggest that the better a child listens, the better is their likelihood of classroom success. Within the existing body of research, it is relatively easy to locate evidence that not only is auditory discrimination a key predictor of children's classroom success, but that instrumental music training can enhance children's auditory discrimination skills.

Optimizing auditory discrimination is as equally important for children who have a disability as it is for those who do not have a disability. However, the essential problem of (virtually all) the available literature examining music training and its associated non-musical benefits, is that it rarely identifies whether any children who had a disability were included in the study's experimental samples. This limitation is problematic. While the findings of many studies that investigate auditory discrimination and instrumental music training may well be relevant for children who have a disability, it simply cannot be known with certainty whether they are or not. Therefore, specifically identifying children who had a disability within the participant sample of this study was the critical aspect differentiating this project from the way other, similar studies have been typically run and reported.

In all, this study involved 185 eight-year-old children drawn from four schools in south-east Queensland, Australia. Of these, 131 children received instrumental music training (the intervention), while 54 others were not involved in any form of instrumental training over the same 18-week period. A parent survey was used to determine whether individual children who were involved in this study had a disability. Auditory discrimination testing of all the study's participants was performed both before and after the intervention, and scores from each of these tests compared.

This study found that children receiving instrumental music training demonstrated significantly greater improvements to their auditory discrimination than did their peers who were not involved in instrumental music training. Critically, this association between instrumental music training and better auditory discrimination performance remained constant regardless of whether the children in this study had a disability. Moreover, this study also found that the effect size for the association between instrumental music training and improvements to auditory discrimination skill was greatest for the children who had a disability and were involved in regular in-school instrumental music classes learning alongside their peers who did not have a disability.

## Terms and Definitions

1. **State school.** A government run school where children are not required to pay fees.

2. **Private school.** A school that is privately operated. Children who attend private schools are required to pay fees to be a student. While most private schools in Australia have some form of church affiliation, there are also some secular private schools.

   In this study, of the two private schools from where some of the study's participants were drawn, one school was affiliated with the Lutheran Schools Association, while the other was operated by a local congregation who were themselves affiliated with the Australian Baptist Church.

3. **Queensland.** One of the six States and various territories that together make up the Commonwealth of Australia. Although some aspects of schooling are regulated by the Australian Commonwealth Government, each state - including Queensland - has its own state's Department of Education who acts as the regulatory authority. In Queensland, this State Authority is called *Education Queensland.*

4. **Disability.** In Queensland schools, disability (in the context of education) is understood as children having intellectual, hearing, visual, speech/language, or physical impairment; Autism Spectrum Disorder; or Social/Emotional Disorder. In this study, children considered to have a disability will be those falling into (at least) one of the previous categories, and have:

   i. a diagnosis verified by a paediatrician or psychiatrist,
   ii. paperwork submitted to the official State authority, and to have
   iii. been entered into the disability register, accessible from *Queensland Independent Schools* (for non-government schools), or by the *Adjustment Information Management System* (for government schools).

# Chapter 1: Overview

In antiquity, Greek philosophers believed that teaching children to play musical instruments delivered explicit social and personal benefits (Stamou, 2002). The Greeks claimed that instrumental music training, as part of children's schooling, was fundamental both to children's academic and personal development (Bourgault, 2012). Strikingly, contemporary research that will be reviewed below also shows that children who learn to play musical instruments outperform their non-musical peers across a range of non-musical skills. These include: the sequencing of verbal information (Piro & Ortiz, 2009), reading (Moreno et al., 2009), decoding of emotion in prose (Strait, Kraus, Skoe, & Ashley, 2009), spatial awareness (Patston, Hogg, & Tippett, 2007), as well as memory function (Franklin et al., 2008).

According to the Australian Bureau of Statistics (2016) census information - in 2015, 4 million (or 18.3%) of all Australians lived with some form of disability and, of these, 290,000 were children aged between 0-14 years of age. In terms of households, at the time of the census there were 102,000 households in which there was at least one child (0-14 years of age) who had a disability and in which there was a carer, and

a further 70,400 households in which there was at least one child (0-14) who had a disability and in which there was no carer.

Dating from the 1990s (McCrae, 1996), Australian children who have had a disability have been mainstreamed into regular classrooms wherever possible. This means that they have been included in regular classes alongside their peers who have not had a disability. This is confirmed by the Australian Bureau of Statistics (2014) who recorded that 78% of all children who had a disability were attending mainstream schools rather than special schools (that is, schools solely teaching children who have a disability). Forlin, Chambers, Loreman, Deppeler, and Sharma (2013, p. 5) reported that, in terms of mainstreaming, "all jurisdictions [Australian States and Territories] have well-developed policies that support inclusive practices" for people who have a disability.

Paradoxically, while evidence showing that instrumental music training can enhance numerous non-musical skills and, while children who have a disability are routinely mainstreamed into regular schooling typically offering instrumental music training; as a group, children who have a disability rarely participate in school instrumental music programs.

## Statement of the Problem

### Inclusion

In Queensland public (Australian government-run) schools, (virtually) all primary schools and most secondary schools offer students 'free' instrumental music lessons on a weekly basis. These lessons are delivered by specialist instrumental music teachers, who are also fully Registered Teachers. Although some schools require students to pay a small levy for the annual loan of an instrument or require the

purchase of a textbook, the instrumental music tuition delivered through school-based programs is itself entirely free. This is an equalizer. Therefore, no Queensland family should be precluded from accessing instrumental music training for their child/children simply because of their financial capacity to pay for lessons.

In Queensland - at least in theory - every child should have equal access to receiving instrumental music training as part of their regular schooling, including children who have a disability. However, children who have a disability are not just poorly represented in school instrumental music programs, but a cursory look at opt-in school instrumental music programs shows that children who have a disability are virtually non-existent. Given the benefits that participating in instrumental music training is believed to provide for children generally, and the apparent availability of school-run instrumental music training, the question of 'why' children who have a disability are so under-represented in school instrumental music lessons is puzzling.

**Exclusion**

Three main reasons appear to explain why children who have a disability are not included in school instrumental music programs. These are:

i. The view that instrumental music is extra-curricular, not core (Morrison, 2012). This position is shaped by the beliefs that: 1) proficiency in core learning is lessened whenever time is redirected to non-core activities, and therefore, 2) it is only time spent directly in core learning activities that enhances core learning. Therefore, children who have a disability should not be 'distracted' from attending to learning that is specific to core proficiencies; and an example of this would be their involvement in instrumental music lessons.

ii. Competition in the arts (Robson, 2004). Many schools use their instrumental programs as a means of directly competing with other schools. Whenever school excellence replaces personal excellence as an end-goal, only the best performers represent their schools in their instrumental program/s. Thus, the advantage associated with individuals (of varying skill levels) achieving personal excellence, along with any other associated benefits that might come as a result of their involvement in instrumental music training, is replaced by the wholly different community goal of achieving local superiority.

iii. Economic rationalism. This represents the strategy through which schools typically resolve distribution problems when their resources are limited - either physically or operationally (Leenman, 2010). For instance, many schools own a small number of instruments that can be made available for loan to students who commence instrumental music studies. This represents limitations to physical resources. Alternatively, either due to the cost or availability of staff, some schools can (or choose to) only provide limited teaching time for the instrumental music programs that they operate.

Ultimately, when resources are limited, the question is invariably: to *whom* should these few instruments and/or the available teaching time be allocated? Economic rationalist agendas typically select out academic high-achievers with supportive parents and filter these children into their school's instrumental-music programs. However, the idea that the 'best' will *be* the best is itself limited thinking. While an academic record may accurately describe a child's learning history, it can never predict their potential.

### Selection and De-selection, Implications for Children with a Disability

Regardless of the reason, the result is effectively the same - that students who have a disability are typically: not 'distracted' by; overlooked from; or, worse still, purposely excluded from participating their school's instrumental music lessons. This not only undermines the basic premise of inclusion but, by extension, effectively precludes children who have a disability from receiving the potential benefits that participation in school instrumental music programs has been shown to deliver.

Maximising educational effectiveness should be equally important for all children, including those who have a disability. If learning a musical instrument can improve the academic skills of children who have a disability, as research shows that it does for children who do not have a disability, then withholding it from children who *do* have a disability is to deny best practice.

## Background and Need

Australian schools have endeavoured to implement inclusive practices from as early as the 1990s (McCrae, 1996). As a result, Australian children who have a disability are routinely mainstreamed into regular school classrooms and should, in principle, participate in regular school programs. Therefore, it should be expected that how students are selected into contemporary Australian in-school instrumental music programs should likewise reflect the broad principles of inclusion. Article 24 of the Convention of the Rights of Persons with Disabilities (United Nations, 2008, p. 16) to which the Australian government is a signatory, declares that a child's education should be “without discrimination and on the basis of equal opportunity." In other words, children who have a disability should be treated in the same way as children

who do not have a disability, and this should be reflected in their access to the available educational opportunities offered by their school.

In the ability of schools to enact this goal, some researchers find that there is a gulf between intellectual ascent and actual practice. This dissonance between research and practice is what Grima-Farell, Bain, and McDonagh (2011) discovered in reviewing the literature focused on inclusive education. The researchers found that where this gulf exists, and inclusion is treated as an aspirational goal, the process of inclusion falters. Grima-Farell et al. (2011, p. 118) concluded that - in order to close the research-to-practice gap, and to provide the best possible educational opportunities to every child, including those who have a disability - inclusion must become a "whole-school concern".

Australia is a signatory to not only the Convention on the Rights of Persons with Disabilities (United Nations, 2008), but also to the Convention on the Rights of the Child (United Nations, 1989). However, as UNICEF states: "Ratification alone will not be enough. The process of honouring commitments in practice will require effort on the part of national governments." (UNICEF, 2013, p. 75). For full inclusion to be realised for every child who has a disability, mere ratification by government, even many governments, is never going to bring real change. It is action at the individual school level that is required, not simply aspirational national goals.

I have already referred to the three arguments that generally typify why children who have a disability are either under-represented in, or absent from, school instrumental music programs. They are the beliefs that:

i. professional sounding music programs are a selling-point for many schools,
ii. music is extra-curricular - not core learning, and
iii. economic rationalism (how best to allocate limited school resources).

Whenever a school uses its music ensembles for the purpose of demonstrating its excellence outside of its own community, the purpose of these ensembles is fundamentally about marketing. Marketing is not necessarily a bad thing. However, in using a school's music ensemble/s for the purpose of marketing, there is an inherent danger that when a school's corporate image overshadows the image of the individual an *elite* emerge, and the aspiration for personal excellence suffers as a result (Friedman, 2013).

Schools who 'compete' through their Arts programs are careful about who is selected for inclusion in their ensembles. Accordingly, where competition is a primary end-goal, auditioning procedures for school music programs become more about deselecting students 'out' of ensembles, rather than selecting students 'into' those ensembles (Gaylin, 2016). This highlights a particular social problem in education. In the instance of schools with rigorous auditioning processes, only the highest-performing students are typically selected into music programs. They are effectively an elite, and it is they who represent their schools and it is this cohort that likewise reap the associated benefits of participating in those ensembles.

To properly understand the other two issues, economic rationalism, and music as an extra-curricular activity for children who have a disability, the sensible course of action would be to determine what the research literature that investigates music training and inclusion shows. That is, can children who have a disability be shown to benefit (or fail to benefit) from their inclusion in school instrumental music programs? If they benefit, then their involvement in instrumental music learning may well be warranted. If not, then the question is moot.

Reviewing the research literature about music and disability should be the means that enables educators to rationally determine whether instrumental music training is of benefit to, or whether it is merely an extra-curricular exercise for, children who have a disability. Likewise, in terms of assessing the validity of the economic rationalist argument for or against the inclusion of children who have a disability in instrumental music programs, it is necessary to determine the potential 'return' that might be expected for the weekly half-hour of in-school teaching time that would be required for classes of this type.

**A Gap in the Literature**

Many music research experiments find strong associations between instrumental music training and a range of non-musical benefits [For instance, dos Santos-Luiz et al. (2016); Hallam and Rogers, (2016); or Holochwost et al., (2017)]. In the study by Holochwost et al. (2017) the researchers found that children engaged in instrumental music training outperformed their peers in both language and mathematics. As part of this study, the researchers also investigated whether variables such as gender or race might influence the study's results. They determined that they did not. Like most studies, the researchers defined typical characteristics of the study's participants. For instance, in the Holochwost et al. (2017) study 86% of the participants were Afro-American and 58% of the study's total sample were female. However, the researchers did not indicate whether any child in their study had a disability.

This example of not indicating whether there were any children who had a disability in the experimental sample is not unique. It describes a pattern of how studies in this field are typically reported. Repeatedly across the literature, the problem is that despite the volume of research that investigates and associates music education

to an array of non-musical benefits, the researchers simply fail to identify whether any children who had a disability were included in their experimental samples. Unsurprisingly, there is clearly a need for educators (and indeed parents) to know whether children who have a disability *also* benefit through their involvement in school (or private) instrumental music programs.

Unfortunately, research specific data that addresses this question is lacking. Unlike the considerable body of music education research that has been conducted with children who have not had a disability, similar music education research measuring whether instrumental music instruction has been (and therefore might be) of benefit for children who do have a disability cannot be found. Consequently, educators are precluded from knowing whether the non-musical benefits described in the array of studies in this field can appropriately generalise also to children (who are like those described in these studies, but) who *do* have a disability. The existence of such a gap in the literature is not merely an insignificant research anomaly. Instead, it critically weakens what can currently be known.

## Purpose of this Study

Understood across the breadth of research associating instrumental music training, children's auditory skills and improved academic performance, there is evidence to show that instrumental music training improves children's auditory discrimination in measurable ways (Banai & Ahissar, 2013; Tierney et al., 2015). The caveat of course is that what can be known from studies such as these can only extend to children who do not have a disability, since none of the children involved in these studies were noted as having been diagnosed with a disability of some type.

Simply stated, the general body of research clearly shows that the better children in these studies 'take in' information, the better is their likelihood of grasping that information. This is unremarkable. A study by Kraus and Chandrasekaran (2010) examined the influence of instrumental music training on the human auditory system. The researchers determined that the effect of instrumental music training was profound. Further, they determined that a quantifiable change had occurred for the subjects in their study, and that this was as a direct result of the children's involvement in instrumental music tuition. Kraus and Chandrasekaran (2010, p. 599) summarised their findings by describing instrumental music training as "a resource that tones the brain for auditory fitness". This is an important understanding. However, because of the gap in the literature, whether instrumental music training can be utilised as a resource appropriate for 'toning the brains' of children who have a disability for 'auditory fitness' is far less clear.

**The Dual Purpose of This Present Research**

The purpose of this research project has always been two-fold. Primarily, it was designed to be compatible with the style of other, similar studies in this field that investigated instrumental music training (and its potentially associated non-musical benefits). In terms of what was investigated, this study aimed to determine whether children's auditory discrimination could be shown to change as a result of their involvement in practical instrumental music training. However, the special feature of this study was that within the group of children who participated in the project, children who had a disability were specifically identified as a special cohort.

It was through this simple but critical difference; that is, identifying children who had a disability within the overall experimental sample, that the greater aim of

this study was able to be realised. That was: to determine whether similarities or differences existed between the results of the auditory discrimination testing of children who had a disability when they were compared with those of children who did not have a disability. Therefore, the auditory discrimination skills of all the participants were measured both before and after the period of instrumental music training was conducted. The results of the two auditory discrimination tests were then compared to determine the extent to which change may have occurred in each of the experimental and control groups.

Importantly, in this study, the results were also examined to determine how the scores of the children who had a disability compared to the scores of the children who did not have a disability. Thus, this study aimed to determine how the results of the children who had a disability could be understood as a subset of the larger groups of children who had received, or had not received, instrumental music training; and whether any change that could be determined to their auditory discrimination could be seen to show similarity or difference to the changes in auditory discrimination for those children who did not have a disability.

## Rationale

**The importance of addressing this gap.** Maximising educational effectiveness should be equally important for all children, including for those who have a disability. Although much is known about how instrumental music training can benefit children who do not have a disability, the fact that the literature (presently existing in this field) does not show whether children who have a disability also might experience benefits from their involvement in instrumental music training is problematic.

The fact that educators are unable to determine whether the studies that investigate music and its non-musical benefits are also of relevance to children who have a disability has direct implications for both educational practice and policy. If learning a musical instrument can improve the physical capacity of children who have a disability as it does for children who do not have a disability, then this is a highly important understanding in terms of how to best educate children who do have a disability.

**The worth of academic investigation to resolve this gap.** With the important caveat that, from the general body of literature, research presently only exists for children who do not have a disability - there is compelling research to show that:

i. auditory discrimination "certainly is a skill required for decoding and recognising the sounds of language and, thus, is one of many pre-requisites for the ultimate comprehension of spoken language" (Bellis, 1996. p.54).
ii. the better a child's level of auditory discrimination, the higher their likelihood of academic success,
iii. children's auditory discrimination is not determined by the time of their schooling, but
iv. children's auditory discrimination abilities can be improved through their involvement in instrumental music training.

Investigating whether the involvement of children who have a disability in instrumental music training, and whether it might also alter the auditory discrimination of these children (in ways that are like those known to be of benefit to children who do not have a disability) is of significance.

**A limitation of this study's disability type sample.** As understood within Queensland's schooling systems (both private and public) children who have a disability are considered to have one, or more, of the following diagnoses: Intellectual, hearing, visual, speech/language, or physical impairment; Autism Spectrum Disorder; or Social/Emotional Disorder. The types of disability that were represented in this study was limited by the types of disability that the children at the participating schools had. This, in turn, was also limited by the subset of children who had a disability, and who chose to participate in the study. In this study, children who were determined to have a disability only fell into three of the disability categories. These were children who had Autism Spectrum Disorder, Speech/Language Impairment and Physical Impairment.

## The Significance of Selmer as a Measurement Instrument

To measure auditory discrimination in this study, the *Selmer* test (Selmer, n.d.) was used. The Selmer test was selected as the measurement instrument for two reasons. The first of these was primarily logistical. Selmer is widely used in many Australian schools -including schools in Queensland - as a measure of the students' ability to hear differences between various sounds (Ng & Hartwig, 2011). The elements Selmer tests include differences between discrete pitches, simultaneously sounded pitches, rhythm and melodic contour. The second reason that Selmer testing was utilised as the measurement instrument in this study was that it is typically run by schools as children commence Year 3, but *before* they begin instrumental music training.

The commonness of Selmer testing was a significant, contributing feature to this study's design. In order to determine whether instrumental music lessons influenced student's auditory discrimination, a baseline measurement of individual

children's auditory discrimination was necessary. As an instrument for measuring this, Selmer was fit for purpose. Additionally, because this study drew upon students from four different schools, it was important that the instrument used to determine children's auditory discrimination was common to each participating school. Again, Selmer was the common denominator. Another benefit of utilising Selmer testing was that all four schools in this study each 'blanket-tested' their entire cohort of 8-year-old students as they commenced Year 3. This meant that even for students who did not ultimately become part of school instrumental music programs (at the schools where the student elected to participate in instrumental music) a Selmer score was still recorded. Also critical to this study, the blanket testing of all Year 3 children meant that children who had a disability were also Selmer tested and their results recorded along with the students who did not have a disability.

**Description of this Study**

In total, $n$=185 Year 3 (8-year-old) students elected to participate in this study. Of these, $n$=100 children went to schools where weekly instrumental music training was a compulsory element of their regular Year 3 teaching program. In the two remaining schools where instrumental music training was optional, $n$=85 children elected to become part of this study. However, of these children, a further $n$=31 undertook instrumental music training either as part of an opt-into in-school instrumental music program, or in the form of private lessons (conducted outside school hours), or both. The 'true' control group in this study therefore totalled $n$=54 students. These were children who could be shown to have not received instrumental music training from any source at all over the duration of the intervention.

Normal Year 3 Selmer testing performed by the individual schools before the commencement of instrumental music training represented the baseline for this study.

At the conclusion of the intervention - one semester's instrumental music lessons (18 weeks tuition on violin) - the students were retested, again using Selmer. From this, the student's auditory discrimination was again determined in the four Selmer categories - their ability to discriminate change to: individual pitch, multiple pitches played together, melodic contour and rhythm.

The scores from both Selmer tests represent the pre-test and the post-test that was used for the purpose of data analysis in this study. Comparison of the pre-test/post-test data was what was used to determine whether change to individual student's auditory discrimination was evident and the degree to which that change had occurred.

Violin was the instrument used for the purpose of teaching instrumental music to Year 3 children at all the schools involved in this study. The choice of violin for Year 3 instrumental music lessons is unremarkable in the Queensland context. In most Queensland schools, including the schools in this study, violin lessons were offered to Year 3 children while lessons on brass, woodwind and percussion instruments were offered to children who are commencing Year 5. One reason for violin being a popular 'instrument of choice' for Year 3 classes is that violins (and their bows) can be purchased in various sizes – for example: ¾, ½, and ¼ sizes. This is a particularly advantageous feature of the violin as an instrument and means that violins of varying sizes can be matched to children of varying heights and arm lengths.

A second, integral part of this study was the use of a parent survey. Firstly, the parent survey was used to ascertain whether individual children had a disability (or not). This information facilitated this study's ability to compare the test scores of children who had a disability with those of the children who did not. Thus, the parent survey - through identifying the pool of children who had a disability - enabled

comparisons to be made between the Selmer test scores for children who did, or did not, have a disability.

The other equally important purpose of the parent survey was to determine whether any child involved in this study had received instrumental music training outside of school hours. Since instrumental music training was the independent variable in this study, music lessons that had been taken outside school hours may well have mimicked the effect of the independent variable. The inability to separate out children who were receiving instrumental music lessons outside of school hours away from those who had not might well have otherwise corrupted the study's results. Thus, the parent survey performed these two critical functions.

## Research Questions

Positioning this study squarely within the field of other, similar studies that had investigated music and its (various) non-musical benefits, has always been a central feature of how this study was envisaged. Therefore, careful genre-positioning has directly influenced the way that many elements, including how the research questions in this study were crafted and determined. Similarly, the focus of this study - children who have a disability - has been an equal important consideration to the development of this study's research questions. Ultimately, the following questions were proposed for investigation:

I. Can instrumental-music instruction be shown to affect the auditory discrimination skills of children who have a disability? and

II. Do the auditory discrimination skills of children, who have and do not have disabilities, display similarity/difference before and after the introduction of instrumental-music training?

The ability to answer these questions has clear implications for educational practice. For both research questions to be answerable, it was necessary to be able to specifically identify children who had a disability as a subset within both the experimental and the control groups of this study. The importance of Research Question II particularly, was that for meaningful comparisons to be made, it demanded of the study to have the ability to be able to identify those individual children within the total participant sample who had a disability, and those individual children who did not.

## Significance of this Research to the Field

This study has shown that children involved in instrumental music training received significantly better results in auditory discrimination tests than did their peers who were not involved in similar musical training. This remained true regardless of whether the children had a disability or not. Critically, this study found that the greatest percentage mean increase to auditory discrimination skills was exhibited by the group of children who were involved in instrumental music training (the intervention) *and* who had a disability. The mean statistical improvement for this cohort (children who had a disability and received the intervention) was, on average, twice as great as it was for the children who did not have a disability and who had received similar training.

The question ultimately emerging from the results of this study is: Since in this study it was shown that children who had a disability received significant benefits through their involvement in instrumental music training; in how many *other* studies that claim powerful associations between music and various non-musical benefits, might children who have a disability also benefit?

## Definitions

### Disability

There is considerable disagreement internationally regarding the use of terms like 'disabled', 'challenged', and 'special-needs'. Throughout this document the terms *disabled* and/or *disability* will be used. Their use is in accord with the World Health Organization guidelines (World Health Organization, 2002, p. 3) that suggests that the term disability be used to refer to any person experiencing "impairments, activity limitations and participation restrictions" that are result of a specific genetic or acquired condition.

### Auditory Discrimination

Auditory discrimination is simply the ability of a person (or animal) to determine that a variance exists, or does not exist, between two or more sounds. The extent to which humans can discriminate between various sounds is clearly an important ability. In educational terms, the variance between individual children's ability to aurally discriminate sound/s is of extreme importance. Research such as that by Bugaj and Brenner (2011) has already demonstrated that a positive association can be shown to exist between instrumental-music training and measurable improvements to human auditory discrimination as a result of that training.

Critically, auditory discrimination is, as described by Osman and Sullivan (2014), a chief determinant of a child's likelihood of success, including that within a classroom environment. Moreover, research such as that by Pantev and Herholz (2011) clearly demonstrates that children's auditory discrimination abilities are not determined by the time of their early schooling, or even over the course of their early schooling. Instead, Pantev and Herholz (2011) describe instrumental training operating as a key to altering plasticity within the human auditory cortex, and that the window for this to

occur is not limited to infancy. The cumulative effect of research such as this cannot be ignored in terms of the best teaching and learning practice.

## Special Ethical Considerations

Running this study necessitated the inclusion of children who had a disability. Since some of these children also had an intellectual impairment, it was necessary to carefully consider how these children could offer informed consent, and thus be included in the study should they be willing to do so.

In every case, formal written consent was sought from the children's parents/caregivers as well as from the children themselves. Also, the participants were given the assurance that, up until the point where individual children's and school's data was de-identified and summarized for the purpose of analysis, any participant could withdraw from the study at any time without consequence. Copies of the *Participant Information Letter* and the *Study Consent Forms* appear as Appendix A.

Because this study also drew upon data held by the school, the children's parents/caregivers were specifically asked for their consent to allow each of the schools to release their child's Selmer test information for the purpose of data comparison and analysis. Access to this information was particularly important because it represented the baseline data that was used for this study.

Ascertaining whether a child had a disability was a central element of this study. Therefore, it was critical to collect and determine this information. In considering the ethical issues involved in this study, it was conceivable that a child's parents or caregivers might not, for various reasons, want information about their child's disability status shared with either their child's school, or with the State

authority. Therefore, in seeking consent for participation in this project, the children's parents were explicitly guaranteed that any details relating to whether any specific child had a disability, would neither be shared with their child's school, nor with Education Queensland.

## Limitations

An important limitation of this study was that quasi-experimental research design was necessitated since a true experimental study design could not be ethically achieved. This is because, in Queensland, school instrumental music programs operate on one of two models. They are where:

a) children themselves elect to participate/not participate in lessons, or

b) all children are required to participate in mandatory instrumental lessons.

Given each of these conditions, it was not possible to achieve a true random sample without breaching the individual school's policies that determine who should be included in their instrumental music programs. Consequently, a quasi-experimental research design was necessitated. While it is true that the inability to randomly assign children into/out of various experimental groups might have limited this study's internal validity (Thyer, 2012), in this case it was not possible to generate student-assignment groups that were both random and ethical.

Finally, an obvious limitation of many studies, including this one, is the number of participants who are willing to become involved. In this study, from the four schools investigated with a combined population of $n$=325 Year 3 students, only $n$=185 Year 3 children elected to participate. Within this group, $n$=25 children met the requirements that formalised their having a disability. As is the case for all research, the greater the number of participants, the greater is the potential the study’s results to

have experimental power. However, while more participants in this study would have been desirable, 185 children (the number of Year 3 children involved in this study) is not uncommon for the total enrolment (Years Prep to 6) of many small inner-city Brisbane schools.

Similarly, while the greater involvement of children who had a disability would have been desirable, the involvement of 25 children with a disability, that is about 13.5% of this study's sample, is in keeping with what might be expected according to data collected by the Australian Bureau of Statistics (2016) about the incidence of young Australians who have a disability within the general population.

Despite these limitations, this research project will show that a clear proof of concept can be found. In this research project, not only did children benefit from their involvement in instrumental music training, the children who benefitted most from instrumental music training appeared to be those children who had a disability. Beyond the scope of this Master's level project, a natural extension of this project would be to test whether, *if* greater numbers of children could be recruited, could the results of this study be replicated to the extent they were shown in this study's results.

# Chapter 2: Literature Review

Optimizing educational outcomes is just as vital for children who have a disability as it is for those without. Research to be reviewed in this chapter shows that the things to which a person listens can directly affect their task performance, including many aspects of children's overall academic achievement. Critically, it will also show that there is a significant body of evidence to demonstrate that students who receive instrumental music instruction academically outperform their peers who do not receive this type of instruction. It is for this reason that the overlap of music education, its non-musical benefits, and how current research informs the practice of educators towards children who have a disability, deserves special scrutiny.

This literature review will address three areas of research that relate to the use of music and children who have a disability. These are:

(i) general understandings of music and academic performance,

(ii) studies examining the use of music for children who have a disability, and

(iii) the extent to which these two areas intersect.

## Music and Academic Performance

### Listening

Where music operates as an independent variable in human research, it follows that listening is invariably involved. Essentially, music research that uses actual sound sources can be divided into two broad categories; namely, either research that investigates *what is heard,* or research that investigates the *conditions* in which sound (or sounds) is/are heard (Stefanija & Schüler, 2011).

In the process of reviewing literature in this field, it has become clear that three distinct lines of research characterize the studies that examine how music might affect children's academic performance. These are studies that investigate:

i. Background sound (passive listening),
ii. The Mozart effect (externally-initiated, active listening), and
iii. Instrumental music tuition (self-initiated, active/passive listening).

### Background Sound (Passive Listening)

**Theoretical foundations.** The idea that the ordinary sounds of everyday life, that is - *background sound* - can arouse physiological or cognitive response is not new (Gibbons & Heller, 1985). Attributed to Cherry (1953), the *cocktail party effect* describes a phenomenon of selective attention where a listener can isolate one particular voice (or sound) by *spiking* other sound/s that might otherwise impede their listening. Selective attention theorists deem sound/s to be either of the foreground or of the background. The fundamental premise of experiments that investigate background sound is that the variable (sound) is generated in the 'background' - that is, it is loud enough to be audible, yet soft enough so as not to be intrusive.

In contemporary studies, background sound can exist as 'noise' or as music, or in some cases both, (Kussner, 2017). When noise is used experimentally, it is usually either pure noise (white, pink, red or grey) or common, recorded, environmental sounds. (For example, street or office sounds, children playing or people talking).

**Background sound in the classroom setting.** Optimizing the learning and recall of students is central to the learning/teaching process. In studies such as that by Søderlund, Sikstrom, Loftesnes, and Barke (2010), the researchers demonstrated that the background sound of classrooms could significantly alter the cognitive performance of students. Subsequently, noise has repeatedly been found to be a factor that influences not merely concentration (Meinhardt-Injac et al., 2015), but also children's overall classroom performance (Niemitalo-Haapola et al., 2017).

Across the body of research that has investigated background sound and student cognition, the result of introducing noise into experimental situations can be seen to vary widely. For instance, while Langan and Sachs (2013) found that background music could increase student comfort, confidence and memory retention; in other noise and cognition experiments, background sound was identified as an active distracter to the study's subjects, (Hynes & Manson, 2016). In yet another aspect of this type of investigation Fraser and Bradford (2013) found that the introduction of lyrics in 'background music' could substantially impede human recall, and somewhat unsurprisingly, that loud noise generally had a detrimental effect on the overall teaching and learning processes.

The purpose of a (now) seminal study by Dobbs, Furnham, and McClelland (2011) was two-fold. Firstly, it aimed to measure the extent to which silence, noise and music could affect cognition. However, it also sought to identify whether the degree of introversion or extroversion that was exhibited by individual subjects was itself a

dependent variable. The novel aspect of this study was to conceive that a subject's personality type might itself exert influence on the degree to which background sound affected listener's cognition. The study was conducted in a British classroom and 118 female students (11 to 18 years of age) participated. Subjects were tested on three tasks measuring abstract reasoning, verbal reasoning and intelligence quotient (IQ). The subjects were randomly assigned to one of three groups (silence, noise or music).

Commercially available sound effects were mixed to emulate natural sounds that students might hear in normal classroom environments. The resultant mix was 12 minutes long and represented the condition of 'noise' in the experiment. For 'music', 15 minutes of commercially available, UK garage-style recordings were used. This music was described by the researchers as having "a high tempo, [and had a] vocal [line]" (Dobbs et al., 2011, pp. 308-309). In other words, they were fast songs with lyrics. Four dependent variables were identified for measurement in the study: silence, noise, music and each individual student's introversion/extroversion score.

**Educational implications.** The results of the Dobbs et al. (2011) study have influenced actual classroom practice. Firstly, the researchers found that background silence, noise and music each operated differently according to the type of test that was being administered. Secondly, the experiment revealed that the strength of the correlation between the background sound and test-type was further mitigated by the degree of introversion/extroversion displayed by individual subjects. Further, this study's validity has been repeatedly tested. The similarity of its findings to the findings of other subsequent studies that have also investigated the relationships between an individual's personality, background noise and the impact of that sound on an individual's concentration during practical tasks, has remained consistent.

For instance, Sörqvist and Rönnberg (2014) determined that individual personality differences could indeed be shown to affect the extent to which particular types of noise distracted subjects engaged in visual-verbal task performance tests. Similarly, McClelland, Kou, and Furnham (2017) found that the degree to which noise impacted the concentration levels of test subjects could be shown to be directly related to the extent to which those subjects displayed tendencies toward introversion or extroversion.

In the original Dobbs et al. (2011) study, the researchers found that for tasks involving abstract reasoning, all subjects performed best in silence and worst with background noise. The study's results for IQ tests performed with the addition of background sound were more complex. The researchers determined that on IQ tests the most introverted subjects performed best in silence ($p<.05$). Conversely, the most extroverted subjects performed best with music [$F(2,109)=11.47$, $p<.001$ ($R^2$=8.0%)]. The introduction of background noise during IQ testing was shown to have negatively impacted the scores for 'generally' extroverted subjects, but not for the most extroverted subjects. In IQ testing, background noise proved a strong predictor for 'underperformance' for the cohort of introverted students [$F(1, 37)=128.89$, $p<.001$ ($\beta$=0.90, $R^2$=58.7%)]. Strikingly, the most extroverted subjects tested *with* background music during their IQ testing far outperformed all others [$F(1, 29)=16.60$, $p<.001$ ($\beta$=0.50, $R^2$=19.0%)].

Finally, verbal reasoning testing yielded the most complex results of all. For verbal reasoning, the researchers found that the most introverted subjects performed best with music [$F(2, 111)=5.13$, $p<.01$ ($R^2$=4.4%)] and worst with noise. However, the most extroverted students performed best with noise and worst with music.

Significantly, in verbal reasoning tasks, the most extroverted subjects outperformed all peers under any sound condition [$F(1, 29)=79.23$, $p<.001$ ($\beta=0.77$ $R^2=44.3\%$)].

**Scientific implications.** A common criticism levelled at many background sound studies is that: because personality type is not factored into the research analysis, the meaningfulness of many experimental results is undermined. This is a valid criticism.

Yet, from the time of the Dobbs et al. (2011) initial investigation, through to more contemporary studies like that of McClelland et al. (2017), evidence has mounted to show that the experimental effect size of background noise and background music (as they relate to task performance) are indeed moderated by the degree to which the experimental subjects displayed introvert or extrovert tendencies. The special significance of the Dobbs et al. (2011) study is that it described complex multivariate correlations that appear to indicate the ways in which specific personality types are likely to respond when they are put in situations where they are exposed to background sound in varying forms.

## Limitations

Unfortunately, there are some important limitations to the Dobbs et al. (2011) study. For instance, as it will be shown below, the researchers' description of their 'music' selection significantly limits the power of this study. Contemporary to the Dobbs et al. (2011) research, Thompson, Schellenberg, and Letnic (2011) in their own study demonstrated that fast and/or loud music had a disruptive effect on verbal reasoning tasks for subjects generally, regardless of personality type. Since their choice for music is simply described as being of a "fast tempo" (Dobbs et al., 2011, p. 308), the investigators may have inadvertently introduced a confounding variable into the study's design through their music selection; and this, in turn, may have possibly

compromised the study's ability to accurately measure the subjects' performance in verbal reasoning tasks.

Volume is another troubling limitation of this study. In reading the Dobbs et al. (2011) paper, neither the volume of the music, nor the volume of any of the noise conditions was reported in the description of the researchers' methods. Whether the reason was that this was not measured by the researchers, not considered relevant, or simply not reported, this omission ultimately lessens the experimental power possible for this study. Similarly, Thompson et al. (2011) - again contemporaries to the Dobbs et al. (2011) team - also determined that volume could also act as an independent variable. Therefore, like tempo, volume too had the potential to be a powerful factor disrupting verbal reasoning tasks.

Further, the choice of Dobbs et al. (2011) to utilise music with lyrics also had the potential to introduce still more problems into their study. It is now known through a slightly later study, that Brodsky and Slor (2013) demonstrated that verbal reasoning tasks were also capable of being disrupted though the presence of background music that contained lyrics.

Because tempo, volume and lyrics each can be shown to individually operate as potential variables within background sound research, the experimental veracity of the Dobbs et al. (2011) study deserves (at least, some) qualification. Finally, since the study only tested female adolescent students, it is impossible to know from this study alone whether its findings generalize also to boys, or even to adult women; or, in the context of this present study, for adolescent girls who have a disability.

**Implications for Classroom Practice**

While the experimental strength of the Dobbs et al. (2011) study results might be weakened through some methodological elements within its research design, this is

not to say that its findings are irrelevant. In fact, the study's results clearly demonstrate that by manipulating background sound in classrooms, student performance can be materially altered. Since classrooms typically contain students across the full spectrum of introversion to extroversion, the Dobbs et al. (2011) study also clearly shows that (at least in terms of manipulating background sound to enhance learning) simple, generic solutions to improve academic classroom performance cannot be easily applied.

Despite some weaknesses, studies like these show that understanding the interactions between background sound, learning, a student's level of introversion or extroversion and their resultant academic performance should not be underestimated. The challenge for educators is how to utilise what research investigating background sound and human performance can help us to know.

**Diversity of Opinion**

It is important to note that not all researchers agree as to the extent that background sound can affect cognitive processes. Some studies fail to find a correlation between children's learning and background sound at all. For instance, in two studies by Lutz Jäncke, a Swiss neuropsychologist, the researchers again investigated the link between background sound and verbal learning (Jäncke, Brügger, Brummer, Scherrer, & Alahmadi, 2014; L. Jäncke & Sandmann, 2010). In each of these studies, the researchers found that background music (with lyrics) failed to exert an influence on the verbal reasoning tasks that were trialled under their own research conditions.

These two studies (and others that are similar) underline the fact that the influences of background sound/s as a cognitive operator are not universal for all situations. Alternatively, other researchers, for example Chou (2010) or Kang and

Lakshmanan 2017), suggest that background sound can actually create an *attention draining* effect and thereby it can inhibit performance.

Conversely, still others suggest that the applications of what is now known through research about background music, and especially how it associates to other aspects of human behaviour, are so powerful they should not be limited to teaching practice but extend well beyond the classroom. For instance, Ziv and Dolev 2013), found that background music broadcast into a school playground significantly reduced the incidences of bullying (baseline/music comparison: $i = -7.91$, $p<.001$). Extending this understanding well beyond the schoolyard, and drawing (at least partially) upon educational music/attention studies, Huang and Shih (2011) in their own research, hypothesised that workers' concentration could be enhanced through the broadcasting of background music into the workplace. As a result of their research Huang and Shih (2011) concluded that carefully selected background music could indeed result in increased worker productivity.

Existing research clearly frames the function of background sound (and particularly music) as a cognitive operator. It is important to note that in more recent studies into background sound, an important change in focus has occurred. Unfortunately, the chief pedagogical limitation of much contemporary research in this field is that it is not educators, or even music therapists, who are now driving the research - it is retail marketers. So, while compelling evidence has long shown that background music can directly influence human behaviour (Andersson, Kristensson, Wästlund, & Gustafsson, 2012; Eroglu, Machleit, & Chebat, 2005), attention (Huang & Shih, 2011; Shih, 2012) and decision making (Sunaga, 2018; Ziv, Hoftman, & Geyer, 2011), and while these ideas and understandings are retested and re-confirmed through many contemporary studies, there is an inherent danger in educators

informing their classroom practice from research that results from cross-disciplinary understandings.

While caution should be exercised, educators should not be tempted to dismiss the body of research that has been conducted by non-educators as wholly irrelevant. Clear, empirical evidence exists to demonstrate that by manipulating background sound it is possible to deliver positive, measurable effects on human listening, response and productivity across an array of circumstances. Since classrooms are not sterile auditory environments, wise educators should be open to allowing all relevant research to inform their pedagogy. If, through the skilful manipulation of background sound student learning can be enhanced - this is not merely desirable, this is good pedagogy.

**The Mozart Effect (Externally-initiated, Active Listening)**

**Rise of the idea.** The critical difference between unfocussed and focussed music studies is that focussed listening requires active, rather than passive, exposure to the music source. Typically, in studies of the active listening to background sound (or music), subjects might be instructed to 'listen to something' before undertaking a test or use music to actively 'relax' during pre-test conditions.

Scientific discussion about focussed music listening is dominated by a single study. Originally published in *Nature* and cited 530 times (Scopus, 2019), Rauscher, Shaw, and Ky (1993) ignited scientific controversy that would last beyond two decades. Their simple study tested the performance of three groups of 36 college students engaged in four abstract/spatial reasoning tasks. Three, ten-minute pre-test conditions of listening to: silence, 'relaxation music' or Mozart's Sonata (K.488) were determined as the dependent variables. No statistically significant difference in test scores resulted for subjects sitting in either silence or relaxation music groups during

the pre-test conditions. But, after just ten minutes of pre-test listening, the subjects in the Mozart group outperformed their peers in a series of abstract/spatial reasoning tests.

Almost immediately, the study received cautious peer review through scientific correspondence (McLachlan, 1993). The obvious limitation of the study was its brevity. For example, variance of subject scores was not provided and, while an experimental mean was shown (as a simple histogram), distributions of test results were neither provided nor explained. Essentially, the study's experimental power could not be ascertained because the report contained insufficient explanation.

Despite this, the idea of simply listening to ten minutes of Mozart resulting in a higher IQ seemed like 'something for nothing', and the study the ignited the public's imagination. Hetland and Winner (2001) account for the enormous interest in the Rauscher et al. (1993) study to be likely as a result of the international press coverage that their article received. But the short report also piqued the interest of the scientific community, and many other researchers attempted to replicate the Rauscher et al. findings.

**Demise of the idea.** Despite consistent, widespread, ongoing public acceptance for the *Mozart Effect*, empirical evidence for its existence is poor. While some studies, such as Rideout and Taylor (1997) quickly followed, and Rauscher et al. (1993) and were able to demonstrate results similar to the initial study, other attempts to replicate the original research were simply failed to find any significant effect size (Chabris, 1999).

In a study by Nantais and Schellenberg (1999), both a *Schubert Effect* and a *Stephen King Effect,* albeit limited, were found. Mimicking the central idea of the Rauscher et al. (1993) study, these 'effects' were found as the result of subjects

listening to ten minutes of Schubert's music or a short story by Stephen King (respectively) during pre-testing. In each case, a small improvement for spatio-temporal performance was shown when the test results of these subjects were compared to those of the subjects who sat in silence during the pre-testing period. Rather than quelling the debate, the Nantais and Schellenberg (1999) evidence not only reinflamed, but broadened, the scientific debate by suggesting that listening to Mozart, or indeed anything, is a better predictor for spatio-temporal success than is sitting in pre-test silence.

In a meta-analysis conducted by Pietschnig, Voracek, and Formann (2010), the results of almost 40 *Mozart Effect* studies involving over 3,000 subjects were analysed. Pietschnig et al. (2010) concluded that, while the evidence does suggest that a Mozart effect *exists*, its effect size is too small to be significant - that is, with two exceptions. The researchers determined that experiments affiliated with two researchers: Rauscher or Rideout. These two researchers typically delivered results in their experiments that were three times greater than the results of studies that had been conducted by other researchers. Pietschnig et al. (2010) concluded that the results that were reported (separately) by either Rauscher or Rideout reflected publication bias.

**Monetising the Mozart Effect.** Despite these problems, the *Mozart Effect* is an idea that is unlikely to disappear. In 1997, Don Campbell, an American researcher, author and entrepreneur trademarked the term *Mozart Effect*, and registered it for his commercial advantage. Campbell subsequently authored over 20 books linking music, and particularly the music of Mozart, to health, education and creativity. Despite considerable subsequent research that has undermined the scientific veracity of a *Mozart Effect* having power to enhance human performance other than to a very small

degree, the relentlessly marketed Mozart Effect® brand remains essentially undamaged.

## Instrumental Music Tuition (Self-initiated Active *and* Passive Listening)

**Conceptual frameworks.** Studies examining music and its non-musical effects are as diverse as the researchers who investigate them, from neurophysiologists and music therapists through to retail marketers. However, across the literature investigating instrumental music, two clear conceptual frameworks emerge: arousal, and transference. These are the idea that human performance can be altered (enhanced) because of the action of some outside factor. Moreover, since these outside factors can be manipulated, the human performance can likewise be altered as a response to these factors.

***Arousal.*** Studies conceptually grounded in *arousal* suggest that change to subjects' arousal can alter their performance. When reaction speed and/or problem solving tasks are involved, elevated arousal has been shown to facilitate subject performance by modulating the autonomic nervous systems (Ünal, de Waard, Epstude, & Steg, 2013). Additionally, manipulating *arousal* has also been shown capable of inducing relaxation, altering human emotional response (Imbir & Gołąb, 2017; Juslin & Vastfjall, 2008) and changing test subject's sense of self-esteem (Elvers, Fischinger, & Steffens, 2018).

***Transference.*** The theoretical framework characterizing most studies that correlate instrumental music to various non-musical effects is *transference*. Dating from the early twentieth century, Thorndike and Woodworth (1901) postulated a *transfer of practice* theory suggesting that learners do not approach new situations with an 'absolute' lack of knowledge. Instead, competency in new situations is

facilitated as a result of the cumulative knowledge and practical skills that any person has acquired over their lifetime.

While some internal dissent still exists among transfer theorists as to how transference occurs, transference is generally understood to operate in two categories. These are that it is either *near* or *far* (Dixon, 2000). *Near transference* explains competency as a function of the similarity between two seemingly unrelated tasks. When near transference occurs, automated skills are subconsciously engaged, and a near transfer of skills facilitates a person's performance in the new task occurring without intentional thought. Schunk (2013) describes *far transference* as connections that are formed across disciplines or contexts. That is, seemingly disassociated competencies become associated.

**Music and far transference.**

***Evidence.*** Empirical evidence demonstrates that children who learn musical instruments academically outperform children who do not, and that this phenomenon can be shown to generalize across their schooling. In a study grounded in the idea of far transference, Cabanac, Perlovsky, Bonniot-Cabanac, and Cabanac (2013) analysed the general school scores of 560 Alaskan high school students. The researchers compared the grades of students who had elected to continue instrumental music study (when it became optional) to those who had not. For every subject (sport, science, maths, history, French, English, Spanish, environmental science, ethics, chemistry, physics and socioeconomics) the instrumental music student cohort outperformed the non-music cohort.

More recently, in study of 265 American elementary [primary] school children, Holochwost et al. (2017) found that when their general academic school results were compared, children randomly chosen to participate in music studies performed better

than their peers who did not. The researchers concluded that the children who were involved in the instrumental music training not only outperformed their peers (generally) who did not undertake instrumental music training, but consistently produced significantly better scores in English language skills [$t(163) = 3.58$, $p < .001$] and mathematics, [$t(163) = 2.56$, $p = .011$]. The researchers also determined that when tested on short-term memory tasks, the music group showed better results than did the non-music group.

Importantly, these results do not seem to be geographically specific. For instance, in a study of Portuguese children, dos Santos-Luiz et al. (2016) also found that children involved in instrumental music training clearly outperformed their non-musically trained peers in both language and science, and (to a lesser degree) also in history, geography and mathematics. The researchers attributed the difference between the two groups as being a direct result of the instrumental music training. Similarly, Wetter, Koerner and Schwaninger (2008) in a study of 120 Swiss children determined not only was instrumental musical training strongly associated to increased school performance, but that when the musical training was 'continuous' over longer durations it helped "to achieve and maintain school performance at a high level over time" (p. 365).

The research group, primarily interested in cognitive science and neurophysiology, accounted for their results in determining that instrumental music training was likely to have functioned as a cognitive agent to children's neurological maturation process. They concluded that instrumental music training had "appeared to induce structural and functional variations of certain regions of the brain resulting in manifold implications…[and that in terms of maximising educational potential]…it makes sense to take advantage of this period of high brain plasticity [early childhood]

and to promote an early beginning of musical training for children" (Wetter et al., 2008, p. 372).

***Causality.*** While many studies, like that of Cabanac et al. (2013) do not suggest an actual *causal* link between music and improvements in children's educational attainment, the results of research such as this clearly suggests that an association is highly likely to exist between a child's involvement in instrumental music tuition and their subsequent academic success. Hargreaves and Aksentijevic (2011) argue that the greatest problem in establishing music/IQ causality, is that children with higher IQs might well be drawn to music in the first place. Therefore, superior academic performance shown by music students in many studies might ultimately be as the result of executive function, rather than because of the student's (coincidental) involvement in music training.

There is no doubt that two papers by Schellenberg [(2004), (2006)] are seminal to research investigating links between music and IQ. Cited 405 and 187 times respectively (Scopus, 2019), these two articles are quoted as support for positive correlations existing between instrumental music training and IQ (Hille & Schupp, 2015). They are disputed (Bialystok, 2011), and they have also been used as a springboard for other international studies that validate Schellenberg's results and suggest that they remain true across multiple geographical contexts (Wetter et al., 2008).

Measuring IQ before and after the introduction of instrumental music training, Schellenberg found that children who were involved in instrumental music training demonstrated statistically significant increases to their IQ when compared to children in the control group who received no music training. He subsequently demonstrated

(Schellenberg, 2005) that the longer a child continued instrumental music training, the stronger was the association of music as a predictor for higher IQ.

***Finding a balance between opposing theories.*** Criticizing Schellenberg's linkage of music training to improvement in a child's IQ, Bialystok (2011) suggested that (i) the IQ/music relationship is mediated chiefly because of the overlap between executive function and IQ, and thus (ii) Schellenberg's measures of executive function are invalid. Responding, Schellenberg (2011) countered that both his hypothesis for, and his measures of, executive function were each well-grounded in what had been shown by contemporary research literature that had investigated executive function, and that Bialystok's criticism was itself flawed.

What is ultimately important is not that Schellenberg or Bialystok are right or wrong regarding causality. Instead of arguing about the nature of causality and how it remains unproven in these experiments, it is the *trend* that emerges across the literature and shows associations between recurring variables that is important. Discovery should compel scientific discussion and further investigation. While it would be desirable to be able to determine causality in a way that was conclusive, the validity of experimental findings should not be considered invalid simply because of doubt surrounding (present) causal certainty. Regardless of causality, if a co-variant association can be shown to exist, then scientifically this is important.

Understood across its breadth, contemporary research reveals that learning a musical instrument is repeatedly shown as a strong predictor for increases in a children's general academic performance. In reviewing the literature, students who are involved in practical music training can be repeatedly shown to demonstrate higher proficiency than their non-musical peers in a diverse range of non-musical tasks including the sequencing of verbal information (Piro & Ortiz, 2009), reading (Moreno

et al., 2009), decoding emotion in prose (Thompson, Schellenberg, & Husain, 2004), spatial awareness (Patston et al., 2007) and memory function (Franklin et al., 2008).

***The need for prudence.*** Vaughn (2000) through meta-analytical analysis of studies undertaken in this field cautions that, across the literature, the strength of correlations between students learning music and extra-musical improvements can be widely varied. While some studies demonstrate a powerful (apparently) close association between the two, in other cases the association between music and improved academic outcomes can be weak. While it is true that the effect sizes varied largely between individual studies, Vaughn (2000) nonetheless found an association between instrumental music training and children's academic achievement, although suggested that many reasons could possibly account for this variance. Ultimately, while suggesting the need for prudence, the Vaughn (2000) meta-analysis also clearly shows that a sizable body of literature substantiates that there is some form of association existing between instrumental music training and children's academic achievement and that this can be demonstrated through an array of different measures such as literacy, numeracy and social skills.

***Problems of sample size.*** A common criticism of studies that positively associate instrumental music and academic achievement is that their experimental results lack power due to small sample sizes. That is, while the results of individual studies might be 'internally' significant, they may simply represent only a localized effect. Small sample sizes prevent researchers safely extrapolating experimental results. This is one of the chief limitations of pilot studies and cross-sectional sampling methodologies, both of which are used extensively in this field of research.

*Champions of Change* (Fiske, 2004) was a report that described the findings of a study of more than 25,000 American school students. Produced in cooperation with

the United States Department of Education, the report represented a longitudinal analysis of the impact of Arts education in America. The significance of this report was that it eliminated the possibility of a localized effect. The report's executive summary (Fiske, 2004) concluded that high arts participation:

a. was the most significant predictor of academic success,
b. correlated positively to community engagement and self-learning,
c. was highly correlated to success in reading and interpersonal skills, and
d. made a greater difference for students from low income backgrounds than it did for those who came from higher income backgrounds.

Although now dated, but still of considerable importance because of its study size, Morrison (1994) performed a longitudinal study of 13,000 high school students and determined that those students who had been involved in instrumental music training clearly outperformed their peers who had not undertaken music training in the areas of English, mathematics, history and science.

Similarly, Johnson and Memmott (2006) considered the academic results of 4,739 third grade and fourth grade American children. In this study the researchers were able to show that the cohort of children who were involved in instrumental music training significantly outperformed those children who had not been involved in that training. This was evident in the scores of children for mathematics, reading and also for their overall academic school attainment (grades). The researchers concluded that instrumental music training was the single greatest factor most likely to be responsible for the disparity between the grades for individual children involved in their study. The researchers concluded that there was a statistically strong relationship evidenced between children who had been involved in instrumental music training and those children receiving significantly better academic results.

**Transference and auditory discrimination.**

***Defining auditory discrimination***. Auditory discrimination is the term used to describe the ability for humans (or animals) to comprehend some variance between two sounds. That is, for a person to determine whether two sounds are the same, or whether they are different.

***Evidence.*** Auditory discrimination is measurable. In their professional practice, audiologists measure auditory discrimination by determining the extent to which individuals vary in their ability to aurally discriminate between sounds, sound-patterns and silence (Müller, Fleischer, & Schneider, 2012). Audiologists commonly measure auditory discrimination across four values - discrete pitch, simultaneously sounded pitches, rhythmic variance and sound patterns (Cooper & Roberts, 2009). Moreover, these same measures define four discrete parameters through which standard deviations for auditory discrimination can be described for individuals at various ages (Jilek, Šuta, & Syka, 2014).

***Educational importance.*** In educational terms, individual variance between children's auditory discrimination abilities should not be underestimated. Researchers such as Conway, Pisoni, and Kronenberger (2009) find that auditory skills are more important than are visual skills in the scaffolding of cognitive sequencing abilities. Peterson (2012, p. 88) describes a student's ability to listen as the "key to their success". Importantly, Osman and Sullivan (2014) suggest that the better a child's auditory discrimination, the better the likelihood of that child's academic performance at school.

As proof of the power of altering listening environments on overall learning, Osman and Sullivan (2014) showed that by degrading classroom listening situations, auditory discrimination was itself degraded, and that poorer academic performance resulted as a consequence. It has also been shown that distinct anatomical changes exist between musicians and non-musicians (Gaser & Schlaug, 2003). Further, these differences appear to provide an advantage to musicians across a range of non-musical tasks (Sluming, Brooks, Howard, Downes, & Roberts, 2007). Iuşcă (2011) proposed that not only did anatomical differences exist when the neuroanatomy of musicians and non-musicians was compared, but that neural change (brain plasticity) could be shown to have occurred as a direct consequence of individuals being involved in instrumental music training.

***Instrumental music and neural plasticity.*** With the understandings delivered through research such as this, and in the light of recent research investigating children, music training and its capacity to positively affect neural plasticity, the place of music training within a child's broader education should not be underestimated. For instance, Gmehlin et al. (2011), showed that children's brains do not cease maturation during early childhood. Rather, the researchers determined that children's brains could be shown to develop continuously throughout their entire schooling.

Moreover, Wolfe (2010) found that during the entire period of their schooling children's brains demonstrated an enormous amount of neural-plasticity, that their brains had the potential for dramatic change, and that this change appeared capable of being regulated by various activities in which children were involved. It is in the light of studies such as these that work such as Iuşcă's (2011) showing that positive neural change occurring as a direct consequence of children's involvement in instrumental music training is of enormous importance.

In real terms, changes to auditory discrimination impact educational outcomes. Gordon et al. (2015) found that musical training affected children's auditory perception of rhythm. While this might be an interesting discovery of itself, these researchers also found that children's ability to discriminate rhythm also explained differences that they found between individual children's grammar skills. In the Gordon et al. (2015) study, the children who could best auditorily discriminate musical rhythms (that was the children had been involved in instrumental music training), consistently demonstrated the best grammar skills and produced the best literacy scores.

Further, in a study investigating the effects of instrumental music training on children's auditory discrimination, Tierney et al. (2015, p. 10062) sought to determine whether there was a period during which auditory discrimination could (or could not) be significantly altered with a significant effect. The researchers concluded that children's involvement in instrumental music training that had started even as late as adolescence was of benefit and that it could materially "enhance neural processing of sound and confer benefits for language skills".

***Instrumental music as a mechanism for neural plasticity.*** If differences in neural anatomy do provide advantages to children simply because of their involvement in instrumental music training as is suggested by Holochwost et al. (2017) or by Gordon et al. (2015), then this has very important ramifications as to how music should be considered within the overall picture of a child's education. That is, whether instrumental music training should be considered simply an ancillary activity, or whether it should be considered as fundamental to maximising the development of a child's overall learning.

A link between instrumental music training and improvements in children's auditory discrimination has certainly been established in the research literature; and

critically, children's involvement in instrumental music training has been positively associated to changes to children's auditory discrimination skills. Notably, Hyde et al. (2009) found that improvements to the auditory skills of children who undertook instrumental music training were significant and long-term. Further, researchers such as Lappe, Herholz, Trainor, and Pantev (2008), found that children showed beneficial changes to cortical plasticity even after short periods of instrumental music training.

## Music for Children with a Disability

### A Gap in the Literature

Given the body of knowledge demonstrating the efficacy of music as a tool in general learning, the question of how instrumental studies function as a tool within a disability context - and if students who have a disability show academic gain/s that are comparable to those of the general population - is of great interest. A literature review of five databases (*ERIC, A+ Education, ProQuest, Research Starters - Education*, and *Education Source*) revealed surprising results. There is a paucity of study in this area.

Studies that exist that link children, disability and music are (typically) dated For example, (Murphy, 1957) or (Dreikurs, 1960). Alternately, like the study of Ockelford et al., (2011), they are skewed away from direct school-based application. While research dating from the post-WWII period has frequently investigated the effect of music for people who have a disability, these particular studies most commonly describe how music can deliver a range of beneficial outcomes for returning soldiers who have *acquired* a disability (Quilty, 1957).

More recent music therapy studies, such as that by Calcaterra et al., (2014), tend to be hospital-focused and largely ignore the classroom. The commonality of this focus for investigations of music with children who have a disability and published

within music therapy literature is likely to be attributable to the modern re-positioning of music therapy as a paramedical discipline, and the journal articles simply reflecting this.

**Content Analysis of the Extant Literature**

The under-representation of children who have a disability in the greater body of research is not a problem limited to the area of music. For instance, in a review of the literature that investigated comparative education contained in the leading four journals within that field, and ranging over the years 2000 to 2013, Brown (2013) determined that only a very small percentage (1.08%) of the total reports published in these journals made any effort to consider how students who had a disability fitted into the overall picture.

In reviewing the literature for this study, of the studies that did specifically involve music and children who had a disability, two clear types of disability research emerged. In both instances these were studies that examined how music was used 'functionally' for students who had a disability and were divided broadly between two distinct fields. These were: (i) medical intervention and (ii) pedagogy.

**Medical interventions research.** Medical intervention studies focused on how music could affect physiology in one of three ways. For instance, anatomical studies revealed that music could do such things as alter heart-rate (Khalfa, Roy, Rainville, Dalla Bella, & Peretz, 2008), induce calm (Hooper, 2012) and modify gait (Thaut et al., 2007). Conversely, biomechanical studies typically investigated the enabling of musicians after some form of physical trauma. An example of this is the study by Boyette, (2005).

Finally, complementary medical intervention studies focused their investigation on music as an adjunct to some form of physical therapy (with the aim of

enhancing that therapy). For example, Wetherick (2014) investigated music as a communication strategy that could be employed by children with language impairment. While studies of this type with a specific physiological focus also have some classroom application, the function of music in this type of research remains primarily as a medical intervention.

**Pedagogical research**. The general problem with the pedagogical studies that name children who have a disability as a specific feature of the study, is that they are largely about how teachers can *use* music with children who have disabilities, rather than how it can function for these children [For example, the studies by Hourigan, (2007) or McDowell, (2010)]. Even in some studies, like that by Hash (2011), that directly examined both instrumental music and children who had a disability, pedagogical research involving music and children who have a disability remains principally about *how* to teach music to students who have a disability, not about whether music might deliver various non-musical benefits to children who have a disability (as is the case for the general studies that investigate music and involve children who do not have a disability).

Finally, a rather limited number of studies investigate the idea of music and inclusion. For example, this is the purpose of the study by Gerrity, Hourigan and Horton, (2013). However, in these studies the focus is chiefly how to include children who have a disability into general classroom music, and not into instrumental training.

## Implications from the Literature Review

### Toward a Research Proposal

Literature review of the studies investigating instrumental music training and its ties to children's academic improvement reveals a gap. Despite research existing to

show that teaching instrumental music to children *without* disabilities correlates positively to numerous non-musical benefits, similar studies that examine cohorts of children who do have a disability (or even children who have a disability as a subset within these general studies) do not exist.

As a result, the trends and correlations shown to exist for children who do not have a disability and who are involved in instrumental music training, cannot translate directly into a disability context. Because the research does not exist, likewise a clear understanding of whether children who have a disability might also benefit from their involvement in instrumental music training cannot exist.

**The Decision to Collect Quantitative Data**

Interestingly, in reading the literature about music and its non-musical benefits one form of analysis dominates virtually all these studies: quantitative analysis. Therefore, in developing this present research project to determine whether instrumental music tuition might deliver any effect for children who do have a disability, also adopting a quantitative approach was the most appropriate.

It is logical that mirroring the approach used to determine the effect of music on one cohort (that is, children who do not have a disability) and utilised by almost all of the studies in this field, this approach should be equally valuable and thus, the most appropriate means of examining another cohort (children who are similar to the group typically investigated, except that they have a disability). While the decision to use quantitative analysis in this study is for the purpose of aligning it to the methodology typically employed by other studies in this field, the critical issue is not ultimately style, it is discovery.

**Use and Function as Terms**

It is important to understand that in the field of music, the terms *use* and *function* are, in some ways, loaded words and have quite specific meanings. Dating from the 1950/60s, ethnomusicologists noticed that in almost every setting where music was present, music could be described in two quite distinct ways. These were: either by its use, or by its function. Consequently, in musical terms, the word 'use' describes how music might operate situationally. (For instance, its use at a birthday party, or it use as background music). The term use also suggests that while the listeners/participants are exposed to (or hear) the music/sound source openly, they do so passively.

Conversely, the musical idea of function refers to isolating the reasons why music might be employed in particular situations. Function necessarily infers that there is a purpose for the inclusion of music in a particular situation (For instance, its function in ritual, transmission of knowledge, song lines, in an elevator, or in a shopping centre). Importantly, while in many situations use and function can both operate simultaneously, each can be considered, investigated and analysed discretely.

The ethnomusicological idea that a distinction exists between the way that music is used and the way that it functions is not new. Merriam (1964, p. 209) stated that identifying "the uses and functions of music represent one of the most important problems in ethnomusicology". However, understanding this distinction of how the use of music might differ from its function is important in the context of this literature review because it explains (at least partially) the lack of literature that examines music and its non-musical benefits for children with disabilities.

Reviewing the literature that involves both music and students who have a disability, most of the studies measure only the use of music. That is, in these studies the student is simply a passive recipient of the music and the music is situationally

applied. This contrasts with studies investigating the function of music, where the music is instead purposefully applied, and the student an active participant within their sound environment.

**Use and Function in the Light of the Literature Review**

The lack of literature discussing instrumental music and children with disabilities appears to result from a disproportionate focus on the 'use' rather than the 'function' of music. This literature review has revealed that most studies that do examine music for students with disabilities tend to measure the *use* of music where the student is a passive recipient, rather than the *function* of music where the student is an active participant.

In the context of studies that show that music has delivered specific non-musical benefits, it is the function of music that is paramount. Therefore, the impact of music on student performance is viewed as a *function* - that is, one upon the other. Importantly, in the music studies that involve students without disabilities, it is music's function that is primarily discussed. Studies that investigate how music might educationally 'function' for children who have a disability is what is missing from the research literature, particularly those that examine music and its effect/s through a disability lens.

## Conclusion

Research identifies that background sound and, particularly, instrumental music training closely relate to children's academic performance. Despite the limitation of not being able to establish definitive causal links, compelling evidence exists to demonstrate that children who are taught to play music instruments academically outperform those who do not (Ewing, 2011; Holochwost et al., 2017).

Maximising educational outcomes is just as important for students who have a disability as it is for those who do not. However, in reviewing the literature examining the links between music, academic performance and those children who have a disability, it is clear that music research is not conducted in the same way for children who have a disability as it is for those who do not. For children who have a disability, music is primarily used therapeutically, and these are the results that are typically reported. Unlike other cohorts, scientific research does not appear to exist to measure what happens when children who have a disability are included in instrumental music training.

Consequently, knowledge about the effect that instrumental music training might have for children who have a disability is limited because research in this field is itself severely limited. The function that music might have in a disability context deserves reconsideration.

# Chapter 3: Methods

**The reason for this study.**

Research investigating music and its associated benefits has shown that instrumental music lessons can be extremely effective in enhancing children's learning, (Ewing, 2011; Gordon et al., 2015). Yet, a gap exists in this literature. Despite the body of research investigating music and its associated non-musical benefits, it cannot be shown, whether (or not) children who have a disability receive the same benefits as do their peers who do not have a disability, if they too participate in instrumental music tuition.

Before embarking on this project, it was a review of the literature in this field that revealed this troubling gap. The problem was that, in the *A+ Education, Education Source, ERIC, ProQuest and Research Starters - Education* databases, research purposefully identifying children who have a disability as participants in music/non-musical benefit/s investigations does not exist. Since, as a cohort, children who had a disability were not identified as being part of these studies, likewise it cannot be automatically be presumed that what is experimentally true for children who do not have a disability is also true for those students who do.

This is even more puzzling when juxtaposed against the volume of research dedicated investigating various aspects of disability - including children and their education. It seems peculiar that researchers would not also be interested in whether

(or not) music might positively affect the learning outcomes of children who have a disability in the same (or, at least similar) way/s as it has been shown to do for children who do not have a disability.

The existence of this gap is even more strange when considered in the context of the years post-2000 where, at least in Australian educational practice, equity and *inclusion* have been acknowledged as a fundamental principles (Australian Bureau of Statistics, 2014). Yet, for educators not to *know* whether involvement in instrumental music training is likely to be helpful for children who have a disability is more than just philosophic. In terms of educational best practice, this gap is as problematic as it is surprising.

## The Purpose of this Study

### Aligning this Study's Methodology

To address the gap in the existing literature, research that attempts to do this must be comparable to the literature in which the gap can be shown to exist. It is for this reason that this study's methodological elements have not simply been arbitrarily chosen. As it will be shown below, most physical elements of this study such as its research questions, design, methodology and theoretical framework, have each been purposefully selected to carefully align this study with other similar research studies in the field of music and its non-musical benefits. This has been of importance because by positioning this study to sit harmoniously among other studies of a 'like kind' (that is, to have a comparable methodology and purpose), this study might appropriately address the gap in the literature.

**Towards the Development of Appropriate Research Questions**

The fundamental goal of this study was, in some ways, always defined. At its broadest, it was to engage in research investigating possible association/s between instrumental music training and non-musical benefits. In this case, the non-musical attribute was physiological - children's auditory discrimination. While this study represents 'new' research, it was always a goal of this project for it to be conducted in ways that were similar to other studies that already exist in this field. It was for this reason that the research questions sought to identify whether instrumental music training might affect children's auditory discrimination skills and, in turn, deliver a benefit beyond the child simply learning to play a musical instrument.

Yet, to address the gap found in the literature, this study has had a unique focus. By crafting its research questions to necessitate the identification of children who had a disability within the participant sample, it directly addressed the gap that was found to exist within the literature. It is for this reason that the following research questions were determined as the basis for this study's investigation:

I. Can instrumental-music instruction be shown to affect the auditory discrimination skills of children who have a disability? and
II. Do the auditory discrimination skills of children who have, or who do not have a disability, display similarity/difference before and after the introduction of instrumental-music training?

**Wording the Research Questions**

While consistent to the 'type' of research question typically investigated by studies in this genre, the wording of research question I has been designed to address the gap in the literature (about children who have a disability) by specifically making the words "who have a disability" a feature. Research question II addresses the

problem of the gap in the literature directly by requiring the comparison of children who have a disability with children who do not have a disability.

These are simple yet significant inclusions, because in music studies typical of this genre children who have a disability are neither named nor described in the results. Critically, therein lies the essence of the problem within the typical research designs in this field that has, in turn, produced the gap that has been found to exist in the literature.

While it is not necessarily true that children who have a disability are considered unimportant as a cohort by researchers, it is just that it seems that they are not formally considered. Therefore, the specific wording of both research questions, but research question II particularly, is wholly about removing any doubt regarding the implications of involving children who have a disability in instrumental music training and including them as an important cohort within the investigation.

The Research Questions in this study had a purposeful dual-focus. They were as much about meaningfully investigating instrumental music training and its possible association/s to children's auditory discrimination, as they were about exploring similarities and differences that might be found when the results of the children in this study who had a disability were compared to those of the children who did not have a disability.

**From Research Strategy to Research Design**

The structure of this study was relatively simple; that is, two cohorts of children. These were: children who, over one semester, undertook instrumental music training (the experimental group), and similar children who, over the same period, did not undertake instrumental music training (the control group). However, in order to understand whether involvement in musical training resulted in a quantifiable benefit

for children who had a disability, it was necessary to establish subsets within the two basic cohorts. Therefore, both the control and experimental groups were each subdivided into two important sub-groupings: children who had a disability, and those who did not have a disability.

**The Impact of Ethics on this Study's Design and Method**

There is an ethical dilemma commonly associated with experimental studies where one group is likely to receive something that is potentially 'of value' yet the other does not. When this is a possibility, then the ethical formation of groups within a study's design must be considered carefully. The ethical consideration of how groups were formed in this study was very important since the project was predicated on the understanding that the literature generally shows that children who are involved in instrumental music training are highly likely to receive numerous, positive educational outcomes as a result (Cabanac et al., 2013; Degé, Wehrum, Stark, & Schwarzer, 2011).

Although it in this instance it could not be absolutely known whether children who had a disability would also experience benefits that might be similar to their peers who did not have a disability, given the volume of research that has associated instrumental music training to an array of other non-musical benefits, there was always a strong likelihood that children who had a disability would also receive some benefit. Therefore, the freedom to randomly assign children - regardless of if they had a disability - into a 'control' group where they were likely to miss out on any potential benefits occurring as a result of the intervention was fundamentally unethical.

As a solution to this problem this study adopted a quasi-experimental design rather than a true experimental design. This meant that the participants were not randomly allocated into either of the control or experimental groups. Instead, from

within the schools where this investigation was conducted, the existing groups in which the children were already being taught instrumental music became the groups used for the investigation.

This ultimately proved to be a facilitator to this study's design rather than limitation to how it operated. As it will be shown below, by utilising the already existing groups within the schools functionally provided groupings that were suitable to operate as the control and experimental groups, yet without the need for researcher interference. Moreover, by utilising these existing groups (i) the children's general teaching within the participating schools was not disrupted, and (ii) the ethical dilemma that would have been otherwise associated with the random selection of children into either of the experimental and control groups was, in this case, eliminated.

**Understanding the Two Instrumental Music Models Operating in Queensland Schools**

In the following sections, the mechanics of how instrumental music is taught in Queensland schools will be discussed. It is important to note that the terms *opt-in* and *all-in* are not terms that are in general usage in either schools, or in the general literature. They are used here as a means of describing 'how' schools manage the mechanics of their instrumental music teaching. In investigating this project, it became clear that two distinct, yet quite distinct models defined the way in which instrumental music training was commonly delivered across Queensland schools. The choice to use the labels opt-in and all-in was essentially a convenient means of delineating the difference between how instrumental music teaching was delivered through each of the two models.

**Model 1: Opt-In**. In many Queensland schools, learning to play a musical instrument is an option made freely available to students. Through their school, many children 'opt-in', or choose to learn to play a musical instrument. Many more children opt-out of instrumental music training, choosing not to spend the time required to learn a musical instrument.

Education Queensland, Queensland's state education authority, offers instrumental music training in its state (government-run) schools. To provide this it employs registered teachers who are also instrumental music teachers to deliver these lessons. In-school instrumental music lessons typically commence for children when they are in Year 3 (that is, children who are 8 years-of-age, and turning 9). These instrumental music lessons are taught as weekly lessons over the school year, are conducted in large groups, and are run during school hours. In Queensland schools, children miss other regular classes in order to attend these instrumental music lessons.

In most state schools, Year 3 students can borrow a musical instrument directly from their school and, although there might be a small levy for a year's instrument ‘hire’ or a one-off cost for a tutor book, the instrumental music lessons themselves are completely free. Therefore, at least in state schools, children who wish to learn an instrument should not miss out simply because they do not have the economic means to either afford lessons, or to purchase an instrument.

Similarly, many private (non-government-run) schools also offer opt-in instrumental music programs. Like state schools, instrumental music lessons in these private schools are run during school time, are weekly, and are taught by registered teachers who are also specialists in one or more instruments. However, unlike state schools, instrumental music programs in private schools are typically run as a user-pays system. Therefore, these programs attract children whose families have the

additional financial means to pay for lessons. Again, like state schools, children in these private schools 'choose' to participate in these programs, and thus are given the opportunity to opt-in.

The opt-in model for instrumental music training in Queensland has had particular importance for this research project. This is because the opt-in model effectively generated the two basic cohorts that were required for a meaningful comparison in this study. That is, one group of children who learned an instrument, and a second similar group of children (of the same age and situation) who did not learn an instrument over the same time period. Thus, in design terms, these two groups formed the basis of both the experimental and the control groups in this study.

In contrast, in this study the chief limitation of the opt-in model was that, as it has already been shown, children who have a disability are rarely part of opt-in school instrumental music programs. Therefore, while at the state schools in this study there was a group of children who had a disability and readily ‘available' for inclusion in the control group (that was, children who did not receive instrumental music training), there was not a similarly large group available from these same schools appropriate for inclusion in the experimental group (that was, children who had a disability and had also opted-into being part of their school's instrumental music training).

**Model 2: All-In.** Importantly, a limited number of private Queensland schools operate a second, quite different model as to how they conduct their in-school instrumental music tuition. In some schools, an instrument (usually the violin) is taught to all children of a particular year level, regardless of the personal circumstances of those children - including, whether any of these children have a disability. Again, in most cases schools offering these all-in instrumental music lessons most often provide them for children who are in Year 3.

In the private schools utilising this all-in model, children do not choose to become part of their school's instrumental music program. Instead, children who learn music under the all-in teaching model are compelled to participate in their school's in-class instrumental music lessons - just as they would be compelled to learn science or mathematics. In these schools where the all-in model operates, instrumental music lessons are simply regarded as a general activity of that year level. Therefore, all children participate.

**Significance of the models to answering the research questions.** In terms of this study, this alternate all-in model for instrumental music instruction has been extremely important. This was because finding reasonable numbers of children who had a disability in the opt-in music programs was, as expected, difficult. It has already been noted that children who have a disability are rarely involved in school instrumental music programs where those programs are optional, and this was the case in the schools where their instrumental music training was delivered through the opt-in model.

Yet, it is known that not only are Australian children who have a disability actively mainstreamed into general classrooms wherever possible, but that around 82% of these children [according to the most recent report of the Australian Bureau of Statistics (2014)] attend schools where instrumental music opportunities are available. The reality, affirmed by what was found in the schools involved in this study was that: at the schools where instrumental music lessons were optional, while numerous children had a disability, they did not generally participate in instrumental music lessons either through their school, or privately.

Conversely, in the schools running the all-in model for how they taught instrumental music to their Year 3s, children who had a disability were involved in

regular classrooms. Therefore, by necessity and because of the all-in model, these children who had a disability were caught up into the instrumental music teaching in the same way as were those children who did not have a disability. Therefore, in terms of this study, through the all-in model, it was possible to find and observe a cohort of children who had a disability, and who had also received 'normal' instrumental music training.

## The Significance of Auditory Discrimination in the Research Design

### A Theoretical Basis for Understanding Auditory Discrimination

Auditory discrimination is the ability to listen to various sounds and to discern any similarity or difference between them. Developed over a twenty-year period, Jones (1976, 1990) proposed his *dynamic attending theory* (Jones, 1976) as a means of explaining the way that humans make sense out of the sets of sounds, or series of sounds, that they hear. Jones' dynamic attending theory is the idea that complex auditory sequences are comprehensible because humans use discrete elements of sound - such as *tempo* (the speed of the sound, or music) and/or hierarchies of (musical) time - to perceive patterns within sound sets. In turn, these patterns provide cognitive reference points to the listener. It is this referencing of incoming data that allows the listener to discern and interpret what they hear. Thus, at the centre of dynamic attending theory is the idea that the human perception of the similarity or difference between sounds (that is: auditory discrimination) is discernible because of the developed ability for listeners to generate reference sets of auditory data, and that new auditory data is interpreted through this filter.

Explaining dynamic attending theory Drake, Jones and Baruch (2000) describe three features that are pertinent to my own study. These are the ideas of *referent level,*

*attunement* and *analytic attending.* Referent level is the term used to describe how a listener is enabled to "expect an important pattern [or event, or] …when, in time, attention should be heightened (Drake, Jones, & Baruch, 2000, p. 254). Attunement describes how an audio event might be aligned or misaligned. Thus, it describes how it is possible to aurally predict a particular sound event. Finally, analytic attending is used to describe how listeners can predict certain sounds because of reference points that are made within a sound sequence.

**Dynamic Attending Theory in the Context of this Study**

In my own study, student performance as measured by the Selmer testing is predicated on the children's capacity in these three areas. That is, the ability to listen attentively for a point in a musical sequence (Selmer's melodic contour and rhythmic memory tests – Parts C and D), to reference a single sound among others (Selmer's discrete sound test – Part A) and to analyse the similarity between varying sound combinations or patterns (Selmer's simultaneous sound test – Part B).

Researchers such as Bauer, Jaeger, Thorne, Bendixen and Debener (2015) describe dynamic attending theory as being extensively used in music psychology studies. Further, they describe Jones' dynamic attending theory as a means of both understanding and appropriately investigating the various elements of sound as they relate to auditory processing.

**Auditory Discrimination and Childhood Development**

Dynamic attending theory provides a means of understanding how humans make sense of the sounds they hear. However, human auditory discrimination can also be shown to follow a typical path of development. Since the 1980s it has been shown that children's auditory skills, and particularly their competency in discriminating

between discrete sounds develops through early childhood mirroring their general acquisition of speech and language skills (Spetner, & Olsho, 1990).

In investigating the auditory development of pre-school children, Jensen and Neff (1993, p. 106) concluded that "prolonged maturation of specific auditory discrimination abilities may compound the problems of children with impairments affecting speech and language acquisition". Moreover, there is evidence to show that impaired speech language skills are closely associated with problems with frequency discrimination. In a three-and-a-half-year longitudinal study of children aged between 9 and 12, the researchers concluded that there is "considerable heterogeneity in auditory function among children with SLI [Speech language impairment] and suggest that, as with auditory temporal deficits, difficulties in FD [frequency discrimination] are important in this population" (Hill, Hogben & Bishop, 2005, p. 1136).

That there are defined ways that children (or indeed adults) process auditory information and that these processes can been seen to both develop over time and follow norms across the population is important. In this study dynamic attending theory underpins how the information gathered in this investigation can be understood in terms of child development.

Integral to this study is the understanding that it was never designed to be principally an extension of scientific understandings of 'how' the mechanics of auditory discrimination operate. Instead, it had a very specific purpose. That is, it proposed to address the gap that exists in the literature investigating the teaching of music and the possibility of that yielding other non-musical benefits. Therefore, the design of this study was purposefully crafted to emulate – as closely as was possible - the style, methodology and theoretical framework of other studies typical of this genre.

## Overview of the Research Design

### Design Alignment: Methodology and Theoretical Framework

This study used a quantitative methodology. The choice for quantitative research was, like most other aspects of this study's design, purposeful. Music education literature, when filtered to isolate that which discusses music and its non-musical benefits, is characterised by a clear methodological mode: quantitative research. Jorgensen and Ward-Steinman (2015) found that, in music education research post-1978, a paradigm shift occurred where quantitative methodology largely replaced qualitative methodology. Yarbrough (2012, p. 278), in a content analysis of articles published in the *Journal of Research in Music Education,* determined that quantitative methodology was not merely historically dominant in the field of music-education research; but that quantitative methodology exerted a "continuing dominance" on music education research and that this was, in turn, reflected by what was published.

Finally, in applying the filter of music/non-musical benefits to music research - especially in the field of education - it was revealed that published research was driven (mainly) by psychologists and neuroscientists, both of whom were primarily interested in *transference* - that is, the idea that one skill could sometimes benefit seemingly unrelated skills (or skill sets).

In the context of this study, to appropriately address the gap in literature dominated by quantitative methodology, and with a prevailing theoretical framework of transference, it was essential that the paradigms of both the new and existing literature aligned. Hence, both the methodology and the theoretical framework choices selected for use in this study have been wholly intentional - quantitative methodology, and research grounded in the theoretical framework of transference.

## Study Design

### General Features of the Design

In the broadest terms, this study was designed as an intervention study. As such, it compared groups that were "deliberately subjected to different regimes" (Martin & McFerran, 2014, p. 473). Specifically, this intervention regime was whether children undertook, or did not undertake, instrumental music training. To determine whether instrumental music training resulted in any degree of change between the experimental and the control groups, pre-/post-intervention testing of children's auditory discrimination was employed. However, the greater aim of this study was to determine whether any similarities or differences emerged when the data from the cohort who had a disability was compared to the cohort who did not have a disability. Thus, children who had a disability needed to be identified as a subset within the overall cohort of both the experimental and the control groups.

### The Intervention

In this study, the intervention was instrumental music training that was delivered over the period of one semester. This consisted of 18 weeks of lessons, during which participants received one half-hour instrumental music lesson per week. In this study, the children who received the instrumental music tuition represented the experimental group. The children who did not receive instrumental music tuition over the same timeframe represented the control group in this study.

## Setting

This study drew data from four coeducational schools each located in south-east Queensland, Australia. Of these, two private schools provided instrumental music training through an all-in instrumental music teaching model, and two public schools

provided instrumental music training through an opt-in instrumental music teaching model. In each case, instrumental-music training was taught as in-school lessons and delivered during school time.

Of the two private schools, one was regional, the other metropolitan. Similarly, of the state schools, one was also regional, while the other was metropolitan. Table 1 (following) summarises the general characteristics of each of the schools that were selected for investigation in this study.

Table 1.

*Features of the Schools Involved in this Study*

| | School A | School B | School C | School D |
|---|---|---|---|---|
| Year range | P-6 | P-6 | P-6 | P-6 |
| School sector | State | State | Private | Private |
| Location | Regional | Metropolitan | Metropolitan | Regional |
| \Instrumental-music to Year 3 students | Elective Opt-in Model | Elective Opt-in Model | Mandatory All-in model | Mandatory All-in model |
| Group represented in this study | Control group AND experimental group | Control group AND experimental group | Control group | Control group |

## Participants

### Sampling, and the Formation of Groups.

This study formed its investigative groups through purposive sampling. To appropriately address this study's research questions, the investigative group's makeup needed to be finely focused. In order to determine what happens to the auditory discrimination of children with disabilities when they are included in instrumental music tuition, it was necessitated to select schools where children who had a disability were included in their school's instrumental programs.

This was simpler in the schools where an all-in model for instrumental music training was employed since, in accordance to their school policies, the only reason a child would not be included in instrumental music training would be either that:

i. modifying an instrument (or technique required to play that instrument) was not possible because of physical limitation/s, or
ii. a child exhibited physical distress that resulted from their inclusion in instrumental classes. For example, some children with Autism Spectrum Disorder (ASD) have been known to sometimes be unable to physically cope with the sound/s produced in instrumental music classes (Stiegler & Davis, 2010).

### Advantages and Disadvantages of Forming Groups in this Way

**Advantages.** By selecting the two private schools through which the all-in model compelled all Year 3 students be involved in instrumental music training, the result has been a purposive selection of both these schools and, by extension, their students. However, the benefit of this sampling procedure was that all the children who had a disability within the regular classes of each of those schools were also

included in the pool of subjects that were potentially available to form the experimental group in this study.

A known advantage of purposive sampling is that it easily allows a study's design to specifically examine particular criteria (Onwuegbuzie & Collins, 2007). By purposively selecting the two private schools where all the children received instrumental music (because of their use of the all-in model), a large enough experimental cohort of children who had a disability was generated. By including the children at the opt-in schools who had elected not to participate in instrumental music training, the control group was also effectively a purposive sample, albeit derived in a different way.

**Problems.** Purposive sampling has an inherent problem. That is, purposive samples necessarily describe particular groups, in particular places at particular times. Accordingly, purposive samples may not properly represent broader general populations (Newell & Burnard, 2006).

One of the chief limitations of purposive samples is the possibility of selection bias (Clark-Carter, 2009). That is, because of this selection bias the results observed in a purposive sample may not also be true for the broader population (Gideon, 2012). While random sampling would certainly have optimised the representativeness of the experimental samples; in this case, it has been shown how the value of randomising this study was outweighed by the ethical considerations of selecting/deselecting children into/out of either of the experimental or control groups.

Offsetting this, in this study a benefit of including of children from four different schools meant that multiple, independent purposive samples were able to be made. Drawing children from multiple samplings has allowed far greater

representativeness within the sample to be possible than had only a single, purposive sample been taken from a single source.

In terms of this study, this added degree of independence has yielded other distinct benefits. For instance, data derived from each of the independent samples was able to be:

a) treated discretely (thereby helping to isolate whether factors such as a school's regional or metropolitan location might act as a contributing factor to the results), or
b) combined (to increase overall sample size).

Additionally, research has shown that by generating multiple, independent purposive samples, overall representative balance of studies that use purposive samples can be greatly improved (Busk, 2005). As multiple purposive samples were exactly what were used in this study, some of the problems associated with purposive sampling were (at least, in part) mitigated.

**Assigning participants to the investigative groups in this study.** In all, this study involved $n$=185 Year 3 Queensland primary school students. In Queensland, children commencing prep (the first year of their schooling) must be five years-of-age by June 30 in the year that they enrol. That means that (theoretically) all children in this study should have been, unless they were held back for some reason, eight years of age and turning nine sometime during that academic year. Since the Education Queensland considers children in Year 3 to be eight years-of-age (Queensland Government, 2019), for this reason, the children's specific birth dates were not collected.

All participants in this study lived in south-east Queensland, Australia. The total pool of subjects was divided into two groups: those who received instrumental music training as a mandatory part of their Year 3 education ($n$=100), and those who could elect to receive instrumental music lessons ($n$=85). In the schools where instrumental music training was mandatory, two further subsets were also determined: children who received instrumental music training only from in-school lessons ($n$=73) alone; and children who, in addition to taking these in-school lessons, also received private instrumental music lessons outside of school hours ($n$=27).

From the schools where instrumental music lessons were optional, no children received these lessons from their school only (and no other source). Instead, all those children who has elected to be involved in instrumental music lessons through their school also undertook private lessons outside of school hours ($n$=12). This was an unexpected aspect to this study as it seemed likely that at least one of the children who had chosen to be involved in their in-school music training may have learned privately (through outside of school-hours lessons) as well. Of the remaining children in schools where instrumental music training was optional, 19 undertook private music lessons outside school hours but were not involved in their in-school music programs, while 54 did not receive any instrumental music training from any source at all during the period of the intervention. These 54 children represented the control group in this study. The groups in this study and the numbers of children who represented each group are shown in Figure 1.

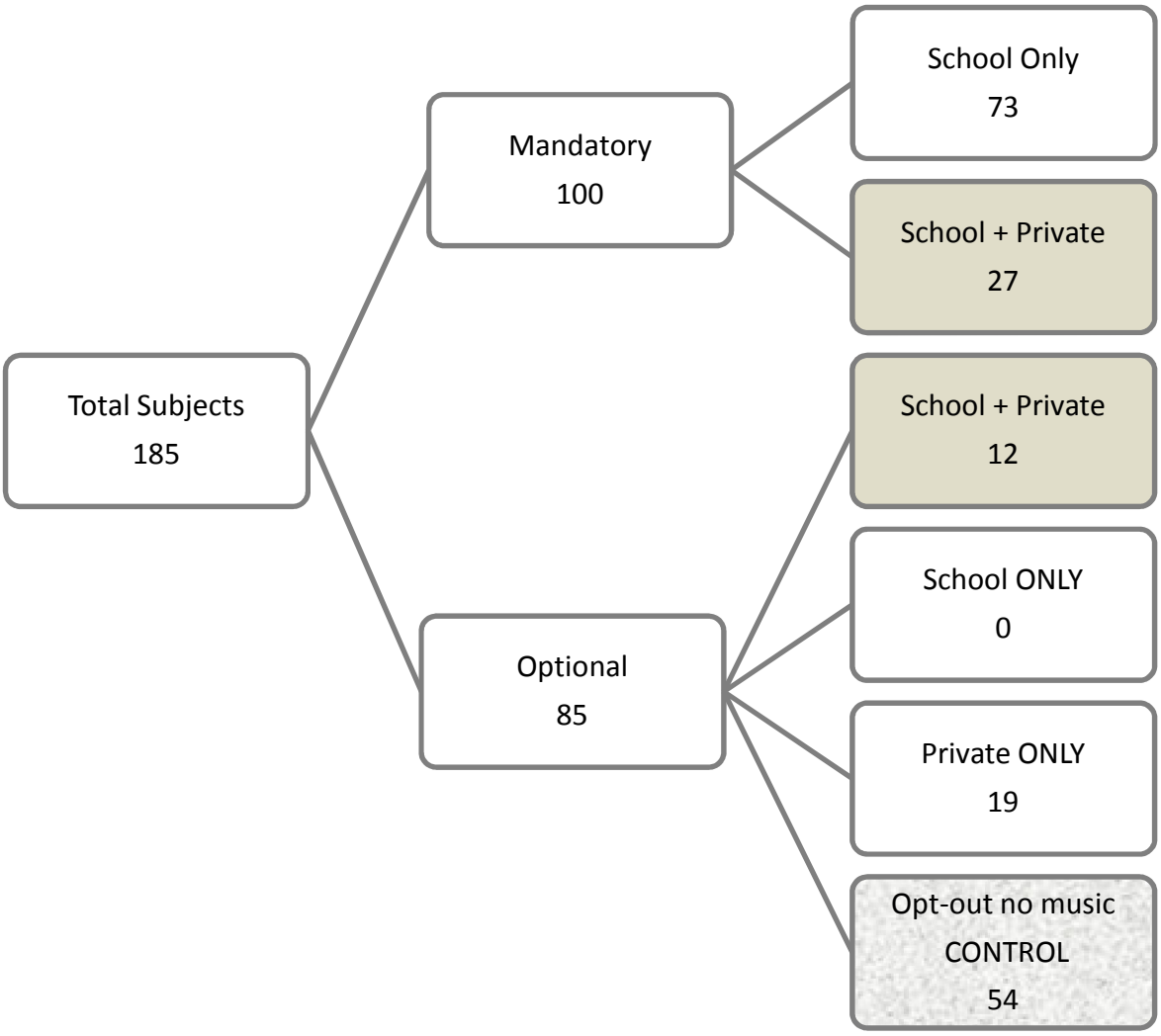



*Figure 1.* Investigative groups in this study.

**Balancing for Socio-Educational Advantage.**

A factor that needed to be managed in the development of the design for this study was socio-educational advantage. This was extremely important because it has been shown that differences in socio-educational advantage can directly influence children's performance in school testing. For instance, Dufur, Parcel, and Troutman

(2013) demonstrated that the higher the level of education that a child's parents have, the higher also is the likelihood of that child succeeding academically.

Because this study drew its sample of children from four different schools, it was important to ensure that the children were similar in terms of their socio-educational advantage. A measure used in this study to manage this problem was the use of the *Index of Socio-Educational Advantage* [ICSEA]. The ICSEA bands are an indication of parental similarity in terms of their educational qualifications and of their employment. ICSEA band values are calculated for all Australian schools, and reported on the *My School* website (Australian Curriculum Assessment and Reporting Authority, 2018). Matching for ICSEA similarity among the four schools participating in this study was extremely important because, as the Australian Curriculum Assessment and Reporting Authority (2016, p. 2) acknowledges, the "educational performance of students...[is related to]...parental education and occupation".

Accounting for socio-educational advantage was also highly important in this study since, according to Plewis and Bartley (2014), factors such as those identified by ICSEA markers not only predict children's likelihood of academic success in school, but also their cultural aspirations. In this study, the desire of children to be part of their school's music programs (their cultural aspiration) may well have directly affected 'which' children were ultimately part of the music programs in the schools that adopted the opt-in instrumental model and allowed those children to 'choose' to be involved in instrumental music training.

Matching ICSEA co-banded schools is, in terms of this study, imperative. The features of the individual schools, their ICSEA bandings and the way in which they delivered instrumental music training are shown in Table 2 following.

Table 2.

*Participants and Supplementary School Features*

| | School A | School B | School C | School D | TOTALS |
|---|---|---|---|---|---|
| Year range | P-6 | P-6 | P-6 | P-6 | |
| ICSEA Band | 1000 - 1100 | 1000 -1100 | 1000 - 1100 | 1000 - 1100 | |
| Instrumental-music model to Year 3 students | Mandatory All-in model | Elective Opt-in model | Elective Opt-in | Mandatory All-in | |
| Total Year 3 enrolments | 83 | 86 | 74 | 82 | n = 325 |
| Total Year 3 students in instrumental music | 38 | 70 | 74 | 82 | n = 264 |
| Total Number of children electing to participate in this study | n=27 | n=58 | n=40 | n=60 | n = 185 |
| Total number of participants in the study who have a disability | 6 | 10 | 4 | 5 | n = 25 |
| Total number of participants who do not have a disability | 21 | 48 | 36 | 55 | n = 160 |
| Group represented in this study | Control and experimental | Control and experimental | Experimental group only | Experimental group only | |

By selecting participants who came from co-banded ICSEA schools ensured this study's validity. The ICSEA band information in the Table 2 is drawn from the information provided about individual schools on the My School Website (Australian Curriculum Assessment and Reporting Authority, 2018).

**Disability.** In Queensland schools, disability is understood as children who have intellectual, hearing, visual, speech/language, or physical impairment; Autism Spectrum Disorder, or Social/Emotional Disorder. In this study, children who were considered to have had a disability were those falling into (at least) one of the previous categories, and had:

i. a diagnosis verified by a paediatrician or psychiatrist,
ii. paperwork submitted to the official State authority, and
iii. been entered into the disability register, accessible from *Queensland Independent Schools* (for non-government schools), or by the *Adjustment Information Management System* (for government schools).

In all, the number of children who met these criteria and who were prepared to be part of this study was 25. Of the total number of children involved in the intervention group, the number of children who had a disability was 15. In the control group: that is, children who did not participate in any form of instrumental music training at all ($n$=54), 10 more were considered to have some form of disability.

Of the 185 children involved in this study, and that of the six potential groups that could have existed, only five truly existed in this investigation because no children from schools where instrumental music lessons were optional took lessons from their school only and not also receive private (outside of school hours) lessons. The

distribution of children in terms of whether they had, or did not have, a disability within each of these groups is shown in figure 2.

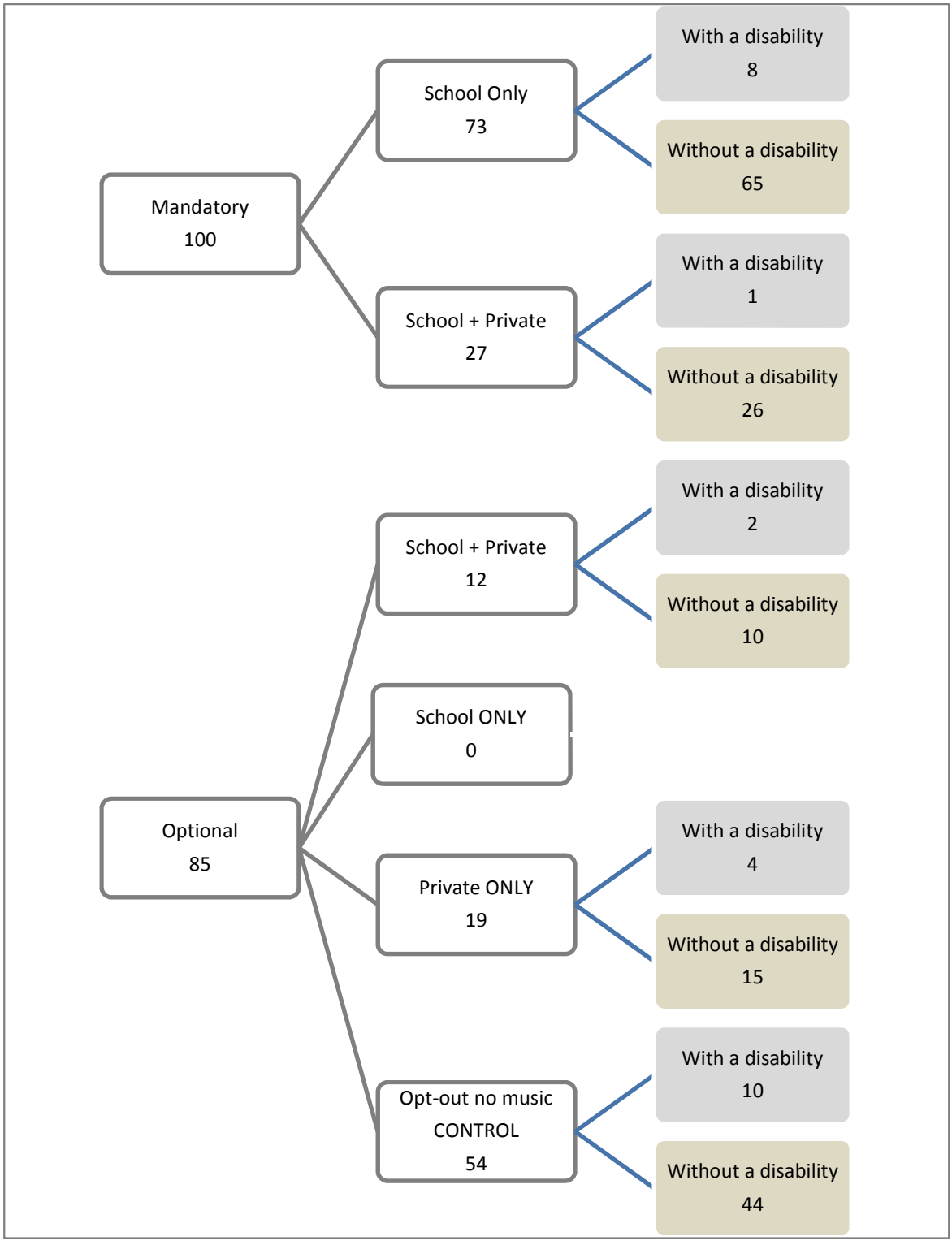



*Figure 2.* Distribution of children who have and do not have a disability.

## Intervention and Materials

### Intervention

**Physical setting.** The independent variable measured by this study was the participant's inclusion in instrumental-music training. Instrumental-music in this study consisted of weekly, half-hour lessons that were delivered over one semester (that is, 18 weeks). In each school, instrumental-music lessons were delivered under very similar conditions. Regardless of whether the school adopted the all-in or the opt-in model for instrumental music instruction, lessons were conducted in large open classrooms with a class set of violins placed in concentric arcs. Children received lessons in their normal class groups, and used the same violin, in the same position, in every lesson.

**Teachers.** In this study, children at each of the schools were co-operatively taught by two registered teachers (one of whom was the researcher in this project). Both teachers were engaged for the purpose of teaching violin.

In each of the schools involved in this study, the children's instruction was delivered from the front of each classroom. This is the standard practice for co-operative instrumental music teaching with both instrumental-music teachers alternating to provide instruction and moving, at times, between individual children helping when required.

**Text book.** A *smartboard* (a whiteboard equipped with data projector) was used in each classroom for the purpose of displaying printed music, and a stereo for the purpose of providing an accompaniment while the children played the violin were also used. The music displayed on the smartboard matched that in the student's individual workbooks.

The same tutor book was used in each school. In this project it was *Encore on Strings: Music Maestros, Book 1* (Gibson, Sharp, & Sharp, 2018). This text, like other beginner violin tutor books, assumes that the learner knows nothing about the violin or reading music notation, and follows the typical progression of similar texts that teach discrete musical elements in a sequential order.

During the in-school lessons all students were taught the same material. The content of the in-school based lesson was delivered regardless of whether the students had ever learned or were presently learning an instrument privately (including where they might be learning the violin through private lessons). This meant that no student needed to have prior musical knowledge to be part of the classes at any of the schools, and for those who did, these initial Year 3 in-school lessons served either as revision or as reinforcement.

Over the six months of this project, the following elements were taught: basic violin posture, pizzicato (plucking of the stings), playing the open strings (that is, strings with no fingers placed on them), basic rhythmic elements and musical notation. Toward the middle of the first term the students learned a basic bow technique and added the bow to play simple musical patterns. Finally, during term two, after the students were demonstrating good posture, a good bow-hold and a working knowledge of the location of the four open violin strings, the students were shown how to place their fingers to the strings to generate ‘new’ notes, and the corresponding musical notation was taught.

**Parameters of the intervention.** The material, the way that it was delivered, and the classroom setup each represented entirely typical practices common for school-based instrumental music lessons. The focus of beginner violin lessons is relatively straightforward; that is, to explain the basic elements required for playing

the violin, and to provide structured opportunities for the students to physically try those things. Importantly, the in-school instrumental music training that the students received consisted of tuition that was delivered within school-time, and with no absolute expectation of home practice.

### The Dependant Variable and its Measurement

The dependent variable in this study was a measure of the children's auditory discrimination. This was determined by testing individual student's ability to aurally discriminate differences between:

I. single pitches,

II. simultaneously played pitches,

III. rhythm, and

IV. melodic contour.

## Measurement Instruments

### Instruments used in this Study

**Selmer.** The *Selmer Music Guidance Survey* (Selmer, n.d.), also referred to as *The Selmer Test,* or *Selmer;* is an instrument commonly used by schools to measure the extent to which children aurally discriminate between musical sounds. Developed in America in the late 1950s, Selmer has long been used for this purpose. Originally Selmer was commercially available but now, out of copyright and not available commercially, the test is downloadable in a digital form from many websites. For example, Griffin, (2016). A complete Selmer package consists of three components: a set of recordings, a student answer sheet and an instructor's form. The instructor's form shows (in musical notation) the sixty tests that are plated on the recordings.

Selmer testing takes approximately 20 minutes, is run in one sitting, and typically delivered to children in their normal class groups. During Selmer testing, each child individually answers 60 questions on their own answer sheet.

Selmer testing requires participants to make decisions about and record what they hear. That is, they are asked to discriminate between various types of sound and decide about them. Students record their decisions about what they believe they have heard individually on their own answer sheet. Time is provided for the students to record their answers after each of the 60 listening examples.

Selmer tests children's auditory discrimination of four discrete elements: single pitches, simultaneously played pitches, rhythm, and melodic contour and was the principal instrument for measure in this study. In all instances during the Selmer testing, either a sound or a musical pattern was played using a piano as the sound source.

In the first of the four Selmer categories (single pitches), the participants were played a single sound and then, after two beats rest, a second sound was played. Participants were asked to decide whether the second sound was the same as, or whether it was higher or lower than the original sound. If the second sound was repeated at the same pitch as the first, they were asked to circle 'S' for 'same' on their personal answer sheet. If, when it was repeated, they believed that the second sound was higher in pitch than the original, then they were to circle an 'up arrow' on their answer sheet. Finally, if they believed that the second sound was lower in pitch than the original, then the subjects were instructed to circle a 'down arrow' on their answer sheet.

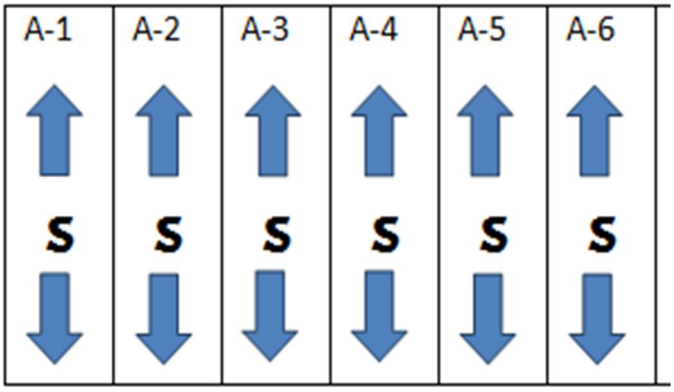



*Figure 3.* Segment of a Selmer answer sheet showing options for Part A (single pitch).

For the last three of these categories (simultaneously played pitches, rhythm, and melodic contour), the participants were required to decide whether, when a sound or musical pattern was 'repeated', it was the same as the original or whether it was different. If they believed that it was the same both times, they were to circle 'S' for 'same' on their answer sheet. If they believed that the second sound (or musical pattern) was different to the original, then they were to circle 'D' on their answer sheet.

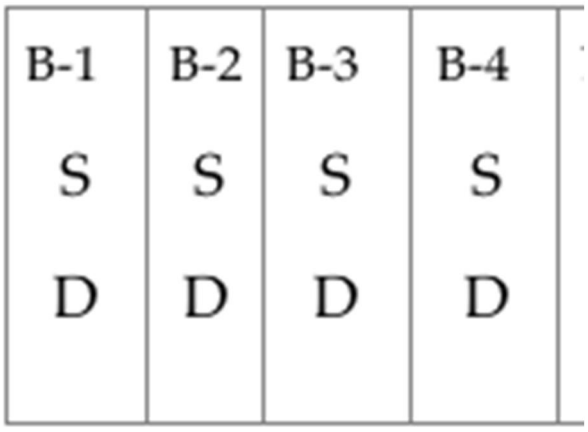



*Figure 4.* Segment of Selmer answer sheet showing the Part B, C and D options.

During Selmer testing participants are instructed to make one selection only on their answer sheet per listening example. Naturally, it was allowable for children to make corrections to their answers. However, in marking the test, should any box be marked with multiple answers, or it not be clear as to which was the intended response, then that question was deemed as incorrect.

Before commencing each section, examples of the type of sounds that the students would hear were played by the Selmer test facilitator. At the conclusion of the testing, the student answer sheets were collected, the student's answers marked right or wrong, and the student's individual results recorded.

***Selmer as an appropriate measurement tool.*** Selmer is a widely accepted tool for determining auditory discrimination. Selmer testing has been extensively used since the 1950s both in the United States (Powell, 2015) and in Australia (Ng & Hartwig, 2011). It is also commonly recommended as the means of testing students' auditory discrimination prior to their commencing instrumental music training and widely used for this purpose (Scott & Wilkinson, n.d.).

One of the principal reasons that Selmer was selected as the measurement tool for this study was because it is the most commonly utilised music test used for the purpose of measuring auditory discrimination in Queensland school music programs. A special benefit of selecting Selmer as the measurement tool in this study was that in most Queensland schools the music department already holds Selmer data on their whole Year 3 student cohort. This is because Selmer testing is routinely run by many schools in preparation for their Year 3 students commencing school instrumental music studies.

Selmer data is what represented the pre-test (baseline) data in this study. At the conclusion of the intervention (the 18 weeks of instrumental music instruction), all the study's participants were retested again using Selmer. The results recorded from the second Selmer 're-testing' provided the post-test data that was used for the purpose of comparison in this study.

The validity of Selmer as an appropriate means of measuring auditory discrimination, is best argued by examining how modern audiologists determine auditory discrimination. In detailing post-surgical cochlear-implant testing, See, Driscoll, Gfeller, Kliethermes, and Oleson (2013) describe audiologists as measuring their patient's ability to discriminate auditory variance in the same four categories as those tested by Selmer. That is, the ability of the subject to discriminate between: simultaneous and discrete pitches, rhythm, and perception of contour. Since both audiologists and Selmer functionally measure the same things, Selmer can be considered a valid measuring tool.

Despite both its long-standing acceptance and international usage, Selmer's reliability as a standardised instrument cannot be shown to have ever been ascertained. While Selmer's validity is strong, proof of its reliability is poor. However, it is useful to remember that, as Bui (2014, p. 150) explains, "a valid measure is always reliable, but a reliable measure is not always valid".

***Data gathering.*** Entirely typically, at all four schools involved in this study, the initial Selmer data was gathered by each school's classroom music teacher for the information of each school's instrumental music teachers. Therefore, each school held a record of every Year 3 child's individual Selmer results that had been recorded for this purpose.

In asking for consent for children to be involved in this study, children and their parents were also asked for permission that each of the schools release participating children's Selmer data to the researcher for the purpose of analysis. The parent consent forms appear as Appendix A. The Selmer scores recorded by each of the schools before the children began their Year 3 instrumental music classes represented the baseline data in this study.

At the conclusion of the intervention children electing to be involved in this study, (including those in the control group) were re-tested by the school's music teachers. Again, this was done in accord to the consent that had been obtained from the parents and children who had elected to be involved in this study. The results of the Selmer re-testing were provided to the researcher and used for the purpose of comparison to the initial Selmer dataset. These two sets of Selmer scores represented the pre-test and post-test data. This was the principal source of data in this study.

***The two-fold nature of the survey.*** The independent variable in this study was instrumental-music instruction that was delivered in school-hours. The presence of any participant in this study who received instrumental music lessons outside of school-hours (that is, private music lessons) had the potential to undermine the independence of the study's independent variable. This was because private music lessons might well emulate the effects that might come as a result of the children in the experimental group receiving the intervention (in-school instrumental music lessons). Therefore, to maintain the independent variable's integrity, identifying children who took private music lessons was imperative.

It was for this reason that a simple survey (see Appendix A) was added as part of the study's design thereby resolving this potential problem. The information delivered by the survey enabled the identification of two discrete groups: children who received

private music lessons outside of school hours, and those who did not. This information was fundamental to protecting against the possibility of finding a false positive, especially as the control group data was analysed.

***Filtering for disability.*** The survey performed one more critical function. Parents were asked whether the children choosing to participate in this study had a disability. This made it possible to separate the data pertaining to individual children who had a disability, away from those others who did not have a disability. Thus, because of the data delivered by the survey and by being able to determine *which* children in this study had a disability, ultimately the research questions were answerable.

## Procedure

Data in this study was collected from two sources: the Selmer test and the survey. To appropriately address the research questions, data relating to students who had a disability was separated from the data relating to students who did not have a disability. The study ran over a single 18-week period (one semester) period and the same content was taught at all four schools. Both the control and the experimental groups ran in parallel, and all participants from all four schools entered/concluded the intervention period concurrently.

### The Use of Selmer

Selmer data was collected as numbers. Five individual scores were recorded for each student, one for each of the four auditory discrimination categories, and a total overall score. Selmer data, routinely collected by each of the schools, before the commencement of their respective instrumental-music programs, is what represented

the data that generated the baseline for this study. Therefore, requesting access to this existing data was necessitated from each of the four schools.

Generation of the post-test data in this study required Selmer retesting for all the students who chose to participate in either the control or the experimental groups. This was run at the conclusion of the intervention (the experimental group's semester's period of instrumental-music instruction). Pairing of individual student's Selmer test results, those recorded by the school at the beginning of the year, and the one conducted at the conclusion of the intervention, generated the student's pre-test and post-test scores. This represented the principal source of the data that was used for analysis in this study.

**The Use of the Survey**

A principal function of the parent survey was to identify any children within the experimental sample who had a disability. This was critical because it represented the gap in the literature that this study has specifically sought to address. However, the purpose of the survey was two-fold: as well as determining whether individual children had a disability, it was specifically designed to identify children who might have engaged in private music lessons outside school hours.

Since the independent variable in the study was instrumental-music training, as previously indicated the survey's function was fundamentally to ascertain whether any children (and most particularly, those in the control group) have received a possible equivalency of the intervention (in-school-hours instrumental-music training) but delivered outside of school-hours (via private music lessons). Thus, the survey aimed to ascertain the following information:

a) Whether individual children had a disability,
b) If they did, what type,
c) Whether a child received instrumental-music lessons outside school hours,
d) The frequency of these lessons,
e) The duration of these lessons,
f) Which musical instrument they may have learnt during that time, and
g) How long had that child learned music privately.

Using this information, children who had a disability were able to be flagged, and data pertaining to students who received private music lessons quarantined away from the data relating to children who had not received private music lessons over the same period. Separating this data was crucial to producing a meaningful analysis about whether children who had a disability experienced any benefit/s through their involvement in instrumental music training. However, the survey was also vital to ensuring the independence of the independent variable and ensuring that the study's integrity was not undermined by the introduction of a confounding variable. That is, the survey safeguarded against the possibility that instrumental music lessons undertaken outside of school hours may possibly emulated the effect/s of the independent variable. Were this to be the case then this would have introduced a confounding variable into the study.

Figure 5 illustrates how the how this study's methodology was mediated by the two Selmer tests and the parent survey. Although each simple in themselves, both the Selmer and survey functionally enabled this study to firstly gather data and then to separate it into meaningful datasets for the purpose of analysis.

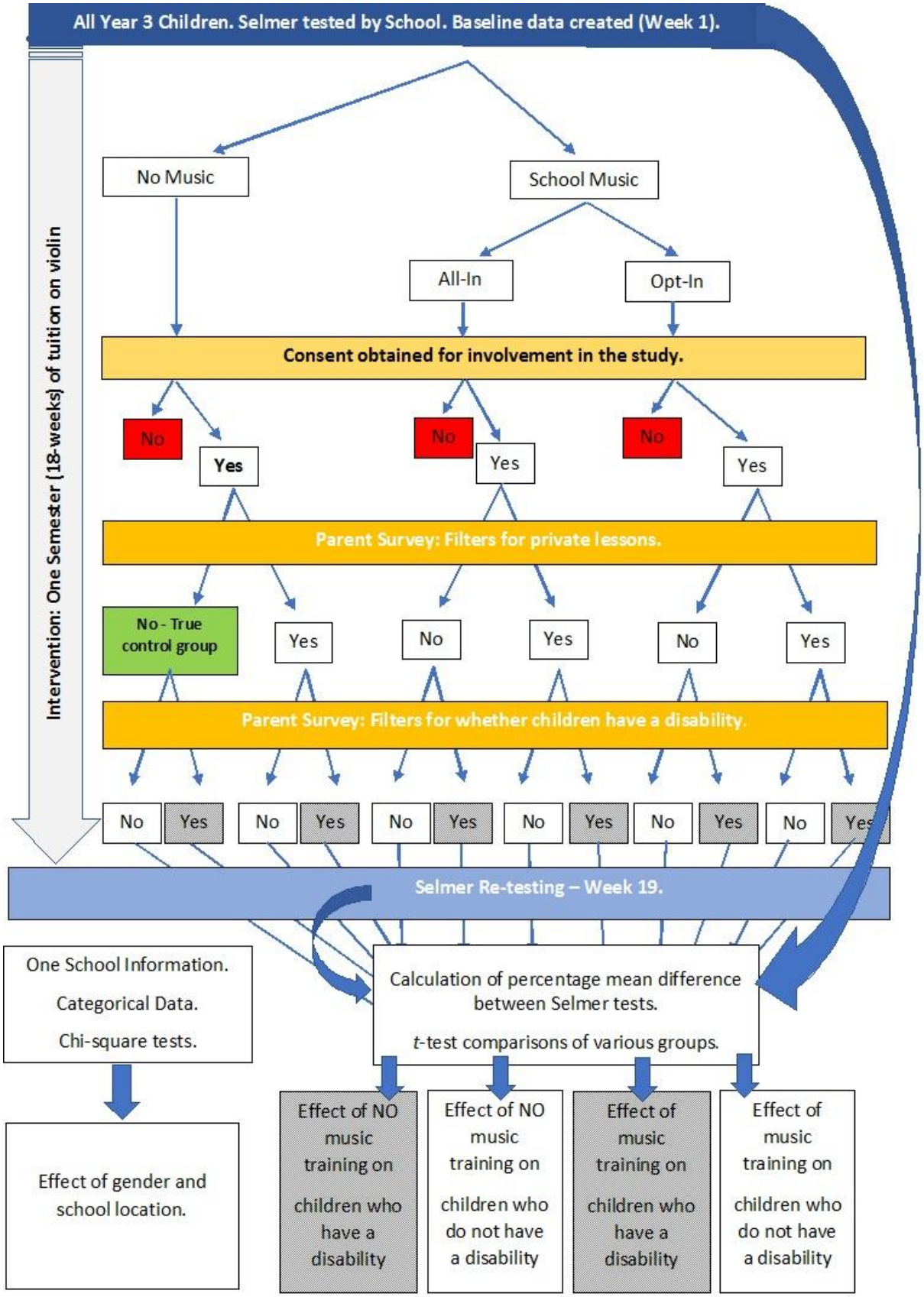



*Figure 5.* Flowchart of Methodology.

## Data Analysis

### Selmer Data

Selmer testing delivers binary information. That is, the student is either right or wrong. Selmer scores are measured on a scale from 0 to 60. On this scale, 0 represents the lowest possible score. That is, an incorrect response was recorded by the student for every question. Conversely, 60 (the highest score possible) is where every response by the student was correct. To calculate statistical information, IBM SPSS® (Version 22) computer software was used.

Although the Selmer test consists of four discrete elements that are tested it is common for schools not to record individual scores for each part. Instead only a total score (out of 60) is what is recorded for each individual student. This was the case for the schools that were involved in this study. In retesting at the end of the intervention, although it would have been interesting to be able to compare whether individual sections of the test had showed greater (or lesser change), this simply was not a possibility given the data that the schools held.

In this study it was determined to allow the second Selmer re-testing to be run and recorded in the same way as was usual for schools. Therefore, the data reported in this study uses the percentage mean difference between the two Selmer totals as the chief measure of whether the children's involvement in instrumental music training had generated some quantifiable effect on their auditory discrimination.

Satisfactorily answering this study's research questions did not merely relate to determining whether similarities/differences existed between a simple control and experimental group. Instead, this study is fundamentally about how the scores of students with disabilities compare to the scores of those students without disabilities.

Accordingly, analysis of the data that also represented the subset of students who had some type of disability was also crucial.

To resolve research question I, statistical comparison of the pre-/post-test data relating to the cohorts who had, or did not have, a disability needed to be assessed in terms of whether their involvement in the intervention (instrumental music training) could be should to have produced any appreciable effect. In contrast, research question II was best addressed through the comparison of multiple cohorts. By splitting the pre-/post-test data within SPSS® into an array of subsets, such children who have specific disabilities, whether a child took private music lessons, or their gender, a distribution of means within specific groupings was able to be determined, and multiple cohorts subsequently compared. (The subsets that were analysed in this study appear as Appendix B).

Further, by splitting the SPSS® categories into these various subsets, themselves defined by the disability categories determined by the Queensland Government (namely: Autism Spectrum Disorder [ASD], speech/language, or physical impairment), discrete groups of children who had particular types of disability were also able to be formed, investigated and compared.

**Survey Data**

In this study, the survey had the added advantage of strengthening the power of the project's statistical analysis. This is primarily because, by subdividing the children in the control group into children taking, and those not taking private music lessons, the Selmer scores of children in the experimental group were also able to be compared to the scores of the children in the control group who did not participate in in-school instrumental music training, but who took private instrumental music lessons outside of school hours.

By considering this subset of control group children who take private music lessons as a further distinct group, additional analyses of pre-/post-intervention Selmer data were facilitated. Finally, by combining the scores of all children who received instrumental music training during the intervention period from any source - that is, children in the experimental group who received in-school music training and those in the control group who received private instrumental lessons - this allowed other similar groups to be formed for the purpose of additional comparison and analysis.

# Chapter 4: Results

From its inception, this study has had two distinct foci. The first of these was to determine whether instrumental music training could be shown to alter children's auditory discrimination. The second was to identify whether any children who had a disability were among the study's participants. Ultimately, while determining whether music training had any effect on children's auditory discrimination abilities; the greater goal of this study was always to be able to compare the results of auditory discrimination testing of children who had a disability with equivalent tests performed with children who did not have a disability. In this study two principal measurement instruments were used to determine these things: Selmer Testing and a Parent Survey.

## Descriptive Statistics

### Participants

In all, 185 children Year 3 children chose to participate in the study. The participants were drawn from four co-educational schools in south-east Queensland, Australia. In Queensland, unless a child has repeated a grade for some reason, children who are in Year 3 are (almost exclusively) children who are eight years-of-age and are turning nine. Of these, 87 children came from schools deemed to be regional, while a further 98 came from schools whose location was deemed to be metropolitan. Balancing the schools in this study in terms of their location was considered important

as there is evidence to show that the geographic location of a school – that is, whether it was regional or metropolitan - can itself sometimes impact students' educational outcomes (Nugent, Kunz, Sheridan, Glover, & Knoche, 2017). Similarly, whether the school was a State school (government-run) or a Private school (non-government-run, where the students paid fees to attend) where affluence may have influenced student outcomes.

It was for this reason that the four schools selected for inclusion in this study were 'counterbalanced' both in terms of their type and their geographic location. That is, two schools (one private and one state school) were metropolitan, and the other two (again, one private and one a state school) were regional. The Queensland government's *My School* website was used as the means by which the location status of each individual school was ascertained (Australian Curriculum Assessment and Reporting Authority, 2018).

The gender of the children who participated in this study was also considered to be potentially relevant, as gender too has been shown to sometimes predict variance between children's individual academic progress (Albright, 2012). It was noted that, in terms of gender, the groups in this study were divided in the following way: overall, 45% of the total sample were girls and 55% boys. Of those in the experimental group, 36% were girls and 64% boys; while 49% of the control group were girls and 51% boys. Importantly, *t*-test and chi-square analysis showed no significant differences had occurred that could be attributable to whether:

i. the participant was male or female,
ii. the participants attended a regional or metropolitan school, or
iii. that school was a State school or a private school.

That is, with respect to both gender and school location, the *p* values for each of these variables was shown to be $p < .05$. Individual *p* values for the Selmer pre-test and post-test variables are indicated in the discussion that follows.

**Participant Allocation**

None of this study's participants were allocated into, or out of, any of the investigative groups. Instead, all the groups that were investigated in this study 'pre-existed'. That is, all the children in this study were already in groups where they learned instrumental music; or else, they had already elected to not participate in their school's instrumental music training (at the two State schools where they were given the choice to undertake instrumental music lessons) and were hence not in any group. However, the children who were not participating in any instrumental music training at all, were the ones eligible to be included in the control group within this study.

The experimental group in this study contained children who, because of the music programs at their schools, received weekly instrumental music training in one of two ways. The first were children who received instrumental music training as a mandatory component of their regular Year 3 classes (*all-in* lessons). The second group consisted of children who attended schools where their involvement in instrumental music training was optional (*opt-in* lessons).

Of the children from the four schools who elected to be part of this study, and of the ways in which those children received (or did not receive) instrumental music training over the period of the intervention, four different groups were identified. These were children who received:

i. instrumental music training from their school only,

ii. private outside school instrumental lessons, but no in-school lessons,

iii. in-school music training, as well as private lessons, or

iv. no instrumental music training (from any source) during the intervention period at all.

It is of special note that - of the students who elected to be involved in this study - from both schools where participation in in-school instrumental music training was optional, all the students who were part in their school's in-school instrumental music training ($n$=12) *also* undertook private music lessons outside of school hours. This was unexpected. It was imagined that (at least) some of the children who attended either of the schools where instrumental music lessons were optional, may have received instrumental music training from their in-school music programs alone, and no extra from any other source.

Of the children who attended schools where instrumental music training was a mandatory part of regular Year 3 classes, a significant number ($n$=73) did not receive instrumental music training from any source other than from in-school lessons. These groups, and the number of children involved in each, are shown in Figure 6.

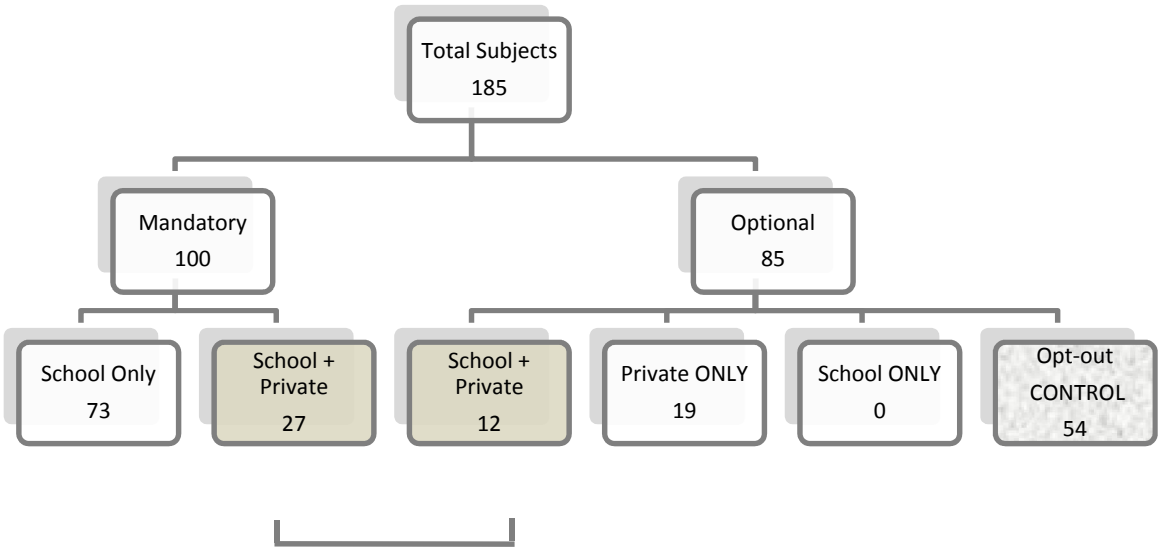



*Figure 6.* Investigative groups and the number of participants.

In this study, 73 children received instrumental music training only from in-school lessons and from no other source. A further 39 (27 + 12) children received instrumental music training from in-school lessons and participated in private instrumental music lessons outside of school hours. Additionally, 19 more children, while electing not be involved in their school's instrumental music programs, received private instrumental music lessons that were undertaken outside of school hours. The remaining 54 participants did not receive instrumental training from any source at all over the 18-week period of the intervention. These 54 children represented the control group in this study.

**Basic Comparison of Control and Experimental Group Results**

On the basis of other studies such as those by Nutley, Darki and Klingberg, (2014) or Tierney et al., (2015), it was expected that there was going to be a high likelihood that children who were involved in the instrumental music training would produce better results than did their peers who did not undertake instrumental music training over the same time period. In this study, not only was this the case, but the degree to which this occurred was substantial.

The results of the Selmer testing showed that children in the study's experimental groups (that is, children who during the intervention received instrumental music training) received considerably higher Selmer score percentage mean improvements than did their peers who were not involved in instrumental music training. The Selmer testing results are summarized in Table 3.

Table 3.

*Descriptive Statistics for the Control and Experimental Groups*

| | | **Mandatory music Involvement** | **Optional music involvement** | |
|---|---|---|---|---|
| Group Type | **Total Experimental Group** | Experimental | Experimental | Control |
| Number of subjects | *n* = 131 | *n* = 100 | *n* = 31 | *n* = 54 |
| SELMER Pre-test results | Mean = 40.89<br>SD = 0.01 | Mean = 40.20<br>SD = 0.084 | Mean = 41.58<br>SD = 6.75 | Mean = 35.02<br>SD = 10.52 |
| SELMER Post-test results | Mean = 46.70<br>SD = 7.75 | Mean = 46.76<br>SD = 7.75 | Mean = 46.65<br>SD = 6.43 | Mean = 36.89<br>SD = 10.27 |
| % Difference Pre-test to Post-test | Mean = 9.69%<br>SD = 0.07 | Mean = 10.93%<br>SD = 0.08 | Mean = 8.45%<br>SD = 0.06 | Mean = 3.34%<br>SD = 0.05 |

Overall, regardless of whether the student's involvement in instrumental music training was mandatory or optional, it was clear that students who were involved in instrumental music training from any source (mandated in-school instrumental music training, optional involvement in in-school music lessons, the undertaking of outside school hours private lessons, or some combination of these) had, when tested at the end of the intervention period, made significantly greater increases to their auditory

discrimination ($M$ = 9.68%, $SD$ = 0.07, $P$ < .001) than had children in the control group ($M$ = 3.34%, $SD$ = 0.05, $P$ < .001).

Accounting for the increase between the children's pre-/post-test scores shown by the control group (3.34%) to represent some form of 'natural' improvement that had occurred over time, the children who were involved in *any* form of instrumental music training during the intervention *still* received auditory discrimination scores that were on average 6.34% better than the scores shown by children in the control group (who were not involved in the instrumental music lessons).

**The Usefulness of the Parent Survey**

From the outset, in this study it was critical to identify children who were involved in instrumental music training outside school hours. This was in order to be certain that the control group was not tainted by a confounding variable; namely, that instrumental music lessons undertaken outside of school hours may have emulated the conditions of the intervention. This was resolved by the parent survey.

Children who were learning instruments privately (outside school hours) were identified through the parent survey, and the results of these children quarantined away from the results of children who were not receiving music lessons outside of school time. This effectively protected the independence of the independent variable.

Importantly, the parent survey did more than merely identify the control group in this study. It also defined how all the children in this study who undertook some form of instrumental music training *received* that training. Thus, it was the survey that was the means through which individual children were determined to belong to the various groups that were investigated in this study. That is, from the survey it was possible to identify whether each individual subject received instrumental music training from:

i. their school only,

ii. private lessons only, or

iii. both their school *and* from privately sourced lessons.

This was of special importance in providing a cross-check for the control group. That is, ensuring that a child who was not involved in their in-school instrumental music program was not receiving similar lesson from an outside source.

**Results from the Experimental Groups**

In this study, the cohort of children who received *any* form of instrumental music training outperformed their peers who did not receive instrumental music lessons. The mean percentage change between the Selmer pre-test and post-test scores are shown in Table 4. This table separates the data in terms of *how* the instrumental music training occurred. That was, whether it was received only through in-school lessons, only through outside school-hours lessons or some combination of the two.

Table 4.

*Comparison of the Three Experimental Groups and the Control Group*

| How lessons were received | Number of subjects | Mean Selmer Pre-test Score | Mean Selmer Post-test Score | Mean % change Pre-test to Post-test | Standard deviation |
|---|---|---|---|---|---|
| From any source | 131 | 40.89 | 46.70 | 9.69 | 0.01 |
| School only | 73 | 33.47 | 42.92 | 15.75% | 0.11 |
| School + Private | 39 | 44.97 | 49.26 | 7.15% | 0.05 |
| Private only | 19 | 40.16 | 45.37 | 8.68% | 0.06 |
| No music (Control) | 54 | 28.64 | 30.64 | 3.34% | 0.05 |

These numbers are critical to properly understanding the importance of what this study found. From the parent survey, it was determined that where children were involved in instrumental music training outside of school hours they had, on average, been learning for at least one year before the commencement of this study. From the numbers in Table 4, children who received private lessons obtained significantly higher average scores on their first Selmer test than did children who had not received any instrumental training before the intervention.

Notably, these children who undertook private instrumental music training still received substantial increases to their auditory discrimination scores when compared to children in the control group at the end of the intervention. However, the higher starting scores for these children already participating in instrumental music lessons, resulted in lowering the overall average for the improvement for the whole experimental group.

This is a very important aspect to these numbers. The scores of the children who received no training before that which was offered by their school ($n$ = 73), is the group that most closely resembles the children in the control group. That is, neither of these groups contained children who were involved in music training at the commencement of the intervention. When the figures of just these two groups are compared the difference between the children's scores is profound. Children who had not previously been involved in instrumental music training and who received the intervention improved an average of 15.75% when compared to the children in the control group who only showed an average improvement of 3.34%

Again, excluding this percentage mean increase between the Selmer scores of the children in the control group as reflecting some form of 'natural' improvement

delivered over time, the percentage mean difference between the scores of the children in the experimental group and those in the control group was on average 12.35% greater. Therefore, in this study the children who undertook music training for one semester from their school (either as mandatory or optional training) made approximately three times the improvement to their auditory discrimination skills as did children in the control group who were not involved in similar instrumental music training. The distribution of the percentage mean difference scores for children in the control group and for those receiving instrumental music training during school-time instrumental music training *only* are shown in Figure 7.

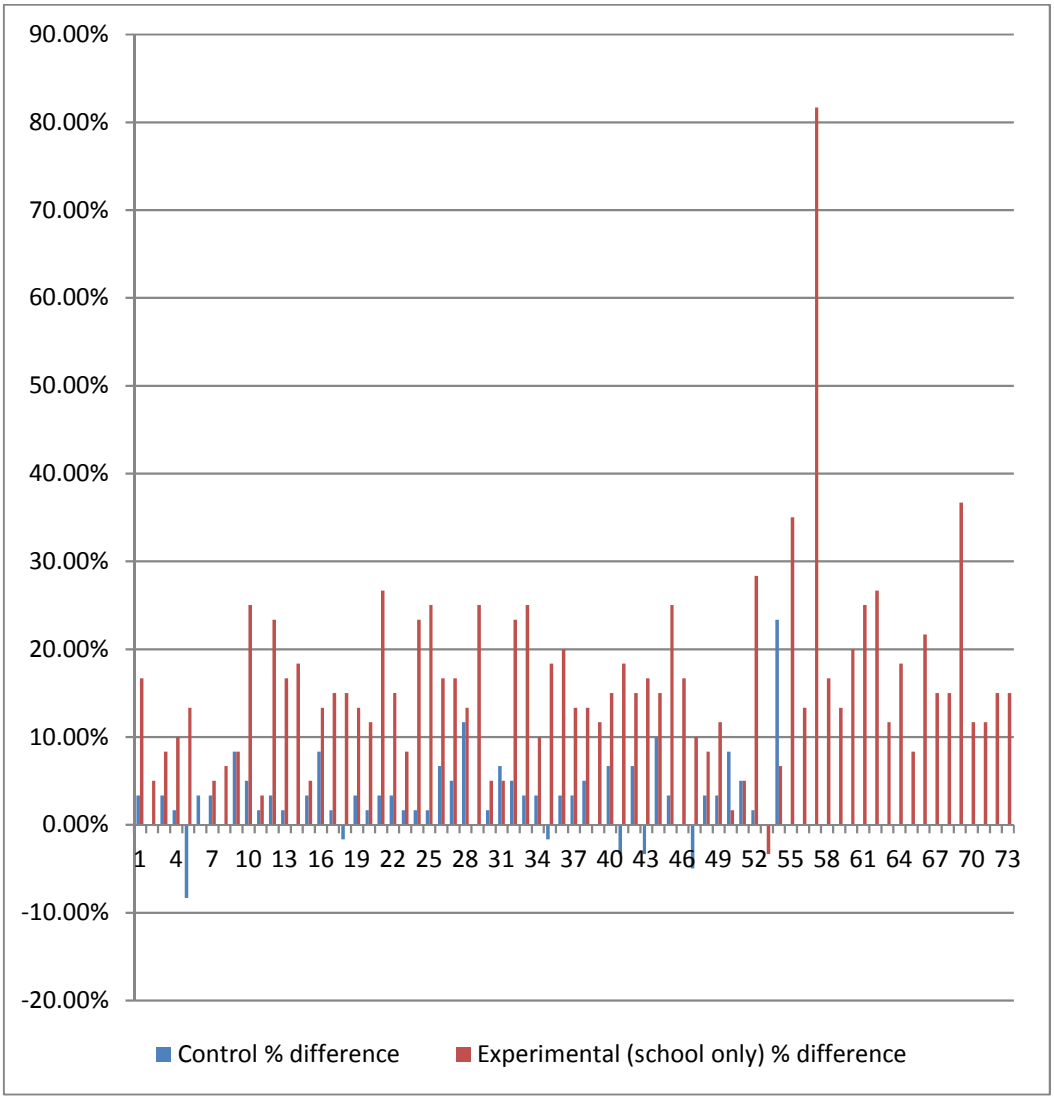



*Figure 7.* Distribution of children's percentage mean difference scores.

**Disability as a Variable**

It was clear from the results of this study that children in the experimental group (that is, children who were involved in instrumental music training) produced significantly better improvements to their auditory discrimination pre-/post-test Selmer scores than did those children who were in the control group. However, the greater purpose of this project was always about determining whether children who had a disability were impacted in ways that might have been similar to, or different from, their peers who did not have a disability, if they too were involved in instrumental music training. Figure 8 shows the percentage mean differences for the pre-test and post-test Selmer results when the control and experimental groups specifically compared the results of children who had a disability with those of the children who did not have a disability.

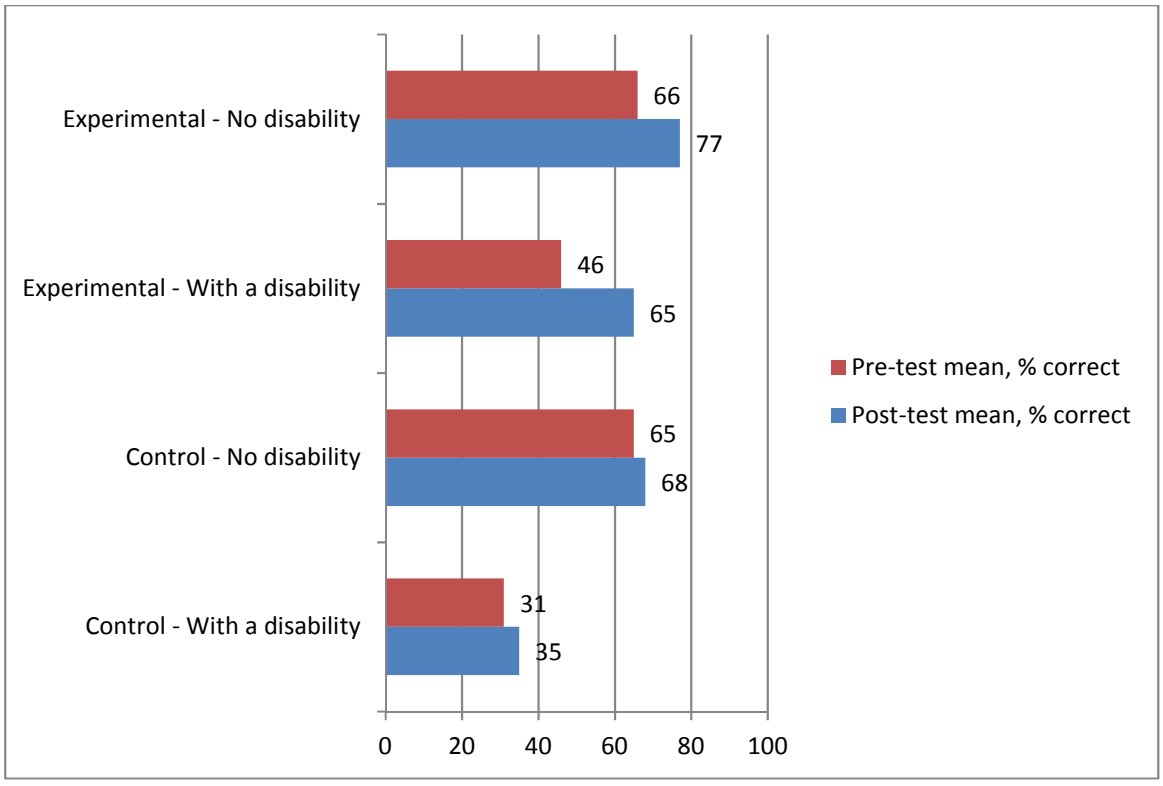



*Figure 8.* Selmer percentage mean differences (pre-test and post-test).

Two things are obvious from these results. Firstly, that the children who were involved in instrumental music training made greater mean percentage improvements to their auditory discrimination scores than did children who did not receive similar instrumental music training. Secondly, of all the subjects in this study, the greatest improvements were shown by the cohort of children who had a disability and who were also involved in instrumental music training.

The specific mean percentage differences between the pre-test and post-test Selmer scores for children who had a disability in the control group is shown in Table 5. The figures indicate a high degree of similarity regardless of whether the participants had, or did not have, a disability.

Table 5.

*Control Group, Cohort Filtered for Disability*

| **Groups** | **Number of subjects** | **Pre-test Mean % correct** | **Post-test Mean % correct** | **Difference between Pre/Post--test %means** |
|---|---|---|---|---|
| **Control group with disability** | *n* = 10 | 30.83 | 34.50 | Mean = 3.67%<br>SD = 0.081 |
| **Control group No disability** | *n* = 44 | 64.61 | 67.62 | Mean = 3.01%<br>SD = 0.034 |

For children in the experimental group, the filtering of results to show which children had a disability yielded a very different picture. The percentage mean improvement between the pre-test and post-test Selmer scores for the cohort who had a disability *and* were involved in the instrumental music training was far greater than was the improvement shown by those children who had received the instrumental music training but *did not have* a disability. Table 6 shows the mean percentage differences between the Selmer pre-/post-test scores for children in the experimental group when filtered for disability.

Table 6.

*Experimental Cohort, Filtered for Disability*

| **Groups** | **Number of subjects** | **Pre-test Mean % correct** | **Post-test Mean % correct** | **Difference between Pre/Post--test %means** |
|---|---|---|---|---|
| **Experimental group with disability** | *n* = 15 | 45.55 | 64.55 | Mean = 19.00%<br>SD = 0.113 |
| **Experimental group No disability** | *n* = 116 | 65.79 | 76.94 | Mean = 11.14%<br>SD = 0.095 |
| **Total control group** | *n* = 54 | 47.73 | 51.07 | Mean = 3.34%<br>SD = 0.045 |

Comparisons of the children's pre-test and post-test scores in both the experimental and control groups in this study clearly showed that the children who were involved in the instrumental music training made far greater improvements to their auditory discrimination skills than did children who were in the control group ($M$ = 3.34%, $SD$ = 0.045, $P < .001$).

However, the most significant aspect of these numbers is that they show that the cohort of children who received the greatest benefit in this study were the children who had received the music training (the intervention) *and* who had a disability. While the improvement shown by children who received the intervention but did not have a disability was substantial ($M$ = 11.14%, $SD$ = 0.095, $P < .001$), the children who had a disability and who received the instrumental music training showed even greater improvements ($M$ = 19.00%, $SD$ = 0.113, $P < .001$).

As striking as these figures are, when the children who had a disability and received instrumental music training as a *mandatory* part of their Year 3 training were filtered out as a unique subset, even more profound results emerged. Unexpectedly, at the end of the intervention children in this category showed a 25.00% mean improvement between their Selmer pre-test and post-test scores. Therefore, Table 7 shows how, when the data was filtered to isolate those children who had a disability and who had received instrumental music training from their school alone, the results changed even more dramatically.

Table 7.

*Comparison: Disability/No Disability Excluding Private Music Students*

| **Groups** | **% difference between Pre-/Post-test Means (Total experimental cohort)** | **% difference between Pre-/Post-test Means (Mandatory music training ONLY)** |
|---|---|---|
| Experimental group who had a disability | Mean = 19.00%<br>SD = 0.113<br>*n* = 15 | Mean = 25.00%<br>SD = 0.087<br>*n* = 9 |
| Experimental group who do not have a disability | Mean = 11.15%<br>SD = 0.095<br>*n* = 116 | Mean = 11.98%<br>SD = 0.103<br>*n* = 91 |

Notably, the greatest percentage mean change for auditory discrimination in this study was shown for the cohort of children who were involved in instrumental music training that was delivered as a part of their regular Year 3 classes. Again, removing the percentage changes shown by the children in the control group (having a disability: 3.67%; no disability: 3.01%) as a form of natural increase over time - the improvement shown by the children who did not have a disability and received mandatory in-school instrumental music training was 8.97%, and the improvement to auditory discrimination shown by the children who did have a disability and who had received the mandatory in-school instrumental music training was 21.33%.

**Determining the Specific Disability Types Present in this Study**

In Queensland schools, children who are determined to have a disability have one of seven conditions. These are: intellectual, hearing, visual, speech/language, or physical impairment; Autism Spectrum Disorder, or Social/Emotional Disorder. Moreover, for a student to be regarded as having a disability in terms of educational definitions they need to have:

i. their diagnosis verified by a paediatrician or psychiatrist,

ii. paperwork submitted to the official State authority, and

iii. been entered into one of two disability registers [*Queensland Independent Schools Register* (for non-government schools), or by the *Adjustment Information Management System* (for government schools)].

In this study, of the total 185 children who chose to participate, 25 children were determined to have had a disability. Of the seven possible disability categories, only three were represented in this study. In this study, these categories were distributed in the following way; namely, children who had:

i. autism spectrum disorder (Total: $n$=13). This consisted of:
    a. Experimental group (school + private) $n$=2,
    b. Experimental group (school only) $n$=4,
    c. Experimental group (private only) $n$=0,
    d. Control group $n$=7.

ii. speech language impairment (Total: *n*=9). This consisted of:

a. Experimental group (school + private) *n*=0,

b. Experimental group (school only) *n*=3,

c. Experimental group (private only) *n*=3,

d. Control group *n*=3.

iii. physical impairment (Total: *n*=3). This consisted of:

a. Experimental group (school + private) *n*=1,

b. Experimental group (school only) *n*=1,

c. Experimental group (private only) *n*=1,

d. Control group *n*=0.

The percentage mean change between the pre-test and post-test Selmer scores for the total cohort of children who had a disability are shown in Figure 9. This table also shows the disability cohort filtered by individual disability type.

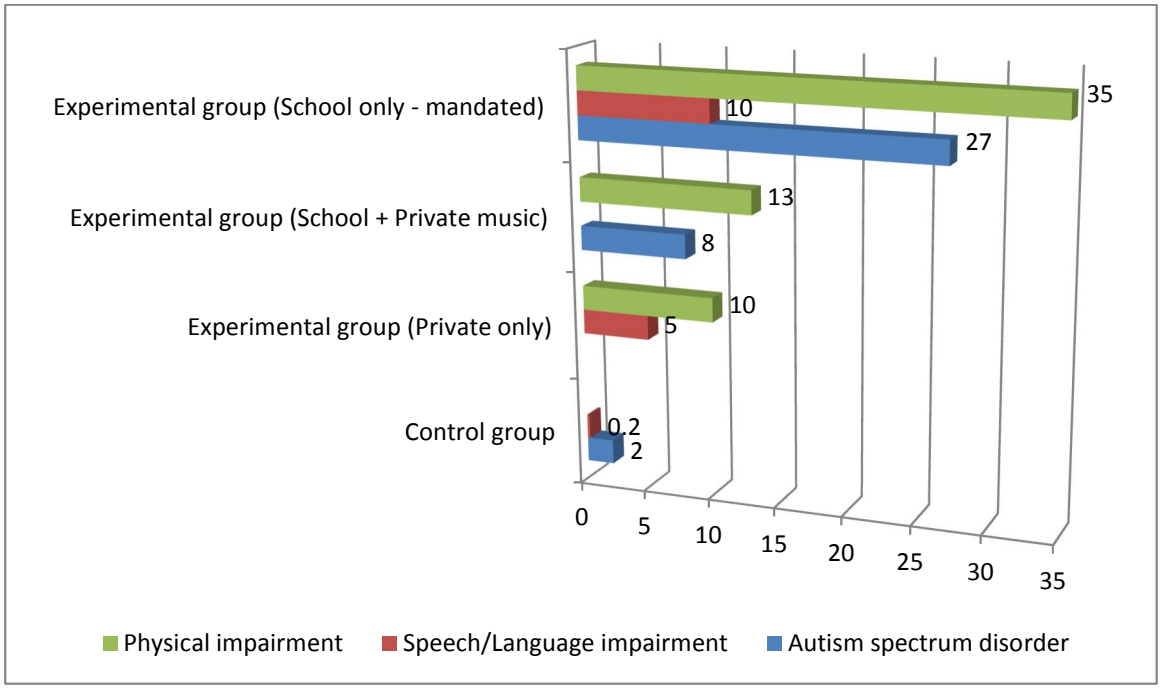



*Figure 9.* Summary of Pre-/Post Test Percentage Mean Change: Organised by Disability Type.

From the percentage change numbers alone, it might be concluded that children who had physical impairments benefitted the most and children who had speech/language impairments benefitted the least. However, prudence must be exercised when looking at these numbers in simple terms.

Because only three children had physical impairments in this study, and so few in the other disability categories, there is insufficient data to make sweeping conclusions. However, taken as a group, the percentage mean change for auditory discrimination scores of children with *any* form of disability in this study is significant.

Of greater importance in these numbers is the evidence that for children who were involved in this study it was clear that regardless of the type of disability that they had that their involvement in instrumental music training was a strong predictor for substantial improvements to their auditory discrimination. Across each of the three disability categories represented by children in this study (speech/language impairment, physical impairment and ASD) the children in these groups followed a similar trend regardless of how they might have received instrumental music training.

Also noteworthy within the data shown in Table 8 are the children who had a disability in the control group. Again, although in this study only children who had either speech/language impairment or ASD were in the control group (children who were not receiving instrumental music training from any source at all over the period of the intervention) the results for these children are strikingly different from those of the children who had a disability and who *had* been involved in the music training.

While the children who had ASD made a small improvement commensurate to that of the control group generally, children who had speech language impairment made virtually no improvement when retested after the 18-week period.

**Measures of Variability**

By examining measures of variability, it was evident that there were also some large differences between the distribution of individual scores for children in both the experimental and the control groups. Across this study the scores of the children resulted in a dataset that, based on its spread, appeared large. However, this was chiefly as a result of a few outlying scores that generated this wide spread-effect.

In interpreting the numbers in this study, it is important to note that the range of the percentage differences between the pre-test and post-test Selmer scores *did* have some extreme outlying values. For instance, within the control group the range for the change between pre-test and post-test percentage difference scores varied from -8% to +23%. Even more striking was the numbers in the experimental group (for the children who received mandatory in-school music training) where the range varied from -3% to +82%. Measures of variability are shown in Table 8 filtered as to the cohorts of children who had, or did not have, a disability.

Table 8.

*Measures of Variability*

| | Range | | Variance | Standard Deviation |
|---|---|---|---|---|
| | Min | Max | | |
| % Difference, Control group who had a disability | -8.33 | 23.33 | 0.007 | 0.08 |
| % Difference, Control group who do not have a disability | -5.00 | 11.67 | 0.001 | 0.03 |
| % Difference, Experimental group who had a disability | 10.00 | 36.67 | 0.008 | 0.08 |
| % Difference, Experimental group who do not have a disability | -3.33 | 81.67 | 0.009 | 0.09 |

**Measures of Central Tendency**

While the degree of variability appeared great, when the measures of central tendency were calculated it was seen that (i) although some children had made dramatic changes between their pre-/post-test scores, there was (ii) a high degree of internal consistency to the children's scores. This was true for both the experimental and the control groups. When these numbers were considered more closely and, despite the extreme nature of some of the furthest outlying scores, calculation of the mode and median values revealed the control and experimental group scores to both be largely consistent. In the control group, the percentage mean difference between the

pre-test and post-test Selmer scores had a mode value of 3% and a median value of 3%. This is shown in Figure 10.

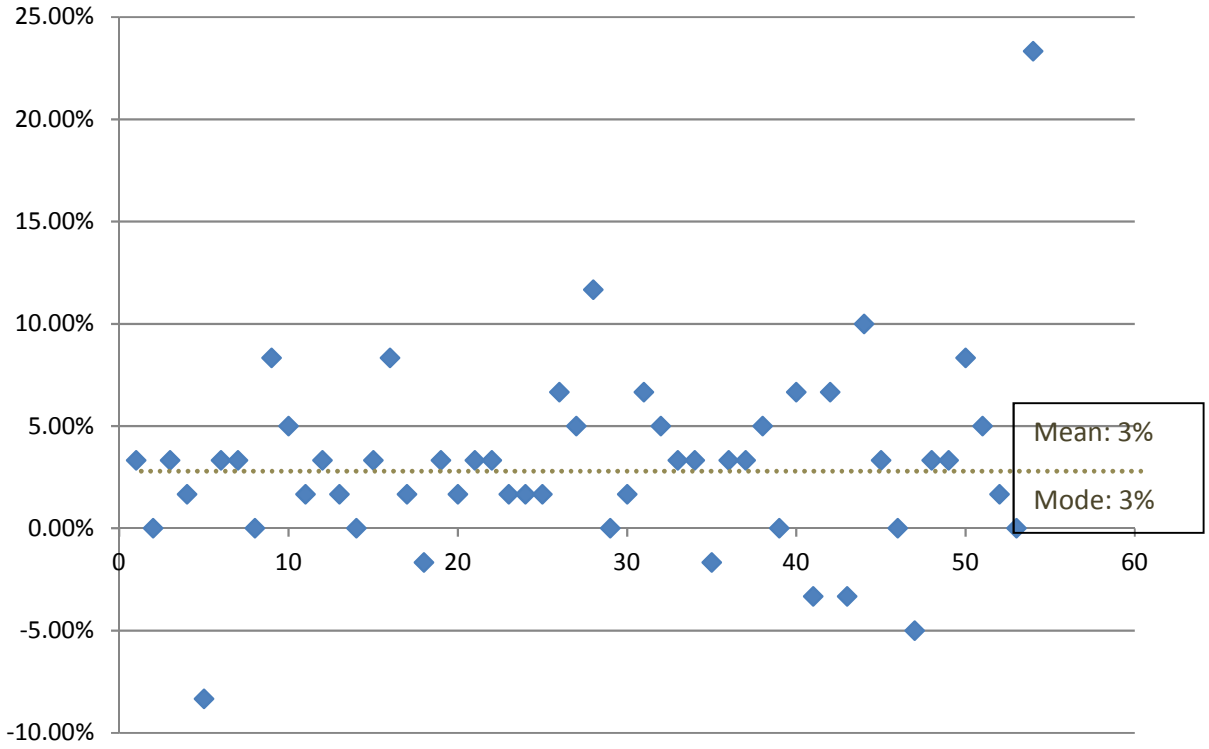



*Figure 10.* Distribution of percentage mean differences - control group.

Similarly, the mode for the percentage mean difference between the pre-/post-test scores for children in the experimental group (with mandatory school involvement) was 13% and had a median value of 15%. Again, like the data for the control group, the range of scores for this experimental group, while affected by a few extreme outlying scores, still maintained a strong degree of internal consistency.

That these distributions occurred simply as a result of chance is far less likely given the level of internal consistency that both the control and experimental groups can be seen to possess. The distribution of the scores for the 73 children in the experimental group who received instrumental music training from their school alone and from no other source is shown in Figure 11.

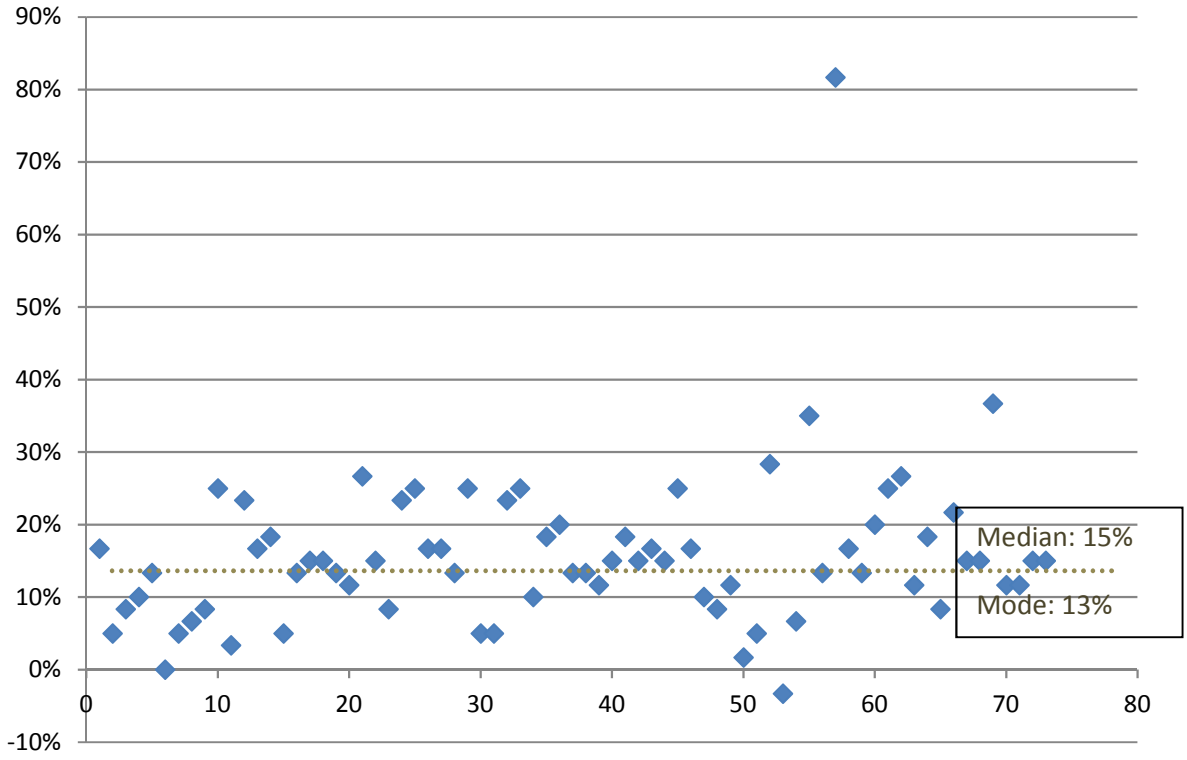



Figure 11. Distribution of percentage mean differences - mandatory delivery only.

In Table 9, the mean, mode and medians values for percentage mean change between the pre-test and post-test Selmer scores are shown. Again, the numbers reveal a far greater internal similarity *within* each of the control and experimental groups, than when the control and experimental groups were compared to each other. The results show that, over the 18-week duration of this study, children in the experimental group improved to a far greater extent between their Selmer scores than did children in the control group. However, also from the calculations of central tendency, again it was clear that the greatest percentage mean improvement was shown by the cohort of children who had received the intervention and who also had a disability.

Table 9.

*Measures of central tendency*

| | Number of subjects | Mean % | Mode % | Median % |
|---|---|---|---|---|
| % Difference, Control group who had a disability | 10 | 3.67 | 1.67 | 1.67 |
| % Difference, Control group who do not have a disability | 44 | 3.01 | 3.33 | 3.33 |
| % Difference, Experimental group who had a disability | 9 | 25.00 | 25.00 | 25.00 |
| % Difference, Experimental group who do not have a disability | 116 | 11.14 | 5.00 | 11.67 |

## Inferential Statistics

### The Null Hypothesis

In testing this study's results for significance, the following null hypothesis was proposed. $H_0$: No significant difference on the Selmer results for auditory

discrimination exists between children who were engaged in in-school instrumental music training and those who were not.

To test the efficacy of in-school instrumental music training as a tool for altering children's auditory discrimination skills, an independent-samples *t*-test was conducted. To further safeguard against the possibility that the results had occurred merely by chance, the significance level for the *t*-test was set at $\alpha = 0.01$. The *t*-test results showed that the percentage mean difference between the scores for the total number of children in both the experimental [$t(255) = 6.20$, $p < .001$, d = 0.80] and control groups [$t(106) = 0.93$, $p < .001$, d = 0.18] were indeed statistically significant. The results indicated that the students who had undertaken the instrumental music training ($M = 9.69\%$, $SD = 0.01$) could be shown to have outperformed their peers who had not been involved in similar training ($M = 3.34\%$, $SD = 0.05$).

A further series of *t*-tests were performed to determine whether the results for children who had a disability were similar to, or different from, those of the children who did not have a disability and were involved in the intervention. The results of these tests are shown below. It was found that the difference between the scores for the children in the experimental group who had a disability [$t(26) = 2.90$, $p < .001$, d = 1.06] and:

a) the control group children who also had a disability was statistically significant [$t(18) = 0.96$, $p < .001$, d = 0.43]. The results indicated that students who had a disability and had undertaken the instrumental music training ($M = 19.00\%$, $SD = 0.113$) showed greater percentage improvement than did the children who had a disability but who had not been involved in the intervention ($M = 3.67\%$, $SD = 0.081$).

b) the control group children who did not have a disability were also statistically significant [$t(86) = 1.17$, $p < .001$, d = 0.25)]. The results showed that students who had a disability, and who had undertaken the instrumental music training ($M = 19.00\%$, $SD = 0.113$) showed a greater percentage improvement than children who did not have a disability and had not been involved in the intervention ($M = 3.01\%$, $SD = 0.034$). This is highly noteworthy.

c) the experimental group children who did not have a disability were statistically significant [$t(229) = 6.20$, $p < .005$, d = 0.81] when the alpha value was raised to the (still acceptable) tolerance of $\alpha = 0.05$. The results when calculated at $\alpha = 0.05$ showed that those students who had a disability and who had also undertaken instrumental music training ($M = 19.00\%$, $SD = 0.113$) showed a greater percentage improvement than children who did not have a disability but had been involved in the intervention ($M = 11.14\%$, $SD = 0.095$). This is also extremely noteworthy.

**Rejecting the Null Hypothesis**

The results of the various *t*-tests indicated that the $H_0$ hypothesis was false. Therefore, it could be concluded that the intervention - instrumental music training - did indeed produce a significant effect in this study. As determined by the Selmer testing, in this study the auditory discrimination of children who were involved in the intervention (instrumental music training) was shown to have improved between two to eight times the amount that could be shown for similar children in the control group who had not received the intervention. Moreover, with the alpha value in all but one of the *t*-tests set to: $\alpha = 0.01$, the probability of the differences between the children's scores in the various groups in this study having occurred merely as the result of chance was statistically improbable.

**Conclusions from the Analyses**

In all, from this study, three conclusions were able to be drawn. The first of these, and most general, was that children's participation in instrumental music training was shown to be associated with significant improvements to their auditory discrimination skills. The second was that this association of instrumental music training and improvements to children's auditory discrimination skills remained strong regardless of whether (or not) the subjects in this study had a disability. The third, and most striking result of this study, was that of all the children involved, it was the children who had a disability who were the ones whose auditory discrimination was most likely to benefit as a result of their participating in instrumental music training.

# Chapter 5: Discussion.

This study was initially undertaken to redress a gap in the literature that had investigated music and its associated non-musical benefits. In reviewing peer-reviewed literature, widespread evidence exists to show that children's involvement in instrumental music training can be directly associated with physical and/or academic improvement. However, across the literature that describes music training and its non-musical associations, researchers rarely identify whether any students who had a disability were included among the studies' participants. Since it should not be assumed, even in studies that have produced powerful experimental results, that the findings described for children who do not have a disability are necessarily applicable to students who *do* have a disability. Therefore, the application of research such as this for children who have disabilities, is materially weakened. Hence, this study has sought to answer the following questions:

I. Can instrumental-music instruction be shown to affect the aural discrimination skills of children who have a disability?
II. Do the aural-discrimination skills of children who have, or who do not have a disability, display similarity/difference before and after the introduction of instrumental-music training?

The decision to measure children's auditory discrimination through *Selmer* testing was shaped by four logistical considerations. They were firstly, that Selmer is a test that has been specifically designed, and is used, for the purpose of measuring children's auditory discrimination (Cavin, 2001). Secondly, it is extensively used in Australian schools (Ng & Hartwig, 2011). This includes schools Queensland, the Australian state in which this study was conducted. Thirdly, in Queensland, schools typically use Selmer to test their entire cohort of Year 3 children and record all their children's Selmer scores regardless of whether or not individual children ultimately participate in their school's instrumental music training. Finally, in Queensland schools Selmer testing is (most) typically done at the very beginning of Year 3. That meant that the Selmer testing was conducted before Year 3 children commenced school instrumental music training. This is because Selmer testing is run in Queensland schools for the purpose of either:

i. flagging children who demonstrate high levels of auditory discrimination skills, and 'selecting' these children for inclusion into school instrumental music programs; or
ii. as a means of providing information to the school's instrumental music teachers about the auditory discrimination skills of individual children's who are about to commence instrumental music training.

Selmer information is typically made available to a school's instrumental music teachers before they commence teaching the incoming year's cohort of instrumental music students as a means of gauging the listening skills of those children before the teachers meet them. It was these school-run Selmer test scores that had been run and recorded before the children commenced any Year 3 instrumental music training that provided the baseline data for this study.

## Understandings

### Accounting for Natural Improvement over Time

In all four schools, the mean percentage score change that students received in the second *Selmer* testing was (generally) higher than at the initial Selmer testing. This was typical regardless of whether, or not, individual students were involved in instrumental music instruction over the course of the intervention.

One reason to account for this apparent global improvement between the two tests may have simply been that at the time of the second Selmer testing, the children were now almost six months older. Another reason to possibly account for this general improvement between the pre-test and post-test Selmer scores in this study was that by re-testing with Selmer again (at the conclusion of the intervention), the subjects had now had the experience of doing the *Selmer* test once before (during the initial testing). This, in turn, may have resulted in better results during the second round of testing as it is conceivable that the students may have better 'known what they were doing' when the second Selmer test was re-administered. Thus, the better scores produced by the second round of Selmer testing may possibly have occurred as a result of the initial Selmer test acting as a form of 'rehearsal'.

Regardless of the reason *why* a global improvement occurred between the two Selmer testing points across all the groups at in this study, when the percentage mean differences between the pre-/post-test scores were calculated and the results for the groups in this study compared, it was evident that the degree of improvement shown for the control and experimental groups was clearly unequal. Analysis of the differences between the pre-test and post-test Selmer scores showed that, in terms of the degree to which the auditory discrimination scores of this study's subjects altered, children in the experimental group ($M = 9.69\%$, $SD = 0.01$) who had received the

intervention of instrumental music training, were shown to have significantly outperformed their peers in the control group ($M$ = 3.34%, $SD$ = 0.05) who had not received similar instrumental music training by a factor of almost 6.35%.

**Positioning this Study**

This study has clearly shown that instrumental music training appears to have functioned in a way that yielded results far greater than merely teaching children how to play the violin. Importantly, this study's results can be shown to be consistent to many other studies that have also found that by involving children in instrumental music training specific, quantifiable benefit/s result [For example, Degé et al., (2011); Moreno et al., (2011); Putkinen, Tervaniemi, Saarikivi, Ojala and Huotilainen, (2014); Schellenberg, Corrigall, Dys and Malti, (2015)]. Thus, merely in terms of positioning, this study belongs to the group of music investigations that describe how instrumental music training can operate as a means of developing children's auditory discrimination skills [For example, Kraus and Chandrasekaran, (2010) or Putkinen et al. (2014)] or those such as Tierney et al. (2015) that describe how music training can be utilised to functionally alter the course of children's auditory development.

**Issues of transference.** Like many other music studies in this field that are grounded in the idea of transference, this study has not sought to determine whether it was near transference or far transference that had occurred and thus accounted for the study's results. Since this study measured the auditory discrimination skills of children who did and did not learn to play the violin, if an association between the two existed, there may be good justification to suggest that since music, like listening, is largely about the production of sound, that near transference may have occurred. That is, an association had occurred because of the existence of two closely related skillsets. Conversely, because the instruction in this study was not chiefly about ear training it

may still have been far transference that could better account for the association of the training to improvements in the subject's auditory discrimination capacities. In this study, the specific musical elements that were explicitly taught to the children were performance posture (how to hold the violin, and later the bow), and the production of just four notes (the four open strings of the violin). It was only toward the very end of the experimental period that other notes were included as the children began to learn how to put their fingers on the strings. In this program, lines on the violin's necks physically indicated the placement positions needed for the fingers. While this is a common practice with beginner violin pedagogy, it almost fully reduces the need for children to 'find a note' through finger placement and listening for whether that note is in tune or not. Because of this the children in this study did not need to rely on their ear to find the correct place to put their finger/s in order to produce the desired note. For these reasons it might be argued that transfer occurring in this study might be more likely to be far transfer.

That this study does not endeavour to explicitly state whether it is near or far transfer that has most likely occurred is not unusual when compared to other studies in this field. Nor is the fact that it has not attempted to determine a causality (that is beyond question). Like similar studies it merely finds that a very close association appears to exist between whether a child is involved in instrumental music training and improvements to their auditory discrimination capacity. Therefore, as is the case with numerous other research projects in this field, this study is underpinned by the idea that some form of transference – whether it be near or far – appears to have occurred, and that this is the reason that is likely to account for the study's results.

**The centrality of disability as a feature in this study.** When compared to other similar studies in this field, there is a significant difference between the way that this project has been envisaged, observed and reported and other similar studies. From the way studies in this field are typically reported, it is not possible for educators to conclusively know whether the results that have been found for children who (assumedly) did not have a disability, also have relevance for children who do have a disability.

The gap in the literature is essentially due to either a failure in the reporting processes that is typical for studies of this type, or because of a bias that disregards disability as an aspect worth of being considered within the typical design of studies that investigate music and its associated non-musical benefits. Regardless of the reason, as a result the essential problem is that whether children who had a disability were 'actually' present within many of these studies is unknown and therefore the ability to comprehend whether the study also has relevance for children who have a disability is likewise unknown. If children who had a disability were (even inadvertently) tested as part of the experiments in this field and are if their results possible were consistent (or different to) the research's general findings, then this is almost never stated by the researchers.

By contrast, central to the design of this study, was the purposeful identifying of children who had a disability as a specific subset within the overall pool of participants. It was by this simple yet important distinction that when this study's results were analysed it was possible to determine whether the changes to auditory discrimination shown by children who had a disability bore any resemblance to the changes in auditory discrimination that were demonstrated by children who did not have a disability.

The results of this study show that the involvement of children who had a disability in instrumental music programs (at least in this instance) was profound. The real importance of this study's results is best understood when it is considered in the light of what is already known in the area of music/non-music benefits, and from where this study is sited within the greater field of music research. That is, that the better a child's auditory discrimination, their better their likelihood of academic success (Banai & Ahissar, 2013). In this study, children who were involved in the intervention (instrumental music training), including those who had a disability, demonstrated significant improvements to their auditory discrimination skills.

**Special Implications for Children who had a Disability.**

Potentially, the results of this study hold great meaning for children who have a disability. In this study, it was found that children who received instrumental music training demonstrated significant improvements to their auditory discrimination ($M$ = 9.69%, $SD$ = 0.01) when compared to children who were not involved in music training ($M$ = 3.34%, $SD$ = 0.05). Importantly, significant improvements to auditory discrimination were shown for all the children who had received the instrumental music training regardless of whether they had a disability. The $t$-test calculations used to determine whether the study's results may have occurred merely as a result of chance showed that, with the significance level set at $\alpha = 0.01$, the possibility of chance alone accounting for the association between music training and improvements to children's auditory discrimination was extremely unlikely. The $t$-test calculations showed that not only were the average mean differences between the pre-test and the post-test scores for the children in the experimental and control groups statistically significant, but that the greatest percentage mean improvements to auditory

discrimination (as a result of instrumental music training) was shown for the group of children who had a disability.

This study showed that children who had a disability, and were involved in instrumental music training ($M$ = 19.00%, $SD$ = 0.113):

1) performed substantially better in auditory discrimination testing than did children who had a disability, but were not involved in instrumental music training ($M$ = 3.67%, $SD$ = 0.081),
2) obtained better overall mean percentage improvements in their pre-post-test Selmer scores than children who did not have a disability, but who had not been involved in instrumental music training ($M$ = 3.01%, $SD$ = 0.034),
3) showed similar trends as those children who did not have a disability and were involved in the instrumental music training - but to a greater degree. [That is, compared to: ($M$ = 11.14%, $SD$ = 0.095)],

Moreover, the results of this study also showed that children who had a disability and were not involved in instrumental music training:

4) only showed marginal improvements to their auditory discrimination testing over time ($M$ = 3.67%, $SD$ = 0.081); and though slightly better, these were comparable to scores of the children who did not have a disability and were not involved in the instrumental music training ($M$ = 3.01%, $SD$ = 0.034).

Three key considerations emerged from this study. Each relates to how providing opportunities for children who have a disability to participate in school instrumental music programs, and the potential of doing so, should be understood.

They were:

i. whether children who had a disability could be shown to have benefited from involvement in the instrumental music training typically run by schools,
ii. the implications of failing to encourage children who have a disability to involve themselves in instrumental music training opportunities when it is provided by their school, and
iii. whether school-run programs are equally as valuable as are private music lessons for children who have a disability.

It was seen that the children in this study who had a disability and who were included in the all-in school instrumental music programs, alongside their peers who did not have a disability, showed the greatest improvement of all the groups that were investigated ($M$ = 25.00%, $SD$ = 0.082). Secondly, from the results of this study it was also clear that children who had a disability and who were in the control group (that is, who did not receive any instrumental music training) showed very little percentage improvement ($M$ = 3.67%, $SD$ = 0.081). Moreover, this was consistent with the improvements shown for children who did not have a disability and had likewise not participated in instrumental music training. Thirdly, the four children who had a disability but did not participate in in-school lessons, but who undertook private lessons, also showed considerable improvement ($M$ = 10.42%, $SD$ = 0.011). While caution needs to be exercised in extrapolating the importance of just four students it is important to note that this improvement was comparable to the improvements shown by the 15 children who did not have a disability and were similarly *only* involved in music lessons that were undertaken privately ($M$ = 8.22%, $SD$ = 0.053). Finally, the

auditory skill improvement of those children who had a disability and who also undertook private lessons but not school music ($M$ = 10.42%, $SD$ = 0.011) was also of significance when compared to the results of children in the control group children who had a disability and received no instrumental music training from any source at all ($M$ = 3.67%, $SD$ = 0.081).

One of the most interesting aspects of this project's results was that, of all of the children involved in the investigation, the ones who showed the greatest improvements to their auditory discrimination skills were the children who had a disability, attended schools where in-school instrumental music training was mandatory, and were simply involved in instrumental classes alongside their peers who did not have a disability. Further, this finding remained true regardless of the type of disability that individual children in this study had – that is speech/language or physical impairment, or ASD.

## A Rationale for Change

### Justifications for Inclusion and Exclusion

In Chapter 1, it was shown how three widespread beliefs account for *why* children who have a disability are under-represented in school instrumental music programs. Again, these are the beliefs that:

i. professional sounding music programs are a selling-point for a school to the community,
ii. music is extra-curricular - not a core learning, and
iii. economic rationalism - how schools can best allocate limited resources, and to whom those resources are best shared.

**The Place of this Study in Addressing these Arguments**

While these three beliefs are the reasons most often cited as to *why* children who have a disability are not included in instrumental music training, there are fundamental problems inherently associated with them. Ultimately, the first is driven primarily by a consideration of the institution, and not for the betterment of individual students.

The other two are far more troubling because, although they are commonly quoted, they lack proof that they are *actually* true, and they are anti-inclusive. However, even with the caveat that this investigation was a pilot study, its results overwhelmingly support the notion that the ongoing justification to support each of these 'reasons' should certainly be questioned. Certainly, for the children in this study none of these arguments could be reasonably justified given the evidence of the improvements that they made as a result of their involvement in instrumental music training.

Moreover, as a greater consequence of this study's findings, there are direct implications as to how educators might best:

a. reappraise these arguments that hinder inclusion, and thereby
b. reconsider the value of encouraging children who have a disability to be included in school instrumental music programs where they are offered, and these children would like to be involved.

**The extra-curricular argument**. This belief is grounded in the idea that any activity that draws time away from core-learning is a distraction and, as a result, non-core activities are considered detrimental to the best ‘use of time’ for educating children who have a disability. Therefore, activities deemed extra-curricular are

necessarily educationally undesirable and, in the case of children who have a disability, involvement in extra-curricular activity such as instrumental music lessons are considered (by many) to be particularly distracting.

Critically, although widely believed and often stated, there appears to be no evidence to show that it is *actually* true. In fact, for children who do *not* have a disability there is evidence to demonstrate that the exact opposite is true. For instance, in a study by Simoncini and Caltabiono (2012) of 906 Australian children aged between 5 to 8 years of age (none of whom were described as having a disability), the researchers found that participation in extra-curricular activities resulted in a range of desirable outcomes including improvements to children's overall behaviour, and benefits to their general learning. Additionally, in an analysis of longitudinal data relating to American children (who, likewise, were not flagged as any having had a disability), Fredricks and Eccles (2006, p. 132) found that children's involvement in extra-curricular activity was closely "associated with [positive] academic adjustment, psychological competencies, and a positive peer context".

In the light of knowledge such as this, this study is of particular importance because it effectively tests the contention that children who have a disability (at least, those in this investigation) derived no benefit from their involvement in the 'extra-curricular' activity of instrumental music training.

In this study, this proved to be false. Instead, this study clearly showed that for children who had a disability, their participation in school-based instrumental music programs was closely associated to sizable, measurable improvements to their auditory discrimination that were unlikely to have occurred as a mere result of chance. Moreover, this project's results also revealed that children who had a disability and who were involved in instrumental music training were the ones *most* likely to benefit

as a result of instrumental music training. In fact, in this study, children who had a disability showed even greater benefits than did their peers who did not have a disability and who had also received instrumental music training.

For children who had a disability in this study, the result of their involvement in instrumental music programs (particularly those that were school-run) was far from inconsequential. While involvement in instrumental music classes may well have been considered extra-curricular, it was also clear that (at least, for the children in this study) it was of enormous benefit, and well worth the time required for the children to participate and attend teaching sessions.

**The economic rationalist argument**. Queensland schools typically own a small collection of musical instruments, and these instruments are loaned to children who commence instrumental music training that normally occurs in Year 3. These children are given free instrumental music lessons by trained instrumental music teachers who attend the schools and typically teach children in group lessons.

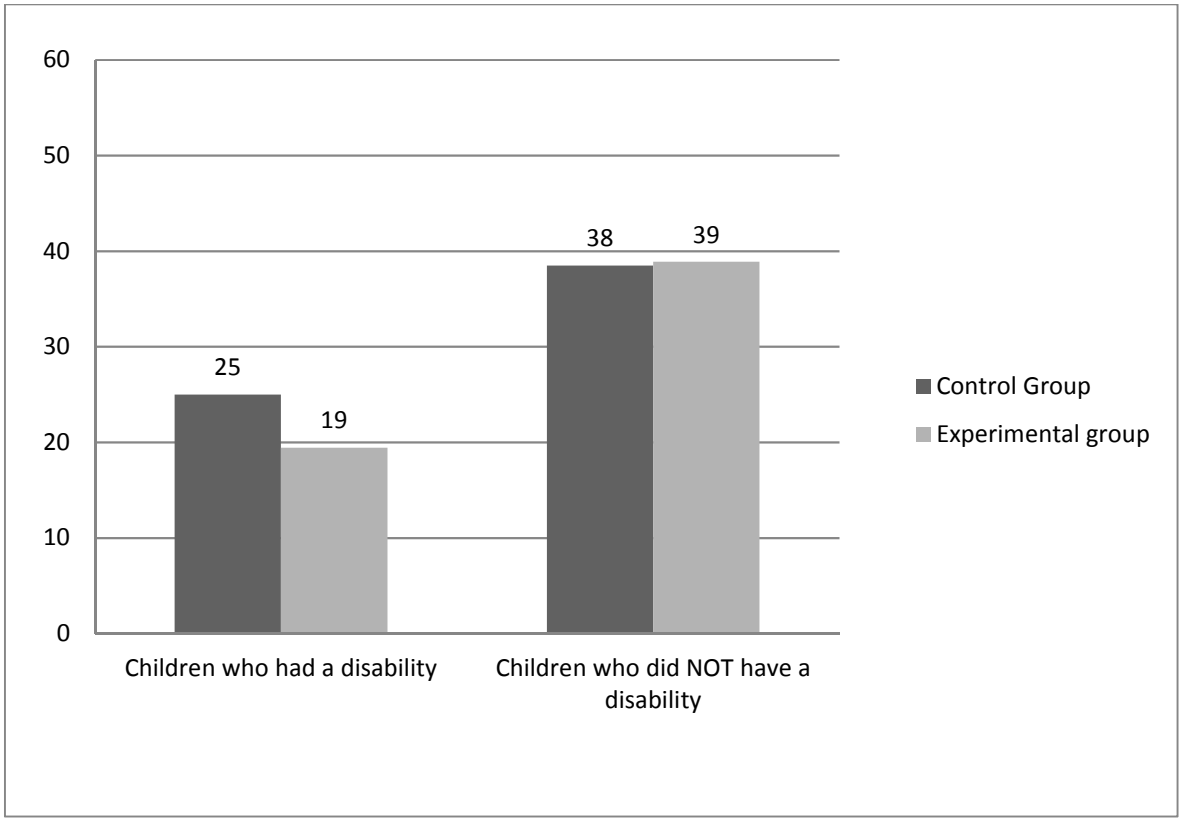
It is a reality that schools have limited budgets. Because of the number of instruments that individual schools own, the number of Year 3 students that a school has, and the teaching time that is ultimately allocated to individual schools by Education Queensland (the State Authority responsible for the administration of Queensland's education system and payment of its teaching staff), there is a need to determine 'who' will get the instruments, and therefore 'who' should be taught.

Children who have a disability do not usually perform well in Selmer testing. This was evident from the data in this study where their scores were on average 26.67% lower than the scores of children who did not have a disability. This is shown in Table 10. A perfect score on the Selmer test is 60. From the data provided by the four individual schools, it was clear from the initial Selmer testing that children who

had a disability answered, on average, approximately 16 fewer questions correctly than did children who did not have a disability.

Table 10.

*Average Number of Initial Selmer Answers Correct*




Selmer test scores are used by many schools to funnel children who have the best auditory discrimination into their school instrumental music programs. Accordingly, Selmer is often used as the means of justifying why children who have a disability should be overlooked in favour of children who do not have a disability being the ones most suited to be selected for inclusion in school instrumental programs. Thus, based on Selmer and justified through economic rationalism, Selmer testing actively disadvantages children who have a disability.

Justified by the argument that children who can best differentiate sound should be the ones to whom limited school resources should be allocated, children who have a

disability predictably miss out. At the core of this argument is the assumption that: whoever has the best (initial) auditory discrimination will have the best 'head-start'; and whoever has the best head-start will, consequently, require the least resources. Although the veracity of whether identifying better listeners (before music training) delivers optimum results is itself untested, the justification for distributing limited school resources by this means has widespread acceptance.

Economic rationalist agendas are about getting the best value for money. Viewed differently, and in the light of this study, there may well be an alternative argument that is still grounded in economic rationalism but delivers a significantly different outcome for children who have a disability. For instance, if the question used as the basis for distributing school-owned instruments was to be: From the research, which students might gain the most through their access of these school resources?

Ironically, in this study it was the children who had a disability, the ones most under-represented in school instrumental music programs, who were the ones who made the greatest improvements to their auditory discrimination as a result of their involvement in school instrumental music training. It was also shown that their improvement was greatest when the children who had a disability were simply included in regular instrumental music training classes alongside their peers who did not have disability. Thus, the economic rationalist's argument of getting 'best value for money' is paradoxically the very reason why children who have a disability might well be considered as the ones *best suited* for inclusion into school instrumental music programs - that is, should they wish to be involved.

An enormous amount of time and money is already allocated to educating children who have a disability in Queensland schools. If involving children who have a disability in instrumental music programs (already running in Queensland schools)

were to produce results like those found in this pilot study, then involvement of children who have a disability in school instrumental music programs is, in pure economic rationalist terms, an excellent return on investment.

**The music program as advertising argument.** If for no other reason, the argument for 'auditioning' as the means of selection into a school's music program is problematic because fundamentally, it is elitist. Where schools use their music programs as a means of advertisement to the broader community, quality is important. Therefore, in schools where music ensembles advertise a school's excellence, auditioning processes are more about the de-selection of students out of school music programs, rather than inclusion of students into those programs.

How any school is perceived by its community (or extended community) is undeniably important. However, in terms of teaching and learning the essential question is: What does a school want the *function* of its music program to be? Schools are best represented when they can show that they maximise the learning potential for all their students, including those students who have a disability.

## In-Principle Government Ascent for Action

The philosophy underpinning how children who have a disability *should* be taught contains a government mandate for action. In its report on young people and disability, the Australian Bureau of Statistics (2016, p. 1) describes the Australian Government's position that:

> as a signatory to both these conventions [that is, the Convention on the Rights of the Child and the Convention on the Rights of Persons with Disability], the Commonwealth and all State and Territory governments signed an intergovernmental agreement in 2012. This was the *National Partnership Agreement for More Support for Students with Disabilities*, (Council of

Australian Governments, 2012). This agreement was signed with the express aim of Australian States working collaboratively to improve educational outcomes for Australian students who have a disability.

## Limitations

### Ethics and Impact Minimization

Because this study could not ethically select/deselect children into/out of either the experimental groups, true randomisation of this study's groups was not possible. However, adoption of quasi-experimental methodology meant that the study's impact both on individual subjects, and on the music programs that were running in the participating schools was minimised. Most importantly, the use of quasi-experimental methodology neither invalidated the study's design nor its results.

### Sample Size

For this study to be meaningful, children with disabilities needed to choose to be involved. Even though no child having decided to be involved in this study chose to withdraw, an obvious limitation was this study's sample size - namely, 185 children, of which only 25 had a disability. 185 children represented only slightly more than half of the combined Year 3 population of the four schools involved in this study. Understood in the context of census information reported by the Australian Bureau of Statistics (2016), as a proportion of the total sample and 25 children (or 13.5% of this study's sample) is consistent to the reported incidence of households in which there is a child who has a disability. Naturally, greater numbers of participants (and particularly the involvement of a greater number of children who had a disability) would have been advantageous since greater participation would have increased both the study's representativeness and its experimental power.

Yet, viewed as a pilot study, the results of this project are nonetheless important. They point to the likelihood that a broader truth exists within research that has been reported in this field. That is, that in this study a clear association was found to exist between children's involvement in music training and an associated benefit (in this instance: improvement to children's auditory discrimination). Importantly, this was evidenced regardless of whether (or not) the children involved had a disability. However, even more importantly, in this study the children who benefitted the most because of their involvement in instrumental music training were the children who had a disability.

As is the case with pilot studies, when participant numbers are relatively small there is a limitation of reduced external validity (Kalof, Dan, & Dietz, 2008). Even with 185 children choosing to participate in this research project, the individual sample size of both the experimental and control groups was still relatively small. Thus, despite strong results, caution needs to be exercised if attempting to generalise this study's results to the broader population. Despite this, the importance of this study's results is not nullified. Viewed as a test of the gap in the literature, the results of this study are highly important.

**An Unexpected Element in Group Formation**

Finally, from the two schools where involvement in instrumental music training was optional, it was expected that at least some children would undertake instrumental music classes from their school and from no other source. In this study this did not occur. Of the children who chose to be involved in this research project, and from the schools where music was optional, all these children also received private music lessons outside of school hours in addition to in-school lessons. While a substantial group ($n$=73) came from schools where instrumental music lessons were mandatory,

and they did not receive lessons from any other source, a similar group did not exist at the schools where children's involvement in their school instrumental music lessons was optional. The lack of a similar group – that is children who received in-school (optional music training) but no private lessons meant that results for children receiving lessons from their school alone could not be generalised to fully compare the optional and mandatory modes of delivery.

## Recommendations for Future Research

### Further Addressing of the Gap

In this study, children who had a disability did not merely show similar trends to children who did not have a disability. Instead, it was children who had a disability who received the greatest benefit from their involvement in instrumental music training. Because of the gap that exists in the literature, and given the results shown of this one study that has tested that gap, salient questions might be: In how many other studies that have associated instrumental music training to various non-musical benefits might there also be benefits that would apply for children who have a disability?

This study has shown that children who had a disability clearly benefited through their inclusion in instrumental music training. Because a body of other music research studies clearly associates instrumental music tuition with a diverse array of non-musical benefits for children who are not noted as having a disability, these studies might well be true also for children who have a disability. If what is generally known in the field of music/non-musical benefits research *is* also true for children who have a disability, then this has direct implications for the practice of educators.

Assumptions are always problematic. The ability of educators to point to actual evidence contained in the research literature that is specific to music and disability, should not be underestimated. This is the aspect where this study has had an important part to play in what can be currently known in this field.

**Increasing overall sample size.** An obvious recommendation for future research is to test whether, if replicated with a much larger sample size, delivered results like those reported in the context of this pilot study. Typical of pilot studies, the principal limitation of this project was the limited number of children who had a disability and chose to be part of this study. Replicating this study with a larger sample size would yield useful information. If the results remained true with a much larger sample size, then the implications relating to the best practice of teaching children who have a disability may well deserve reappraisal.

**Focussing through even more purposive sampling.** An alternative to simply replicating this study on a larger scale might be to specifically target children who have disabilities that represent each of the various types of disabilities and determine whether the results of that study remain consistent to those of this study. In this study, of the seven possible disability categories that could have been included, only children representative of three of these categories chose to participate in this research project. Determining whether instrumental music had the ability to benefit children across all the possible disability categories would be a valuable consideration rather than merely replicating this project on a larger scale.

**Reconsidering disability as worthy of investigation.** What this project has shown is that there is a very real need for researchers in this domain to consider, observe and report whether any children who have a disability were included in their experimental samples, and whether the results shown by these children differ in any

appreciable way to the results that are reported for the general population. To reconsider disability as a normal thing about which researchers should report is not a great leap. It would seem highly unusual for modern studies to not report gender as a routine part of their description of their subjects. Likewise, not showing whether gender had influenced the results would be unlikely. Similarly, it is not unusual for studies (especially those undertaken in the United States of America) to show how particular ethnicities were represented within the study's participant sample and to report whether this had any bearing on the results.

With this as a precedent, to note whether any children had a disability within experimental samples, and whether disability as a variable may have impacted a study's results is not a radical step. Yet, this simple difference in approach would be highly informative for educators, especially given the widespread mainstreaming of children who have disabilities into regular classrooms. This minor modification to way that research in this field is conceived would be, while relatively simple, highly enabling. Readers interested in the field of disability would thus be able to have a far greater understanding of how studies across a broad range of individual investigations might have a direct application for persons who have a disability.

## Ramifications from the Study's Results

This study yielded four major findings. The first was that children involved in instrumental music training by far outperformed those children who were not involved in the period of instrumental music training in terms of their auditory discrimination skills. It was clear that regardless of gender, or whether the children attended a metropolitan or a regional school, that instrumental music training could be shown to be closely associated to improving children's auditory discrimination. That this finding

is consistent to other research is important because it gives this study context within a group of other similar studies.

For example, Chermak (2010, p. 57) found that auditory training was effective in the "treatment and management of children's listening difficulties" and Banai and Ahissar (2013, p. 1) found while testing the auditory skills of third grade children that "very poor auditory and memory skills are rare among children with even a short period of musical training, suggesting musical training could have an impact on both". The consistency of studies such as these to the findings demonstrates in this study show that it occupies a space where it is representative of a greater body of research in this field.

Although the finding in this study that children who were involved in instrumental music training outperformed their peers who did not undertake similar training was significant, this is not the aspect that is of greatest consequence in this investigation. Instead, the aspect that sets this study apart from other (similar) ones in this field is that it sought to

determine whether children who had a disability were impacted in ways that were similar or different to their peers, when they were each involved in instrumental music training.

The second finding of this study is of greater significance. In this study it was clear that children who had a disability benefited from their inclusion in instrumental music training. In this study, the children who had a disability and were included in instrumental music training, produced the greatest mean percentage improvements to their auditory discrimination test scores, even greater than did the children who did not have a disability, and who were included in the same programs.

Thirdly, it was shown that instrumental music training was of benefit to children regardless of its source. That is, whether children were involved in instrumental music lessons that were sourced privately (outside school hours) or whether they received that training from in-school lessons, children who were involved in *any* form of instrumental music training showed significant improvements to their auditory discrimination skills. Moreover, the improvements to auditory discrimination skill associated to children's instrumental music training remained consistent regardless of whether individual children had a disability.

As a logical extension of the results of this study, a strong argument could be made for children who have a disability being given the chance to participate in instrumental music whether that be from in-school lessons or from privately sourced lessons. Where schools cannot or do not provide the opportunity to be involved in instrumental music training for children who have a disability, private lessons may well be the answer. The fact that private lessons come at the expense of the user should not necessarily preclude children who have a disability form accessing these lessons should their families see the benefit. Currently, the Australian National Disability Insurance Scheme (NDIS) offers flexibility to the families of children who have a disability, allowing them to self-determine how money allocated to them for educational support should best be used. Based on the results of this study, undertaking private music lessons (on a suitable instrument) may well be a very wise investment for children who have a disability.

Displacing the onus of involving children who have a disability in in-school instrumental music lessons is short-sighted. This study has shown that for children who had a disability, the greatest percentage improvements to their auditory discrimination occurred when they were simply involved in their own school's

instrumental music programs. That is, the children who received the best benefits were those children who had a disability and were taught in regular classes alongside their peers who did not have a disability.

Involving children who have a disability in this way is not radical. This is inclusion. Currently, the all-in model is (almost) exclusively a private school model and not run in state schools. Given the findings in this study, more schools adopting the all-in model of instrumental music tuition would seem to be a way to extend the benefits of instrumental music tuition to far more children. A broader adoption of the all-in model might be of significant benefit to children generally; but be of particular benefit for children who have a disability.

## Closing the Gap

From this study, it was seen that 8-year-old children who were not involved in instrumental music training showed around a 3% improvement to their auditory discrimination over the course of a six-month period. This study showed that there was little difference in this number regardless of whether the child in the study had a disability (3.67%) or not (3.01%).

Importantly, and despite of the percentage mean *changes* in auditory discrimination being similar, the actual auditory discrimination score of children who had a disability was far lower than it was for children who did not have a disability. This study showed that instrumental music training was a highly effective means of altering children's auditory discrimination skills. Moreover, involvement in instrumental music training was shown to have had the greatest effect for children who had a disability.

Of all the things that this study found, perhaps the single-most important discovery is this: when the post-test Selmer scores of children who had a disability and were also involved in instrumental music training were compared to the scores of the children who did not have a disability but had not been trained in music, the gap between the two is almost closed. That is, after instrumental music training, the children who had a disability in this study approached the auditory discrimination levels of those children who did not have a disability but were not involved in the music training. This is shown in Figure 12.

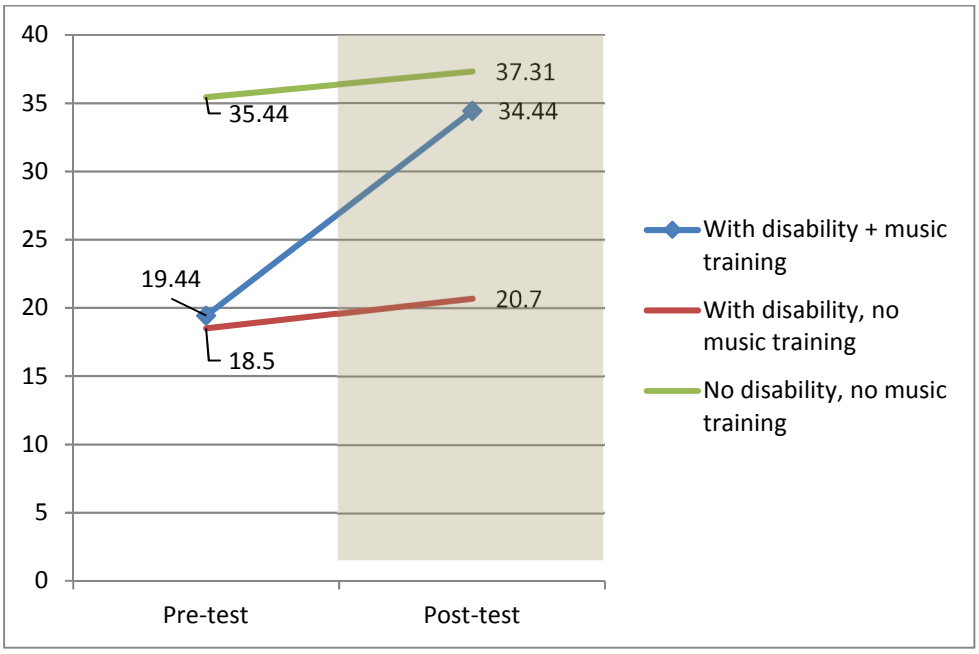



*Figure 12.* Children with a disability and those without, pre/post music training.

Critically, both groups of children who did not receive instrumental music training, (those who had a disability and those who did not) displayed similar improvement trajectories when their pre-test and post-test scores were examined. Therefore, of the children who did not receive instrumental music training, the

children who had a disability recorded much lower auditory discrimination skill test scores than did the children who did not have a disability.

At the end of the intervention period, while both had improved (around 3%), the children who had a disability were still essentially the same distance, and well behind the children who did not have a disability. This represented a difference of 16.6% between their test scores.

The principal result of this study was the indication that the inclusion of children who had a disability into their school's instrumental music programs resulted in significantly narrowing the gap between the auditory discrimination of these children who had a disability, and those who did not. This meant that the difference between the scores for children with and without a disability had narrowed from 16.6% to just 2.87%. This is not merely noteworthy, but of extreme importance both educationally and socially given the evidence from other studies in this field showing that the better a child's auditory discrimination, the better their facility for grammar (Gordon et al., 2015) their academic performance generally (Hille & Schupp, 2015).

## General Recommendations for Action

### A Path Forward

This study has produced some findings that are directly relevant to how the value of including children who have a disability in instrumental music training should be regarded. However, *if* greater numbers of children who have a disability were to involve themselves in instrumental music lessons through their local schools, it would be important to investigate what obstacles they, and the teachers who would provide their tuition, might encounter as a result.

Increased involvement, as desirable as that may be, may necessitate an appraisal of what additional resources and supports might be required should such a plan be enacted. For instance, children with vision impairment might need enlarged versions of their music tutor books, or children with physical impairments might need some instrument alteration or splinting to assist with the manipulation of valves, bows or keys. However, as is the case for disability generally, these are not insurmountable problems. Determining how they might best be resolved may well establish processes and/or guidelines that would be of ongoing benefit both to students and their teachers.

Similarly, while disability is an international issue, there is the potential for strategies for inclusion to vary between cultures. Even in a multicultural nation like Australia a one-size-fits-all strategy might not optimise how best to implement the best practice. Optimal inclusion practices might well require sensitivity and modification as a result of cultural issues. While these need not be impediments to successful inclusion, they deserve consideration.

**The Price of Inclusion**

It is impossible to conclude this discussion without addressing cost. While most people would agree that including more children in (most) school programs is (likely to be) desirable, there is a financial implication that cannot be ignored. To include more children in the current state-run instrumental music programs it would at seem to require additional associated costs – that is, extra children would mean extra teaching time, and extra teaching time extra wages.

This need not *necessarily* be the case. These extra costs are only incurred if the current opt-in model were to be extended to include more children and lessons continued to be taught in small groups. However, should the private school all-in model to be more widely adopted, especially by State schools, then far more children

could be taught without a significant blowout through wage costs. Using the all-in model, classes of up to 30 children could be taught simultaneously with these classes representing the regular class groups of the children. In terms of time allocation, there is already half an hour allocated to children learning classroom music each week where they are away from normal classroom activities. Instrumental music and classroom music could well be merged to facilitate team-teaching that ran under the all-in model with minimal disruption to current timetabling or costs.

Should the results of this study be generally true, then the benefit for children who have a disability and are present in normal classrooms could be substantial. If allowing children to be involved in all-in lessons and receive instrument-specific music training, delivered improvements to children's auditory discrimination as they did for the children in this study then this would be of enormous importance.

## Conclusion

This study has shown that children participating in instrumental music training received tangible benefits to their auditory discrimination skills. This occurred as a result of teaching children how to play a musical instrument - in this instance, the violin. Comparison of auditory discrimination tests clearly before and after instrumental music training showed that the children involved in the instrumental music training clearly outperformed their peers who were not involved in similar training.

Moreover, this study showed that improvements in auditory discrimination were not solely limited to children who do not have a disability, but not only did children who had a disability received benefit from their involvement in instrumental music training, they were the ones who received the greatest benefits.

Perhaps the most profound outcome of this study was that for children who had a disability, their involvement in instrumental music training virtually closed the gap between their auditory discrimination skills and the auditory discrimination skills of those children who did not have a disability but chose not to avail themselves of similar instrumental music training. Moreover, this instrumental music training did not have to be carried out in a way that was materially different because of the inclusion of children who had a disability in these instrumental music classes.

As an educational strategy within the field of disability, the implications of this pilot study, if proved to be true for the general population, are profound. Simmons and Page (2010, p. 65) quote Ralph Waldo Emerson who said that: "The secret of education lies in respecting the pupil". Therefore, failing to encourage children who have a disability from involving themselves in instrumental music training is not only a serious misjudgement, it is one of enormous pedagogical significance.

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# Appendix A

## Letters and Consent Forms

1. Participant information letter.
2. Participant consent form.
3. Parent survey

## Participant Information Letter

Dear Participant,

You are invited to participate in the research project described below.

**PROJECT NAME: Do instrumental music students hear differently? Implications for children who have a disability.**

### *What is the project about?*

This project investigates whether learning to play a musical instrument might benefit the listening skills of Year 3 children. This is an important topic because some researchers suggest that improvements in children's listening skills relate closely to improvements in children's classroom success.

The purpose of the project is to determine whether instrumental music lessons might benefit children's listening skills. As a second part of this study, the project also seeks to determine whether children who have a disability show similar trends as do children who do not have a disability. It is my desire that this project be conducted in a way that is fully inclusive and fully equitable. Because your child is currently in Year 3, you and your child are invited to participate to participate in the research project described below.

### *Who is undertaking the project?*

This project is being conducted by Ross Walker and will form the basis for the degree of Master of Education (Research) at Australian Catholic University under the supervision of Associate Professor Joseph Zajda, Dr. Poulomee Datta. Ross Walker is a registered teacher of 20 years' experience and has taught music at our school for a number of years. He holds qualifications in both music and education and has for the past 12 years worked as an instrumental music teacher.

### *Are there any risks associated with participating in this project?*

Risk for participation in this research is minimal. Risk to your child has been assessed to be no more than inconvenience. A similar inconvenience is being placed on parents/caregivers in completing the survey. A potential minor risk is where a child (or parent/caregiver) has decided that a child should not participate, their child feels excluded. However, the context of this research is to be non-discriminatory and fully inclusive. Therefore, any student not participating will be provided with an alternative activity in co-operation with their classroom teacher. In participating in this study, your school has been selected as one of six schools to be involved in this research. As such, all data will be aggregated across all six schools, and individual students de-identified in the process. The probability of any one student being identified within the results is remote and highly unlikely.

### *What will I be asked to do?*

As a student in Year 3 at (NAME OF SCHOOL), your child's participation in this project will involve a single written listening test that will take around 20 minutes. It will be run at the end of Semester 1, 2017 as a whole-class activity, and will be under the supervision of your child's classroom teacher. During the test children will be played sets of sounds and asked to make a choice whether two sounds are higher or lower; or the same or different as one another; and indicate their choice by circling a response on an answer sheet. In all, there are 60 questions.

As a Year 3 child's parent/caregiver you will be asked to complete a short survey of 8 questions. The survey has two purposes:

i. to determine if any Year 3 children learn musical instruments outside school hours, and
ii. to identify children with disabilities.

I am asking these questions because: learning an instrument privately (but not at school) might well equate to learning an instrument during school hours. Additionally, in reading music education literature, it has become clear that research in music education rarely identifies whether any children who have a disability have been included in the study. Because of this, it is not possible to determine whether results of these studies also apply to children who have a disability. Your choice to provide this information will be treated with the utmost confidentiality and <u>will not</u> be shared with the school (OR EDUCATION QUEENSLAND [- in the case of the State Schools]).

### *What are the benefits of the research project?*
It is expected that this project will not benefit you directly. However, it may benefit other young people in the long term. Through your involvement in this project we will learn more about whether instrumental music can affect children's listening skills, and whether measurable changes can be found to children's listening as a result of their learning to play a musical instrument. As such, this study may well influence educational strategies in the future.

### *Can I withdraw from the study?*
Participation in this study is completely voluntary. Neither you, nor your child, are under any obligation to participate. If you agree to participate, you can withdraw from the study at any time without adverse consequences. However, after the data has been aggregated (July, 2017) it will no longer be possible for you or your child to withdraw from the study because all individuals will be de-identified at that point through the coding process.

### *Will anyone else know the results of the project?*
The results of this project will appear as the basis of Mr. Walker's Master of Education (Research) Thesis, and summarized results from this project may appear in other print forms. However, this study will not report on individuals. Further, all information resulting from this study will specifically de-identify individuals, and the study's results will be provided only in a summarized form. All comments and responses arising during the course of this project will be treated with full confidentially. Neither you, nor your child will be identifiable in any publication or report that results from this study. Any data collected as part of this project will be stored securely so as to comply with Australian regulations on data storage and security, after which it will be destroyed in accord with destruction rules for confidential documents.

### *Will I be able to find out the results of the project?*
All of the schools involved in this project will be made aware of the project results. It is anticipated that the results will appear as part of individual school newsletters. However, Mr. Walker will be available as one of the School's teaching staff to discuss any aspect of this project with you.

### *Who do I contact if I have questions about the project?*
If you have any questions or require further information, please contact one of the research team members below:

Mr. Ross Walker (Chief Investigator)
Email: ross.walker@myacu.edu.au

A/Prof Joseph Zajda (Principal Supervisor)
Email: joseph.zajda@acu.edu.au

### Concerns/ complaints regarding the conduct of this project:

We are committed to the research integrity and ethical conduct of this research project and the study has been reviewed by the Human Research Ethics Committee at Australian Catholic University. However, if you have any concerns or complaints about the conduct of this project, you may write to the Manager of the Human Research Ethics Committee care of the Office of the Deputy Vice Chancellor (Research). Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

Manager, Ethics
c/o Office of the Deputy Vice Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059

**Or, contact: Manager, Ethics**

Ph.: 029739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

### *I want to participate! How do I sign up?*
We would invite you to sign a written consent form (enclosed) to confirm you and your child's agreement to participate in this project. You can return the consent form to the school office.

Yours sincerely,
**Ross Walker**

## Parent/Guardian Consent Form

*Copy for Researcher / Copy for Participant to Keep*

TITLE OF PROJECT: ***DO INSTRUMENTAL MUSIC STUDENTS HEAR DIFFERENTLY?***

PRINCIPAL INVESTIGATOR: Associate Professor Joseph Zajda

STUDENT RESEARCHER: Mr Ross Walker

I ..... (*the parent/guardian*) have read and understood the information provided in the Letter to the Participants. Any questions I have asked have been answered to my satisfaction. I agree that my child, nominated below, may participate in a short, written listening test (Selmer test) to be conducted at the end of Semester 1, 2017. I also grant permission to the school to release the results of my child's earlier 2017 Selmer testing for the purpose of comparison in this study. I realise that I can withdraw my consent at any time. I agree that research data collected for this study may be published or may be provided to other researchers in a form that does not identify my child in any way.

NAME OF PARENT/GUARDIAN: .....

SIGNATURE .....…… DATE:

NAME OF CHILD ……

SIGNATURE OF PRINCIPAL INVESTIGATOR (or SUPERVISOR):……..

SIGNATURE OF STUDENT RESEARCHER (if applicable): ……

DATE:……..

**ASSENT OF PARTICIPANTS AGED UNDER 18 YEARS**

I …… (*the participant aged under 18 years*) understand what this research project is designed to explore. What I will be asked to do has been explained to me. I agree to take part in a written listening test at the end of Semester 1, realising that I can withdraw at any time without having to give a reason for my decision.

NAME OF PARTICIPANT AGED UNDER 18: .....

SIGNATURE:..... DATE:

SIGNATURE OF PRINCIPAL INVESTIGATOR (or SUPERVISOR):.....
DATE:

SIGNATURE OF STUDENT RESEARCHER (if applicable):…….....
DATE:

**Parent/Caregiver Survey**

Thank you for participating in this study.

Child's Name_____ Class:_____

1. Does your child learn an instrument at this school **during** school time? **YES / NO**

2. If Yes, which one: .....

3. Does your child learn an instrument (privately) outside school time? **YES / NO**

*IF **NO,** PLEASE GO TO **QUESTION 9.** IF **YES**, PLEASE CONTINUE TO THE OTHER QUESTIONS.*

4. If yes, which instrument?

_____

5. How often do they have lessons? Weekly / Fortnightly / Other _____

6. Approximately how long is the lesson (in minutes)? _____

7. On average, how much practice is done **at home** each week (in minutes)? _____

8. How long have they been learning this instrument? *(Please circle one of the following).*

a) Less than 6 months.
b) More than 6 months, but less than 1 year.
c) More than 1 year, but less than 2 years.
d) More than 2 years.

9. Does your son/daughter have a disability of any type? **YES / NO**

(Please circle).

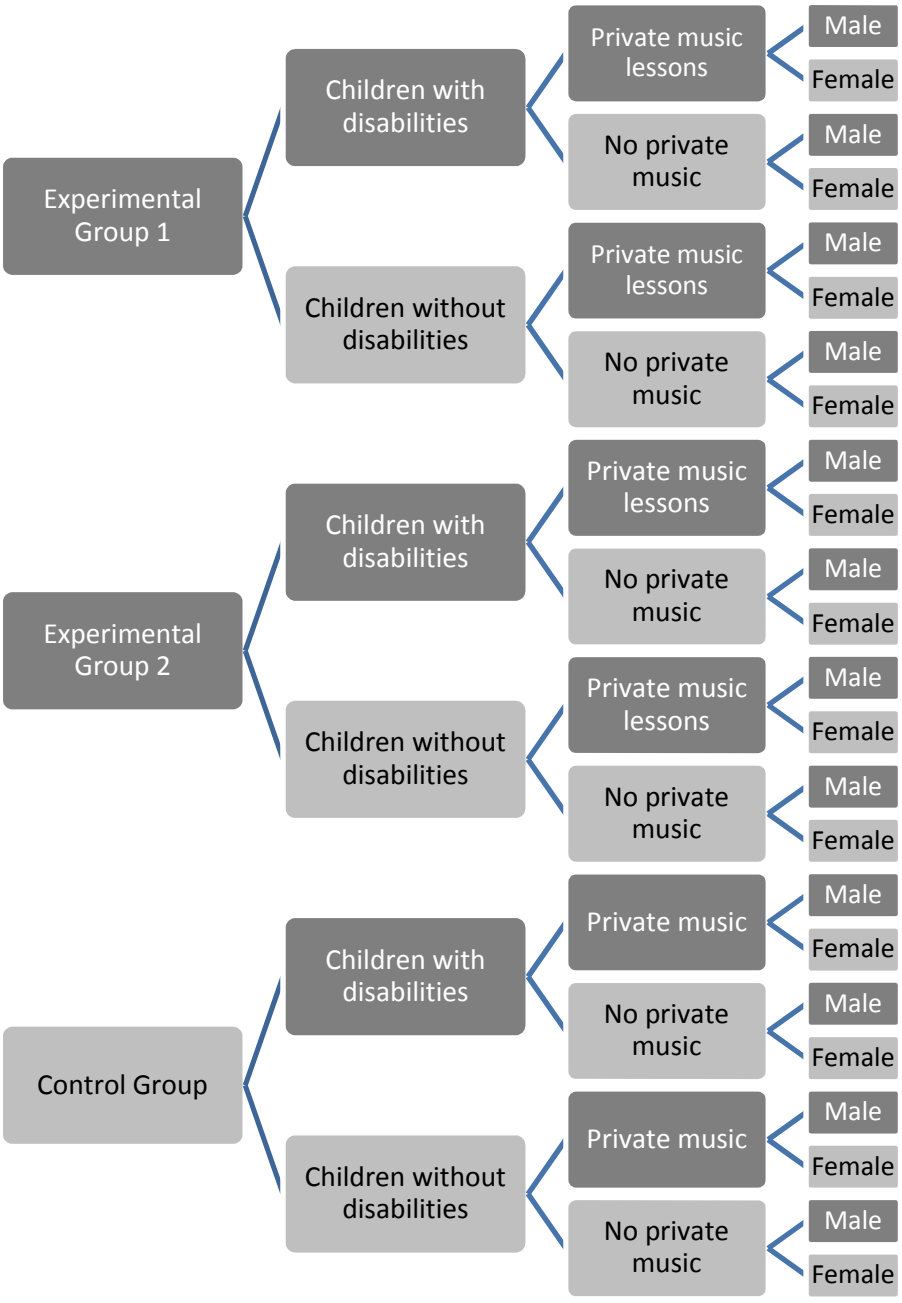
10. If "yes", please specify:_____

*Thank you for taking the time to answer these questions.*

**Your responses will be treated with full confidentiality.**

# Appendix B

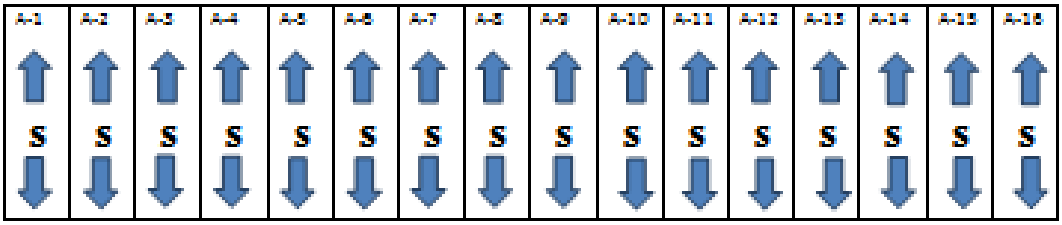
## Data splitting for cohort comparisons



# Appendix C

## Selmer Student answer sheet

Name:_____ Class:_____




| B-1 | B-2 | B-3 | B-4 | B-5 | B-6 | B-7 | B-8 | B-9 | B-10 | B-11 | B-12 | B-13 | B-14 | B-15 | B-16 |
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| D | D | D | D | D | D | D | D | D | D | D | D | D | D | D | D |

| C-1 | C-2 | C-3 | C-4 | C-5 | C-6 | C-7 | C-8 | C-9 | C-10 | C-11 | C-12 |
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| D-1 | D-2 | D-3 | D-4 | D-5 | D-6 | D-7 | D-8 | D-9 | D-10 | D-11 | D-12 | D-13 | D-14 | D-15 | D-16 |
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