Calming effects of repetition in music for children with sensory sensitivities

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Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature: ______[redacted]______

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Abstract

Most people diagnosed with autism experience some form of sensory sensitivity and anxiety. Repetitive behaviours such as rocking, flapping, and spinning are a typical way to self-regulate and help reduce anxiety. Yet, the stigma attached to these behaviours can attract social judgement and isolation. Children with sensory sensitivities often miss out on the emotional, social, and developmental benefits of attending a live classical concert as they are unable to regulate their senses when required to meet the traditional expectation of sitting still and being quiet during the concert. This research investigates how the predictability of intraopus (internal) repetition in classical music can reduce anxiety and increase engagement and interest for children aged 5-14 with sensory sensitivities. The two-part experiments studied the children's responses to live music with strong and weak repetition, performed by a professional musician. Study 1 was conducted one-on-one, and in which parents or carers were asked to observe and record their child's response to the music by filling in a questionnaire using the Music in Dementia Assessment Scale (MiDAS), and the Multidimensional Anxiety Scale for Children (MASC). Study 1 also included FaceReader analyses and finger oximeter measurement of arousal level. Study 2 was organised as a live concert to further explore the research questions in a realistic setting. The parents and carers were asked to record their observations using the MiDAS and MASC. The results showed that both music types had a calming effect; additionally in Study 2 the children responded with significantly higher interest and engagement levels when listening to music with high internal repetition.

List of Abbreviations

ASD – Autism Spectrum Disorder

ADHD – Attention Deficit Hyperactivity Disorder

CST – A Complimentary Sensory Tool for Children with Autism Spectrum Disorders

DSM – Diagnostic and Statistical Manual of Mental Disorders

MASC – Multidimensional Anxiety Scale for Children

MiDAS – Music in Dementia Assessment Scale

SMD – Sensory Modulation Disorder

SPD – Sensory Processing Disorder

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1. Introduction

1.1. Background

According to the Australian Institute of Health and Welfare, 1 in every 150 Australians in 2015 were estimated to have a diagnosis of Autism Spectrum Disorder (ASD), with the fastest growing group being children aged 5-14 (Australian Institute of Health and Welfare, 2017). Yet these figures appear to be increasing substantially, with Australian diagnoses increasing by 25% in 2018 (Australian Bureau of Statistics, 2018), and a 2022 report by the World Health Organization stating that globally 1 in 100 children have been diagnosed with autism (World Health Organization, 2022).

Sensory sensitivity, anxiety, and Attention Deficit Hyperactive Disorder (henceforth ADHD) are common features in children with ASD (Llanes et al., 2020; Simonoff et al., 2008). For children with sensory sensitivities, social outings can be a great challenge (Broady et al., 2017; Gill & Liamputtong, 2011; Lovell & Wetherell, 2019; Peters & Jackson, 2009; Weiss & Lunsky, 2011). Outings are typically managed in such a way that either one parent accompanies the child, or one parent stays at home with the child while the rest of the family has an outing, although in some cases, the entire family avoids outings altogether (Gray, 1994). Reasons for avoiding outings include the child being easily overwhelmed by noise, crowds, lights, and smell. The associated anxiety of outings, and the stigma (Liao et al., 2019; Ng et al., 2020) attached to the child's display of 'socially inappropriate' behaviours, such as rocking and flapping (Broady et al., 2017; Gray, 2002; Kinnear et al., 2016) are other impacting factors. Crucially, such avoidance of social activities can limit opportunities for families to be able to spend quality time together outside the home, as well as restricting exposure and learning opportunities for children with autism to expand their social skills (Spain et al., 2018; Tint & Weiss, 2015).

Music has been shown to positively impact children with ASD in emotional regulation, social connection, and neurological development (Ferreri & Verga, 2016; Foran, 2021; Haering, 2018; Shiloh & LaGasse, 2014). Music has shown to change brain activities in children with ASD directly influencing auditory-motor connections (Sharda et al., 2018). Music can also increase facial and emotional recognition in children with ASD (Wagener et al., 2021) which can lead to better social interactions.

Research also shows that children with ASD display a strong processing ability in music (Jamey et al., 2019; Sharda et al., 2018) and have a preference for classical music (Bhatara et al., 2013; Levasseur et al., 2020). Children with ASD can often be musically gifted (Baron-Cohen et al., 2009; E. Bennett & Heaton, 2012; Sharda et al., 2018), and according to research by autism expert Baron-Cohen (2009), there is an association between sensory hypersensitivity and hyper-systemising nature of individuals with ASD and their musical talent.

In a clinical setting, music therapy is being used to support children with autism to increase social and emotional skills (Brancatisano et al., 2020a; Ferreri & Verga, 2016; Foran, 2021; Geretsegger et al., 2014; Haering, 2018). However, there are few opportunities for these children and their families to attend live concerts, performed by professional musicians. With increasing awareness of autism, a new concept of ‘relaxed’ or sensory-friendly events is beginning to be introduced (Fletcher-Watson & May, 2018; Kempe, 2014; Shiloh & LaGasse, 2014), and this extends to musical concerts. These events aim to make the environment sensory friendly, by introducing reduced levels of lighting and sound, and at times providing early entry hours for people with ASD to avoid crowding. Critically, sensory-friendly concerts can directly benefit these families by providing a genuine opportunity to engage together in social and cultural activities together (Shiloh & LaGasse, 2014). This inclusion affords the social, emotional, and neurological benefits of live music to the children with sensory sensitivities, their families, and the wider community.

Although these benefits of music are well documented (Croom, 2012; Ferreri & Verga, 2016; Geretsegger et al., 2014; Goerlich et al., 2011; Levitin, 2008; Sacks, 2007), limited research has specifically measured the anxiety-reducing effects of professional music concerts for children with sensory sensitivities. The current study aims to measure if internal repetitive elements in classical music leads to reduced anxiety for children with sensory sensitivities in a live performance situation. This thesis begins with a brief outline, followed by definitions of the relevant terminology and a literature review on this area. Following this, the findings of two empirical studies are reported, and the implications and limitations of these studies are discussed, as well as future recommendations.

1.2. Thesis Outline

In Chapter 1 I present the groundwork for an argument that there exists a need for equal access to the benefits of music for children with sensory sensitivities. Following this I will introduce the relationship between ASD and sensory sensitivities, anxiety, and ADHD, and how this may impact social participation and the quality of life for children with sensory sensitivities and their families. Chapter 2 will explain sensory sensitivities in further detail and outline how they affect everyday life. Chapter 3 will discuss the benefits of music and how it can be used to help children with sensory sensitivities to regulate their emotions, as well as contribute to the physical and mental wellbeing of these children and their families. Chapter 4 will provide an overall summary of the topics discussed, and explain the research design, which is disclosed in Chapter 5. Chapter 5 reports a pilot study, in which the effects of repetition in music is examined through individual sessions (Study 1). Building from this, Chapter 6 reports a study investigating the effects of repetition in music in a more ecologically valid group performance setting (Study 2). Chapter 7 concludes this thesis, provides a summary of the research, discuss its limitations, and future directions.

1.3. Definitions and Terminology

Definitions

1.3.1. Sensory sensitivity

Sensory sensitivity refers to the experience of some individuals who display atypical responses to sensory input (Neil et al., 2016). This study focuses on hypersensitivity, which describes individuals who are easily overwhelmed, beyond the typical neurological threshold of the general population (Costa-López et al., 2021).

1.3.2. Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition where individuals demonstrate a range of symptoms characterised by “varying but often marked difficulties in communication and social interaction” (APA Dictionary of Psychology, 2022). People with ASD often display restricted, repetitive behaviours and interests (Barker & Galardi, 2015; CDC, 2020; Morgan, 2019).

1.3.3. Attention Deficit Hyperactivity Disorder (ADHD)

Attention Deficit Hyperactivity Disorder (ADHD) is a behavioural syndrome (APA Dictionary of Psychology, 2022) characterized by two main categories of behaviour: Inattention and Hyperactivity-Impulsive (Healthdirect Australia, 2022a). These behaviours can be displayed as becoming easily distracted, and/or in constant motion (APA Dictionary of Psychology, 2022; Austerman, 2015).

1.3.4. Sensory Processing Disorder (SPD)

Sensory Processing Disorder, (SPD), also known as Sensory Modulation Disorder (SMD), is a term used for the condition experienced by individuals who have difficulty understanding and responding to their sensory input (Biel & Peske, 2009; Kranowitz, 2005; Myles et al., 2004; Yochman et al., 2013).

1.3.5. Comorbidity

Presence of one or more (co-existing) disorders in a person (Klykylo, 2002).

1.3.6. Repetition

Repetition refers to the same instance or instances occurring over a period of time (Brown, 1999). For the purpose of this study, intraopus repetition refers to re-occurring internal patterns of rhythm, melody, and harmony in music, as distinct from repeated hearings of the same piece of music.

1.3.7. Stimming

Stimming is an abbreviation for 'self-stimulating'. This comprises of repetitive actions such as rocking, flicking, and spinning. Children with ASD 'stim' as a means of emotional and sensory regulation. (Charlton et al., 2021b; Leekam et al., 2011).

1.3.8. Anxiety

Anxiety is a complex emotion, described as a state of fear or stress from uncertainty which impacts negatively on physical and mental health (Levitt, 2016). Social anxiety disorder is common in people with ASD and ADHD (Spain et al., 2018).

1.3.9. Regulation

Within the context of ASD, regulation refers to controlling, managing, and balancing of sensory or emotional overwhelm or underwhelm (Reebye & Stalker, 2007).

Terminology

1.3.10. Persons first vs Identity-first

It is important to acknowledge the conflict between using identity-first ('autistic person') and person-first ('person with autism') language in scholarly articles (M. Bennett &

Goodall, 2022; Best et al., 2022; Botha et al., 2021; Dwyer, 2022; Lei et al., 2021; Tepest, 2021; Vivanti, 2020). Existing literature addressing this topic does not give a clear consensus. Person-first language was adopted in 1970's to replace terms such as 'disabled' or 'handicapped' (Vivanti, 2020). It is reported to stem from the words of a self-advocate at a disability rights convention; "I'm tired of being called retarded. We are people first" (Vivanti, 2020).

However, in recent times, some scholars and self-advocates call for the use of identity-first language. One of the arguing points is that the person-first language connotates negativity and offence to the autism community (M. Bennett & Goodall, 2022; Botha et al., 2021). Advocates argue that the use of person-first language can perpetuate the notion that autism is a separate, undesirable force that can be eliminated (Botha et al., 2021), without any thought to the actual life of a person. Botha and colleagues (Botha et al., 2021) mention cases where the linguistic separation can promote violence against autistic people; such as a parent accused of filicide claiming she didn't kill her daughter, but it was autism itself that she wanted to kill; "I loved my child very much, but I hated autism, and wanted autism out of my life" (Botha et al., 2021, p. 3). This argument for using identity-first language aligns with the current neurodiversity movement which promotes autism in a positive way, as a part of a bigger umbrella of diverse minds rather than a 'deficit' or 'impairment' (Kenny et al., 2016).

However, not everyone agrees. There is no conclusive evidence that identity-first language is preferred by all individuals with ASD; for example, families who live with the intense challenges of the condition may not identify with this positive perception of autism. Furthermore, people who are non-verbal may not be able to adequately express their views on the matter (Kenny et al., 2016). A study by Gernsbacher (2016) tested a theory by disability scholars claiming that person-first language is not used in a fair way. After examining over 5 million books, 25 million abstracts, and 150 million articles that use identity-first language, the author concluded that despite best of intentions, identity-first language did not necessarily reduce stigma (Gernsbacher, 2017).

For the purpose of this thesis, I have taken guidelines from APA (American Psychological Association) and relevant publications (Dunn & Andrews, 2015; Gernsbacher, 2017) that justify the use of person-first language, on the basis that we are first and foremost equally humans before anything else. This thesis will therefore primarily use the phrase "person with ASD" rather than "autistic person". However, I acknowledge and respect personal preferences in using both terms, in and outside academia.

2. Sensory sensitivities and Disorders

2.1. Sensory sensitivities

Sensory sensitivities can be classified under the category of Sensory Processing Disorder (SPD). Sensory Processing Disorder, also known as Sensory Modulation Disorder (SMD), is a term used for individuals who have difficulty understanding and responding to sensory input. SPD can be divided into two types: hyper-sensitivity (easily overwhelmed) or hypo-sensitivity (failure to recognise and respond at a normal level to sensory input) (Zachor & Ben-Itzchak, 2013). Both types of abnormalities to sensory sensitivities exceed the comfortable sensitivity range of the general population (Robertson & Simmons, 2013). For example, individuals may feel intense pain at the slightest touch or sound (hyper-sensitive), or severely underreact to extreme temperatures or pain (hypo-sensitive). This thesis will primarily focus on hypersensitivity.

Sensory sensitivities are common in both ASD and ADHD (Ghanizadeh, 2011; Robertson & Simmons, 2013; Suarez, 2012). This condition can also affect children without a formal diagnosis since Sensory Processing Disorder (SPD) is yet to be listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM–5) despite considerable advocacy for its inclusion (Critz et al., 2015; Koziol & Budding, 2012). In order to identify, process and understand their senses, individuals may avoid, or seek sensory input (Biel & Peske, 2009). Sensitivities can include in the areas of touch, smell, being in a crowd, sight (when lights and/or colours are too bright), and even emotions (Engel-Yeger et al., 2016). These sensitivities can lead to poorer health outcomes for the children. Some of the challenges include food selectivity leading to lack of nutrients (Cornish, 1998) and poor oral hygiene (Stein Duker, 2019). In addition, sensory sensitivities can hinder the development of language (Tomchek et al., 2015) which can impede the ability to communicate details of ailments, needs or to follow instruction given by health professionals.

Many studies show the presence of sensory processing irregularities in children with ASD and ADHD compared to children without ASD and ADHD (Adamson et al., 2006; Balasco et al., 2020; Cermak et al., 2010; Myles et al., 2004; Reebye & Stalker, 2007). An example is a study (Ermer & Dunn, 1998b) of 769 children with and without disabilities in the eight categories of Auditory, Visual, Activity Level, Taste/Smell, Body Position, Movement, Touch, and Emotional/Social, showed both children with ASD and ADHD showed irregular sensory responses, as stated by the authors, "... the profile of children with autism was opposite that of a child without disabilities." (Ermer & Dunn, 1998 p.287).

A comparative study on the Short Sensory Profile (Tomchek & Dunn, 2007) again showed significant sensory processing differences in children with ASD and ADHD, displaying processing behaviours that were different to their neurotypical peers - "rubbing surface, finger flicking, body rocking, repetitive jumping, decreased eye contact, limited or inappropriate social smile and laugh, using object ritualistically, ignoring objects, and absent response to stimuli". In some cases, 92% of the participants with ASD were reported to have atypical sensory behaviour (Green et al., 2016). A high presence of irregular sensory sensitivities are also confirmed in another study (Hiruma et al., 2021). The study results showed children with ASD showed higher ratings in Unusual sensory interests, Repetitive use of objects or parts of objects compared to children without ASD.

Therefore, sensory sensitivities are often present in children with ASD and ADHD and can manifest in unusual processing behaviours. These atypical behaviours can cause stigma, negatively impacting the social participation of children with sensory sensitivities.

A study of the relationship between social communication and atypical sensory processing in ASD (Thye et al., 2018) addressed the need for early recognition and intervention for abnormalities in sensory processing categories of Vision (gaze, face, and biological processing), Auditory (speech recognition, prosody, and evaluation of affect), Tactile (touch), Olfaction and gustation (smell, taste, texture), and Multisensory integration (language, emotion recognition, imitation, interoception). The investigation of the neurological and social implications concluded that sensory sensitivities could lead to clinical and social dysfunction in people with ASD. This is verified and discussed by another study (Marco et al., 2011), investigating the three primary categories of Auditory, Tactile and Visual processing difficulties experienced by people with ASD. The results suggested that Auditory sensitivity could be a cause for language delay and deficits, Tactile sensitivity could contribute to inappropriate emotional/social responses, Visual sensitivity can impact understanding of facial expressions and the ability to make eye contact. Individuals may have varying degrees of difficulties in one or across all these categories which impact the severity of their social challenges. The study concludes with the suggestion that sensory processing difficulties could be in fact be the primary cause for core autistic traits. Understanding sensory sensitivities therefore plays a major role when considering inclusive public events (such as concerts) for children with ASD.

It is suggested that irregular sensory processing also contributes to attention problems in both ASD and ADHD (Dellapiazza et al., 2021). As mentioned in the introductory paragraph (2.1), children with hypersensitivity can be easily overwhelmed (Black et al., 2017). An overload of sensory input can cause failure of the already sensitive processing system, resulting in poor registration of information needed to succeed in social and academic settings, such as schools (Dellapiazza et al., 2021; Marco et al., 2011). Poor attention due to sensory overwhelm can also manifest itself at public events, and this study aims to find musical ways to keep the children engaged and interested during live concerts.

Anxiety is often present in children with sensory sensitivities (Black et al., 2017). According to Anita Lesko, one of the Asperger's Syndrome mentors who penned the book "Been There. Done That. Try This!" (Attwood et al., 2014), sensory sensitivity is "…like living with Dolby Surround sound, wearing 3-D glasses... and having your sense of smell and touch jacked up to the max." (Attwood et al., 2014, p. 111). The fear and the extreme overwhelm to the senses can cause much distress for hypersensitive people, especially for the younger ones. For some, such distress can lead to the point of aggression or self-harm (Marco et al., 2011). One case study (Fodstad et al., 2021) reported a teenager with ASD and noise hypersensitivity displaying aggressive behaviours such as hitting, and/or choking a small child in reaction to the child's crying and tantrum noises. There were also reports of self-injuring behaviours such as violently hitting himself on the head or chest. This study investigates ways to help reduce anxiety in public concert settings.

For many families with autism, limiting or avoiding social settings and public outings is one way of coping with these sensory challenges (Black et al., 2017; Charlton et al., 2021b). Individuals also may use repetitive self-stimulating behaviours (stimming) such as flicking, rocking, spinning, or vocalisations to regulate their body and the senses. Children with sensory sensitivities can be precluded from attending live classical music events because environments and musical programming are often over-stimulating and are unable to cope with the typical response of sensory sensitive children. Atypical behaviours that manifest in order to process sensory input can also cause stigma and social judgement (Charlton et al., 2021a). Stigma can result in lower self-esteem and reduction in social interactions and relationships (American Psychiatric Association, 2020). This research will help to clarify how live music performances can be planned in such a way that children with sensory sensitivities will find them beneficial rather than overwhelming.

2.2. Autism Spectrum Disorder (ASD)

As defined above (see 1.3.2) ASD is a neurodevelopmental disorder demonstrating an impairment in social interaction and communication, as well as displaying restricted, repetitive behaviours and interests (Barker & Galardi, 2015; CDC, 2020; Morgan, 2019). Initially, there was a distinction between the diagnosis of classic autism and a milder form of autism, (often called high functioning, or Asperger's Syndrome), however the modifications were made to the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-4) listing these two diagnoses under the one umbrella of Autism Spectrum Disorder. The three disorders listed therefore under ASD in the current DSM-5 are Autistic disorder, and Asperger disorder, and Pervasive developmental disorder – not otherwise specified (PDD-NOS) (Faras et al., 2010).

As mentioned previously (2.1), sensory sensitivity is common in people with ASD (Black et al., 2017; Ermer & Dunn, 1998a; Gillott et al., 2001; Morgan, 2019; Suarez, 2012), with estimated 90% of ASD experiencing some form of sensory processing difficulties (Balasco et al., 2020). This high rate of prevalence in abnormal sensory functioning prompted its inclusion as an additional diagnostic feature for ASD in DSM-5 (CDC, 2022). There is no clear explanation for the cause of sensory sensitivities, however it is considered a primary core trait of autism (Jussila et al., 2020).

Public display of unusual repetitive behaviours that are used to regulate senses (stimming) is deemed socially inappropriate and can attract social stigma and judgement, leading to a feeling of social rejection for the individual and their families (Charlton et al., 2021b; Kapp et al., 2019). Historically, people displaying these traits were subjected to prejudice and discrimination. These children were often deemed “mad” or “retarded” and put away in institutions, ostracised and even killed (Greydanus & Toledo-Pereyra, 2012).

Anxiety is often present in ASD in conjunction with sensory sensitivities (Baribeau et al,; Vasa & Mazurek, 2015). This will be explained in more detail under Anxiety section (2.4).

Misconceptions regarding autism have also contributed to the ongoing misrepresentation of the condition, such as the “refrigerator mother” theory, which was first introduced by Bruno Bettelheim, claiming a lack of emotional warmth from the mothers to be a cause of infantile autism (M. Bennett et al., 2018, pp. 62–64). This ungrounded theory was accepted by Austrian American psychiatrist Dr. Leon Kanner, who was the first person to systematically describe and coin the term “infantile autism” (Harris, 2018). Dr. Kanner’s acceptance of Bettelheim’s theory played a significant role in wide spreading of this negatively biased perception. This unfounded viewpoint was discussed and contested in 1964 by Dr. Rimland (Edelson et al., 2014), and after regular correspondence with Dr. Kanner, it was reported that Dr. Kanner had acknowledged and apologised at a conference to the parents for suggesting parental blame for infantile autism (Edelson et al., 2014), and later wrote the Forward to Dr. Rimland’s book “Infantile Autism”. Dr. Rimland successfully debunked the refrigerator mother theory, and Dr. Rimland’s own preliminary theories linking biological and neurological factors as a potential cause of autism gave precedence to researching autism from a neurophysiological perspective (Edelson et al., 2014; Harris, 2018). Despite advancements in awareness of ASD, stigma still remains (Broady et al., 2017) and this study aims to find way to promote social acceptance, with a focus on sensory friendly concerts especially designed for children with sensory sensitivities and their families.

2.3. Attention Deficit Hyperactivity Disorder (ADHD)

According to the Australian Institute of Health and Welfare, ADHD was the most common disorder among children in 2013-14. It is estimated that 1 in 20 Australians have ADHD (Healthdirect Australia, 2022a). ADHD is a major comorbity of ASD (Grzadzinski et al., 2016). There are neurobiological differences in ADHD compared to neurotypical brains, with symptoms manifesting in behaviours such as being easily distracted, restless, impatient, taking unnecessary risks, and blurting out (CDC, 2021). One of the prominent global neurological differences in children and youths with ADHD is the thinner cortex compared to the control group in areas that relates to control of attention (Ghanizadeh, 2011; Shaw et al., 2006). The Inattentive type symptoms include easily losing things, making careless mistakes, daydreaming, procrastinating, and missing appointments (APA Dictionary of Psychology, 2022). The Hyperactive-impulsive type symptoms include talking non-stop, finding it hard to wait their turn, interrupting conversations or activities, and appearing to be in constant motion (APA Dictionary of Psychology, 2022). These behaviours make daily functioning challenging (Austerman, 2015; Healthdirect Australia, 2022a).

Sensory sensitivities and problems with self-regulation are a major contributor in negatively impacting the school and home lives of children diagnosed with ADHD (Austerman, 2015; Ghanizadeh, 2011; Koziol & Budding, 2012). Self-regulation refers to the process in which when overwhelmed, the individual manages (regulates) their senses and emotions back to the level required in order to function normally. Due to the nature of the condition, people with ADHD find it extremely difficult to control emotions and behaviours (Koi, 2021). ADHD children with sensory sensitivities are reported to suffer from other issues, such as anxiety (Ghanizadeh, 2011; Jarrett, 2016; Sciberras et al., 2014). These coexisting conditions, when untreated, can impact the personal and professional relationships of people with ADHD in later years (Benarous et al., 2020; Suarez, 2012). There is a greater risk for children with ADHD and anxiety in developing substance abuse and depression, and a reduced likelihood of reaching their academic and social potential (Van Ameringen et al., 2010). This research aims to find ways to introduce children with sensory sensitivities to the regulatory benefits of music.

2.4. Anxiety

Anxiety is a "complex state characterized by a subjective feeling of apprehension and heightened physiological reactivity" (Levitt, 2016, p. 5). It is commonly associated with stress, fear and uncertainty, crippling daily functioning and behaviours (Gillott et al., 2001; Neil et al., 2016; Sciberras et al., 2014). Anxiety is fundamentally human emotion that is necessary for human survival (Ströhle et al., 2018). It keeps us in an alert state to escape danger and threatening situations (Healthdirect Australia, 2022b; Kinnealey, 1999). However, when this heightened feeling persists without the presence of danger, it can lead to extreme stress impacting daily functioning (Kinnealey, 1999; Levitt, 2016; Vasa & Mazurek, 2015). There is growing research (Carleton, 2012; Rodgers et al., 2017; Rosser, 2019) supporting the relationship between Intolerance of Uncertainty (IU) and the inflexible, restrictive traits of ASD and anxiety. IU can be described as essentially fear of the unknown, a predisposition for negative predictions and the unwillingness to accept those negative situations leading to excessive distress and inability to cope with the stress (Carleton, 2012). According to these researchers, IU is considered "transdiagnostic" to anxiety (Carleton, 2012; Rodgers et al., 2017; Rosser, 2019). It is interesting to note this parallel between the inflexibility of ASD and IU, and IU as a precursory link to anxiety.

Along with sensory sensitivities, anxiety is a common occurrence in both ASD and ADHD. In 2013-14, anxiety rated as the second most common disorder among general Australian children aged 4-11 (Australian Institute of Health and Welfare). School aged children with ASD are reported to have anxiety as the most common co-existing disorder, second to ADHD (Llanes et al., 2020; Simonoff et al., 2008). Studies show dysregulation of emotions is one of the leading factors contributing to anxiety (Pickard et al., 2020; Vasa & Mazurek, 2015; White et al., 2014) and inability to self-regulate can lead to mental illness and risky behaviours (Foran, 2021). Bob Castleman, another mentor from the book "Been There. Done That. Try This!" (Attwood et al., 2014) described anxiety as follows: "Anxiety is a destroyer… It paralyzes the mind and prevents making decision, or worse, prevents even correctly assessing situations so you can make good decisions. Anxiety forms a feedback loop into the sensory and processing differences we experience, magnifying their effects and often escalating anxiety to crisis levels." (Attwood et al., 2014, p. 19).

A comprehensive Australian study (Sciberras et al., 2014) found the presence of anxiety disorder in 64% of the participating children (aged 5-13 years) diagnosed with ADHD. Another clinical study of 108 high functioning youths (aged 7-15) with autism found almost all (91.6%) participants qualified for two or more anxiety disorders (Ung et al., 2013). It is reported that youths with ASD and anxiety as a coexisting condition have higher occurrences of self-injury, depression, and parental stress compared to youths with ASD but without anxiety (Kerns et al., 2015).

Anxiety can be an emotional state, as described above, or a clinical mental illness if it is present in a disproportionate way that affects the individual from living a normal way of life, requiring treatment (Levitt, 2016; Ströhle et al., 2018). There are several types of anxiety disorders – Generalized anxiety disorder, Panic disorder, Panic disorder with agoraphobia, Agoraphobia, Social phobia, Specific phobia, Selective mutism, Separation anxiety, Obsessive compulsive disorder (OCD) and Post-traumatic stress disorder (PTSD) (NeuRA, 2016; Ströhle et al., 2018).

Social phobia, now known as social anxiety disorder, is most common in both ASD and ADHD (Llanes et al., 2020; Van Ameringen et al., 2010; White et al., 2014). Social anxiety can be described as an intense fear of doing or saying something that may cause embarrassment, humiliation, or being rejected in social or public performance settings (Crome et al., 2015). It can affect individuals in three ways – physiological, cognitive, and behavioural. Physical symptoms can include rapid heart rate, dizziness, trembling and nausea (Aderka et al., 2013). Other symptoms include negative thoughts, self-criticism, and non-compliance (Weeks & Weeks, 2014). This will lead to attempts to avoid the suffering that is associated with a social anxiety disorder (Crome et al., 2015). A study (Beidel et al., 1985) comparing the levels of these three categories (physiological, cognitive, behavioural) between 26 anxious and 26 non-anxious individuals showed significant difference across all three factors – higher physiological arousal, more negative evaluations, and less cognitive coping skills compared to non-anxious individuals. Children with sensory sensitivities can experience a constant state of fear (anxiety) due to their sensory overwhelm (Black et al., 2017; Farrow & Coulthard, 2012). Many rely on repetitive or restrictive actions and rituals to cope with the stress (Black et al., 2017; Brooks et al., 2016; Cermak et al., 2010; Farrow & Coulthard, 2012).

2.4.1. Summary

High prevalence of sensory sensitivities and anxiety can negatively impact children with ASD and ADHD in their everyday functioning. It can limit social participation in activities that may enhance their quality of life (Boldsen, 2022). By investigating the potentially anxiety reducing effects of internal repetition in music, this research may help design a sensory friendly program to be included in social and cultural opportunities that may be beneficial to young children with sensory sensitivities.

2.5. Regulatory effects of repetition (stimming)

Humans perform repetition and rituals to create a sense of order and calm (Lang et al., 2015). Rituals are performed in various occasions; communal or religious (church service, Christmas, birthdays, weddings, funerals), family (eg. annual family holiday, pancakes on Sundays), to individual (parking at the same place, wearing 'lucky' pants) (Hobson et al., 2018; Lang et al., 2020; Spagnola & Fiese, 2007). Although not exclusive to ASD, many individuals with ASD do rely on repetitive (often restrictive) physical or verbal actions to cope with anxiety. Another condition where individuals rely on repetitive rituals is Obsessive Compulsive Disorder (Dalgleish & Power, 1999). Symptoms include excessive washing and cleaning, repeatedly checking (eg. if the lights are off, door is locked), hoarding, and constant fear of hurting others.

Repetitive self-stimulating actions, called stimming, are a stereotypical feature of ASD and can be displayed in many ways, such as rocking, flicking, spinning, rubbing, or repeating a certain word or phrase (Kapp et al., 2019; McLaughlan & Fleury, 2020). An in-depth study of stimming by Kapp et al. (2019) showed that the participants used stimming to control sensory overload, whether that be from the internal ("noisy thoughts", "uncontainable emotions") or external environment. Often the adult participants reported frustration when needing to repress their stimming in the public eye, in order to avoid negative attitude from the others (Kapp et al., 2019, p. 1787). The study called for further research in stimming as a coping tool beyond autism to create understanding, acceptance, and support for a greater variety of people.

Another noticeable autistic trait is a strong preference for routine, structure, and predictability (Honey et al., 2007; Leekam et al., 2011), and a love of 'systemising' and organising patterns (Baron-Cohen, 2017; van der Zee & Derksen, 2021). Autism expert

Baron-Cohen described a boy called Joe with severe autism (Baron-Cohen, 2006) who was obsessed with watching Disney videos. Instead of watching the whole film, Joe repeatedly replayed the same section of the film to the point of obsession. Baron-Cohen theorised that this was Joe's way of hyper-systemising. Systemising can be described as process of understanding of rules and how things work (Baron-Cohen, 2006). By replaying the same sections repeatedly, Joe was zooming in only on the fragments that form the patterns to a sequence; contrary to the usual viewing process of relating the sequences to the bigger picture to follow the overall story line. According to Baron-Cohen, this systemising gives enjoyment to Joe, fulfilling his need for predictability (details are always the same on rewind) and control, rather than the plot itself. Given the importance of using repetition as a self-regulation for people with ASD, this research investigates the musical interpretation of this restrictive interest in pattern, and whether that can serve as a musical equivalent to stimming.

2.5.1. Summary

Sensory sensitivities and anxiety are the most common overlapping comorbities of ASD and ADHD. Repetitive actions such as stimming are used as a coping mechanism to regulate the senses, emotional overwhelm, and anxiety. Predictability in rituals and repetition creates calm and order for individuals with anxiety and related disorders such as ASD and ADHD. Choosing music with elements that emulate the regulatory effects of stimming, systemisation, and repetition could play a role in reducing anxiety in concerts for children with sensory sensitivities and enhance their concert experience. The following chapter will therefore examine more closely the potential for music to benefit children with sensory sensitivities.

3. Music and emotional regulation

3.1. Benefits of music

Music as we know it (organised sounds and rhythms) has existed since the beginning of humanity (Montagu, 2017). Music promotes social cohesion (Levitin, 2008; Montagu, 2017), evokes powerful emotions (Levitin, 2008; Sacks, 2007) and fires up multiple regions of the brain, triggering neurological benefits (Ferreri & Verga, 2016; Hetland, 2000; Levitin, 2008; Sacks, 2007). Music can induce physical pleasure, releasing the 'feel good' chemical, dopamine (Menon & Levitin, 2005; Salimpoor et al., 2011), as well as social and musical "chills"- a physical 'goosebump' skin reaction to emotions felt during music listening (Bannister & Eerola, 2021; Panksepp, 1995; Quintin, 2019). Listening to music can also alleviate pain and anxiety (Guétin et al., 2012; Kulinski et al., 2021).

As a direct primal link to emotions (Panksepp, 1995), music can improve the quality of life of children with sensory sensitivities by helping develop the vital skill of emotional regulation (Laukka, 2007; Thoma et al., 2012). Emotional regulation can be described as the ability to control distress by diverting attention to something non distressing, and to stop disproportionate responses by keeping their emotions in check (Weeks & Weeks, 2014). Self-regulation of emotions unlocks the pathways needed to learn, understand, and maintain information, leading to a higher chance of achieving a richer life (Bryant, 2015; J. Kim et al., 2009; Thoma et al., 2012). As discussed in the above sections (2.1, 2.2, 2.3) self-regulation is often a challenge for children with sensory sensitivities.

Music can also benefit the sensory system. An integrated review (Simhon et al., 2019a) addressed the lack of study focusing solely on musical response in children with SPD. In their review of 17 studies, Simhon and Colleagues found a beneficial relationship between music and the sensory system, including generation of neuroplasticity.

Music can enhance cognitive development. An exploratory study by Lockhart (2017) (Lockhart, 2017) conducted as part of their Master's thesis, suggested that musical rhythmic proprioceptive input improved attention in children with ASD. Music can also provide therapeutic benefits in neurological disorders (Brancatisano et al., 2020b). The benefits of using music as therapy were evident in a literature review (Brancatisano et al., 2020b). In it, the authors outline the capacities of music to benefit people with four neurological conditions – dementia, Parkinson's Disease, stroke, and ASD. Their review reports benefits for these people in the seven categories of Engaging, Emotional, Physical, Synchronous, Personal, Social, and Persuasive, as well as benefits to cognitive functioning, psychosocial behaviours, motor functioning, and behaviour (Brancatisano et al., 2020b). The review advocated for the development of music-based therapy as a non-pharmaceutical treatment option. This research investigates how music can benefit children with sensory sensitivities.

Individuals with ASD oftentimes respond positively to listening and creating music (Hillier et al., 2012), and can even show exceptional talent (Baron-Cohen et al., 2009). As a direct link to our emotions, music is a natural, non-invasive way to promote emotional and social wellbeing. We aim to make these benefits of music also available to children with sensory sensitivities.

3.2. Music Therapy

The above section considers the broad benefits of music in a variety of contexts. Music therapy is a process where music is used as a tool by a trained therapist to reach a clinical outcome, rather than for educational or entertainment purposes (Pavlicevic et al., 2015). The involvement of a trained music therapist distinguishes formal music therapy from other uses of music for therapeutic purposes since the relationship with the therapist is a crucial part of the process. There is considerable evidence of the benefits of music therapy

(Brancatisano et al., 2020b; Geretsegger et al., 2014; Gold et al., 2006; Simhon et al., 2019a) and musical instrument learning for children with ASD (Haering, 2018). A review of fourteen music therapy studies for ASD (Quintin, 2019) found that the majority of the studies conducted (twelve out of fourteen) showed improvement in the areas of Social, Communication, Joint attention, Child-therapist and child-parent relationships, Self-regulation, and Reduction in anxiety (Quintin, 2019, table 1).

An example of improvement in social communication from music therapy comes from a study involving a twelve-week randomised controlled trial (Kim et al., 2009), where children aged three to five years diagnosed with ASD were individually placed in two different conditions - a musical improvisation session, and a non-musical toy play session. Each type of session was either one child-led, or therapist-led and the sessions were recorded on high quality video and audio devices. The effects on the behaviour of the children were measured by frequency and duration. There was a significant higher frequency of engagement in the music therapy session compared to the non-music (toy) session in behaviours indicative of Joy, Emotional synchronicity, Initiation of engagement from the child, Interpersonal responsiveness to interactions initiated by the therapist, and Compliance. There was a higher frequency of “no response’ during the non-musical therapy sessions. Therefore, music therapy can be an effective way to engage and improve social communication in children with ASD.

3.3. Repetition in music

Repetitive patterns in music can provide a solid compositional structure and affect physical and emotional calm in the listener (Wilson, 1989). Western Art Music (mainly European) does not generally use ‘pure’ repetition (i.e., only using the same rhythm, key, and pitch throughout the entire piece) in comparison to musical styles from other cultures such as the Indian Rāga. Traditional Western art music instead utilises musical forms to create balance between the predictability and surprise. This includes Sonata Form (3 sections; A (exposition)-B (development)-A (recapitulation), where the first section A returns as a recapitulation, Variations Form (where the main theme is introduced, then in the subsequent sections the theme undergoes changes in keys, mood, rhythm and/or character whilst still retaining the original thematic line or idea), and Rondo Form (A-B-A-C-A; The first section A is repeated alternating with new themes) (Arnold et al., 2011). Compound forms can also occur, such as Sonata-Rondo form. Smaller internal repetitive patterns are frequently also used within this broader repetitive framework.

J.S. Bach used repetitive patterns to create a meditative state in his church music, and Beethoven effectively used short repetitive motifs to build monumental symphonies such as the famous 4 note figure (ta-ta-ta-Da) in his Symphony No.5 (Wilson, 1989). At the beginning of the twentieth century, advancement in travel and technology allowed for globalisation and further cross-fertilisations of musical styles (Hijleh, 2012; Utz & Laurence Sinclair Willis, 2021). The Minimalist movement explored the idea of going back to pure repetition within a simple tonal structure. American composers Terry Riley, Philip Glass and Steve Reich established this concept, inspiring other composers such as John Adams (America), Louis Andriessen (The Netherlands), and Arvo Pärt (Estonia) to further advance minimalism in music (Potter et al., 2013). The musical selections for the high repetition pieces for this research will be based on this information.

3.4. Live concerts

Live concerts can create a sense of social belonging, where one can experience a social, emotional connection with others (Radbourne et al., 2014). The unique experience of interaction between the performers, audience, music and the environment cannot be duplicated outside of a live music setting (Burland et al., 2014).

A study (Liljeström et al., 2013) found that both emotional intensity and physical arousals were stronger when listening to music with a close friend or partner rather than alone, thus demonstrating that the social setting of live music concerts perhaps contributes to its particular appeal to audiences. Another study (Garrido & Macritchie, 2020) found that emotional contagion (transfer of emotions between audience members or from the music to the audience) during a live concert provided an amplification effect on the emotional response of the audience.

Despite these social benefits, classical music concerts carry a reputation of being an elitist activity only afforded by the wealthy and educated; where one is expected to be familiar with the music and observe the traditional concert etiquette of being formally dressed, sitting still and being quiet (Dearn & Price, 2016; Dobson & Pitts, 2011, p. 11; Wald-Fuhrmann et al., 2021). This elitist reputation tends to deter first timers from attending (Getz, 2015).

Even though live concerts are only one of many ways of listening to music, the real time social, emotional, and aesthetic experiences felt during live concerts will always be a strong motivation for the existence of live events (Wald-Fuhrmann et al., 2021). Our research advocates for such live concert experiences to be equally available to all members of the community, no matter their social status or personal circumstances. This study aims to investigate ways to make live classical concerts accessible to children with sensory sensitivities and their families.

3.5. Live music for children with sensory sensitivities

Professional live concerts are not often available to children with sensory sensitivities and have therefore seldom been studied in literature; online searches via the Western Sydney University library portal with the keywords "sensory, friendly, concerts" with the filter of "Peer-reviewed & Scholarly Articles" resulted in only three articles, of which two were not relevant to the current topic: one article (Kim, 2021) was regarding supporting students with autism as performers of music rather than audience, and the other was unrelated to the research topic. The one remaining article will be discussed below. A search using the keywords "sensory, friendly, AND music" resulted in 42 articles, all of which were non-academic newspaper articles or unrelated content except the abovementioned articles.

The only study that related to the research topic introduced an initiative called Sensory Friendly Concerts® - a program conceived and developed by C. J. Shiloh, Director of The Musical Autist (Shiloh & LaGasse, 2014). This study used a simple survey form as an evaluation tool, which was inserted into the printed program for audience feedback. The three-part survey included asking for reasons for attendance, a 1 to 5 rating scale to indicate any observations of behaviour changes in the audience members themselves or other adults or children including those with ASD. The survey concluded with a 1-5 rating of their overall experience with comments. A total of eight questions within the survey were brief and general, using a combination of multiple choice, comment boxes, and a 1-5 Likert rating scale. Their results showed a generally positive impact on the attendees, with the total rating of 4 out of 5 for their overall experience. Whilst many of the comments were complimentary, some comments included a wish for a more structured program with clear ground rules, so that the parent could relax and enjoy the concert without worrying about what is allowed, and what is not allowed. The sensory friendly elements of the concerts were mainly environmental, such as modifications of seating arrangements, adjusted lights and allowing freedom of movement. The study did not mention or provide explanations for their choices in the musical pieces presented. The Sensory Friendly Concerts primarily promoted community music making; and although some concerts may involve professional musicians, most of their concerts were held and performed by music therapists, and/or creating a platform for individuals with autism to perform (Shiloh & LaGasse, 2014). There was no evidence of research about the elements of musical programming that might contribute to the performances being sensory friendly.

Another example of ‘relaxed’ performances is documented in a case study (Kempe, 2015) of a theatre performance of Jack and the Beanstalk. This study was conducted in the form of interviews. One of the participants’ comments highlighted a positive aspect of inclusive events:

> I’d go to the relaxed performance again because if there were to be negative attitudes from members of the public at a regular performance – and I’m not saying they’ve got a right to say those things – but I’d say they’ve got even less of a right to do it at the relaxed performance (Kempe, 2015, p. 67).

Again, the focus was not so much on the actual programming content but more on the preparation (eg. social stories) leading up to the event and external environmental factors such as lighting and volume.

The apparent minimal literature available on the topic of sensory friendly concerts and the perceived lack of awareness in sensory friendly musical programming warrants further research. Identifying certain musical elements that may help to reduce anxiety could be helpful in further elevating the quality of sensory friendly concerts. It is possible that repetition in music is a key element and that is what will be investigated in this study.

3.6. Summary

With increasing awareness of neurodiversity in our communities, there is a growing need for equal access to quality social and public events. Sensory sensitivity, ADHD, and anxiety are the most common co-occurrences in children with autism. Daily life can be a struggle, and for some children, sensory sensitivities can even impact their eating, sleeping, and drinking (Boterberg & Warreyn, 2016; Cermak et al., 2010; Farrow & Coulthard, 2012).

The predictable nature of repetition and rituals give a sense of control and calm to anxious individuals. Many people with ASD find the repetitive action of stimming helpful. The physical noticeability of stimming, however, can create social isolation for the individual and their families (Broady et al., 2017; Liao et al., 2019). Sensory overwhelm, stigma, and the expectation of sitting still and being quiet can cause withdrawal in participation of activities that may help develop and enhance their quality of life, such as live classical concerts (Green, 2003; Kinnear et al., 2016; Lovell & Wetherell, 2019).

There are many ways music can benefit children with sensory sensitivities. Music therapy involves first and foremost accredited trained therapists who utilise music as a tool to reach a clinical outcome (Pavlicevic et al., 2015; Rabeyron et al., 2020). Music can be also used as an intervention tool outside therapy (such as schools) for children with ASD to improve their social and emotional wellbeing. Another way can be live musical concerts performed by trained professional musicians, delivering a musical outcome or aesthetic experience (Wald-Fuhrmann et al., 2021). Live concerts create a sense of belonging and promote emotional wellbeing, all of which can have a therapeutic effect on the audience. This study focuses on making professional concert experiences accessible for children with sensory sensitivities, increasing their social participation and connections.

Despite numerous literature showing benefits of music, there is little literature available of studies that focus on live music concerts and children with sensory sensitivities (Simhon et al., 2019b), nor potential anxiety reducing musical elements that can be used in sensory-friendly programming. Repetition in music may be one of these key elements. This thesis addresses the lack of in-depth research and published literature in this field and aims to gain deeper understanding and generate knowledge to make quality live concerts accessible to benefit children with sensory sensitivities, their families, and the wider community.

4. Overall Research Design

4.1. Aim

To investigate whether classical music with strong intraopus repetition (i.e., predictable internal patterns) can reduce anxiety and to capture the interest and engagement of children with sensory sensitivities during the music.

4.2. Concurrent nested design

As children with ASD demonstrate atypical facial, verbal expressions and body language (Sarabadani et al., 2020; Tager-Flusberg et al., 2017; Wagner et al., 2013), research involving autistic children often uses observations and information given by parents or carers who are familiar with their individual expressive profile. Therefore, I have used a mixed method, using concurrent nested design (Creswell & Creswell, 2018). Used in various disciplines including behavioural science, concurrent nested design collects both qualitative and quantitative data in one method, where one is given more weight and the other is integrated into the method (Creswell & Creswell, 2018; Kroll et al., 2005; M.Aultman, 2020). My primary source of data was a questionnaire, drawn from the Music in Dementia Assessment Scale (MiDAS) (McDermott et al., 2015), and the Multidimensional Anxiety Scale for Children (MASC) (March et al., 1997). In addition, Study 1 collected objective measurements from the finger oximeter and FaceReader to minimise any potential bias, ensuring the reliability of data. For example, a high arousal level could indicate distress; however, it could also indicate excitement, thus the combination of the objective data from FaceReader and finger oximeter with the subjective responses from the questionnaires and anxiety scales would provide a more comprehensive result. Supplementing the measurements, qualitative data was collected via an additional open ended comment box in order to give the parents/carers opportunity to further express or explain their observations. Study 2 only used the MiDAS, MASC and the additional observational comments.

4.3. Ethics Considerations

This project was granted ethics approval from the Human Ethics Committee of Western Sydney University (ID: H14471). Conducting research with sensory sensitive children involved a number of ethical considerations, such as the possibility of the children experiencing extreme sensory or situational distress. Since the researcher is using her existing Sensory Concerts® program format, and personal and professional networks to conduct this project, transparency in declaring any potential financial or personal gain was an important consideration. In addition, it was important to consider ways to protect the rights and privacy as well as respecting the wishes and welfare of all participants. All participants were provided with a detailed information sheet about the research. Dual consent was sought from both parent and child where the child was able to give such consent. Otherwise only parental consent was obtained.

In order to ensure that the participants met the sensitivity threshold and requirements, a pre-screening questionnaire with inclusion and exclusion criteria was used, and any children with extreme sensitivities that may cause them distress, were excluded. In consideration of the children's welfare, the session ended on a positive note, by offering them with options of playing some popular music unrelated to the research, aligning with the child's interest, such as themes from Harry Potter, Star Wars, or Thomas the Tank Engine.

It is worth noting that during the ethics application process, I had come across some limitations. Namely, the participant categories provided by the Human Research Ethics Application online portal, were quite restrictive in my opinion. The choices provided were:

- Women who are pregnant and the human fetus

- Children and young people
- People highly dependent on medical care who may be unable to give consent
- People with a cognitive impairment, intellectual disability or mental illness
- People in dependent or unequal relationships
- People who may be involved in illegal activities
- People in other countries
- Aboriginal and Torres Strait Islander peoples

Whilst “children and young people” was an obvious choice, to find a category for sensory sensitivities and ASD was more challenging. The closest category was “People with a cognitive impairment, intellectual disability or mental illness”. However, I believe that this was not an accurate description of the participants for this study. Although some of the participants conditions may apply to one or more of these conditions listed, to bundle the diverse and often complex conditions such as sensory sensitivities and ASD, under this one umbrella of cognitive impairment, intellectual disability or mental illness, seemed unfair.

There are other scholars arguing a similar view (Cascio et al., 2020, 2021; Miller, 2015). Human Ethics, especially when involving young people and vulnerable communities, is necessary to protect the rights and privacy of the participants (Einarsdóttir, 2007). Arguing the case for diverse and intersectional groups in the autism community, these studies (Cascio et al., 2020, 2021) address the need for a “person-orientated research ethics framework” (Cascio et al., 2020, p. 33) rather than identifying individuals under the ‘one size fits all’ umbrella of disability. This is an area that calls for future review.

5. Study 1 - Pilot

5.1 Method

In order to investigate the calming effects of repetition in music for children with sensory sensitivities, our choice of methodology accounted for understanding of the atypical behaviours and responses that are trademarks of people with ASD. I used a mixed method (concurrent nested design) of using a combination of collecting measurements from MiDAS, MASC, finger oximeter, and FaceReader, and qualitative data from the subjective observational comments from the parents/carers.

5.1.1. Hypotheses

H1: Children demonstrate significantly lower rates of Anxiety (as measured by proxy ratings, arousal levels and oximeter) when listening to music containing a higher degree of internal repetition, in comparison to listening to music with less internal repetition (anxiety scale and oximeter).

H2: Children demonstrate significantly higher rates of Engagement (as measured by behavioural observation ratings and eye gaze direction) when listening to music with a higher degree of internal repetition in comparison to listening to music with less internal repetition.

5.1.2. Participants

After completing the initial pre-screening questionnaire, twenty eligible children (6 female, 14 male) and their parents/carers were selected to participate. The age of the children ranged from 5-13 years (M = 9.5, SD = 2.1), with frequency of age shown in Table 1. The prescreening questionnaire contained questions regarding age, gender, diagnosis, and exclusion criteria. The responses showed that ten children were diagnosed with ASD, seven children with ADHD, seven children with SPD/SMD, two children with Oppositional Defiant

Disorder (ODD), two children with Anxiety, and five children with undiagnosed sensory sensitivities, with 45% of the children having more than one diagnosis.

Table 1

Number of children participants in Study 1, with the frequency of ages listed (N=20)

Age	Number of children
5	1
6	5
7	4
8	3
9	2
10	2
11	2
12	0
13	1

5.1.3. Procedure

After obtaining ethics approval, the participants were recruited at Josey Sharpe Paediatric Occupational Therapy (now known as Playful Stages) clinic in Sydney's West. Printed flyers and information sheets were posted up on the noticeboards at the clinic and the therapists were also asked to give out flyers to any clients who may be interested. Potential participants were asked to give permission to be contacted by the researcher and their preferred contact method. After email/phone exchanges confirming their interest, the parents were sent a short online prescreening questionnaire link via SurveyMonkey by the researcher to determine their eligibility for the study. Pre-school aged children (under 5) were excluded as some may not have yet developed the ability to fully distinguish all musical elements (Moog, 1976) and this may affect the reliability of the data. Exclusions also applied to children with uncorrected hearing problems, cerebral palsy, Down Syndrome, and sensory difficulties of a severity that might cause distress during the study. Parents who were non-English speaking and/or with visual impairment that makes observations impossible were also excluded.

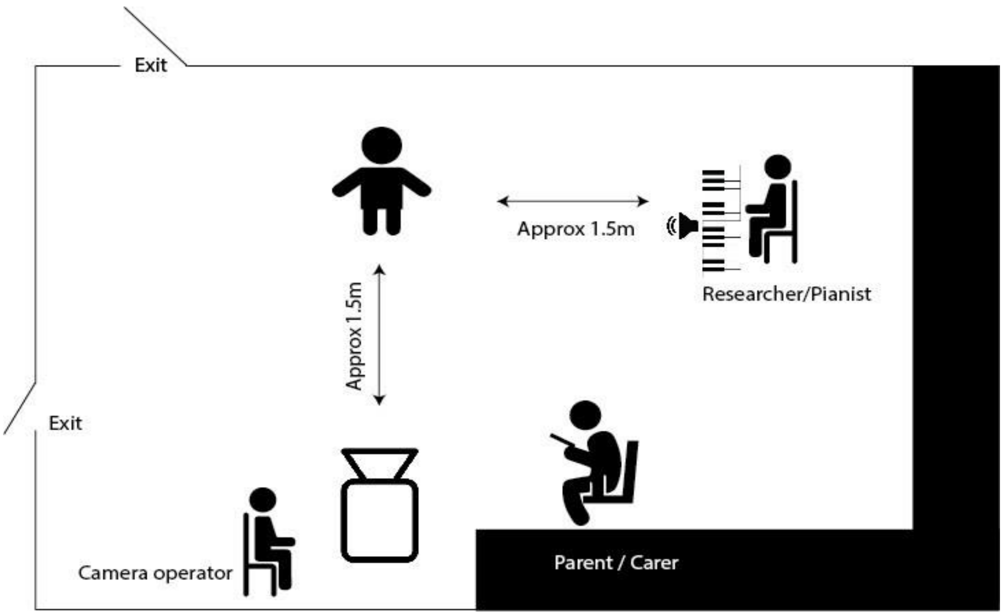
The selected parents and carers were given date and time options, and efforts were made whenever possible, to coincide with their usual therapy time for minimal disruption to their routines. The participant information sheet and consent forms were sent via email and a printed version was also made available on the day to sign before commencing the study.

Study 1 was conducted in a private room at the paediatric occupational clinic where the children were attending their usual therapies. The children were therefore already familiar with the surroundings and their regular occupational therapists were available onsite for any additional support as well as their parents/carers in the room. Most of the participants came before or after their usual therapy times, with only a couple of people coming in especially for the study. The children were invited to the room individually with one parent/carer accompanying the child. Sibling/s were allowed in the room when necessary. In addition to the researcher, a cameraman was present to operate the video camera and assist with the oximeter readings. The child's regular occupational therapist was allowed to come in to support if necessary, however only one therapist was eventually present. Parents/caregivers were asked to fill in a Complimentary Sensory Tool (CST) for Children with Autism Spectrum Disorders questionnaire before commencing the study. The parents/carers were then asked to observe their child during the performance of two pieces in each set and wait until each set of the music was finished before recording their observations of the child's response to the music.

Prior to commencing, the children were gently introduced to wearing a finger oximeter, with an explanation of the purpose of the oximeter. The researcher explained that the oximeter was being used to measure their heart rate to see if the numbers would go higher or lower during the music. The children were also informed that this session was being filmed and that they could stop at any time if they felt uncomfortable. The video camera was statically placed directly across about 1.5 metres from where the child was sitting (Fig.1). The room was well lit to maximise clear picture quality. The digital piano was placed on the left side of where the child was sitting, and the volume was on the same setting (halfway), only having to adjust to a lower level on two occasions for the children verbally expressed their wish for the volume to be softer at initial hearing.

Figure 1

Research room layout for Study 1

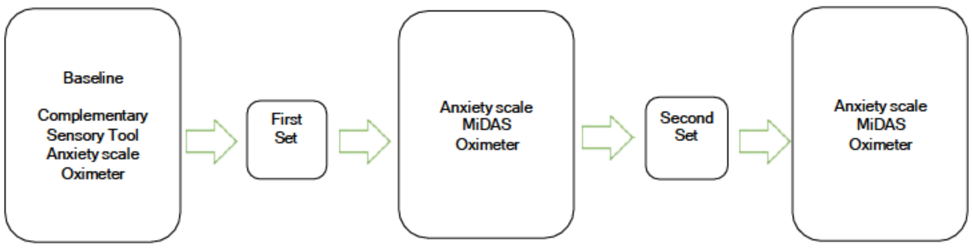


The children were individually introduced to a live performance on a digital piano by the researcher, who is a professional concert pianist, playing two musical pieces with strong internal repetition and two musical pieces with weak internal repetition. Conditions compared pieces with a highly predictable repetitive structure and low predictable repetitive structure. The presentation order of these conditions was counterbalanced. The children were free to listen without restriction to their movements or vocalisations. Given the size of the room (approximately $8m^2$) most of the children were happy to sit on the chair at the table provided. Some brought their own sensory toys for comfort. Only one child was quite mobile and didn't sit long enough for to us to capture their facial expression on the video.

The oximeter measurements were recorded at baseline, after the first set, and after the second set by the cameraman. Both the anxiety scale (MASC) and the MiDAS questionnaire were used by the parents/carers at baseline (i.e., prior to listening) and after the first set of two pieces, and then again after the second set of two pieces (see Fig.2).

Figure 2

Timepoints (Baseline, After first set, After second set) at which the measures were taken – Study 1



Note. Facial expressions were filmed continuously from baseline to the end of the study.

The session concluded with a ‘feel-good’ piece looking after young children’s emotional welfare (National Statement on Ethical Conduct in Human Research, 2018). Each session lasted around 20 minutes. Much effort was made to ensure that the children felt comfortable. Each child received a sensory-friendly gift bag for participating.

5.1.4. Measures and materials

Prior to the commencement of the study, demographic information about participants was collected as well as information about sensory sensitivity using the Complementary Sensory Tool for Children with Autism (Barrios-Fernández et al., 2020). This scale has 41 items describing three factors commonly experienced in Autism: (i) modulation disorders, (ii) discrimination disorders, and (iii) sensory-based motor disorders. Since the current study focuses on children with sensory sensitivities across a broad range of diagnoses, we were primarily interested in the first factor measuring modulation disorders, which refers to difficulty in regulating one’s responses to sensory experiences (Schoen et al., 2009). Therefore, participants completed the first 13 items of the scale which focus on that factor. The items were proxy rated by parents/carers, who rated each item according to the frequency with which the symptom is experienced by their child on a scale of 1 (Never) to 5 (Always).

The MiDAS is a behavioural observation rating tool that was initially developed to measure the engagement of people with dementia with musical programs. MiDAS is often used in music therapy studies (Dowson & McDermott, 2019; McDermott et al., 2014, 2015; Ray & Götell, 2018), however we decided it to be a suitable tool to use in this study in case of any potential non-verbal participants in children with ASD, given its applicability to musical engagement. Of the six subscales, we were primarily interested in the three categories of Enjoyment, Interest, and Involvement, as the other questions were not appropriate for our participants. The wordings of the questions were slightly modified to tailor to the study; for example, replacing the word “therapist” with “musician” and adding the ‘they/them’ pronouns. For the purpose of easier useability for the parents, the 101-point scale (0 never – 100 always) was simplified to a 3-point scale (Yes, No, Unsure). For analysis these were categorised numerically as 1 (“Yes”); -1 (“No”); and 0 (“Unsure”). An additional comment box was added for more in-depth subjective observations.

The MASC is a reliable standard scale in measuring anxiety in children (March et al., 1997; van Gastel & Ferdinand, 2008; Wei et al., 2014). Qualtrics was used to format the online questionnaires, and the 4-point scale was adjusted to a 7-point scale to broaden the range (Strongly disagree, Disagree, Unsure/Not applicable, Slightly agree, Agree, Strongly agree). An iPad Pro was provided to complete the survey.

To minimise any potential bias from the subjective responses from the online questionnaire, the children’s facial expressions were also filmed with a Canon EOS 5D Mark IV camera. The video was analysed by FaceReader software by Noldus Information Technology. The majority of facial expression research that involves children with autism tends to focus on how the participant interprets facial expressions and emotions of others, rather than studying the expressions of the actual participant (Harms et al., 2010; Monk et al., 2010; Spencer et al., 2011; Wieckowski et al., 2020) which can involve neuroimaging. However, the use of neuroimaging can be more invasive and difficult to use in children with autism who have sensory sensitivities. Therefore, the less invasive FaceReader was used to supplement the primary data from the questionnaire. Noldus FaceReader software is regarded as a reliable software for such purposes with high accuracy ratings (Borsos et al., 2022; Danner et al., 2014; Lewinski et al., 2014).

In addition, Study 1 used a Santa Medical SM-1100S finger pulse oximeter to measure arousal levels as an indicator of whether the child was calm or distressed. The oximeter was clipped onto the child’s index finger after a brief demonstration by the investigator. The children were informed that they could take it off at any time if they felt uncomfortable. The readings were displayed on the screen of the oximeter, which was manually recorded on paper by the videographer at three time points (baseline; after first experimental condition; after the second experimental condition). At each of the three time points, the readings were recorded at regular intervals (whenever convenient), at least two times per musical piece. Most of the children were happy to leave the oximeter on; only one child declined to wear it at the beginning of the study. One other child did not want to wear it at the beginning of the second experimental condition and another child took it off during the second experimental condition, with only one reading obtained per piece for that particular child during the second experimental condition. A KAWAI ES 8 digital piano was used to perform the selected musical pieces.

5.1.5. Musical selections

There were four musical pieces used in Study 1, as shown in Table 2. Each piece could be described as belonging broadly to traditional Western Classical music, although one of the pieces (Glass) was taken from a sub-category within this (Minimalism). These four pieces were specifically selected with the intention of presenting audible differences in the amount of internal repetition that was present within the music (split as two high repetition examples, and two low repetition examples). All pieces except the Glass were complete pieces and the selected excerpt from Glass was a complete middle section.

Table 2

Selected four solo piano pieces (2 pieces for each condition) for Study 1

Selection	High repetition	Low repetition
1	J.S. Bach: Prelude BWV 846 Book 1 from The Well-Tempered Clavier	F.Chopin: Mazurka Op.33 No.1
2	P. Glass: excerpt from “Metamorphosis” No.5	Debussy: Élégie L.138

High repetition pieces. The choice of the high repetition repertoire was a musical interpretation of the traits associated with autism – repetition, predictability, transparent texture (Goris et al., 2020; Leekam et al., 2011; McLaughlan & Fleury, 2020), based on research (see 3.3), expert knowledge and experience of the researcher as a professional musician and artistic director. The continuous arpeggio (broken chord) patterns in Bach’s Prelude from Well-Tempered Clavier Book 1 BWV 846 creates a circular “spinning” effect (Fig.3). This could be interpreted as a musical equivalent to spinning in stimming. The rhythmic pattern remains constant throughout the piece. Therefore, the underlying harmonic changes are subtle to the ear and create a feeling of predictability. The second piece of the high repetition group, an excerpt from “Metamorphosis” No.5 by Philip Glass, is Minimalist in style meaning that the harmonic, rhythm, and pitch elements of the main musical phrase are repeated with minimal variation. The excerpt selection was at the middle section where the main repetitive pattern occurs (Fig.4).

Figure 3

Excerpt from Prelude (Well-Tempered Clavier) BWV 846 by J. S. Bach as a high repetition piece

Music source: Public Domain

Note. The circular effect is created by continuous semiquaver arpeggios.

Figure 4

Excerpt from "Metamorphosis" No.5 by Philip Glass (Amsco Publications) as a high repetition piece

Note. Constant quavers in the left hand and recurring octave motif in the right hand with minimal variation.

Low repetition pieces. As mentioned in chapter 3, although Western Art Music does not tend to contain ‘pure’ repetition, it is also quite difficult to find music with zero repetition. Therefore, the choice of low repetition pieces was based on a more narrative style in the music which contains less continuous internal patterns. A study on musical rhythms of Western classical music (Levitin et al., 2012), reported that out of the 1,788 movements from 558 compositions, 16 musical genres by 44 composers studied by the authors, folk styles such as Mazurkas showed the least predictability. Therefore, a Chopin Mazurka was selected for the low repetition condition (Fig.5). In the final chosen piece, Élégie by Debussy (Fig.6), despite the initial phrase being repeated in the next bar (with a slight note modification), the subsequent bars change in rhythm and direction. The piece continues in this manner, sometimes with abrupt changes (eg. Bar 6) creating a feeling of vagueness and unpredictability. The four pieces were similar in performance duration of around two minutes each.

Figure 5

Excerpt from Mazurka Op.33 No.1 by F. Chopin, selected as a low repetition piece

Music source: Public Domain

Note. Narrative folk style with irregular phrasing.

Figure 6

Excerpt from Élégie by C. Debussy L.138, selected as a low repetition piece

Music source: Creative Commons license

Note. The piece begins without a clear tonal centre (musical key). Unpredictable musical phrasing throughout; the initial first one-bar material is followed by a 3-bar phrase, which is then followed by another one bar material, before introducing a new rhythmic idea (Bar 6).

Spectral examination. While the stimuli were initially selected based on the levels of repetition that were apparent from listening and examinations of the musical scores, follow-up visual inspections and comparisons were performed to further justify this selection. Visual analysis of the four pieces was performed with a spectrogram, using the program Sonic Visualiser (Cannam et al., 2010). These are included in the Appendix. All spectrogram images contain frequency (measured in Hz) on the y axis, and time on the x axis, whereas the amplitude of observed frequencies over time (measured in dB) are shown by colour, with darker colours equating to increased loudness. All spectrogram analyses were performed with a Hann window, with a 50% window overlap and a window size of 8192.

In Appendix Figure A (Bach, high repetition piece) the lowest, sustained pitch is clearly visual along the bottom of the spectrogram and occurring at regular spacings throughout the piece. Additionally, the higher pitched notes occur repeatedly in cyclical, wave-like patterns. Thus, this visual examination supports the suggestion that this piece contains a comparatively high level of internal repetition through repeated motifs. Similarly, Appendix Figure B (Glass, high repetition piece) depicts even spacing between pitches, and a steady pulse with little fluctuation. As above, this supports the earlier suggestion that this piece contains a comparatively high level of internal repetition through repeated rhythmically-based motifs.

In contrast to these, Appendix Figure C (Chopin, low repetition piece) depicts more variation in the pulse and melodic content, with a clear visual indication of fluctuations in the spacings. Irregular patterns occur almost immediately. In a similar fashion, Appendix Figure D (Debussy, low repetition piece) displays immediate inconsistency in melodic and rhythmic content, with strong visual variations throughout the piece. In sum, these spectral analyses support the distinction of stimuli as high and low repetition pieces, as listed in Table 2.

5.1.6. Data analysis

Video recordings of facial expressions during the session were analysed using Noldus FaceReader software. This software analyses facial expressions using Ekman's Facial Action Coding System (FACS) (Ekman & Rosenberg, 2005) a well-established technique for coding the activation of facial action units (AUs; muscle groups) that can be indicators of affective states, and is increasingly being used in detection of engagement in educational contexts (Grafsgaard et al., 2013). FaceReader software calculates activation of individual AUs as well as aggregate scores that can indicate overall affective states such as happiness or sadness, and data relating to head orientation. The aggregate score for Arousal was taken as an indicator of anxiety in the current study. X-Head Orientation was used as an indicator of engagement, since this demonstrates a head turn to the left when numbers decrease. Participants were sitting with the piano slightly to their left side and thus a head turn to the left indicated engagement with the performance.

After calibration for individual participants, average scores for Arousal and X-Head Orientation were obtained for both a neutral baseline period and during the two test conditions. Recordings of facial expressions were not obtained for one child who did not sit long enough to capture the minimum duration required for analysis.

5.2. RESULTS – Study 1

5.2.1. Anxiety ratings

Given that 19 response questions were used, each containing a 7-point scale, the possible range of anxiety ratings was from 19 (least anxiety) to 133 (most anxiety). To test for order effects, an initial independent samples t-test was first performed with all aggregate MASC scores as the dependent variable, and with participants grouped according to the order that they were presented the stimuli (either high repetition first and low repetition second, or the reverse). The t-test was non-significant ($t(38) = -1.25$, $p = .167$) indicating that the data had not been influenced by an order effect. Data from both conditions were therefore compared across 3 time points (baseline; high repetition; low repetition) regardless of the order in which the experimental conditions were presented. Descriptive statistics for anxiety ratings are reported in Table 3.

Table 3

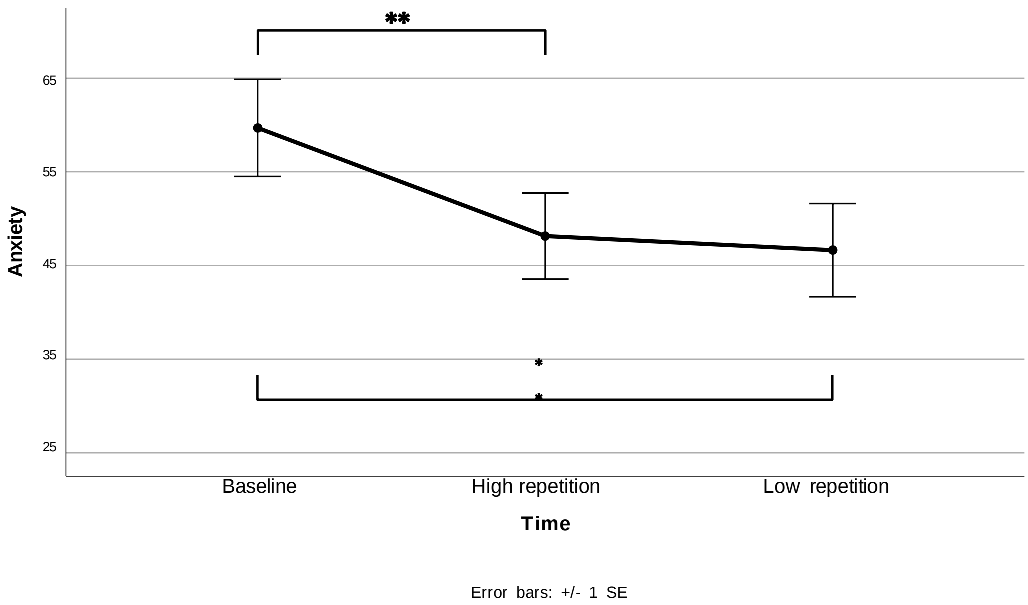
Descriptive statistics of ANOVA anxiety ratings for Study 1.

Anxiety	M	SD	N
Baseline	59.70	23.15	20
High repetition	48.15	20.56	20
Low repetition	46.65	22.26	20

Following this, in order to test Hypothesis 1, a repeated measures ANOVA was used to compare the anxiety rating for the two experimental conditions. The ANOVA contained anxiety as the dependent variable and time (three time points as defined above) as the independent variable. Cases with missing data were excluded casewise from analysis. The ANOVA did not violate the assumption of sphericity, and produced a significant result ($F(2,38) = 11.10$, $p < .001$, $\eta2 = .369$). Following this, Šidák post hoc tests indicated significantly lower ratings of anxiety for the high repetition category compared to baseline ($t(18) = 11.55$, $p = .002$), as well as significantly lower ratings of anxiety for the low repetition category compared to baseline ($t(18) = 13.05$, $p = .004$). However, no significant differences were observed between the high repetition and low repetition categories (t(18) = 1.50, p = .936). These differences, including significance indicators and error bars, are reported in Fig.7. Therefore, these findings do not support Hypothesis 1, but indicate a reduction in Anxiety across both musical conditions compared to baseline.

Figure 7

Aggregate anxiety ratings for the 19 anxiety responses for Study 1- this figure depicts anxiety ratings on a scale from 13 (the least possible amount of anxiety to report) to 133 (the most possible amount of anxiety to report)



Note. These ratings are split across three time periods, although the actual order of stimulus presentation was counterbalanced for the sample. Significance indicators: * $p < .05$; ** $p < .01$; *** $p < .001$.

5.2.2. Oximeter scores

As a further measure of anxiety and test of Hypothesis 1, a repeated measures ANOVA was conducted with Oximeter scores as the dependent variable and Condition (baseline, high repetition, low repetition) as the independent variable. No significant differences between conditions were obtained ($F(2, 15) = 1.20$, $p = .329$, $\eta 2 = .14$).

5.2.3. FaceReader Arousal

As a further test of Hypothesis 1, a repeated measures ANOVA was conducted with FaceReader Arousal measures as the dependent variable and Condition (baseline, high repetition, low repetition) as the independent variable. No significant differences between conditions were obtained, ($F(1, 13) = 2.57$, $p = .094$, $\eta 2 = .17$). Thus, FaceReader Arousal measures did not support the first hypothesis, although a trend in the expected direction was obtained with Arousal levels being lowest in the high repetition condition ($M = 0.30$, $SD = 0.06$), compared to baseline ($M = 0.30$, $SD = 0.24$), and the low repetition condition ($M = 0.34$, $SD = 0.06$).

Taken together, these results of the proxy rated Anxiety measure, the Oximeter and facial analysis do not support the first hypothesis. However, there is some indication that music in general may reduce proxy-report anxiety levels in children with sensory sensitivities.

5.2.4. FaceReader Head Orientation

In order to test the second hypothesis, a paired samples t-test was conducted with X-Head Orientation as the dependent variable and Condition (high repetition, low repetition) as the independent variable. Results showed significant differences between conditions $t(15) = -1.91$, $p = .038$, with the high repetition condition returning lower scores (indicating more head turns to the left) ($M = -8.22$, $SD = 7.74$) than the low repetition condition ($M = -4.92$, $SD = 8.73$). Thus, the second hypothesis was supported.

5.2.5. MiDAS ratings

MiDAS scores were examined with three paired samples t-tests (each concerning a separate MiDAS subscale, being interest, involvement, and enjoyment), and comparing responses accompanying the low repetition versus high repetition stimuli. Descriptive statistics are reported in Table 4. Due to multiple comparisons, the t-tests were subjected to sequential Holm-Bonferroni correction (Holm, 1979); *p* values reported have been adjusted according to this correction. All three t-tests were non-significant: for interest ($t(19) = 1.82$, $p = .170$); for involvement ($t(19) = 1.18$, $p = .126$); for enjoyment ($t(19) = -.82$, $p = .419$). Thus, results from the MiDAS do not support the hypothesis that the high repetition condition would be more engaging than the low repetition condition, although a larger sample size may have led to observable differences.

Table 4

Descriptive statistics of MiDAS scores for Study 1. These ratings were made on a 3-point scale, ranging from 1 to -1, and based on these an aggregate was collated for each MIDAS subscale.

MiDAS subscale	Stimulus type	M	N	SD
Interest	High repetition	.75	20	1.92
	Low repetition	.05	20	1.99
Involvement	High repetition	-.35	20	1.53
	Low repetition	-.95	20	1.00
Enjoyment	High repetition	1.10	20	7.35
	Low repetition	2.00	20	5.54

The optional comments at the end of the questionnaire were analysed using thematic analysis after initial coding process. The comments from the high repetition music condition were divided into three themes; Fidgeting, Relaxed, Enjoy. There were 5 responses for Fidgeting, 8 for Enjoy, and 9 for Relaxed. Therefore, music with high repetition overall yielded relaxed and enjoyable responses from the children. As one example, P5 described their child as having:

‘Relaxed posture. Shy facial expression indicates that she enjoyed it but didn’t want us to know she did. Her smiling at me gave it away.' P8 described their child as ‘pensive and looked reflective. I observed him tapping along to the music.’

Comments from observations made during the listening of the low repetition were divided into three themes of Calm, Interested, Disinterested. There were 5 responses under Calm, 6 for Interest, and 14 for Disinterested. Therefore, although there was some interest and calming during the music with low repetition, most children showed signs of disinterest. According P14, their child was ‘uninterested and slouching’, and P16 wrote their child ‘became impatient, restless legs, looking at watch, fidgeting’. The result supported our hypothesis that music with high repetition was more calming and engaging than low repetition for the children.

5.3. Discussion

It was hypothesised that the High repetition musical condition would have a greater calming effect on participants than the Low repetition condition, and that the High repetition condition would be more engaging to them than the Low repetition music. Although some trends in the expected direction were detected, on the whole the results did not support this first hypothesis. However, some support for the second hypothesis was observed, specifically for results regarding FaceReader Head Orientation. When comparing high repetition pieces with low repetition pieces, the preliminary results showed a decreasing trend in anxiety rating for music with higher repetition. However, with the given small sample size, it was non-significant. The results from the MiDAS and FaceReader Arousal showed a similar trend. Yet there are some factors that are likely to have contributed to this outcome.

Firstly, the small sample size of twenty participants meant the results did not yield a large range of responses. Secondly, there was an adjustment made to the original MiDAS scale, with the intention of creating easier useability for the parents. The original 101-point Likert scale (0 = none at all, 100 = highest) seemed too big and visually tiring for the parents, particularly on hand-held devices. Due to this, the decision was made to simplify this scale to a 3-point option (Yes/No/Unsure), allowing the parents to click one response button rather than use a slider scale. However, this seems likely to have limited the range of responses and made it difficult to detect subtle changes in interest across time points and between study conditions. With this in mind, the following study (Study 2) will therefore contain a larger rating scale for MiDAS responses (although still substantially smaller than a 101-point scale). Finally, one possible explanation for these findings may be the fact that there were two pieces used in each condition. In some cases, the parents commented that responses to the two pieces within the same condition were varied, meaning that the child enjoyed one piece more than the other despite the pieces belonging to the same repetition grouping. In an effort to better control for differences such as individual preferences between pieces, Study 2 will utilise one piece per condition.

The Head Orientation results from FaceReader did show more support towards higher interest and involvement when listening to music with higher repetition, suggesting that this is worth exploring further in Study 2. Additionally, some of the parental observational comments mentioned their child's interest in the oximeter (P4 and P7). We do not know whether this is a cause for distraction or rather helped with focusing, or if it potentially impacted their responses. With this in mind, the oximeter is a potential additional confound between participants, and so was removed from Study 2.

Even with these discrepancies and methodological limitations, the key significant finding of Study 1 indicates that for children with sensory sensitivities, music in general was calming compared to their prior listening level. As discussed in the literature review (3.5), there is an apparent lack of published research in the field of sensory friendly musical programming, and presentation of live professional concerts for children with sensory sensitivities. Using the resources and materials available at hand, this first laboratory style study served as a pilot to inform the planning of the second study, which aimed to be closer to the real-life situation of a public concert.

6. Study 2 – Live Concert

This study aimed to investigate whether or not high levels of repetition in music are more calming and engaging to children with sensory sensitivities in a live music performance setting. Study 1 investigated the hypotheses in individual settings and discovered some evidence to suggest that music as a whole had a calming effect and that high repetition music tended to be more engaging to young participants than low repetition music was. In Study 2 similar hypotheses are examined, although in a group performance setting in order to reflect the conditions of a live concert more realistically. Again, I used a combination of the MiDAS and MASC scales, as well as qualitative data from the subjective observational comments from the parents/carers. Some methodological modifications were also made based on the apparent limitations discussed following the pilot study (Study 1).

6.1. Method

6.1.1. Hypotheses

H1: For music containing a higher degree of internal repetition, accompanying ratings of anxiety will be significantly lower when compared to: i) no music, and ii) music with less internal repetition (anxiety rating).

H2: Children show higher interest, involvement, and enjoyment in music with higher degree of internal repetition than in music with less internal repetition (MiDAS rating and observational comments).

6.1.2. Participants

Although there were no COVID-19 lockdowns occurring at the time of testing, COVID numbers in the community were still high and people were testing positive. Close contacts were required to socially isolate. Therefore, a number of attendance cancellations were received just prior to the concert, resulting in lower attendance than intended. The concert was attended by 17 children, although after data collection was complete, one response was removed due to incompletion; this participant had remained in the audience although had requested their parent/carer not to continue with the survey. Therefore, this sample contained 16 children (5 female and 11 male) with age range 6-14 years (M = 9.6, SD = 2.7), as well as their parents or carers. There were 8 children with a diagnosis of ASD, 8 children with ADHD, one with SPD, and 8 children with undiagnosed sensory sensitivities. Some children had more than one diagnosis.

Due to the smaller than anticipated attendance rate, an online component was subsequently added to help recruit additional participants to view a recording of the concert online and participate in the study virtually. With little time remaining during the Research course period, only 4 participants (ages 10, 8, 8, 9; M = 8.75, SD = 0.96) successfully completed the online version of Study 2 before the experiment window was closed. Out of the four participants, two were diagnosed with only ASD, one with undiagnosed sensory sensitivity, and one child with multiple conditions - ASD, ADHD and anxiety.

Table 5

Number of children participants and age groups for Study 2 – live concert

Age	Number of children
6	2
7	3
8	2
9	1
10	2
11	1
12	2
13	2
14	1

6.1.3. Procedure

Study 2 was intended to evoke a more ecologically realistic listening setting than the pilot study. An appropriate space was found within a Western Sydney University campus. This performance area was spacious, with natural light and various seating options available. This space allowed the attendees to be spaced out in line with COVD-19 recommendations, as well as to provide sufficient buffer room for them sit or lie down while listening, or to move around while listening if desired. Participants were recruited via online social media advertisements and mailing list of professional networks of the researcher.

In response to the limitations identified with Study 1, some procedural changes were made. Most notably, the MASC scale was adjusted to a 5-point scale as opposed to the 7-

point version used in Study 1, and the MiDAS questionnaires were corrected from a 3-point scale to an 11-point Likert scale, to allow greater variation of responses. The questionnaires were also updated to include ‘they’ pronoun to show respect for gender equality. Similar to Study 1, in Study 2 the examination of MiDAS focused only on the three subscales of Interest, Involvement, and Enjoyment, as the other two (Response, Initiation) did not apply to the children. This decision was made because the remaining MiDAS scale questions were more relevant to the musical experiences of older participants (e.g., “Did she/he talk about his/her life experiences?” [Initiation], or “Did he/she make eye contact with the musician?” [Response]).

For Study 2 the oximeter and video recording of facial expressions were removed due to logistical reasons. Apart from the oximeter being a potential confounder mentioned in the previous discussion (5.3), it was not feasible to produce a separate video camera, oximeter, and operator for each of these for every participant. Instead, the decision was made to focus on ratings of MASC and MiDAS.

The live concert was held on a Sunday, where there was minimal public access in- and outside the building. Upon arrival and check in, a sheet with a unique participant identifier number and a QR code link to the survey (completed on personal devices) were handed out to each parent/carer. Most arrived earlier and had a chance to acclimatise to the space and to each other. Siblings were allowed to join in.

The concert was based on the Sensory Concerts® format, small numbers with plenty of personal space, flexible seating options, sensory toys, freedom of movement. The performance space provided sensory friendly seating options (crashmats, textured rugs, weighted toys) and had a wall-to-wall glass window which allowed natural light and visual respite (Fig.8). The children could choose anywhere to sit. Some children chose to stay in their preferred seating option, at times wrapped in a sensory blanket, while others chose to lie on crash mats, textured rugs or similar. The children were also provided with sensory items such as weighted soft toys, sequined cushions, and various fidget toy options. Most of the children sat separately to their parents, with only two children sitting in chairs directly next to their parents. As instructed, the parents and carers sat in chairs where they could clearly observe their child. Prior to commencing the study, the parents/carers were asked to fill out the CST and the pre-listening rating of the MASC scale.

After the completion of the CST and baseline MASC, the children were presented the first piece, with their parents/carers observing. The parents and carers were encouraged to observe without intervening in their child's movements. The parents were asked to wait until the first piece was completed before filling in the MiDAS and second set of MASC. There was a brief break before playing the second piece to allow everyone to finish the questions. The children were then asked to listen to the second piece. Again, parents were asked to observe and wait until the piece was finished before filling in the final part of the questionnaire. Some devices (iPads) were available if required, and a paper version of the survey was also available, although most people used their own devices (smartphone or tablet), with only one carer using the paper version. The children were free to roam and vocalise.

For Study 2, the music was performed by a professional solo cellist (as opposed to the researcher also being the sole performer), to minimise any potential bias. The cellist performed two pieces: the first piece contained stronger internal repetition whereas the second piece contained weaker internal repetition. The performance duration of each piece was 3 to 4 minutes. These two pieces were the only ones in which survey data were gathered; the rest of the concert consisted of popular, uplifting music played by piano and cello duo, to conclude the event. The total duration of the concert was approximately twenty minutes. At the completion of the concert, the children were offered a small sensory gift for participating, such as glitter pens, scratch and sniff stickers, playdough, and kinetic sand. The complete concert was filmed, although the camera focused on the performer(s) rather than the audience. This filming was done with the intention that a future online study containing the same performance content was possible, if required.

Figure 8

Live performance space layout at The MARCS Institute for Brain, Behaviour and Development, Western Sydney University – photo image produced with permission from the cameraman (left) and cellist (right)

Following Ethics amendment, the online component was run approximately three months later. An initial online pre-screening questionnaire on Qualtrics was configured to select only the qualifying candidates. The first page of the new Qualtrics online link contained the pre-screening questionnaires for eligibility purposes and was streamlined to provide both participant information and digital consent to begin the study. The survey questions were identical to the group study and the responses were recorded anonymously. The participants watched online in their preferred location. The musical performance was the live video recording of the group session, meaning that the online participants were exposed to the same musical conditions, albeit in a virtual format. The video recordings of the live performance were presented via an unlisted YouTube link embedded in the online questionnaire.

6.1.4. Measures and materials

As with the pilot study (Study 1), our primary source of data for Study 2 was MiDAS (McDermott et al., 2015), and MASC (March et al., 1997). As in Study 1, only three subscales of the MiDAS were used (concerning interest, involvement, and enjoyment) as the other categories were not relevant to our target group or hypotheses. The 3-point MiDAS rating was increased to an 11-point scale (0 = None at all to 10 = Highest), which was theorised to be a more appropriate rating scale that would allow potential differences in the responses to emerge. As with study 1, an optional comment box was included for any additional comments.

The session was filmed on Canon EOS 5D Mark IV camera, statically placed capturing mainly the musician performing as children were free to move around the space. The choice of music was narrowed down to one piece per condition so as to reduce variability of responses between the pieces within each condition (Table 5). The choice of instrument (cello) was also intended to further narrow any possible confounding effects of the musical elements down to a minimum, the cello playing a single melodic line, as opposed to the piano, which usually plays two or more lines simultaneously, often containing melody and complex harmony in addition to rhythm and pulse.

Musical selection. Study 2 contained one high repetition piece and one low repetition piece. J.S. Bach's Prelude from Cello Suite No.1 BWV 1007 was used as the high repetition piece, and was performed first, and Dawn Lament by Australian composer Paul Stanhope was used as the low repetition piece and was performed second. As the number of attendees allowed only a single concert, Study 2 did not contain counterbalance in the playing order of the high and low repetition pieces.

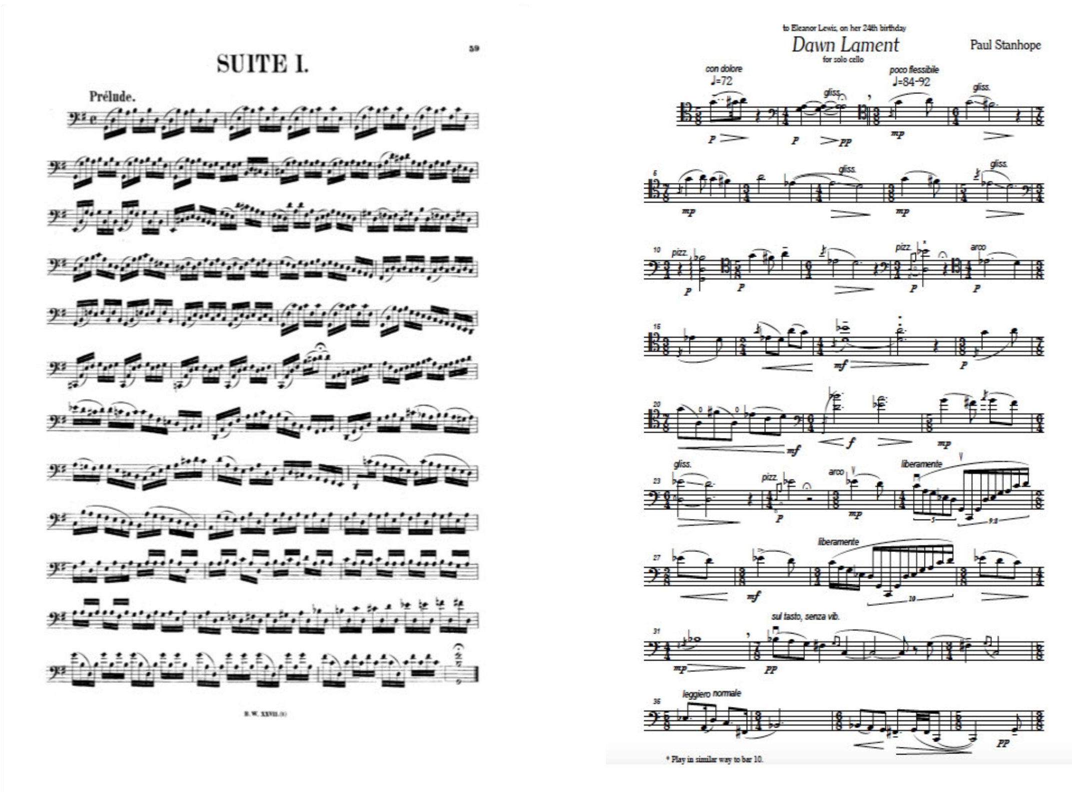
Table 5

Selected solo cello pieces for Study 2 – one piece per condition

Repetition	Piece
High	J.S. Bach – Prelude BWV 1007 from Cello Suite No.1
Low	P. Stanhope – Dawn Lament

Figure 9

Comparison between Bach's Prelude from Cello Suite No.1 (left, high repetition) and Dawn Lament by Paul Stanhope (right, low repetition)



Note. Repetitive semiquaver arpeggio patterns in Bach (high repetition) throughout the piece creates a feeling of predictability compared to the variable polymetric time signatures and irregular melodic patterns of Stanhope (low repetition).

Music source: 1. Bach (left) - IMSLP

https://imslp.org/wiki/Cello_Suite_No.1_in_G_major%2C_BWV_1007_(Bach%2C_Johann_Sebastian)

2. Stanhope (right) – supplied by the composer

As seen in the musical excerpts (Fig.9), the contrast between the continuous cyclical pattern of the Bach and the improvisatory nature of Dawn Lament is evident. Spectrogram images (Appendix Figure E) of the selected musical pieces echo this contrast between the two pieces, the Bach displaying regular symmetry compared to the sparse, non-repetitive segments of Stanhope.

6.2. Data Analysis

Independent samples Mann-Whitney U-Tests were performed to see whether significant differences existed between people who participated in-person and online on Anxiety scores at baseline, and after both test conditions, and also on Enjoyment, Involvement, and Interest scores from the MiDAS during the two test conditions. No significant differences were found at $p < .05$, and therefore data from the two groups were combined and analysed as a single data set.

6.3. RESULTS – Study 2

6.3.1. Anxiety ratings

Given that 19 response questions were used, with each containing a 5-point scale, the possible range of anxiety ratings was from 19 (least anxiety) to 95 (most anxiety). Cases with missing data were excluded casewise from analysis. Descriptive statistics for anxiety ratings are reported in Table 6. In order to test Hypothesis 1, a repeated measures ANOVA was conducted to see if there were significant differences in Anxiety scores at three different time points with Time (baseline, high repetition condition, and low repetition condition) as the independent variable. Assumptions of normality were satisfactory, however, Mauchly’s test of sphericity indicated some violation of this assumption ($p < .001$) and therefore Greenhouse-Geisser correction was used. The ANOVA results indicated a statistically significant difference between time points ($F(2,38) = 17.30$, $p < .001$, $\eta 2 = .477$) . Following this, Šidák post hoc tests indicated significantly lower ratings of anxiety for the high repetition category compared to baseline ($t(18) = 14.40$, $p < .001$), as well as significantly lower ratings of anxiety for the low repetition category compared to baseline ($t(18) = 12.40$, $p = .003$) (see Table 6 for means). As with Study 1, no significant differences were observed between the high repetition and low repetition categories ($t(18) = -2.0$, $p = .367$). These differences, including significance indicators and error bars, are reported in Figure 10. Thus, as with Study 1, anxiety levels were significantly reduced in both music conditions with no differences between high and low repetition conditions. Therefore, the findings of Study 2 do not support Hypothesis 1.

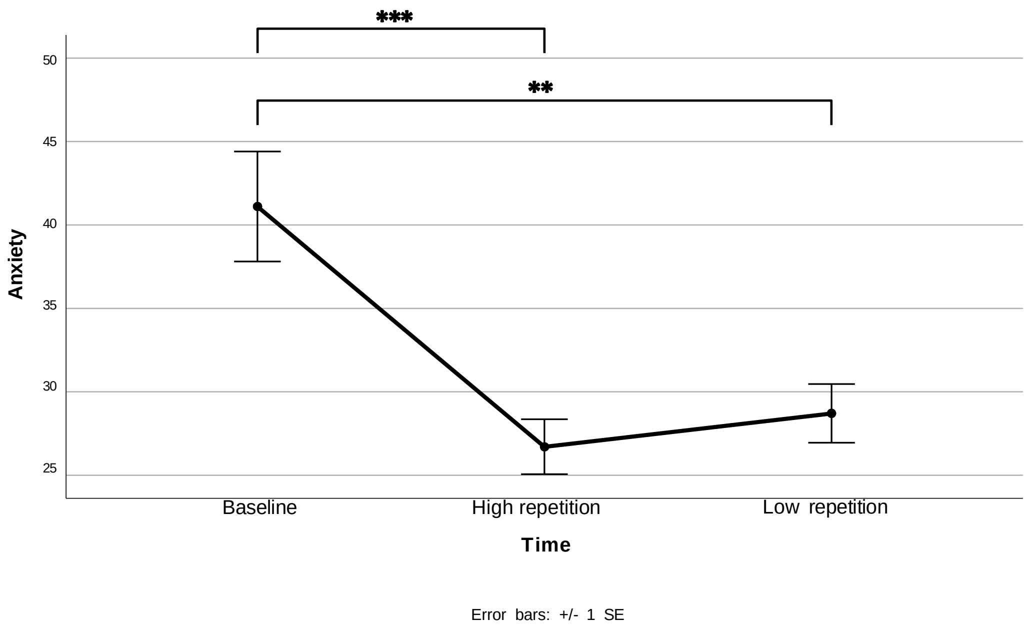
Table 6

Descriptive statistics of ANOVA anxiety ratings for Study 2

Anxiety	M	SD	N
Baseline	41.10	14.75	20
High repetition	26.70	7.36	20
Low repetition	28.70	7.86	20

Figure 10

Aggregate anxiety ratings for the 19 anxiety responses in Study 2



Note. On a scale from 13 (the least possible amount of anxiety to report) to 95 (the most possible amount of anxiety to report). These ratings are split across three time periods. Significance indicators: * $p < .05$; ** $p < .01$; *** $p < .001$

In order to test whether the degree of sensory modulation difficulties in participants influenced the effect of music listening, CST scores were split at the median (33.5) into low and high sensory modulation difficulty groups. The above analysis was run again with CST groups as a between-subjects effect. Results indicated no significant interaction between CST group and condition ($F(1.31, 23.55) = 3.11$, $p = .081$, $\eta2= .015$). The main effect of Condition remained significant ($F(2, 18) = 19.22$, $p < .001$, $\eta2 = 0.52$). Thus, the degree of severity of sensory modulation difficulties experienced by participants did influence the results and music was found to have a reductive effect on Anxiety regardless of condition or of the degree of sensory modulation difficulties experienced by participants.

6.3.2. MiDAS ratings

In order to test Hypothesis 2, three paired-sample t-tests were performed to see if there were significant differences in Enjoyment, Involvement, and Interest scores between the high repetition and low repetition conditions. Descriptive statistics are reported in Table 7. Due to multiple comparisons, the t-tests were subjected to sequential Holm-Bonferroni correction (Holm, 1979); adjusted *p* values are reported. All three t-tests were significant: for Interest ($t(19) = 3.17$, $p = .01$); for Involvement ($t(19) = 2.48$, $p = .022$); for Enjoyment ($t(19) = 4.80$, $p = .003$). Taken together, these results support Hypothesis 2, that music with higher repetition creates more interest and engagement for children with sensory sensitivities.

Table 7

Descriptive statistics of MiDAS results for Study 2

MiDAS subscale	Stimulus type	M	SD	SE
Interest	High repetition	18.05	6.36	1.42
	Low repetition	12.25	6.22	1.39
Involvement	High repetition	8.50	5.78	1.29
	Low repetition	5.20	5.48	1.23
Enjoyment	High repetition	15.55	6.31	1.41
	Low repetition	8.95	7.74	1.73

Parental observational comments given for the high repetition music were 100% positive. The responses were divided into three categories of Watching, Relaxed, and Imitating. There were 4 responses of Imitating, 14 responses for Watching, and 16 responses for Relaxed. The result indicated a strong engagement and calming response to music with high repetition. Some of the comments were: ‘Very focused on the musician. Very still while listening’ (P3), ‘His breathing rate slowed and deepened; restless repetitive leg and hand movements stopped; line of gaze looked up to focus on musician; smiles and a nod acknowledging he was liking the experience; he appeared significantly more relaxed and engaged (he was very nervous and unsettled on arriving and prior to that, on making our way from car to concert room)’ (P9). Interestingly, many children were observed watching the cellist with great interest, some imitating his gestures; ‘Started to imitate the cellist, copying his hand movements’ (P15). This interest in the cellist also applied for online participants, with comments from P20; ‘He became quieter and engaged in listening. He was interested in the musician and asked several questions about him. He happily listened to the clip’, and from another online participant, ‘They had many questions about the musician, the instrument, and the music. They said "it is very good"’ (P22).

Observational comments for music with low repetition were divided into thematic categories of Anxious, Disinterested, and Attentive. There were 8 responses for Anxious, 11 for Attentive, and 16 responses for Disinterested. Some of the comments were; ‘Seemed a little on edge fidgeting and worried look on face’ (P13), ‘Jittery fingers, pulling her hands backwards, tense hand movements. During the first piece my child was looking towards the musician but during the 2nd piece, my child never looked up at the musician, my child appeared uncomfortable’ (P12). Although the majority of the children were observed as anxious and disinterested, the children who were attentive to the music were described as ‘Very focused on the musician. A little distracted by others in the room at times, but mostly very still and focused. No nail-biting or fiddling like usual' (P1). One participant (P15) appeared to enjoy the music in both high and low conditions. The child who had started to imitate the cellist in the high repetition condition 'Continued to try and imitate cello playing. Ranged between relaxation to more body movements as session went on' (P15, low repetition).

6.4. Discussion

Study 2 aimed to investigate the calming effect of music with high repetition on children with sensory sensitivities in comparison to music with low repetition. Unlike Study 1, which was a one-on-one laboratory style experiment, this study evoked a realistic live concert setting, with participants attending as a group. I had hypothesised reduced anxiety when listening to music compared to no music, and when listening to music with high repetition compared to listening to music with low repetition. There was also a hypothesis that music with high repetition will create more interest, involvement, and enjoyment for children with sensory sensitivities. The findings of Study 2 indicated that music had a calming effect and facilitated interest, involvement, and enjoyment for children with sensory sensitivities.

It is promising to see significant findings for ratings of MiDAS, in the categories of involvement, interest, and enjoyment. I believe the correction of the scaling of both MASC and MiDAS from Study 1 delivered in a more robust result, and thereby supported both hypotheses (in full or partly), that music with high repetition is more calming than none, and music with high repetition creates more interest and engagement than music with low repetition. The MiDAS result was also reflected by the overwhelming parental observational comments supporting greater engagement and interest in music with high repetition.

It is interesting to observe that the children were imitating the cellist during the high repetition piece, and for one child, in both conditions. There could be a few factors that could have contributed to this response. Firstly, there is a more physical component to playing the cello compared to the piano. The piano is a static instrument which requires smaller movements from the performer to produce a sound. The cello requires a larger movement. The cello also creates sound vibrations which can be felt more physically than a digital piano. The cellist usually faces the audience rather than the pianist who usually sit with their profile to the audience, although in Study 1 the pianist was facing the profile of the child, and the child was facing the camera. These factors could have contributed to the cello being both visually and aurally stimulating. It would be interesting to see if the visual presence of a grand piano would have made a difference.

Another factor to consider is the setup of the space of the group study. In a realistic setting of a concert versus laboratory style experiment, whether a larger space, the sensory toys and sensory friendly environmental adjustments all played a role in influencing the outcome in some way. One could argue that the sensory friendly modifications were there to counteract the unfamiliar setting, to provide an external sensory regulation opportunity for the children to be at somewhat even level of arousal prior to commencing. This could be then comparable to the environmental condition for the children in Study 1 which was conducted in a clinic where all the children were already familiar with their surroundings. Whatever the case may be, music, regardless of the condition, was shown to be calming, compared to no music, even in a non-familiar environment. This only reiterates the benefits of music, the study therefore confirming the overall anxiety reducing role music plays in children with sensory sensitivities.

Although we focused primarily on anxiety for this exploratory study, the highly significant results from the second study show potential for extending beyond the parameters of anxiety. Future research could investigate how, and what kind of music can impact other variables such as different emotional responses, and how those findings make a difference in the social and emotional wellbeing of the children and their families. Different choices in the musical repertoire, the duration of the pieces, further physical modifications to the concert environment, or even different times of the day (morning, day, evening) may indeed deliver a different statistical outcome.

7. Discussion and conclusion

This thesis focused on making quality professional concert experiences accessible to children with sensory sensitivities and their families. Autism is a multi-faceted, lifelong condition that may require ongoing care; thus it is important to acknowledge the importance of mental and physical wellbeing of families and carers in addition to children with ASD (Tint & Weiss, 2015). A live musical concert is one of the ways that can contribute to their health and wellbeing, a wholesome place where they can enjoy quality time together as a family. The project stems from this core idea – how to make live concerts comfortable and accessible for families with sensory sensitivities, without compromising the quality of the musical content.

Despite these potential benefits, examination of how specific musical components (in this case, repetition) might be able to improve the lives of people with sensory sensitivities and autism is significantly under-researched. To address this point, this thesis examined various ratings and objective measures for children with sensory sensitivities, alongside music that contained either low or high levels of internal repetition. The key finding of this research was that children with sensory sensitivities demonstrated significantly reduced levels of anxiety when listening to live music. This finding reinforces the existing literature regarding the general benefits of live music. Moreover, music with higher repetition induced additional interest and engagement levels from these children, compared to music with low repetition. This secondary finding can be explored further, with the intention of incorporating music deeper into therapeutic approaches for sensory-sensitive children. Although our hypothesis regarding anxiety ratings between the high and low repetition was not supported, a non-significant difference was observed between the high and low repetition stimuli in both studies; in both cases the high repetition stimuli were accompanied by lower Mean values of anxiety. Therefore, this positive trend shown towards music with higher repetition in the results warrants further investigation, and with a larger sample number, this research could produce a more robust result.

I am a professional concert pianist and educator, and a parent to a child with ASD and ADHD. Realising the lack of social and cultural opportunities for families (including my own) with sensory needs, I created Sensory Concerts® in 2016; where people of all ages and abilities can experience high-quality professional live classical music in an inclusive, sensory friendly setting, without fear of judgement. Differing to music therapy, Sensory Concerts aims to provide real time live classical concert experiences performed by professional musicians (currently active in major Australian and international orchestras) with onsite support of allied health professionals (occupational therapist, physical therapist specialising in neurological disorders, and child psychologist). The staff also includes special needs educators and parents who have first-hand experiences. The concerts are set with small numbers, various seating materials and options, retreat space. The children are free to move around and vocalise. The musical programs that are designed to appeal to first timers as well as seasoned concert goers. Since the pilot concert in 2017 there has been increasing demand for these concerts, leading to performances in Australian metropolitan and regional areas of New South Wales, Victoria, and South Australia. Sensory Concerts has attracted several community grants and partnerships with various performing arts and educational organisations, and additionally were the Featured Artists for the 2022 Musica Viva NSW Regional Tour.

As other Australian arts organisations are now beginning to introduce these sensory friendly concepts in the presentation of some of their concerts, it is timely to consider the musical content that may elevate the sensory friendly concert experience. With the apparent lack of published information available in this field, I am undertaking academic study to create a knowledge base for interested musicians and organisations who wish to utilise the information obtained from this study. Starting with repetition as a focal point, the studies within this thesis aimed to promote further investigation in sensory friendly music, helping to create and develop musical content that may contribute to the success of sensory friendly concerts. As with most arts entities, the nature of the project is non-profit; therefore this research is motivated by a genuine quest for knowledge and societal improvement rather than commercial interest. With this in mind, there is no commercial conflict of interest in the production of these studies.

The examined topic of repetition in music originated from the concept of exploring the musical equivalent to stimming, and whether the calming effects of repetition in both stimming and predictability can be also delivered musically. Although there may be other musical elements that link to other autistic traits, we begin with the strongest established typical autistic trait and the accompanying coping mechanisms based on existing publications. There are numerous published and anecdotal evidence of stimming and the strong preference for sameness as being a stereotypical trait of autism (Attwood et al., 2014; Baron-Cohen, 2006; Baron-Cohen et al., 2009; Black et al., 2017; Charlton et al., 2021a; Gotham et al., 2013; Kapp et al., 2019; McLaughlan & Fleury, 2020; van der Zee & Derksen, 2021).

As mentioned in chapter 3, most studies that involve music and children with sensory sensitivities are in the form of music therapy. Music therapists are first and foremost trained therapists, with varying degrees of proficiency in their musical skills. This has been mentioned (Simpson & Keen, 2011) as a possible confounding factor in the effectiveness of music therapy. Equally, this can be said about concerts; the musical skills and level of the performers can affect the enjoyment and engagement of the audience. In an effort to control this factor, the studies contained within this thesis used professional musicians who are highly trained and currently active as performers at industry-recognised venues, such as the Sydney Opera House.

Another point to consider is that often terms such as 'therapy' and 'intervention' are used in association with activities for children with autism. From first-hand experience, as a parent of a child with ASD and ADHD, this can provoke a negative connotation that one has a problem that needs fixing. Whilst recognising the importance of therapies and interventions, I am advocating for musical concerts where, even it is just for the duration of the concert, one can leave any problems behind; and simply experience the joy of quality live music as a fellow human being without feeling patronised or defined by their disabilities or circumstances.

7.1. Limitations and future recommendations

7.1.1. Time constraint.

The current COVID-19 pandemic, and the associated nation and state-wide restrictions that were in place for much of this Master of Research thesis, led to substantial challenges. Notably, these restrictions were subject to change, meaning that intended research plans often needed to be re-worked with little notice. This led to challenges in coordinating group gatherings and face to face events. Additionally, there were the uncertainties associated with the reluctance to attend group gatherings, venue availabilities, and last-minute cancellations due to COVID-19 and other illnesses such as cold and flu. These challenges all played a role in severely limiting sample numbers. Furthermore, the time constraint of the Master of Research degree (less than a year for thesis writing), in tandem with the above challenges, led to the decision to include a wider age range for participants than was initially intended, to maximise recruitment possibilities. Future work may benefit from stricter age inclusion criteria, such as targeting a specific age group for each separate study. Indeed, focusing on participants aged 10 to 14 years may prove fruitful, as this age group showed the largest increase in the prevalence of autism diagnoses in 2018 (Australian Bureau of Statistics, 2018).

Additionally, Ethics Approval required amendment to include further details relating to online-only questionnaire for Study 2, and this amendment process was costly for the allotted data collection window. The administration process for social media advertising from the University also took several weeks, meaning that only four eligible participants managed to complete the online-only questionnaire. Several additional participants completed the questionnaire but were either ineligible or did not fully complete it. This is a limitation of online studies during the COVID-19 pandemic; though generally more convenient for participants, on the other hand these online studies can be pushed down the priority list, especially with the already demanding lives of families with special needs children. A one-time livestream event was considered, although not implemented. Future studies may find this an effective approach, although it was not possible within the timeframe of the current study. Some of the additional factors beyond my control for the online studies were for example, the quality of the video and audio on the participants' devices, the listening space (eg. Was it in a quiet space, or near the kitchen with the dishwashing machine on) and the number of people present in the room. Future online studies may be able to account for these factors.

7.1.2. Methodology.

In Study 1, the decision was made to reduce the 101-point scales to a 3-point scale. It is likely that this narrowing of the MiDAS scale would have limited the findings of Study 1, by not allowing much variance in responses. With this in mind, in Study 2 the decision was made to adjust it to a more appropriate 11-point scale. As expected, Study 2 produced greater variance in MiDAS responses, and this led to statistically significant results as the second study with the corrected scale provided a more comprehensive result. Building on this result, future studies can explore other measures including measurement of emotional and social responses in children with sensory sensitivities.

7.1.3. Confounding factors.

There may be other factors that could have influenced the results. In Study 1 two participants were reported to be focused on the oximeter. This could have either distracted or helped focus on the music. The unnatural setting of listening to live musical performance with their faces being filmed in the presence of strangers, could have influenced their arousal levels. Additionally, in Study 2, aspects such as the sensory friendly space layout, and the social dynamic created by the gathering of people may have had subjective impacts on various participants, although we were not able to collect this information due to time constraints. The choice of instrument could also be explored further, such as examining whether the visual or the timbral properties of certain instruments contribute to increased interest and engagement in children with sensory sensitivities.

7.1.4. Participants.

This study recruited children with sensory sensitivities with a variety of diagnoses. Yet future studies could focus on a single diagnosis at a time, as well as hypo-sensitivity. However, this approach is complicated by the fact that there are usually comorbidities present, thereby reducing the available sample even further for this approach.

7.1.5. Musical material.

This study aimed to investigate a sensory-friendly way to introduce children and their families to live classical concerts. The choice of musical repertoire therefore was drawn from Western Art Music. The musical selections for both Study 1 and Study 2 were planned to maintain the similar format. Each condition contained pieces from pre-twentieth century Western European music (Study 1 - Bach, Chopin, Debussy; Study 2 - Bach) and twentieth century modern music by non-European living composers (Study 1 - Glass; Study 2 - Stanhope).

Yet the compositional format of Western classical music does not easily allow focus on only one single element. Future studies wishing to purely focus on a single rhythmic element would need to consider moving away from traditional classical music. For example, the use of only rhythm on a percussion instrument (eg. the use of drums, negating harmonic aspects entirely) could potentially be used to eliminate any potential confounding factors such as pitch, tempo, modality, and dynamics. However, this approach may also negate much of the ecological validity gained by the present approach, in that it is unlikely to represent everyday listening experiences for most people. Research might also extend to focus on these other individual musical elements (pitch, tempo, modality, dynamics) to investigate what effects those elements can have and whether they can be used in a sensory friendly way. If future funding opportunities allow, the use of specially commissioned materials by a professional composer that specifically aims to allow examination of these separate musical elements, may prove fruitful.

7.2. Conclusion

Based on the findings of Study 1 and Study 2, I conclude that music can have a calming effect (compared to no music) on children with sensory sensitivities. Yet more work is required to understand the complexities at hand, and to examine the reproducibility of these findings. Concert organisations are beginning to show interest in looking for inclusive ways to widen their audience participation. In addition to the existing efforts being made, such as modifying the physical environments, allowing freedom of movement and retreat, and providing preparation materials (eg. social stories), now it is time to focus on quality of the musical content. But other areas must also be prioritised, such as the choice of music, the reasons behind these choices, and evidence of these choices contributing to the positive outcome of sensory friendly concerts. This study sheds light on this under-researched area and aims to provide a reference point and pathway for further research to explore how live music can benefit children with sensory sensitivities, as well as their families. Given the limited time and resources available here—including the unprecedented challenges of the COVID-19 pandemic at the time of research—this study can be considered as an initial examination, intended to lead to further investigation. This preliminary research advocates for genuine understanding and improvements to the musical and environmental content that satisfies both sensory and musical aspects in sensory-friendly concerts. The findings can be used to inform and support the musical programming of existing and future concerts by all interested parties, including arts organisations, educational, and allied health sectors, to make quality music accessible for all.

8. Reference List

Adamson, A., O’Hare, A., & Graham, C. (2006). Impairments in Sensory Modulation in Children with Autistic Spectrum Disorder. *British Journal of Occupational Therapy*, *69*(8), 357–364. https://doi.org/10.1177/030802260606900803

Aderka, I. M., McLean, C. P., Huppert, J. D., Davidson, J. R. T., & Foa, E. B. (2013). Fear, avoidance and physiological symptoms during cognitive-behavioral therapy for social anxiety disorder. *Behaviour Research and Therapy*, *51*(7), 352–358. https://doi.org/10.1016/j.brat.2013.03.007

American Psychiatric Association. (2020). *Psychiatry.org—Stigma, Prejudice and Discrimination Against People with Mental Illness*. https://www.psychiatry.org:443/patients-families/stigma-and-discrimination

APA Dictionary of Psychology. (2022). https://dictionary.apa.org/

Arnold, D. A., Latham, A. L., & Dunsby, J. D. (2011). Form. In *The Oxford Companion to Music*. Oxford University Press. http://www.oxfordreference.com/view/10.1093/acref/9780199579037.001.0001/acref-9780199579037-e-2624

Attwood, T., Evans, C. R., & Lesko, A. (2014). *Been There. Done That. Try This! An Aspie’s Guide to Life on Earth An Aspie’s Guide to Life on Earth*. Jessica Kingsley Publishers.

Austerman, J. (2015). ADHD and behavioral disorders: Assessment, management, and an update from DSM-5. *Cleveland Clinic Journal of Medicine*, *82*(11 suppl 1), S2–S7. https://doi.org/10.3949/ccjm.82.s1.01

Australian Bureau of Statistics, (2018). *Disability, Ageing and Carers, Australia: Summary of Findings, 2018 | Australian Bureau of Statistics*. https://www.abs.gov.au/statistics/health/disability/disability-ageing-and-carers-australia-summary-findings/latest-release

Australian Institute of Health and Welfare, (2017, March 21). *Autism spectrum disorder*. Australian Institute of Health and Welfare. https://www.aihw.gov.au/reports/disability/autism-in-australia/contents/autism

Balasco, L., Provenzano, G., & Bozzi, Y. (2020). Sensory Abnormalities in Autism Spectrum Disorders: A Focus on the Tactile Domain, From Genetic Mouse Models to the Clinic. *Frontiers in Psychiatry*, *10*, 1016. https://doi.org/10.3389/fpsyt.2019.01016

Bannister, S., & Eerola, T. (2021). Vigilance and social chills with music: Evidence for two types of musical chills. *Psychology of Aesthetics, Creativity, and the Arts*. https://doi.org/10.1037/aca0000421

Baribeau, D. A., Vigod, S., Pullenayegum, E., Kerns, C. M., Mirenda, P., Smith, I. M., Vaillancourt, T., Volden, J., Waddell, C., Zwaigenbaum, L., Bennett, T., Duku, E., Elsabbagh, M., Georgiades, S., Ungar, W. J., Zait, A. Z., & Szatmari, P. (n.d.). *Co-occurring trajectories of anxiety and insistence on sameness behaviour in autism spectrum disorder*. 8.

Barker, K., & Galardi, T. R. (2015). Diagnostic Domain Defense: Autism Spectrum Disorder and the DSM-5. *Social Problems*, *62*(1), 120–140. https://www.jstor.org/stable/26370838

Baron-Cohen, S. (2006). Living with autism: Joe, the extreme systemiser. *The Lancet*, *367*(9516), 1047–1048. https://doi.org/10.1016/S0140-6736(06)68454-7

Baron-Cohen, S. (2017). Editorial Perspective: Neurodiversity - a revolutionary concept for autism and psychiatry. *Journal of Child Psychology and Psychiatry*, *58*(6), 744–747. https://doi.org/10.1111/jcpp.12703

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in Autism: Hyper-Systemizing, Hyper-Attention to Detail and Sensory Hypersensitivity. *Philosophical Transactions: Biological Sciences*, *364*(1522), 1377–1383. https://www.jstor.org/stable/40485909

Barrios-Fernández, S., Gozalo, M., Díaz-González, B., & García-Gómez, A. (2020). A Complementary Sensory Tool for Children with Autism Spectrum Disorders. *Children*, *7*(11). https://doi.org/10.3390/children7110244

Beidel, D. C., Turner, S. M., & Dancu, C. V. (1985). Physiological, cognitive and behavioral aspects of social anxiety. *Behaviour Research and Therapy*, *23*(2), 109–117. https://doi.org/10.1016/0005-7967(85)90019-1

Benarous, X., Bury, V., Lahaye, H., Desrosiers, L., Cohen, D., & Guilé, J. M. (2020). Sensory Processing Difficulties in Youths With Disruptive Mood Dysregulation Disorder. *Frontiers in Psychiatry*, *11*. https://doi.org/10.3389/fpsyt.2020.00164

Bennett, E., & Heaton, P. (2012). Is Talent in Autism Spectrum Disorders Associated with a Specific Cognitive and Behavioural Phenotype? *Journal of Autism and Developmental Disorders*, *42*(12), 2739–2753. https://doi.org/10.1007/s10803-012-1533-9

Bennett, M., & Goodall, E. (2022). Choice of Terminology. In *Autism and COVID-19* (pp. 83–83). Emerald Publishing Limited. https://doi.org/10.1108/978-1-80455-033-520221006

Bennett, M., Webster, A. A., Goodall, E., & Rowland, S. (2018). *Life on the Autism Spectrum*. Springer Nature Singapore Pte Ltd. https://doi.org/10.1007/978-981-13-3359-0

Best, K. L., Mortenson, W. B., Lauzière-Fitzgerald, Z., & Smith, E. M. (2022). Language matters! The long-standing debate between identity-first language and person first language. *Assistive Technology*, *34*(2), 127–128. https://doi.org/10.1080/10400435.2022.2058315

Bhatara, A., Quintin, E.-M., Fombonne, E., & Levitin, D. J. (2013). Early sensitivity to sound and musical preferences and enjoyment in adolescents with autism spectrum disorders. *Psychomusicology: Music, Mind, and Brain*, *23*(2), 100–108. https://doi.org/10.1037/a0033754

Biel, L., & Peske, N. (2009). *Raising a Sensory Smart Child*. Penguin Group USA.

Black, K. R., Stevenson, R. A., Segers, M., Ncube, B. L., Sun, S. Z., Philipp-Muller, A., Bebko, J. M., Barense, M. D., & Ferber, S. (2017). Linking Anxiety and Insistence on Sameness in Autistic Children: The Role of Sensory Hypersensitivity. *Journal of Autism and Developmental Disorders*, *47*(8), 2459–2470. https://doi.org/10.1007/s10803-017-3161-x

Boldsen, S. (2022). Autism and the Sensory Disruption of Social Experience. *Frontiers in Psychology*, *13*. https://www.frontiersin.org/articles/10.3389/fpsyg.2022.874268

Borsos, Z., Jakab, Z., Stefanik, K., Bogdán, B., & Gyori, M. (2022). Test–Retest Reliability in Automated Emotional Facial Expression Analysis: Exploring FaceReader 8.0 on Data from Typically Developing Children and Children with Autism. *Applied Sciences*, *12*(15), Article 15. https://doi.org/10.3390/app12157759

Boterberg, S., & Warreyn, P. (2016). Making sense of it all: The impact of sensory processing sensitivity on daily functioning of children. *Personality and Individual Differences*, *92*, 80–86. https://doi.org/10.1016/j.paid.2015.12.022

Botha, M., Hanlon, J., & Williams, G. L. (2021). Does Language Matter? Identity-First Versus Person-First Language Use in Autism Research: A Response to Vivanti. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-020-04858-w

Brancatisano, O., Baird, A., & Thompson, W. F. (2020a). Why is music therapeutic for neurological disorders? The Therapeutic Music Capacities Model. *Neuroscience & Biobehavioral Reviews*, *112*, 600–615. https://doi.org/10.1016/j.neubiorev.2020.02.008

Brancatisano, O., Baird, A., & Thompson, W. F. (2020b). Why is music therapeutic for neurological disorders? The Therapeutic Music Capacities Model. *Neuroscience & Biobehavioral Reviews*, *112*, 600–615. https://doi.org/10.1016/j.neubiorev.2020.02.008

Broady, T. R., Stoyles, G. J., & Morse, C. (2017). Understanding carers' lived experience of stigma: The voice of families with a child on the autism spectrum. *Health & Social Care in the Community*, *25*(1), 224–233. https://doi.org/10.1111/hsc.12297

Brooks, A. W., Schroeder, J., Risen, J. L., Gino, F., Galinsky, A. D., Norton, M. I., & Schweitzer, M. E. (2016). Don't stop believing: Rituals improve performance by decreasing anxiety. *Organizational Behavior and Human Decision Processes*, *137*, 71–85. https://doi.org/10.1016/j.obhdp.2016.07.004

Brown, P. (1999). Repetition. *Journal of Linguistic Anthropology*, *9*(1/2), 223–226. https://www.jstor.org/stable/43102472

Bryant, M. L. (2015). *HANDBOOK ON EMOTION REGULATION PROCESSES, COGNITIVE EFFECTS AND SOCIAL CONSEQUENCES*. Nova Publishers, Incorporated.

Burland, K., Pitts, S., & Welch, P. G. (2014). *Coughing and Clapping: Investigating Audience Experience: Investigating Audience Experience*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/uwsau/detail.action?docID=1815567

Cannam, C., Landone, C., & Sandler, M. (2010). Sonic visualiser: An open source application for viewing, analysing, and annotating music audio files. *Proceedings of the 18th ACM International Conference on Multimedia*, 1467–1468. https://doi.org/10.1145/1873951.1874248

Carleton, R. N. (2012). The intolerance of uncertainty construct in the context of anxiety disorders: Theoretical and practical perspectives. *Expert Review of Neurotherapeutics*, *12*(8), 937–947. https://doi.org/10.1586/ern.12.82

Cascio, M. A., Weiss, J. A., & Racine, E. (2020). Person-oriented ethics for autism research: Creating best practices through engagement with autism and autistic communities. *Autism*, *24*(7), 1676–1690. https://doi.org/10.1177/1362361320918763

Cascio, M. A., Weiss, J. A., & Racine, E. (2021). Making Autism Research Inclusive by Attending to Intersectionality: A Review of the Research Ethics Literature. *Review Journal of Autism and Developmental Disorders*, *8*(1), 22–36. https://doi.org/10.1007/s40489-020-00204-z

CDC. (2020, June 29). *Diagnostic Criteria | Autism Spectrum Disorder (ASD) | NCBDDD | CDC*. Centers for Disease Control and Prevention. https://www.cdc.gov/ncbddd/autism/hcp-dsm.html

CDC. (2021, January 26). *What is ADHD?* Centers for Disease Control and Prevention. https://www.cdc.gov/ncbddd/adhd/facts.html

CDC. (2022, November 2). *Diagnostic Criteria | Autism Spectrum Disorder (ASD) | NCBDDD | CDC*. Centers for Disease Control and Prevention. https://www.cdc.gov/ncbddd/autism/hcp-dsm.html

Cermak, S. A., Curtin, C., & Bandini, L. G. (2010). Food Selectivity and Sensory Sensitivity in Children with Autism Spectrum Disorders. *Journal of the American Dietetic Association*, *110*(2), 238–246. https://doi.org/10.1016/j.jada.2009.10.032

Charlton, R. A., Entecott, T., Belova, E., & Nwaordu, G. (2021a). "It feels like holding back something you need to say": Autistic and Non-Autistic Adults accounts of sensory experiences and stimming. *Research in Autism Spectrum Disorders*, *89*, 101864. https://doi.org/10.1016/j.rasd.2021.101864

Charlton, R. A., Entecott, T., Belova, E., & Nwaordu, G. (2021b). "It feels like holding back something you need to say": Autistic and Non-Autistic Adults accounts of sensory experiences and stimming. *Research in Autism Spectrum Disorders*, *89*, 101864. https://doi.org/10.1016/j.rasd.2021.101864

Cornish, E. (1998). A balanced approach towards healthy eating in autism. *Journal of Human Nutrition and Dietetics*, *11*(6), 501–509. https://doi.org/10.1046/j.1365-277X.1998.00132.x

Costa-López, B., Ferrer-Cascales, R., Ruiz-Robledillo, N., Albaladejo-Blázquez, N., & Baryła-Matejczuk, M. (2021). Relationship between Sensory Processing and Quality of Life: A Systematic Review. *Journal of Clinical Medicine*, *10*(17), 3961. https://doi.org/10.3390/jcm10173961

Creswell, J. W., & Creswell, J. D. (2018). *Research Design Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications, Inc.

Critz, C., Blake, K., & Nogueira, E. (2015). Sensory Processing Challenges in Children. *The Journal for Nurse Practitioners*, *11*(7), 710–716. https://doi.org/10.1016/j.nurpra.2015.04.016

Crome, E., Grove, R., Baillie, A. J., Sunderland, M., Teesson, M., & Slade, T. (2015). DSM-IV and DSM-5 social anxiety disorder in the Australian community. *Australian & New Zealand Journal of Psychiatry*, *49*(3), 227–235. https://doi.org/10.1177/0004867414546699

Croom, A. M. (2012). Music, Neuroscience, and the Psychology of Well-Being: A Précis. *Frontiers in Psychology*, *2*. https://doi.org/10.3389/fpsyg.2011.00393

Dalgleish, Tim., & Power, M. J. (1999). *Handbook of cognition and emotion*. Wiley.

Danner, L., Sidorkina, L., Joechl, M., & Duerrschmid, K. (2014). Make a face! Implicit and explicit measurement of facial expressions elicited by orange juices using face reading technology. *Food Quality and Preference*, *32*, 167–172. https://doi.org/10.1016/j.foodqual.2013.01.004

Dearn, L. K., & Price, S. M. (2016). Sharing Music: Social and Communal Aspects of Concert-Going. *Networking Knowledge: Journal of the MeCCSA Postgraduate Network*, *9*(2). https://doi.org/10.31165/nk.2016.92.428

Dellapiazza, F., Michelon, C., Vernhet, C., Muratori, F., Blanc, N., Picot, M.-C., Baghdadli, A., Baghdadli, A., Chabaux, C., Chatel, C., Cohen, D., Damville, E., Geoffray, M.-M., Gicquel, L., Jardri, R., Maffre, T., Novo, A., Odoyer, R., Oreve, M.-J., … for ELENA study group. (2021). Sensory processing related to attention in children with ASD, ADHD, or typical development: Results from the ELENA cohort. *European Child & Adolescent Psychiatry*, *30*(2), 283–291. https://doi.org/10.1007/s00787-020-01516-5

Dobson, M. C., & Pitts, S. E. (2011). Classical Cult or Learning Community? Exploring New Audience Members' Social and Musical Responses to First-time Concert Attendance. *Ethnomusicology Forum*, *20*(3), 353–383. https://doi.org/10.1080/17411912.2011.641717

Dowson, B., & McDermott, O. (2019). Approaches to Measuring the Impact of Music Therapy and Music Activities on People Living With Dementia. In A. Baird, S. Garrido, & J. Tamplin (Eds.), *Music and Dementia: From Cognition to Therapy* (p. 0). Oxford University Press. https://doi.org/10.1093/oso/9780190075934.003.0009

Dunn, D. S., & Andrews, E. E. (2015). Person-first and identity-first language: Developing psychologists' cultural competence using disability language. *American Psychologist*, *70*(3), 255–264. https://doi.org/10.1037/a0038636

Dwyer, P. (2022). Stigma, Incommensurability, or Both? Pathology-First, Person-First, and Identity-First Language and the Challenges of Discourse in Divided Autism Communities. *Journal of Developmental & Behavioral Pediatrics*, *43*(2), 111–113. https://doi.org/10.1097/DBP.0000000000001054

Edelson, S. M., Lombardo, M., Naviaux, R. K., Hardy, P. M., Miller, L. J., Goodwin, M., Sullivan, J., Pangborn, J., Baron-Cohen, S., & Auyeung, B. (2014). *Infantile Autism: The Syndrome and Its Implications for a Neural Theory of Behavior by Bernard Rimland, Ph. D.* Jessica Kingsley Publishers. https://ebookcentral.proquest.com/lib/uwsau/detail.action?docID=1820828

Einarsdóttir, J. (2007). Research with children: Methodological and ethical challenges. *European Early Childhood Education Research Journal*, *15*(2), 197–211. https://doi.org/10.1080/13502930701321477

Ekman, P., & Rosenberg, E. L. (2005). *What the Face Reveals: Basic and Applied Studies of Spontaneous Expression Using the Facial Action Encoding System (FACS)*. DOI: 10.1093/acprof:oso/9780195179644.001.0001

Engel-Yeger, B., Muzio, C., Rinosi, G., Solano, P., Geoffroy, P. A., Pompili, M., Amore, M., & Serafini, G. (2016). Extreme sensory processing patterns and their relation with clinical conditions among individuals with major affective disorders. *Psychiatry Research*, *236*, 112–118. https://doi.org/10.1016/j.psychres.2015.12.022

Ermer, J., & Dunn, W. (1998a). The sensory profile: A discriminant analysis of children with and without disabilities. *The American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association*, *52*(4), 283–290. https://doi.org/10.5014/ajot.52.4.283

Ermer, J., & Dunn, W. (1998b). The Sensory Profile: A Discriminant Analysis of Children With and Without Disabilities. *American Journal of Occupational Therapy*, *52*(4), 283–290. https://doi.org/10.5014/ajot.52.4.283

Faras, H., Al Ateeqi, N., & Tidmarsh, L. (2010). Autism spectrum disorders. *Annals of Saudi Medicine*, *30*(4), 295–300. https://doi.org/10.4103/0256-4947.65261

Farrow, C. V., & Coulthard, H. (2012). Relationships between sensory sensitivity, anxiety and selective eating in children. *Appetite*, *58*(3), 842–846. https://doi.org/10.1016/j.appet.2012.01.017

Ferreri, L., & Verga, L. (2016). Benefits of Music on Verbal Learning and Memory. *Music Perception*, *34*(2), 167–182. https://doi.org/10.1525/mp.2016.34.2.167

Fletcher-Watson, B., & May, S. (2018). Enhancing relaxed performance: Evaluating the Autism Arts Festival. *Research in Drama Education: The Journal of Applied Theatre and Performance*, *23*(3), 406–420. https://doi.org/10.1080/13569783.2018.1468243

Fodstad, J. C., Kerswill, S. A., Kirsch, A. C., Lagges, A., & Schmidt, J. (2021). Assessment and Treatment of Noise Hypersensitivity in a Teenager with Autism Spectrum Disorder: A Case Study. *Journal of Autism and Developmental Disorders*, *51*(6), 1811–1822. https://doi.org/10.1007/s10803-020-04650-w

Foran, L. M. (2021). Listening to Music: Helping Children Regulate Their Emotions and Improve Learning in the Classroom. *Listening to Music*, 9.

Garrido, S., & Macritchie, J. (2020). Audience engagement with community music performances: Emotional contagion in audiences of a 'pro-am' orchestra in suburban Sydney. *Musicae Scientiae*, *24*(2), 155–167. https://doi.org/10.1177/1029864918783027

Geretsegger, M., Elefant, C., Mössler, K. A., & Gold, C. (2014). Music therapy for people with autism spectrum disorder. *Cochrane Database of Systematic Reviews*, *6*. https://doi.org/10.1002/14651858.CD004381.pub3

Gernsbacher, M. A. (2016). *Analyses of person-first language in scholarly writing: Technical report.* https://doi.org/10.17605/OSF.IO/982AJ

Gernsbacher, M. A. (2017). Editorial Perspective: The use of person-first language in scholarly writing may accentuate stigma. *Journal of Child Psychology and Psychiatry*, *58*(7), 859–861. https://doi.org/10.1111/jcpp.12706

Getz, E. (2015). Why Classical Music Still Matters. *All Regis University Theses. 641.*, 51. https://epublications.regis.edu/theses/641

Ghanizadeh, A. (2011). Sensory Processing Problems in Children with ADHD, a Systematic Review. *Psychiatry Investigation*, *8*(2), 89–94. https://doi.org/10.4306/pi.2011.8.2.89

Gill, J., & Liamputtong, P. (2011). Being the Mother of a Child With Asperger's Syndrome: Women's Experiences of Stigma. *Health Care for Women International*, *32*(8), 708–722. https://doi.org/10.1080/07399332.2011.555830

Gillott, A., Furniss, F., & Walter, A. (2001). Anxiety in High-Functioning Children with Autism. *Autism*, *5*(3), 277–286. https://doi.org/10.1177/1362361301005003005

Goerlich, K. S., Witteman, J., Aleman, A., & Martens, S. (2011). Hearing Feelings: Affective Categorization of Music and Speech in Alexithymia, an ERP Study. *PLoS ONE*, *6*(5), e19501. https://doi.org/10.1371/journal.pone.0019501

Gold, C., Wigram, T., & Elefant, C. (2006). Music therapy for autistic spectrum disorder. In The Cochrane Collaboration (Ed.), *Cochrane Database of Systematic Reviews* (p. CD004381.pub2). John Wiley & Sons, Ltd. https://doi.org/10.1002/14651858.CD004381.pub2

Goris, J., Brass, M., Cambier, C., Delplanque, J., Wiersema, J. R., & Braem, S. (2020). The Relation Between Preference for Predictability and Autistic Traits. *Autism Research*, *13*(7), 1144–1154. https://doi.org/10.1002/aur.2244

Gotham, K., Bishop, S. L., Hus, V., Huerta, M., Lund, S., Buja, A., Krieger, A., & Lord, C. (2013). Exploring the Relationship Between Anxiety and Insistence on Sameness in Autism Spectrum Disorders: Anxiety and Insistence on Sameness in ASD. *Autism Research*, *6*(1), 33–41. https://doi.org/10.1002/aur.1263

Gray, D. E. (1994). Coping with autism: Stresses and strategies. *Basil Blackwell Ltd/Editorial Board*, 27.

Gray, D. E. (2002). 'Everybody just freezes. Everybody is just embarrassed': Felt and enacted stigma among parents of children with high functioning autism. *Sociology of Health & Illness*, *24*(6), 734–749. https://doi.org/10.1111/1467-9566.00316

Green, D., Chandler, S., Charman, T., Simonoff, E., & Baird, G. (2016). Brief Report: DSM-5 Sensory Behaviours in Children With and Without an Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *46*(11), 3597–3606. https://doi.org/10.1007/s10803-016-2881-7

Green, S. E. (2003). “What do you mean ‘what’s wrong with her?’”: Stigma and the lives of families of children with disabilities. *Social Science & Medicine*, *57*(8), 1361–1374. https://doi.org/10.1016/S0277-9536(02)00511-7

Greydanus, D. E., & Toledo-Pereyra, L. H. (2012). Historical Perspectives on Autism: Its Past Record of Discovery and Its Present State of Solipsism, Skepticism, and Sorrowful Suspicion. *Pediatric Clinics of North America*, *59*(1), 1–11. https://doi.org/10.1016/j.pcl.2011.10.004

Grzadzinski, R., Dick, C., Lord, C., & Bishop, S. (2016). Parent-reported and clinician-observed autism spectrum disorder (ASD) symptoms in children with attention deficit/hyperactivity disorder (ADHD): Implications for practice under DSM-5. *Molecular Autism*, *7*(1), 7. https://doi.org/10.1186/s13229-016-0072-1

Guétin, S., Giniès, P., Siou, D. K. A., Picot, M.-C., Pommié, C., Guldner, E., Gosp, A.-M., Ostyn, K., Coudeyre, E., & Touchon, J. (2012). The Effects of Music Intervention in the Management of Chronic Pain: A Single-Blind, Randomized, Controlled Trial. *The Clinical Journal of Pain*, *28*(4), 329–337. https://doi.org/10.1097/AJP.0b013e31822be973

Haering, S. I. (2018). Are music-based interventions a way to improve executive function in autism? *International Journal of Learning and Teaching*, *10*(1), 27–37. https://doi.org/10.18844/ijlt.v10i1.3143

Harms, M. B., Martin, A., & Wallace, G. L. (2010). Facial Emotion Recognition in Autism Spectrum Disorders: A Review of Behavioral and Neuroimaging Studies. *Neuropsychology Review*, *20*(3), 290–322. https://doi.org/10.1007/s11065-010-9138-6

Harris, J. (2018). Leo Kanner and autism: A 75-year perspective. *International Review of Psychiatry (Abingdon, England)*, *30*(1), 3–17. https://doi.org/10.1080/09540261.2018.1455646

Healthdirect Australia, (2022a, June 22). *Attention deficit hyperactivity disorder (ADHD)* [Text/html]. Healthdirect Australia. https://www.healthdirect.gov.au/attention-deficit-disorder-add-or-adhd

Healthdirect Australia, (2022b, August 19). *Anxiety—Symptoms, treatment and causes* [Text/html]. Healthdirect Australia. https://www.healthdirect.gov.au/anxiety

Hetland, L. (2000). Listening to Music Enhances Spatial-Temporal Reasoning: Evidence for the 'Mozart Effect'. *Journal of Aesthetic Education*, *34*(3/4), 105–148. https://doi.org/10.2307/3333640

Hijleh, M. (2012). *Towards a Global Music Theory: Practical Concepts and Methods for the Analysis of Music Across Human Cultures*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/uwsau/detail.action?docID=956291

Hillier, A., Greher, G., Poto, N., & Dougherty, M. (2012). Positive outcomes following participation in a music intervention for adolescents and young adults on the autism spectrum. *Psychology of Music*, *40*(2), 201–215. https://doi.org/10.1177/0305735610386837

Hiruma, L., Pretzel, R. E., Tapia, A. L., Bodfish, J. W., Bradley, C., Wiggins, L., Hsu, M., Lee, L.-C., Levy, S. E., & Daniels, J. (2021). A Distinct Three-Factor Structure of Restricted and Repetitive Behaviors in an Epidemiologically Sound Sample of Preschool-Age Children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *51*(10), 3456–3468. https://doi.org/10.1007/s10803-020-04776-x

Hobson, N. M., Schroeder, J., Risen, J. L., Xygalatas, D., & Inzlicht, M. (2018). The Psychology of Rituals: An Integrative Review and Process-Based Framework. *Personality and Social Psychology Review*, *22*(3), 260–284. https://doi.org/10.1177/1088868317734944

Holm, S. (1979). A Simple Sequentially Rejective Multiple Test Procedure. *Scandinavian Journal of Statistics*, *6*(2), 65–70. http://www.jstor.org/stable/4615733

Honey, E., Leekam, S., Turner, M., & McConachie, H. (2007). Repetitive Behaviour and Play in Typically Developing Children and Children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *37*(6), 1107–1115. https://doi.org/10.1007/s10803-006-0253-4

Jamey, K., Foster, N. E. V., Sharda, M., Tuerk, C., Nadig, A., & Hyde, K. L. (2019). Evidence for intact melodic and rhythmic perception in children with Autism Spectrum Disorder. *Research in Autism Spectrum Disorders*, *64*, 1–12. https://doi.org/10.1016/j.rasd.2018.11.013

Jarrett, M. A. (2016). Attention-deficit/hyperactivity disorder (ADHD) symptoms, anxiety symptoms, and executive functioning in emerging adults. *Psychological Assessment*, *28*(2), 245–250. https://doi.org/10.1037/pas0000190

Jussila, K., Junttila, M., Kielinen, M., Ebeling, H., Joskitt, L., Moilanen, I., & Mattila, M.-L. (2020). Sensory Abnormality and Quantitative Autism Traits in Children With and Without Autism Spectrum Disorder in an Epidemiological Population. *Journal of Autism and Developmental Disorders*, *50*(1), 180–188. https://doi.org/10.1007/s10803-019-04237-0

Kapp, S. K., Steward, R., Crane, L., Elliott, D., Elphick, C., Pellicano, E., & Russell, G. (2019). 'People should be allowed to do what they like': Autistic adults' views and experiences of stimming. *Autism*, *23*(7), 1782–1792. https://doi.org/10.1177/1362361319829628

Kempe, A. (2014). Developing social skills in autistic children through 'Relaxed Performances'. *Support for Learning*, *29*(3), 261–274. https://doi.org/10.1111/1467-9604.12062

Kempe, A. J. (2015). Widening Participation in Theatre through 'Relaxed Performances'. *New Theatre Quarterly: NTQ*, *31*(1), 59–69. https://doi.org/10.1017/S0266464X15000068

Kenny, L., Hattersley, C., Molins, B., Buckley, C., Povey, C., & Pellicano, E. (2016). Which terms should be used to describe autism? Perspectives from the UK autism community. *Autism*, *20*(4), 442–462. https://doi.org/10.1177/1362361315588200

Kerns, C. M., Kendall, P. C., Zickgraf, H., Franklin, M. E., Miller, J., & Herrington, J. (2015). Not to Be Overshadowed or Overlooked: Functional Impairments Associated With Comorbid Anxiety Disorders in Youth With ASD. *Behavior Therapy*, *46*(1), 29–39. https://doi.org/10.1016/j.beth.2014.03.005

Kim, J., Wigram, T., & Gold, C. (2009). Emotional, motivational and interpersonal responsiveness of children with autism in improvisational music therapy. *Autism*, *13*(4), 389–409. https://doi.org/10.1177/1362361309105660

Kim, S. (2021). CREATING Sensory-Friendly Recitals for Music Students with Autism. *The American Music Teacher*, *70*(6), 30–33. https://www.proquest.com/docview/2619747297/abstract/61AC932F8A647A7PQ/1

Kinnealey, M. (1999). *The relationship between sensory defensiveness, anxiety, depression and perception of pain i*. 12.

Kinnear, S. H., Link, B. G., Ballan, M. S., & Fischbach, R. L. (2016). Understanding the Experience of Stigma for Parents of Children with Autism Spectrum Disorder and the

Role Stigma Plays in Families' Lives. *Journal of Autism and Developmental Disorders*, *46*(3), 942–953. https://doi.org/10.1007/s10803-015-2637-9

Klykylo, W. M. (2002). Comorbidity. In M. Hersen & W. Sledge (Eds.), *Encyclopedia of Psychotherapy* (pp. 475–479). Academic Press. https://doi.org/10.1016/B0-12-343010-0/00053-2

Koi, P. (2021). Born which Way? ADHD, Situational Self-Control, and Responsibility. *Neuroethics*, *14*(2), 205–218. https://doi.org/10.1007/s12152-020-09439-3

Koziol, L. F., & Budding, D. (2012). ADHD and Sensory Processing Disorders: Placing the Diagnostic Issues in Context. *Applied Neuropsychology: Child*, *1*(2), 137–144. https://doi.org/10.1080/21622965.2012.709422

Kranowitz, C. S. (2005). *The Out-of-Sync Child* (2nd ed.). Penguin Group USA Inc.

Kroll, T., Neri, M. T., Miller, K., & Seacrest, J. (2005). Using Mixed Methods in Disability and Rehabilitation Research/Commentary. *Rehabilitation Nursing*, *30*(3), 106–113; discussion 113. http://www.proquest.com/docview/218272194/abstract/214B153D0A8F4AF9PQ/1

Kulinski, J., Ofori, E. K., Visotcky, A., Smith, A., Sparapani, R., & Fleg, J. L. (2021). Effects of music on the cardiovascular system. *Trends in Cardiovascular Medicine*. https://doi.org/10.1016/j.tcm.2021.06.004

Lang, M., Krátký, J., Shaver, J. H., Jerotijević, D., & Xygalatas, D. (2015). Effects of Anxiety on Spontaneous Ritualized Behavior. *Current Biology*, *25*(14), 1892–1897. https://doi.org/10.1016/j.cub.2015.05.049

Lang, M., Krátký, J., & Xygalatas, D. (2020). The role of ritual behaviour in anxiety reduction: An investigation of Marathi religious practices in Mauritius. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1805), 20190431. https://doi.org/10.1098/rstb.2019.0431

Laukka, P. (2007). Uses of music and psychological well-being among the elderly. *Journal of Happiness Studies*, *8*(2), 215–241. https://doi.org/10.1007/s10902-006-9024-3

Leekam, S. R., Prior, M. R., & Uljarevic, M. (2011). Restricted and repetitive behaviors in autism spectrum disorders: A review of research in the last decade. *Psychological Bulletin*, *137*(4), 562–593. https://doi.org/10.1037/a0023341

Lei, J., Jones, L., & Brosnan, M. (2021). Exploring an e-learning community's response to the language and terminology use in autism from two massive open online courses on autism education and technology use. *Autism*, *25*(5), 1349–1367. https://doi.org/10.1177/1362361320987963

Levasseur, A., Jamey, K., Foster, N., Hyde, K., & Dalla Bella, S. (2020). Musical genre preferences in Autism Spectrum Disorder. *NeuroMusic Annual Conference,* Hamilton, Ontario.

Levitin, D. (2008). *This Is Your Brain on Music*. Atlantic Books.

Levitin, D. J., Chordia, P., & Menon, V. (2012). Musical rhythm spectra from Bach to Joplin obey a 1/f power law. *Proceedings of the National Academy of Sciences*, *109*(10), 3716–3720. https://doi.org/10.1073/pnas.1113828109

Levitt, E. E. (2016). The Psychology of Anxiety. *Routledge*, 207.

Lewinski, P., den Uyl, T. M., & Butler, C. (2014). Automated facial coding: Validation of basic emotions and FACS AUs in FaceReader. *Journal of Neuroscience, Psychology, and Economics*, *7*(4), 227–236. https://doi.org/10.1037/npe0000028

Liao, X., Lei, X., & Li, Y. (2019). Stigma among parents of children with autism: A literature review. *Asian Journal of Psychiatry*, *45*, 88–94. https://doi.org/10.1016/j.ajp.2019.09.007

Liljeström, S., Juslin, P. N., & Västfjäll, D. (2013). Experimental evidence of the roles of music choice, social context, and listener personality in emotional reactions to music. *Psychology of Music*, *41*(5), 579–599. https://doi.org/10.1177/0305735612440615

Llanes, E., Blacher, J., Stavropoulos, K., & Eisenhower, A. (2020). Parent and Teacher Reports of Comorbid Anxiety and ADHD Symptoms in Children with ASD. *Journal of Autism and Developmental Disorders*, *50*(5), 1520–1531. https://doi.org/10.1007/s10803-018-3701-z

Lockhart, A. E. (2017). The Effect of Rhythmic Proprioceptive Input on Attention in Children with Autism Spectrum Disorder (ASD): An Exploratory Study. *2017*, 108.

Lovell, B., & Wetherell, M. A. (2019). Affiliate stigma, perceived social support and perceived stress in caregivers of children with autism spectrum disorder: A multiple mediation study. *Archives of Psychiatric Nursing*, *33*(5), 31–35. https://doi.org/10.1016/j.apnu.2019.08.012

March, J. S., Parker, J. D. A., Sullivan, K., Stallings, P., & Conners, C. K. (1997). The Multidimensional Anxiety Scale for Children (MASC): Factor Structure, Reliability, and Validity. *Journal of the American Academy of Child & Adolescent Psychiatry*, *36*(4), 554–565. https://doi.org/10.1097/00004583-199704000-00019

Marco, E. J., Hinkley, L. B. N., Hill, S. S., & Nagarajan, S. S. (2011). Sensory Processing in Autism: A Review of Neurophysiologic Findings. *Pediatric Research*, *69*(5 Pt 2), 48R-54R. https://doi.org/10.1203/PDR.0b013e3182130c54

M.Aultman, J. (2020). Utilizing a Concurrent Nested Design for Strengthening Mixed Methods Research. In *SAGE Research Methods Cases*. SAGE Publications Ltd. https://doi.org/10.4135/9781529715859

McDermott, O., Orgeta, V., Ridder, H. M., & Orrell, M. (2014). A preliminary psychometric evaluation of Music in Dementia Assessment Scales (MiDAS). *International Psychogeriatrics*, *26*(6), 1011–1019. https://doi.org/10.1017/S1041610214000180

McDermott, O., Orrell, M., & Ridder, H. M. (2015). The development of Music in Dementia Assessment Scales (MiDAS). *Nordic Journal of Music Therapy*, *24*(3), 232–251. https://doi.org/10.1080/08098131.2014.907333

McLaughlan, A., & Fleury, V. P. (2020). *Flapping, Spinning, Rocking, and Other Repetitive Behaviors: Intervening With Young Children Who Engage in Stereotypy*. https://journals.sagepub.com/doi/full/10.1177/1096250618798338

Menon, V., & Levitin, D. J. (2005). The rewards of music listening: Response and physiological connectivity of the mesolimbic system. *NeuroImage*, *28*(1), 175–184. https://doi.org/10.1016/j.neuroimage.2005.05.053

Miller, K. K. (2015). The Autism Paradox. *AMA Journal of Ethics*, *17*(4), 297–298. https://doi.org/10.1001/journalofethics.2015.17.4.fred1-1504

Monk, C. S., Weng, S.-J., Wiggins, J. L., Kurapati, N., Louro, H. M. C., Carrasco, M., Maslowsky, J., Risi, S., & Lord, C. (2010). Neural circuitry of emotional face processing in autism spectrum disorders. *Journal of Psychiatry & Neuroscience : JPN*, *35*(2), 105–114. https://www.proquest.com/docview/217291364/abstract/31A6D2FCDE234F9APQ/1

Montagu, J. (2017). How Music and Instruments Began: A Brief Overview of the Origin and Entire Development of Music, from Its Earliest Stages. *Frontiers in Sociology*, *2*. https://www.frontiersin.org/articles/10.3389/fsoc.2017.00008

Moog, H. (1976). The Development of Musical Experience in Children of Pre-School Age. *Psychology of Music*, *4*(2), 38–45. https://doi.org/10.1177/030573567642005

Morgan, H. (2019). Connections Between Sensory Sensitivities in Autism; the Importance of Sensory Friendly Environments for Accessibility and Increased Quality of Life for the Neurodivergent Autistic Minority. *PSU McNair Scholars Online Journal*, *13*(1). https://doi.org/10.15760/mcnair.2019.13.1.11

Myles, B. S., Dunn, W., Rinner, L., Hagiwara, T., Reese, M., Huggins, A., & Becker, S. (2004). Sensory Issues in Children with Asperger Syndrome and Autism. *Education and Training in Developmental Disabilities*, *39*(4), 283–290. https://www.jstor.org/stable/23880207

National Statement on Ethical Conduct in Human Research, (2018). *National Statement on Ethical Conduct in Human Research*. 116.

Neil, L., Olsson, N. C., & Pellicano, E. (2016). The Relationship Between Intolerance of Uncertainty, Sensory Sensitivities, and Anxiety in Autistic and Typically Developing Children. *Journal of Autism and Developmental Disorders*, *46*(6), 1962–1973. https://doi.org/10.1007/s10803-016-2721-9

NeuRA. (2016, April 19). Anxiety. *NeuRA*. https://www.neura.edu.au/health/anxiety/

Ng, C. K. M., Lam, S. H. F., Tsang, S. T. K., Yuen, C. M. C., & Chien, C.-W. (2020). The Relationship between Affiliate Stigma in Parents of Children with Autism Spectrum Disorder and Their Children's Activity Participation. *International Journal of Environmental Research and Public Health*, *17*(5), 1799. https://doi.org/10.3390/ijerph17051799

Panksepp, J. (1995). The Emotional Sources of Chills Induced by Music. *Music Perception*, *13*(2), 171–207. https://doi.org/10.2307/40285693

Pavlicevic, M., Tsiris, G., Wood, S., Powell, H., Graham, J., Sanderson, R., Millman, R., & Gibson, J. (2015). The 'ripple effect': Towards researching improvisational music therapy in dementia care homes. *Dementia*, *14*(5), 659–679. https://doi.org/10.1177/1471301213514419

Peters, K., & Jackson, D. (2009). Mothers' experiences of parenting a child with attention deficit hyperactivity disorder. *Journal of Advanced Nursing*, *65*(1), 62–71. https://doi.org/10.1111/j.1365-2648.2008.04853.x

Pickard, H., Hirsch, C., Simonoff, E., & Happé, F. (2020). Exploring the cognitive, emotional and sensory correlates of social anxiety in autistic and neurotypical adolescents. *Journal of Child Psychology and Psychiatry*, *61*(12), 1317–1327. https://doi.org/10.1111/jcpp.13214

Potter, K., Gann, K., & Gann, P. K. (2013). *The Ashgate Research Companion to Minimalist and Postminimalist Music*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/uwsau/detail.action?docID=1426849

Quintin, E.-M. (2019). Music-Evoked Reward and Emotion: Relative Strengths and Response to Intervention of People With ASD. *Frontiers in Neural Circuits*, *13*, 49. https://doi.org/10.3389/fncir.2019.00049

Rabeyron, T., Robledo Del Canto, J.-P., Carasco, E., Bisson, V., Bodeau, N., Vrait, F.-X., Berna, F., & Bonnot, O. (2020). A randomized controlled trial of 25 sessions comparing music therapy and music listening for children with autism spectrum disorder. *Psychiatry Research*, *293*, 113377. https://doi.org/10.1016/j.psychres.2020.113377

Radbourne, J., Johanson, K., & Glow, H. (2014). *The Value of 'Being There': How the Live Experience Measures Quality for the Audience*. 17.

Ray, K. D., & Götell, E. (2018). The Use of Music and Music Therapy in Ameliorating Depression Symptoms and Improving Well-Being in Nursing Home Residents With Dementia. *Frontiers in Medicine*, *5*. https://www.frontiersin.org/articles/10.3389/fmed.2018.00287

Reebye, P. N., & Stalker, A. (2007). *Understanding Regulation Disorders of Sensory Processing in Children*. Jessica Kingsley Publishers.

Robertson, A. E., & Simmons, D. R. (2013). The Relationship between Sensory Sensitivity and Autistic Traits in the General Population. *Journal of Autism and Developmental Disorders*, *43*(4), 775–784. https://doi.org/10.1007/s10803-012-1608-7

Rodgers, J., Link to external site, this link will open in a new window, Hodgson, A., Shields, K., Wright, C., Honey, E., & Freeston, M. (2017). Towards a Treatment for Intolerance of Uncertainty in Young People with Autism Spectrum Disorder: Development of the Coping with Uncertainty in Everyday Situations (CUES©) Programme. *Journal of Autism and Developmental Disorders*, *47*(12), 3959–3966. https://doi.org/10.1007/s10803-016-2924-0

Rosser, B. A. (2019). Intolerance of Uncertainty as a Transdiagnostic Mechanism of Psychological Difficulties: A Systematic Review of Evidence Pertaining to Causality and Temporal Precedence. *Cognitive Therapy and Research*, *43*(2), 438–463. https://doi.org/10.1007/s10608-018-9964-z

Sacks, O. (2007). *Musicophilia*. Picador.

Salimpoor, V. N., Benovoy, M., Larcher, K., Dagher, A., & Zatorre, R. J. (2011). Anatomically distinct dopamine release during anticipation and experience of peak emotion to music. *Nature Neuroscience, 14*(2), 257–262. https://doi.org/10.1038/nn.2726

Sarabadani, S., Schudlo, L. C., Samadani, A. A., & Kushski, A. (2020). Physiological Detection of Affective States in Children with Autism Spectrum Disorder. *IEEE Transactions on Affective Computing*, *11*(4), 588–600. https://doi.org/10.1109/TAFFC.2018.2820049

Schoen, S. A., Miller, L. J., Brett-Green, B. A., & Nielsen, D. M. (2009). Physiological and behavioral differences in sensory processing: A comparison of children with autism spectrum disorder and sensory modulation disorder. *Frontiers in Integrative Neuroscience*, *3*, 29. https://doi.org/10.3389/neuro.07.029.2009

Sciberras, E., Lycett, K., Efron, D., Mensah, F., Gerner, B., & Hiscock, H. (2014). Anxiety in Children With Attention-Deficit/Hyperactivity Disorder. *Pediatrics*, *133*(5), 801–808. https://doi.org/10.1542/peds.2013-3686

Sharda, M., Tuerk, C., Chowdhury, R., Jamey, K., Foster, N., Custo-Blanch, M., Tan, M., Nadig, A., & Hyde, K. (2018). Music improves social communication and auditory–motor connectivity in children with autism. *Translational Psychiatry*, *8*(1), Article 1. https://doi.org/10.1038/s41398-018-0287-3

Shaw, P., Lerch, J., Greenstein, D., Sharp, W., Clasen, L., Evans, A., Giedd, J., Castellanos, F. X., & Rapoport, J. (2006). Longitudinal mapping of cortical thickness and clinical outcome in children and adolescents with attention-deficit/hyperactivity disorder. *Archives of General Psychiatry*, *63*(5), 540–549. https://doi.org/10.1001/archpsyc.63.5.540

Shiloh, C. J., & LaGasse, A. B. (2014). Sensory Friendly Concerts: A community music therapy initiative to promote Neurodiversity. *International Journal of Community Music*, *7*(1), 113–128. https://doi.org/10.1386/ijcm.7.1.113_1

Simhon, V., Elefant, C., & Orkibi, H. (2019a). Associations between music and the sensory system: An integrative review for child therapy. *The Arts in Psychotherapy*, *64*, 26–33. https://doi.org/10.1016/j.aip.2018.11.005

Simhon, V., Elefant, C., & Orkibi, H. (2019b). Associations between music and the sensory system: An integrative review for child therapy. *The Arts in Psychotherapy*, *64*, 26–33. https://doi.org/10.1016/j.aip.2018.11.005

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric Disorders in Children With Autism Spectrum Disorders: Prevalence, Comorbidity, and Associated Factors in a Population-Derived Sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *47*(8), 921–929. https://doi.org/10.1097/CHI.0b013e318179964f

Simpson, K., & Keen, D. (2011). Music Interventions for Children with Autism: Narrative Review of the Literature. *Journal of Autism and Developmental Disorders*, *41*(11), 1507–1514. https://doi.org/10.1007/s10803-010-1172-y

Spagnola, M., & Fiese, B. H. (2007). Family Routines and Rituals: A Context for Development in the Lives of Young Children. *Infants & Young Children*, *20*(4), 284–299. https://doi.org/10.1097/01.IYC.0000290352.32170.5a

Spain, D., Sin, J., Linder, K. B., McMahon, J., & Happé, F. (2018). Social anxiety in autism spectrum disorder: A systematic review. *Research in Autism Spectrum Disorders*, *52*, 51–68. https://doi.org/10.1016/j.rasd.2018.04.007

Spencer, M. D., Holt, R. J., Chura, L. R., Suckling, J., Calder, A. J., Bullmore, E. T., & Baron-Cohen, S. (2011). A novel functional brain imaging endophenotype of autism: The neural response to facial expression of emotion. *Translational Psychiatry*, *1*(7), Article 7. https://doi.org/10.1038/tp.2011.18

Stein Duker, L. I. (2019). Adapting Oral Care Protocols to Support Children with Sensory Sensitivities: Occupational Therapy and Dentistry. In T. M. Nelson & J. R. Webb (Eds.), *Dental Care for Children with Special Needs: A Clinical Guide* (pp. 77–98). Springer International Publishing. https://doi.org/10.1007/978-3-030-10483-2_4

Ströhle, A., Gensichen, J., & Domschke, K. (2018). The Diagnosis and Treatment of Anxiety Disorders. *Deutsches Ärzteblatt International*, *115*(37), 611–620. https://doi.org/10.3238/arztebl.2018.0611

Suarez, M. A. (2012). Sensory Processing in Children with Autism Spectrum Disorders and Impact on Functioning. *Pediatric Clinics of North America*, *59*(1), 203–214. https://doi.org/10.1016/j.pcl.2011.10.012

Tager-Flusberg, H., Plesa Skwerer, D., Joseph, R. M., Brukilacchio, B., Decker, J., Eggleston, B., Meyer, S., & Yoder, A. (2017). Conducting research with minimally verbal participants with autism spectrum disorder. *Autism*, *21*(7), 852–861. https://doi.org/10.1177/1362361316654605

Tepest, R. (2021). *The Meaning of Diagnosis for Different Designations in Talking About Autism*. https://doi.org/10.1007/s10803-020-04584-3

Thoma, M. V., Ryf, S., Mohiyeddini, C., Ehlert, U., & Nater, U. M. (2012). Emotion regulation through listening to music in everyday situations. *Cognition & Emotion*, *26*(3), 550–560. https://doi.org/10.1080/02699931.2011.595390

Thye, M. D., Bednarz, H. M., Herringshaw, A. J., Sartin, E. B., & Kana, R. K. (2018). The impact of atypical sensory processing on social impairments in autism spectrum disorder. *Developmental Cognitive Neuroscience*, *29*, 151–167. https://doi.org/10.1016/j.dcn.2017.04.010

Tint, A., & Weiss, J. A. (2015). Family wellbeing of individuals with autism spectrum disorder: A scoping review. *Autism*. https://doi.org/10.1177/1362361315580442

Tomchek, S. D., & Dunn, W. (2007). Sensory Processing in Children With and Without Autism: A Comparative Study Using the Short Sensory Profile. *American Journal of Occupational Therapy*, *61*(2), 190–200. https://doi.org/10.5014/ajot.61.2.190

Tomchek, S. D., Little, L. M., & Dunn, W. (2015). Sensory Pattern Contributions to Developmental Performance in Children With Autism Spectrum Disorder. *The American Journal of Occupational Therapy*, *69*(5), 1-1A. https://doi.org/10.5014/ajot.2015.018044

Ung, D., Wood, J. J., Ehrenreich-May, J., Arnold, E. B., Fuji, C., Renno, P., Murphy, T. K., Lewin, A. B., Mutch, P. J., & Storch, E. A. (2013). Clinical characteristics of high-functioning youth with autism spectrum disorder and anxiety. *Neuropsychiatry*, *3*(2), 10.2217/npy.13.9. https://doi.org/10.2217/npy.13.9

Utz, C., & Laurence Sinclair Willis, L. S. (2021). *Musical Composition in the Context of Globalization: New Perspectives on Music History in the 20th and 21st Century*. Transcript Verlag. http://ebookcentral.proquest.com/lib/uwsau/detail.action?docID=6756819

Van Ameringen, M., Mancini, C., Simpson, W., & Patterson, B. (2010). Adult Attention Deficit Hyperactivity Disorder in an Anxiety Disorders Population. *CNS Neuroscience & Therapeutics*, *17*(4), 221–226. https://doi.org/10.1111/j.1755-5949.2010.00148.x

van der Zee, E., & Derksen, J. J. L. (2021). The Power of Systemizing in Autism. *Child Psychiatry & Human Development*, *52*(2), 321–331. https://doi.org/10.1007/s10578-020-01014-4

van Gastel, W., & Ferdinand, R. F. (2008). Screening capacity of the Multidimensional Anxiety Scale for Children (MASC) for DSM-IV anxiety disorders. *Depression and Anxiety*, *25*(12), 1046–1052. https://doi.org/10.1002/da.20452

Vasa, R. A., & Mazurek, M. O. (2015). An update on anxiety in youth with autism spectrum disorders. *Current Opinion in Psychiatry*, *28*(2), 83–90. https://doi.org/10.1097/YCO.0000000000000133

Vivanti, G. (2020). Ask the Editor: What is the Most Appropriate Way to Talk About Individuals with a Diagnosis of Autism? *Journal of Autism and Developmental Disorders*, *50*(2), 691–693. https://doi.org/10.1007/s10803-019-04280-x

Wagener, G. L., Berning, M., Costa, A. P., Steffgen, G., & Melzer, A. (2021). Effects of Emotional Music on Facial Emotion Recognition in Children with Autism Spectrum Disorder (ASD). *Journal of Autism and Developmental Disorders*, *51*(9), 3256–3265. https://doi.org/10.1007/s10803-020-04781-0

Wagner, J. B., Hirsch, S. B., Vogel-Farley, V. K., Redcay, E., & Nelson, C. A. (2013). Eye-Tracking, Autonomic, and Electrophysiological Correlates of Emotional Face Processing in Adolescents with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *43*(1), 188–199. https://doi.org/10.1007/s10803-012-1565-1

Wald-Fuhrmann, M., Egermann, H., Czepiel, A., O'Neill, K., Weining, C., Meier, D., Tschacher, W., Uhde, F., Toelle, J., & Tröndle, M. (2021). Music Listening in Classical Concerts: Theory, Literature Review, and Research Program. *Frontiers in Psychology*, *12*, 638783. https://doi.org/10.3389/fpsyg.2021.638783

Weeks, J. W., & Weeks, J. W. (2014). *The Wiley Blackwell Handbook of Social Anxiety Disorder*. John Wiley & Sons, Incorporated. http://ebookcentral.proquest.com/lib/uwsau/detail.action?docID=1643810

Wei, C., Hoff, A., Villabø, M. A., Peterman, J., Kendall, P. C., Piacentini, J., McCracken, J., Walkup, J. T., Albano, A. M., Rynn, M., Sherrill, J., Sakolsky, D., Birmaher, B., Ginsburg, G., Keaton, C., Gosch, E., Compton, S. N., & March, J. (2014). Assessing Anxiety in Youth with the Multidimensional Anxiety Scale for Children (MASC). *Journal of Clinical Child and Adolescent Psychology : The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53*, *43*(4), 566–578. https://doi.org/10.1080/15374416.2013.814541

Weiss, J. A., & Lunsky, Y. (2011). The Brief Family Distress Scale: A Measure of Crisis in Caregivers of Individuals with Autism Spectrum Disorders. *Journal of Child and Family Studies*, *20*(4), 521–528. https://doi.org/10.1007/s10826-010-9419-y

White, S. W., Mazefsky, C. A., Dichter, G. S., Chiu, P. H., Richey, J. A., & Ollendick, T. H. (2014). Social-cognitive, physiological, and neural mechanisms underlying emotion regulation impairments: Understanding anxiety in autism spectrum disorder. *International Journal of Developmental Neuroscience : The Official Journal of the International Society for Developmental Neuroscience*, *39*, 22–36. https://doi.org/10.1016/j.ijdevneu.2014.05.012

Wieckowski, A. T., Flynn, L. T., Richey, J. A., Gracanin, D., & White, S. W. (2020). Measuring change in facial emotion recognition in individuals with autism spectrum disorder: A systematic review. *Autism*, *24*(7), 1607–1628. https://doi.org/10.1177/1362361320925334

Wilson, D. (1989). The Role of Patterning in Music. *Leonardo*, *22*(1), 101–106. https://doi.org/10.2307/1575147

World Health Organization. (2022, March 30). *Autism*. https://www.who.int/news-room/fact-sheets/detail/autism-spectrum-disorders

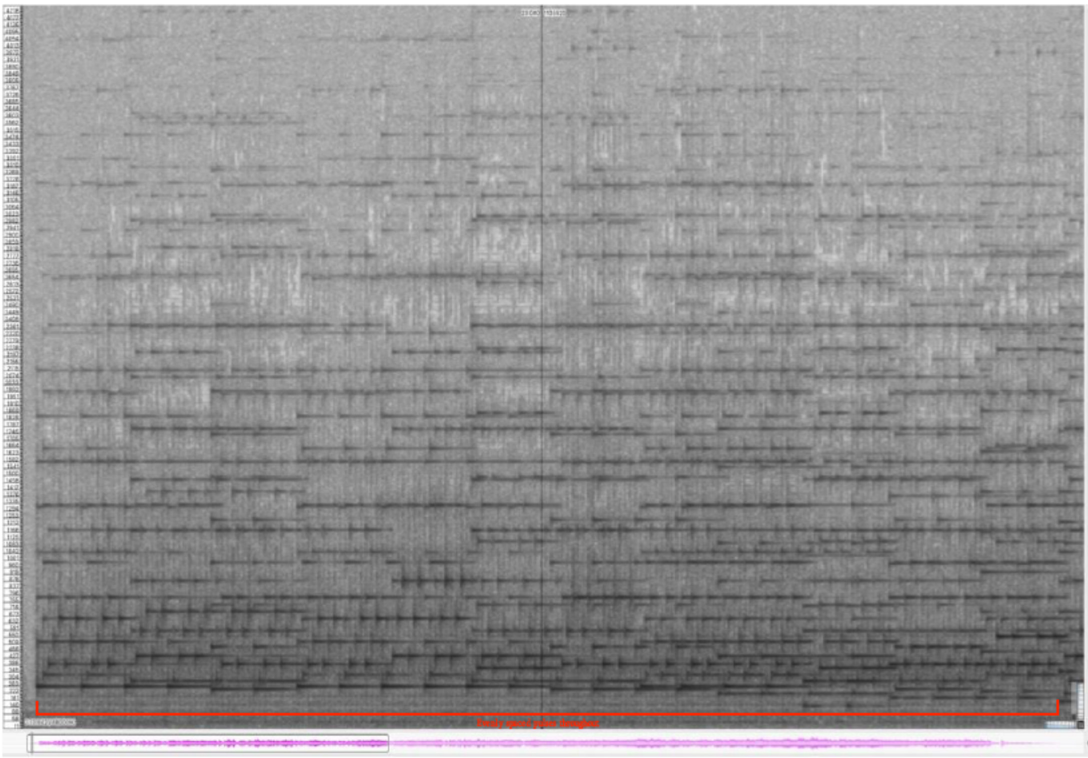
Yochman, A., Alon-Beery, O., Sribman, A., & Parush, S. (2013). Differential diagnosis of sensory modulation disorder (SMD) and attention deficit hyperactivity disorder (ADHD): Participation, sensation, and attention. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00862

Zachor, D., & Ben-Itzchak, E. (2013, May 2). *Sensory Hyposensitivity Is Associated with More Severe Clinical Presentation in Autism Spectrum Disorders*.

9. Appendices – Spectrogram images

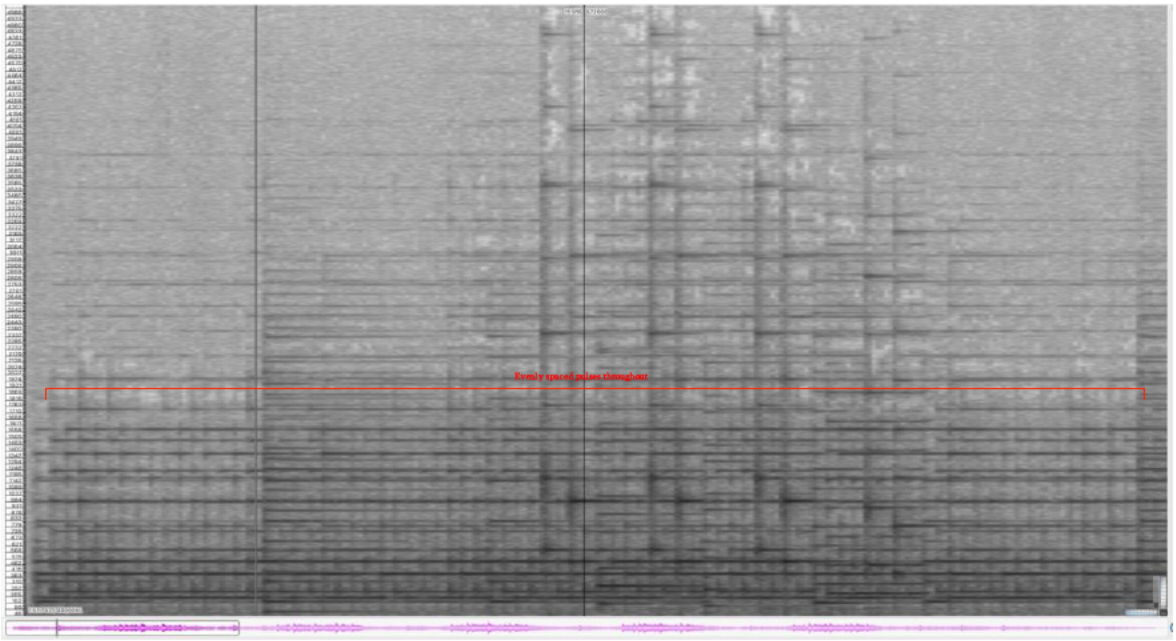
Appendix Figure A

Prelude BWV846 from Well-Tempered Clavier by J.S. Bach (high repetition)



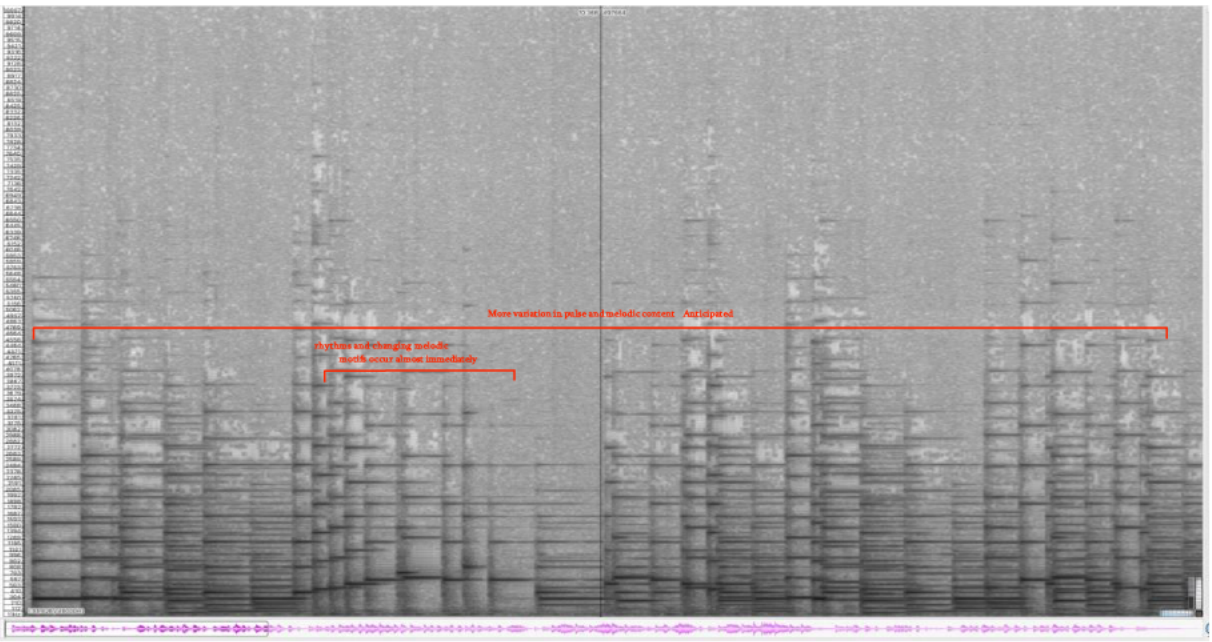
Appendix Figure B

Metamorphosis No.5 by Glass (High repetition)



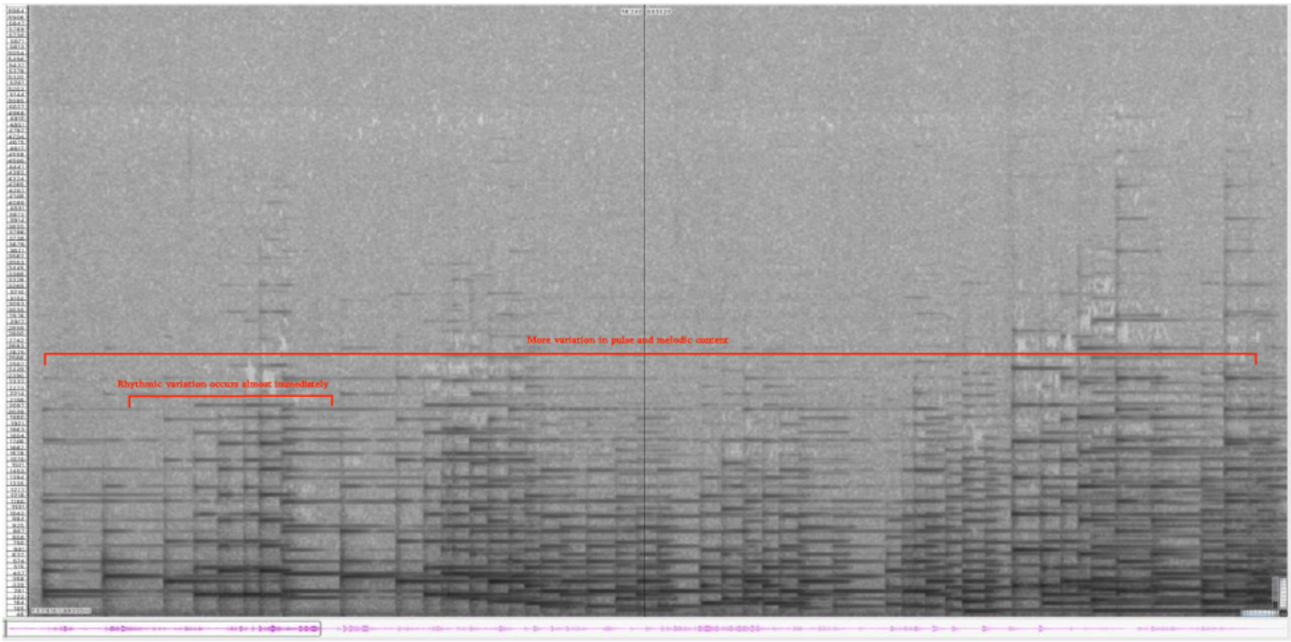
Appendix Figure C

Mazurka by Chopin (low repetition)



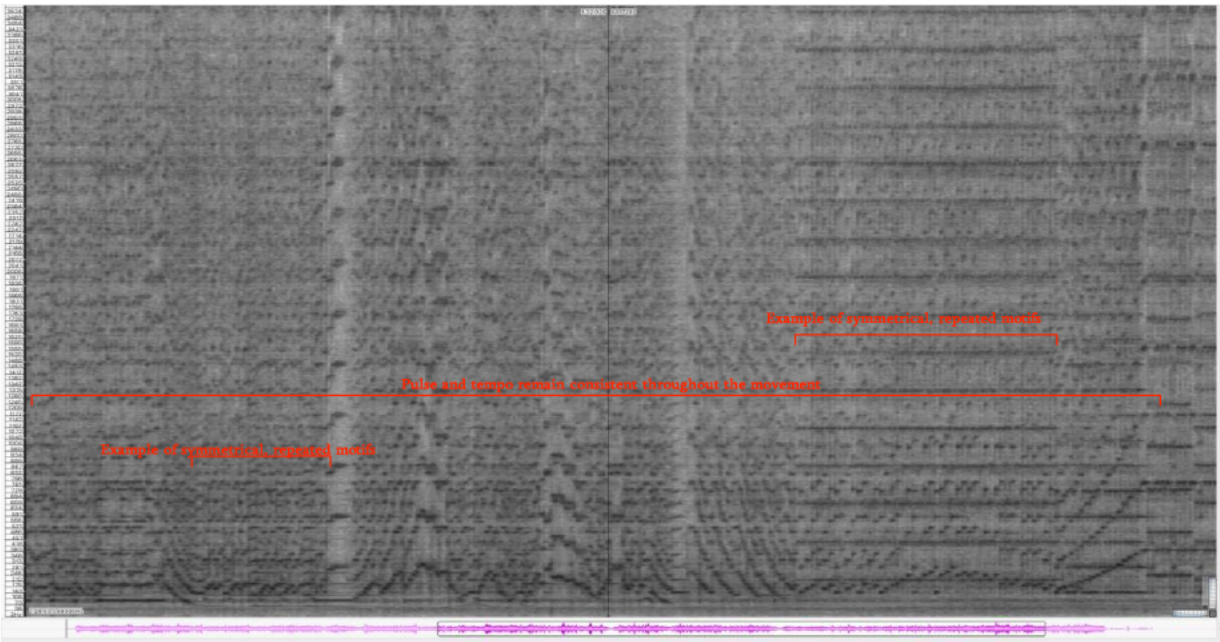
Appendix Figure D

Élegie by Debussy (low repetition)



Appendix Figure E

Prelude from Cello Suite No.1 by J.S. Bach (high repetition)



Appendix Figure F

Dawn Lament by Paul Stanhope (low repetition)