MUSIC AND WILLIAMS SYNDROME:

A SINGLE-CASE STUDY EXPLORING EMERGING SAVANT MUSICAL ABILITY

A Dissertation

Presented to the Department of Applied Music Psychology

Roehampton University

In Partial Fulfilment

Of the Requirements for the Degree

Master of Science

By

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August 2011

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Abstract

Research has implied that music is a relatively spared domain in Williams syndrome (WS). A single-case study design was employed to explore the emerging savant musical abilities of AT, a young girl with WS. AT's musical progress was observed from the commencement of her formal musical education (on piano). Her engagement with music and components of her musical ability were investigated in the context of what is currently assumed about music and WS. Results were consistent with the assumptions that individuals with WS have a strong affinity with music; that there is a higher incidence of absolute pitch amongst this population; and that individuals with WS demonstrated relatively enhanced rhythm abilities. Theories of musical cognition are discussed including the Weak Central Coherence (WCC) account (Frith & Happé, 1994) and Ockelford's 'Music Processing Module' (MPM) (2007b, 2008, 2010). It is suggested that the WCC account may be useful in explaining aspects of cognitive processing in WS. A musical analysis of AT's creative reproduction and improvisatory abilities generated evidence in support of Ockelford's model promoting the value of this model in understanding musical cognitive processing. AT's exceptional musical ability is considered in the context of the current understanding of savant syndrome. In addition, observations are made with respect to the teaching and learning strategies that are employed in this case. Implications for future research are discussed.

Acknowledgements

Firstly, I wish to extend my absolute gratitude to AT and her parents without whose participation and helpful cooperation, this study would not have been possible.

Secondly, I would like to thank Professor Adam Ockelford for his invaluable guidance and encouragement throughout the entire research process. As my supervisor, his advice was integral during each phase of the study, and his vast knowledge of this subject area inspired many aspects of my study.

Finally, I wish to say a special thank you to my family, in particular to my parents, Storm and Caleb, for whose constant and continuing care, support and encouragement I am extremely grateful. Also, thank you to Bobby, Juliet, Barbara, Josh, Andrew and Simon who all provided tremendous support throughout my master's year.

A special thank you to my mum, Storm, for her keen eyesight and help in proof-reading this dissertation.

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Chapter 1: Introduction

'Music is my favourite way of thinking…'

(Quote from a child with WS as cited by Don et al., 1999)

1.1 Background and purpose

The purpose of this dissertation is to report on a qualitative single-case study that was conducted to investigate the emerging savant musical abilities and development of a young girl who presents with Williams syndrome (WS). AT began her formal musical education in January 2011. This study observed her musical development over a period of twenty-seven weeks from the commencement of her tuition. This is the first study of its kind[1] on a relatively new and exciting area of inquiry, and it provided me with a unique opportunity to expand on existing theoretical knowledge, in area of personal academic interest. It is anticipated that it will contribute valuable information to the current understanding of musical ability amongst the WS population.

Research into the cognitive abilities of individuals with neurodevelopmental disorders has been widely endorsed as a means to derive important theoretical outcomes (Karmiloff-Smith et al., 2006). This study seeks to generate theoretical assumptions with regard to aspects of the cognitive processing that may, or may not, be specific to WS. Furthermore, this was rendered an important opportunity to observe the early manifestations of musical savant syndrome, and to potentially contribute to current understanding about this condition.

1.2 Williams Syndrome

Williams syndrome was first identified in 1961 by cardiologist Williams et al. It is defined as a 'neurodevelopmental genetic disorder … characterised by peaks and valleys in mental function: substantial impairment in cognitive domains such as reasoning, arithmetic ability, and spatial cognition, alongside relatively preserved skills in social domains, face processing, language and

[1] This appears to be the first single-case study to explore the developing musical abilities of an individual with WS from the very beginning of formal musical education.

music' (Levitin et al., 2004, p.223). WS is also characterised by a specific heart defect, 'elfin' facial features, low birth rate, apparent auditory sensitivity and developmental delays (Bellugi et al., 1992) as well as an average IQ of 55 (Lenhoff et al., 2001).The estimated prevalence ranges from 1 in 7,500 to 1 in 20,000 births (Stromme, Bjornstad, & Ramstad, 2002; Wang et al., 1997). As it is caused by a microdeletion of approximately 20 genes in the 7q11.23 region of the two chromosomes number seven, it presents as a relatively genetically homogeneous disorder. This homogeneity increases the value of research into this disorder, compared to the more frequently investigated autistic disorder, as it reduces the amount of variance for which researchers must account when researching this population.

1.3 Anticipated outcomes

It was anticipated that this study would yield interesting and important insights into the nature of musical development in a single participant. By employing a single-case study design, it was intended to derive a holistic and integrated impression of the development of musical ability in an individual with WS, and to consider this case in the context of current assumptions about music and WS. It was further intended to evaluate case-study design in this line of inquiry, and to possibly contribute to future research in this regard. In addition, it was anticipated that a detailed exploration of one individual's musical development may yield useful information about musical cognitive processes in general. Finally, it was intended that this study may provide useful information for teachers and caregivers on the musical phenotype that appears to be prevalent in the WS population, and how best to nurture the developing musical ability of an individual with WS.

1.4 Dissertation outline

This dissertation will be structured as follows: Chapter 2 will review in some detail the broad range of literature sources that were consulted in the preparation and throughout the research process of this study; Chapter 3 will outline the methodology paradigm and will delineate the research design that was employed to investigate this subject area, explaining the rationales for any decisions that were involved in the implementation of this design; Chapter 4 will present some of the results that

emerged from this study, and a discussion of these in terms of their implications for current assumptions about musicality and WS; Chapter 5 will present an investigation into two specific areas of musical ability and development in the main participant – creative reproduction of a precomposed piece and interactive improvisation – in an attempt to glean insight into the cognitive processes that are in operation in these contexts; Chapter 6 will comprise a summary of the research process, and a discussion of the main findings and conclusions in terms of their implications for current understanding of WS and musical savant syndrome, and how this may inform future research in this field.

Chapter 2: Literature Review

2.1 Introduction

This chapter will present a review of the broad range of literature that was consulted throughout the course of this study. It was necessary to examine several areas of research literature, including those which investigate

- Music and Williams syndrome
- Development of musical ability
- Savant syndrome
- Theories of musical cognition and processing
- Music education and learning

This chapter sets the background for this study, and conveys the rationale for which it was constructed. Each of the aforementioned topics are reviewed in order to portray how they informed the research process.

2.2 Music and Williams syndrome

The physical and cognitive characteristics that are typical of WS have already been outlined in Chapter 1. The existing literature on musicality, or musical ability, and WS, is relatively limited. However, current findings suggest that further inquiry into musicality in WS could be valuable. Indeed, it is evident that WS provides a useful opportunity to explore cognitive processing as it presents as a genetically homogeneous condition. However, it would be inaccurate to assume that all individuals with WS demonstrate strengths in musical ability. Despite this, there have been some interesting findings which suggest that music may be a relatively 'spared', and perhaps even enhanced, ability in many individuals with WS.

In one attempt to characterise the musical phenotype in WS, Levitin et al. (2004) reported the results of a comprehensive survey on musical behaviours and background. This survey was

administered to four groups comprising 118 WS individuals, a control group of 118 neuro-typical individuals, and two groups of individuals with other neurodevelopmental disorders, namely autism (n = 30) and Down syndrome (DS) (n = 40).The results were compared between groups and indicated that when compared to the other groups, participants with WS exhibited greater emotional responses to music, expressed interest in music at an earlier age, and spent more hours per week listening to music compared to all other groups. Furthermore, the WS participants were as accomplished at reproducing music as chronologically age-matched controls, showed similar levels of achievement, and spontaneously produced rhythmic sequences as often as controls. While some of these results may have been influenced by factors such as socioeconomic status, which wasn't controlled for, this study suggests a general affinity and emotional involvement with music across the WS population, encouraging further exploration into the extent of the musical abilities within the WS population.

In an earlier study, Levitin and Bellugi (1998) assessed the rhythm abilities of eight individuals with WS, and a comparison group of eight neuro-typical controls. In this instance, the researchers employed a task wherein participants were presented with a short rhythm and were asked to replicate it by clapping. It was reported that the WS group achieved accuracy scores equivalent to the control group, demonstrating equivalent abilities in meter change and beat maintenance. Interestingly, the authors also reported that the errors made by WS participants' were three times more likely to be judged as being rhythmically compatible musical elaborations of the test items, than that of the control group. This unexpected finding supports the notion of preserved, or even enhanced, musical ability – at least rhythm ability – in WS. One limitation of this study however, is that the WS sample was recruited from a specialised WS Music and Art camp. While the authors noted that many of the attendees at this camp had no prior musical training, it is likely that the participants may have had a particularly strong interest in music, which perhaps reduces the representativeness of their sample.

Levitin (2005) reported on the melodic production abilities in WS. In this instance 12 WS participants, 12 chronologically typical age-matched controls, and 12 DS participants were presented with a set of melodies, increasing in complexity. After assessing their melodic reproduction ability, Levitin concluded that the WS group and the control group were significantly better at melodic

repetition that the DS group, but not significantly different from one another. This further suggests that music processing is spared in WS relative to other cognitive abilities. However, in the second part of this study, all participants were presented with melodic fragments which they were instructed to complete. This time, the WS group did not perform as well as the control group, and Levitin interpreted these findings, alongside the findings of the aforementioned study, to indicate that WS individuals are better at rhythmic production than melodic production tasks. Levitin's findings warrant further exploration of creative musical abilities in individuals with WS, which will be addressed in the current study.

Another exploration into the musical abilities of children with WS was conducted by Don et al. (1999). This study recruited nineteen children with WS and a comparison group of neuro-typical children who were matched for their ability with receptive vocabulary. The authors concluded that performance of the WS group on music tests was relatively good and judged it similar to that of the comparison group. However, they also noted that music skills were well below that expected for neuro-typical children of equivalent chronological age, and therefore emphasised the fact that music may be special in WS due to its relative strength, but not because of exceptional, savant-like skill.[2] This finding reiterates the importance of remembering that the WS population is musically heterogeneous.

Hopyan et al. (2001) further highlighted this heterogeneity in their investigation of music skills and the expressive interpretation of music in children with WS. This study tested five aspects of music in a sample of fourteen WS children and adolescents and fourteen age-matched controls, including pitch and rhythm discrimination, musical expressiveness (melodic imagery and phrasing), and the ability to identify the emotional resonance of a musical excerpt. The results indicated that compared to their age-matched peers, WS participants had similar levels of musical expressiveness, but did not perform as well when they were required to discriminate pitch and rhythm, or to attach a semantic interpretation to emotion in music. Hopyan et al. concluded that individuals with WS appeared

[2] This is an interesting point in the context of the current study, as over the course of this study it emerged that the main participant did in fact possess some musical savant ability. This will be discussed further in subsequent chapters.

particularly strong in their engagement with music as a means of expression play and improvisation, rather than in their technical ability.

A further area of research that supports the idea of preserved, and perhaps enhanced, musical ability in individuals with WS examines the incidence of absolute pitch (AP) in this population. AP is commonly defined as the ability to recognise or to produce pitches without referring to an external standard (Takeuchi & Hulse, 1993). It is an extremely rare ability, present only in 1 in every 10,000 individuals in the neuro-typical population, rendering its possessors a subgroup of exceptional cases in musical development. Lenhoff et al. (2001, 2006) tested the AP abilities in five WS individuals and reported that each participant possessed near ceiling levels of AP despite limited cognitive abilities. In fact, the authors proposed that their participants demonstrated exceptional AP ability. This was based on their performance where, as a group, they scored 97.5% correct out of 1084 trials. Lenhoff et al. observed that this was a particularly high score compared to results from an earlier study wherein well-trained musicians, who claimed to possess AP, collectively scored 84.3% correct on tests for AP (meta-analysis data, Takeuchi & Hulse, 1993). Although differences in methodology may limit the comparability of these results, the apparent AP ability of WS participants continues to promote the notion of musical strength in WS. Lenhoff et al. reflected on their results to discuss two possibilities.

Firstly, they proposed that the prevalence of AP among WS individuals is higher than in the neuro-typical population. Based on the results from their study and the known population of WS individuals in Canada and USA, they hypothesised that the incidence of AP in WS population is at least 1 in 1000, although they speculated that the prevalence is closer to 1 in 10. This finding could be important in future research into the cognitive processing and neural mechanisms that are implicated in both WS and AP. Indeed, similar research has already investigated the significance of the high prevalence of AP in individuals with autism. It may be possible that there exists a link between AP and the cognitive style that is implicated in both autism and WS. This will be discussed further in Section 2.5.

The second possibility that arose from this study (Lenhoff, 2006) was that the proposed normal early childhood 'critical period' for AP acquisition may be extended in individuals with WS. This was based on the fact that four of their five participants began musical training after the normal 'critical period' of ages 3-6 for acquiring AP. However, throughout their research Lenhoff employed a definition of AP that is arguably inaccurate. He implied that AP is the ability to match verbal labels to pitch stimuli. This suggests that individuals cannot possess AP until they have learned to match verbal labels to pitches. This notion can be criticised as it does not account for individuals, such as those with developmental disorders, who evidently demonstrate AP abilities but cannot verbally label pitches, and may never develop the ability to do so. It also fails to account for individuals who exhibit AP abilities without having musical training before the age of 6. Therefore, it is arguably more useful to assume an alternative approach in investigating the issue of AP, and the notion of a 'critical period' for its acquisition. The current study will seek to explore this possibility further.

The studies reviewed in this section have revealed that there does indeed appear to be a link between musicality and WS. While there are mixed reports concerning the extent of the musical ability that exists in the WS population, the studies consistently report that individuals with WS appear to have a natural affinity for music at the very least. Furthermore, there is substantial evidence of relatively enhanced musical ability in many individuals with WS. The findings that have been outlined in this section were intrinsic in the approach that was undertaken in designing this study, as it sought to expand on current assumptions about music and WS.

2.3 Development of musical ability

This section will comprise a brief review of some general aspects of musical development, in order to put in context the extent of the musical abilities of the main participant of this study.

It is widely accepted that musicality is an inherent, universal skill, and this assumption has been supported by an abundance of research (see Trehub, 2003; Malloch & Trevarthen, 2009; Hodges, 2006). The existing research also investigates the many factors that influence the

development of musical ability, in typical and exceptional cases, and the progression of steps which are involved in such development.

McPherson and Lehmann (in press), discuss the development of exceptional or prodigious ability, alluding to a definition of intellectual giftedness: 'a musically gifted child can be described as one who rapidly and effectively acquires declarative and procedural knowledge, who applies this knowledge adequately in varying situations to solve novel problems, who learns swiftly from experience acquired in new situations and who recognizes where knowledge can be transferred (generalized) and where not (differentiated)' (Rost, Sparfeldt, & Schilling, 2006 as cited in McPherson & Lehmann, in press). They endorse a model of talent development that was designed in the domain of sport (Abbott & Collins, 2004 as cited in McPherson & Lehmann, in press), which they suggest could be readily applied to the music domain. This model proposes four stages of talent development:

- Sampling stage (ages 6-12) – During this stage practice is described as 'deliberate play', where the emphasis is on increasing motivation and enjoyment rather than technical skill.
- Specialization stage (ages 13-15) – Practice includes deliberate practice of skills and techniques provided by specialist teachers as well as deliberate play for social enjoyment. With increasingly challenging tasks, self-efficacy is enhanced.
- Investment stage– Emphasis on deliberate practice and goal-setting
- Maintenance stage (after school years) – Emphasis on sustaining performance at a consistently high level.

The emphasis of this model appears to lie on the importance of practice and teaching strategies, which will be discussed in section 2.6.

An alternative model of musical development was developed by Kratus (1996) who focused on musical improvisation, which, he asserts, develops as a variety of different behaviours that unfold sequentially. This model proposes that certain musical characteristics are indicative of a particular level of improvisatory skill:

1. Exploration – making seemingly random sounds;
2. Process-oriented improvisation – evidenced by the appearance of some micro-structures but no macro-structures;
3. Product-oriented improvisation – includes such characteristics as the use of a consistent tonality or meter, the use of a steady beat, phrases, or references to other musical pieces or stylistic traits;
4. Fluid improvisation – exhibits enough technical control of an instrument to render playing automatic, allowing emerging musical ideas to be more easily transformed into sound;
5. Structural improvisation – demonstrates the ability to apply structural techniques such as the development and variation;
6. Stylistic improvisation – demonstrates the mastery of one or more improvisatory styles;
7. Personal improvisation – rarely reached; transcends current styles and creates new original styles.

According to Brophy (2002), who alluded to Kratus' model when investigating the melodic improvisations of children aged 6-12, it is generally assumed that children in this age category exhibit either process- or product- orientation when improvising. Brophy reported that, in his study, the 6-8 year-olds utilised repeated rhythmic and melodic patterns, with their improvisations containing little evidence of larger structures such as phrase organisation or motivic development, characteristics described as indicators of process-orientation. He observed increased sensitivity to pulse, more prevalent application of organising structures, and a greater employment of motivic repetition and development in the improvisations that were generated by 9-12 year-olds, suggesting a product-oriented approach for this age category. Brophy's findings will be considered when evaluating the musical output of the main participant of this study.

Apart from the research that seeks to attribute musical ability to particular phases or stages, this research domain has also hosted inquiries into specific, and exceptional, musical abilities such as absolute pitch (AP). Much of this research investigates the relative importance of nature and nurture in the possession or acquisition of this skill, yielding insights into some of the processes involved in

musical development. Efforts have been made to explain AP, and in particular its apparent links with autism and savant syndrome. Certainly, evidence from research into musical savants, who always present with AP, has yielded tremendous insight into the cognitive functioning of such individuals. The next section will comprise a brief review of the current understanding of savant syndrome, in order to explain the nature of the abilities, including AP, that are linked with this condition and to speculate about whether any of the current theories of savant syndrome and its supposed links with autism may be extended to explain the reports of similarly enhanced musical ability in WS.

2.4 Savant syndrome

Savant syndrome is 'a rare but remarkable condition in which persons with developmental disabilities (including but not limited to autistic disorder) or other central nervous system injuries or diseases, have some spectacular "islands of genius" that stand in stark, jarring contrast to overall limitations' (Treffert, 2010, p. 18). Dr. J Langdon Down coined the term 'idiot savant' in 1887. At that time, the term 'idiot' did not carry the negative implications that it does today. Rather, it was accepted as a medical term, referring to a particular level of intellectual functioning, or more specifically, an IQ of less than 25 (Treffert, 1989, 2010). A century later, Treffert suggested a change in terminology to describe this condition, to 'savant syndrome'. This is more appropriate and accurate as it is less pejorative than the original term, and it accounts for the fact that, in almost all cases of savant syndrome, the IQ is above 25 and usually in the range of 40-70 (1989). Treffert (1989) further defined savant syndrome by distinguishing between three categories of savantism which he labelled splinter skills, talented savants, and prodigious savants. This categorisation is disputable, however, as there does not exist a standardised means for diagnosing savant syndrome, and therefore it is questionable how one could consistently assign labels to this level of ability.

A number of case studies have contributed to the current understanding of musical savant syndrome. Ockelford (2007a) recounted the musical development of a prodigious musical savant, Derek Paravicini, who is representative of the interesting triad of blindness, autistic cognitive impairment, and exceptional musical ability. Some of the findings that have been generated as a result

of Ockelford's work with Paravicini have been intrinsic in the design of the current study, and will be discussed further in Section 2.5.

There have been relatively few longitudinal investigations into the abilities of savants, which is presumably due to the rarity of an opportunity to do so. Selfe (2011) recently reported a longitudinal study of Nadia, an artistic savant, which usefully documents her life and abilities at various moments over a period of thirty years. The benefits of a longitudinal study are manifold, as demonstrated in Selfe's report, as it yields an insight into the manner in which such ability emerged and was realised, and how this was nurtured and developed over time. Selfe's approach to studying Nadia's artistic ability was not dissimilar to the approach that was adopted in the current study. Initially she conducted a five-month longitudinal study, from which she developed a theory that Nadia's impaired language skills and impaired ability to form internal representations of objects as categories, allowed her to draw the visual world 'untrammelled by cognitive processes, which systemised and imposed structure' (2011, p. 16). It is speculated that this can similarly be applied to musical savantism, where musical development may potentially be facilitated as a result of language impairment, as suggested by Miller (see below). The current study is a relatively short longitudinal exploration, but seeks to utilise the longitudinal approach to investigate a similar subject to Selfe, and to capture early manifestations of musical savantism

While there have been several reports of musical savants who possess cognitive impairment, most often that associated with autism, there has been very little research into musical savant abilities in individuals with WS. An indepth review of the WS literature revealed that there has only been one formal report of savant musical ability in an individual with WS. Lenhoff (2009) described the exceptional musical ability of his daughter Gloria, who is an accomplished lyric soprano and accordionist, whose repertoire includes over 3,000 pieces. Gloria, who possesses AP, can sing in thirty foreign languages, and a wide range of musical genres. The current study presents an opportunity to expand on this research domain.

Miller (1989) stated that there is nothing unique about the cognitive processing seen in musical savants, but what is unusual is the intensity and sophistication with which the generic

cognitive processes are applied in the musical environment. He also proposed that it is unlikely that there is an unequivocal relation between any single factor and savant skill. Essentially, Miller implicated a compensatory process in savants with language impairments, wherein such impairment may facilitate the expression and enhancement of other nonlanguage ways of relating to the world. He implied that musical savants may lack the semantic competencies necessary for language development but may retain sufficient competencies for many of the requirements posed by music, noting that the conventional western diatonic scale is well-defined and that the existing musical structure is very accessible to an emerging savant. This is an interesting point in the case of WS as it is generally reported that individuals with WS possess relatively strong language abilities (Bellugi et al., 2000). However, the main participant in this study also presents with a diagnosis of specific language impairment which, along with her apparent savant musical potential, appears to align itself very closely with the compensatory account as outlined by Miller. This study may potentially yield further insight into the relationship between language and music in such context.

Absolute pitch is one of the few universal skills with which musical savants present. This skill has been one of the most important areas of inquiry within the savant literature. Pring et al. (2008) tested the AP abilities of five musical savants, comparing results with neuro-typical musicians and non-musicians. Although the savants did not perform statistically better than musicians on AP tests, the authors noted that only the savants performed better than the non-musicians, and attributed their lack of statistical power to the small sample size. This suggests that the savants presented with stronger AP abilities than the non-savant musicians. More recent research compared the abilities of musical savants and non-savant advanced music students to disaggregate pitches presented simultaneously (Mazzeschi et al., 2011). The results of this study further supports the notion that savants present with exceptional AP ability, but also suggests that they employ different listening strategies when attending to stimuli in such a task. Mazzeschi et al. reported that the savants' accuracy was greatest in this task in relation to the 'bottom' (bass) notes, while the non-savants were more successful in reproducing top notes. This suggests that savants may process music from the bottom

up, attending to harmonic structure in the first instance, while non-savants more typically attend to the melodic component.

This study will seek to expand on the existing findings concerning the nature of musical savant abilities by observing the early manifestations of such ability in the main participant.

2.5 Theories of musical cognition and processing

This section will include a description of theoretical beliefs that are widely endorsed in efforts to explain enhanced musical abilities, including AP abilities, in autism and savant syndrome, which could potentially be extended to similar abilities that have been reported in individuals with WS. This section will also delineate the model of musical cognition and processing that was employed in the analysis phase of this study.

There has been little research to explain the apparently high prevalence of AP in WS populations. However, there have been some efforts to explain a similarly high prevalence of AP in autism, which may be as high as 1 in 20 (Brown et al., 2003). One widely endorsed theory is the weak central coherence (WCC) theory, which was developed by Frith and Happé (1994; 2006). Frith (1989) introduced the idea of central coherence to describe the automatic tendency to process incoming information in its greater context in an effort to extract higher-level meaning, often at the expense of memory for detail. This tendency is known as global processing. Frith suggested that this feature is disturbed in autism, and that people with autism demonstrate detail-focused (local) processing, in which features are perceived and retained at the expense of global configuration and contextualised meaning. Frith & Happé (1994) proposed that weak central coherence (WCC) results in a weaker ability to perceptually integrate sensory stimuli into a gestalt or perceptual whole. This theory is useful in explaining the higher prevalence of AP in autism, and its link with savant syndrome. If individuals with autism show a persistent local-processing bias, they will not be subject to the developmental shift from perceiving individual features to perceiving relations among features, which occurs in neuro-typical populations making it increasingly difficult to acquire AP. Heaton and Wallace (2004) noted that a tendency towards detail-focused processing can be useful for savants at

the early stages of development as it facilitates accurate memory for individual elements upon which increasingly highly structured information is based. Since its emergence, the WCC has been adapted slightly to account for the global processing abilities that have also been reported in individuals with autism, proposing that a local processing bias prevails, rather than a global deficit (Happé & Frith, 2006).

The current study provides an opportunity to investigate if a similar cognitive processing style is present in WS, and to suggest whether or not similar theoretical explanations could be applied to the apparently high incidence of AP in the WS population. Some evidence of a similar processing style in WS has already been reported. Deruelle et al. (2005) investigated the local/global dissociation in the musical processing of sixteen children with WS and sixteen controls. They employed a 'same-different' task to examine the processing of both contour-violated (global) and interval-violated (local) melodies. They reported that the control group were more successful in detecting differences in the contour-violated than the interval-violated condition while the WS group performed equally well in both conditions, although the overall scores of the WS group were below those of the controls. Based on these results, Deruelle et al. concluded that global precedence (a developmental shift) may occur at an early perceptual stage in neuro-typical children but not in children with WS. This suggests that individuals with WS may be more readily able to apply both global and local processing styles to particular tasks, compared to neuro-typical controls who tend to demonstrate a bias for global processing. The notion of global/local processing has also been explored in the drawing abilities of individuals with WS, suggesting a local processing bias in this domain (Rondan et al, 2008; Farran et al., 2003). The WCC theory will be considered when investigating how the main participant in this study attends to particular musical components.

Sloboda (1985) developed a more general theory of musical cognition. He proposed that musical perception and memory depend on how the pattern and structure of music is represented in the brain. He alluded to the typically regular and rigid structure of western diatonic music, describing how musicians are able to build up cognitive representations by constructing, storing, and retrieving the use of rules and patterns that govern this music. He also noted that the rules and patterns that are

inherent in music are learned implicitly when attending to music, and so the ability to form cognitive representations depends partially on the extent of the exposure to a particular musical system that an individual experiences. This theory relates closely to the model of music processing that was used in the analysis phase of the current study that was constructed by Ockelford (2007b; 2008; 2010).

Based on his research with the prodigious musical savant, Derek Paravicini, Ockelford proposes that there exists a 'Music Processing Module' (MPM) in working memory for everybody. This MPM is 'central to musical imagination and creativity, enabling material to be constructed using remembered fragments and features of pieces as starting points, and underpinning musical improvisation (at any level) within a given style system' (2010, p. 1). Its underlying methodological assumption is that perceived sonic relationships provide strong evidence of the processes that are hypothesized to underpin the learning, storage and retrieval of musical elements in cognition. Its design was based on the findings of the REMUS project wherein Paravicini was required to reproduce a newly composed piece on a number of occasions (Ockelford, 2007b). The author predicted that Paravicini would strive to produce something of musical coherence in the first instance, while adhering broadly to the overall content and structure of the piece in question. This model is related to zygonic theory (Ockelford, 2004), which holds that 'a necessary condition for music to make sense is that every feature of each perceived sonic event should be related to another or others, such that each is felt to derive from or generate at least one other through imitation' (2010, p.13). This also accounts for the typical regularity and rigidity of western diatonic music, as discussed by Sloboda (1985).Ockelford observed how Paravicini used his imagination when completing this task to create something new, which was musically coherent, by borrowing, transforming and recombining materials with which he was familiar. By use of zygonic analysis, Ockelford assumed that Paravicini's performance, following the controlled musical input, provided powerful evidence of the cognitive processes involved in such a task, leading to the development of the MPM model.

Ockelford postulates that the MPM has the capacity to achieve a number of musical tasks, which are listed in Chapter 3 (see p. 35). Essentially, this model describes how individuals build up a store of musical fragments and features in a memory *bundle* which are accessed and retrieved, in 'real

time', when required for creative reproduction. The principles which govern the MPM strive to produce something that makes 'musical sense', and if necessary, resembles as far as possible the original composition (not relevant in the case of improvisation). What is important in this model, is that an attempt to make 'musical sense' would take precedence over an attempt to replicate exactly an original composition or arrangement of a piece. Ockelford alludes to the oral narrative traditions to describe how, in the reproduction of a piece of music, some elements will inevitably be dropped, added or modified. He also describes how various musical fragments that are stored in the *bundle* in long-term memory are more durable than others according to their perceived salience, reinforcement, structure, and resilience within the context of a given piece or style.

Ockelford utilises this model to demonstrate how musical analyses can underpin the generation of theory and hypothesis-building in the psychological domain. While this model provides a logical and comprehensive account of the processes that may be implicated when reproducing and creating music, it has not yet received much support due to a lack of evidence. Indeed, Baddeley, who is responsible for developing the model of working memory (Baddeley & Hitch, 1974), commented:

> 'I think the question of a music module in working memory remains an open one. I myself would be inclined to opt for some common music/language processes with separate further determinants based on [long term memory] and skills. I'm not averse to further modules but don't want to end up postulating a new module until the evidence stacks up more convincingly...However, it is almost certainly the case that [Derek Paravacini's] brain has developed in a different way from most of us. Views on neural plasticity are changing, and I think it is not implausible to suggest that the many hours of practice may have caused the normal language area to switch to music. If so, it would seem premature to generalise too widely at this stage...'
>
> (Personal communication between Baddeley and Ockelford, June 2011)

The current study has presented an opportunity to investigate the presence of such a structure in the working memory of another individual, and potentially shed further light on its value in understanding

musical cognitive processing. The MPM model of musical processing has been consulted extensively throughout this research process and was employed in the analysis phase as will be outlined in Chapter 3 and Chapter 5.

2.6 Music education and learning

Apart from investigating the musical development of an individual with WS, this study will also consider the effectiveness and role of the teaching and learning strategies that are implemented over the duration of the study. In order to do this, it is necessary to consult literature that has investigated the effectiveness of particular teaching strategies, and the related factors that impact on the development of an individual's musical ability.

McPherson (2005) noted that the traditional perspective of musical progress and achievement, in many western countries, is that a young musician's ability is often judged by his or her ability to play and produce pre-composed repertoire from notation. Indeed, this approach to teaching and learning has been widely endorsed within the classical tradition. However, McPherson proposes that it is important to expose young learners to a range of visual, aural and creative performance skills to help expose them and challenge them in different ways, so that they can learn how to coordinate their ears, eyes and hands. He alludes to Mainwaring who emphasised the need to 'proceed from sound to symbol, not from symbol to sound' (1951, p. 12).

The emphasis on the importance of developing the ability to 'think in sound', or inner-hearing, is perhaps more in line with folk music traditions, wherein the method of transition is primarily an oral and aural one. Such an approach to learning and teaching music has been investigated with regard to its effect on memory in musical reproduction. Wallace and Rubin (1995) conducted a study posing the question: 'How does memory influence the retelling of a ballad, and how do the characteristics of the ballad tradition influence the retelling?' After asking singers to perform a ballad from memory, they concluded that 'the memory for the ballad is not the exact song, nor is it a collection of words; rather, it is a collection of rules and constraints' (p. 303). This supports the notion of schema, as labelled by Bartlett (1932), which is used to describe how, in the ballad or

oral tradition, it is as if the rules, or constraints, of a given song or tune are transmitted rather than the particular telling. This was evidenced in Wallace and Rubin's study by the changes that occurred in some of the details on each performance of the ballad. They noted that the multiple constraints – that were based on music, poetics, narrative structure, and imagery – tended to limit the systematic drift over repeated performances of the same ballad, constraining recall to the extent that it almost seemed rote or verbatim. The memory processes that are observed in this instance can be related to the aforementioned MPM model of musical processing (Ockelford, 2007b, 2008, 2010). Essentially, the way in which Wallace and Rubin describe the process of creative reproduction of a given ballad, reflects the way in which the MPM operates as an individual strives to reproduce something that is musically coherent, as dictated by the rules and constraints that are stored in the MPM. The existence of a MPM in working memory will be investigated further with reference to the musical output of the main participant of this study.

Ockelford (2008) has also discussed approaches to teaching music, particularly in the context of neurodevelopmental disorders. He emphasises the capacity of the mind to assimilate and intuitively employ sophisticated musical strategies, even in the absence of formal tuition. He implies that teachers should exploit this, listening to students' musical output and responding accordingly. They, then, should pay scrupulous attention to the students' next response, with the intention of stimulating the aural imagination of students and facilitating them in realising this imagination in sound. McPherson (2005) concurs with this point acknowledging the importance of reacting perceptively to students' errors by analysing why they might occur and seeking to understand the students' internal representation of the music. These ideas will be explored further as the teaching and learning strategies that are employed during this study are observed and evaluated.

Other aspects of musical development that will be considered throughout this study include environmental factors and intrapersonal catalysts. McPherson and Lehmann (in press) place strong emphasis on the importance of family support, and parental and teacher reinforcement in the development of musical ability. The intrapersonal catalysts (Gagne, 2003) of the main participant, and

the role of practice (Ericcson et al., 1993; Sloboda et al., 1996) have been observed throughout the duration of this study and will be discussed in subsequent chapters.

2.7 Conclusion

This purpose of this chapter is to acknowledge the research domains that were involved in the design of this study. This chapter has outlined current assumptions regarding music and WS, setting the context upon which this study was built. The next chapter will delineate the methodological paradigm and research process that was implemented in order to investigate the aforementioned assumptions. It is anticipated that this will contribute further to the understanding of musicality and WS, and the implications this may have for some of the other research domains that have been alluded to in this chapter.

Chapter 3: Methodology

3.1 Methodology Background

The main objective of this study was to explore, longitudinally, the musical development of a single WS participant, from the beginning of her formal music education. A thorough investigation of the existing WS literature revealed that such a study had not been conducted prior to the current research. A single-case study research design was employed in an attempt to fill this gap in the literature, which was implemented according to principles of qualitative research. This chapter will outline the background methodology, and the procedures that were undertaken in this research study.

Qualitative research, which is generally concerned with individual experiences, feelings and attitudes, seeks to investigate a phenomenon within the context of its natural environment. Typically in qualitative research, a hypothesis is not tested. Rather, the approach may be exploratory, allowing findings to emerge throughout the course of the data collection and analysis. Emphasis is generally placed upon description rather than explanation, and the importance of viewing the meaning of experience and behaviour in context and in its full complexity (Henwood & Pidgeon, 1992). This paradigm typically employs small samples in order to gain a deep and meaningful insight into the nature of individual experience. While qualitative research can contribute valuable insights to scientific understanding, it also has potential weaknesses, including its limited replicabilty and generalisablilty. Nevertheless, its strength in facilitating a rich and holistic investigation into the individual experience of a single subject rendered it the optimum research methodology to be employed for this study.

3.2 Case Study Design

A case study is ‘one which investigates ... specific research questions (that may be fairly loose to begin with), and which seeks a range of different kinds of evidence, evidence which is there in the case setting and which has to be abstracted and collated to get the best possible answers’ (Graham, 2000, p.1). The current study was an exploratory inquiry, based on a grounded theory approach.

Grounded theory refers to the notion that 'emergent theory is what develops as the data are analysed and as further data gathering proceeds as a consequence' (Coolican, 2009, p.232). This approach implied that, as the study progressed, there were minor revisions made to the research design as feedback from observations suggested optimum ways to proceed. This section will outline the advantages and limitations of case-study methodology, and the ways in which it was implemented in this instance in order to complete the project as successfully as possible.

The choice of case study design was due in part to the research opportunity that was available. While the lack of a research study of this kind in the WS literature meant that there was no available information concerning whether or not it would be an effective design in this context, one could also speculate from the outset, that this study would potentially shed some light on the effectiveness of case study research in this area, and thus contribute to the design of future research. Case study design was also particularly suited in this instance as WS is a rare and relatively under-researched disorder (especially in relation to music). Therefore, any opportunity to expand on existing research is a valuable one. Some of the strengths and limitations of case study research are summarised in Table 3.1.

Table 3.1: Strengths and limitations of case-study research.

Strengths	**Limitations**
Can provide rich descriptive information – complete and comprehensive account of a phenomenon	Lack of reliability, replicability, generalisability
One contrary case can seriously challenge previous assumptions	Observer Interaction
Can gather data on genuine behaviour unconstrained by lab setting	Subjectivity – Researcher bias
Employs multiple sources of evidence	Time consuming

Case study research has been criticised on a number of grounds, one of which is the belief that this type of research maintains a bias toward verification, serving to confirm a researcher's preconceived notions about a specific topic, and in turn, reducing the scientific value of the study (Flyvbjerg, 2006). In order to address this issue during the research process reported here, it was necessary to be self-critical and reflective on the role of researcher within the context of the study, ensuring that any researcher-participant relations did not compromise researcher objectivity, as well as struggling to be aware of alternative findings, and potentially disconfirming evidence throughout the research process.

A second common assumption is that case study research allows little generalisation and therefore cannot contribute to a broader scientific understanding. However, this type of research is not concerned with generalisation, in some *statistical* sense. Rather, it seeks to provide evidence for *analytical* generalisation in which previously developed theories and hypotheses are used as a template with which to compare the results of the case study (Rowley, 2002). In order to enable this kind of generalisation it was necessary to ensure that each stage of the research process was well informed by a thorough examination of relevant existing literature, and to adhere to a case study protocol (see Yin, 1994).

Further important considerations were made when implementing this case-study design. These will be discussed, along with the measures that were taken to address them, in the latter half of this chapter.

3.3 Procedure

3.3.1 Participants

The main participant in this study was a young girl with WS who began her formal musical education (on piano) in January 2011. AT, who is of Indian ethnicity, was seven years and nine months old at the time of her first lesson. She was diagnosed with a classic case of WS, as was

determined by the FISH[3] test, when she was eighteen months old. This revealed that she had a deletion of approximately 20 genes, including the elastin gene, from the 7q11.23 region of chromosome number seven. At the time of this study, AT's cognitive ability was about two years behind what is typically expected for her chronological age[4]. Her cognitive and behavioural phenotype is typical of WS, with strengths in social skills and face recognition, and marked impairments in motor co-ordination, mathematical, and visuospatial skills. In addition to WS, AT also presents with specific language impairment.

AT was the main participant in this study. Her parents and piano tutor, AO, were also involved. AO is a Professor of Music and a specialist music teacher, working mostly with children who have neurodevelopmental disorders or who are visually impaired. He also supervised this study.

3.3.2 Ethics

There were several ethical issues to be considered throughout the course of this study. In particular, there was some concern as to whether AT was in a position to offer informed consent for her participation. In order to address this issue, it was necessary to liaise with her parents to be aware of any behaviours that may demonstrate her distress or discomfort. Furthermore, the circumstantial change that would occur in AT's weekly lesson upon completion of this study was considered. To minimise any negative outcomes, the period between recorded lessons was prolonged towards the end of the observation phase of the study. In addition, a debriefing was held with AT and her family to imbue a sense of closure, and to discuss any reflections or comments that they had with regard to the study and its outcomes. Any findings that were generated from this study were cross-referenced with AT's parents and they were offered an opportunity to contribute to the portrayal of AT and her musical development as it is presented in this dissertation.

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[3] *Fluorescent in situ hybridization* (FISH), is the most commonly used test when diagnosing WS. It involves a specialised type of chromosome analysis that investigates if the patient has two copies of the elastin gene (one on each chromosome #7). If only one copy is present, the individual will most likely be diagnosed with WS (98-99% individuals with WS present with this particular deletion, along with about 26 other genes on chromosome #7, (http://www.williams-syndrome.org/diagnosing-williams-syndrome/diagnosing-williams-syndrome accessed on 10-08-2011).

[4] This information was extracted from the interview that was conducted with AT's mother.

Issues of confidentiality were also considered throughout this study. In order to ensure the anonymity of AT and her family, their real names were not included in this report, and all data was stored on a password protected computer. Upon completion of this study all data will continue to be stored in a confidential manner.

One further aspect of this study that may have had ethical implications was the role of AO. As his involvement in this study was twofold – AT's teacher, and my supervisor – it was important to be conscious of how his awareness of my research motives may potentially have impacted on his work with AT. For instance, in facilitating the research process by investigating specific areas of AT's musical development – for example, conducting an informal test for AP abilities – AO's involvement in this study may potentially have had an impact on his role as AT's teacher.

An ethics form outlining these ethical issues and the measures that were taken to address them was submitted to the university ethics board for approval.

3.3.3 Data Collection

Video Observation

The primary data gathering instrument employed was observation by video recording, which was used to document AT's weekly piano lesson. The observation phase of this study spanned a period of 27 weeks, during which time AT attended 24 hour-long piano lessons, 16 of which were observed and recorded[5] for the purpose of this study. Present at each lesson were AT, her teacher AO, one of her parents, and myself. The recorded lessons are set out in Appendix A. Apart from the first two lessons, which took place at AT's home, all other lessons took place at Roehampton University.

Video observation was a valuable tool as it afforded the opportunity to produce immediate data on real behaviour - rather than possibly distorted self reports - which was unconstrained by a laboratory or artificial setting (Coolican, 2009). This research tool was also particularly useful in the

[5] Lessons were recorded using a Panasonic HDC-TM300 video camera.

analysis phase of this study, as it facilitated a thorough investigation by enabling repeated observations of the same event.

One important issue that was considered during the observation phase was the potential impact of the presence of the researcher, and the camera, at each piano lesson. It is possible that this may have affected AT's behaviour leading to a less accurate interpretation of her performance. In order to reduce the possibility of this, it was necessary to be as discreet as possible when recording each lesson. However, as I was present since AT's first lesson, it is speculated that the impact of my presence was minimal in this regard. It was also necessary to consider the potential impact that my presence, or that of the camera may have had on AO. With his involvement in supervising this study, it is possible that the way in which he approached each lesson was somewhat influenced by the presence of the research instrument, and with the research motive in mind.

Research Journal

The video observations were supported by maintaining a research journal throughout the entire research process. The purpose of this journal was to maintain a record of the weekly schedule and logistics of the study, and to log methodological decisions and the accompanying rationales. The journal was also utilised to maintain an account of personal reflections throughout each phase of the research process, and to evaluate the extent of potential researcher bias.

Interviews

A semi-structured interview was conducted with AT's mother in order to gather biographical data about AT, to determine the extent of her musical involvement and ability prior to the commencement of music education, and also to investigate if her music education, in her opinion, had any extra-musical benefits. The questions that were included in this interview were posed in accordance with guidelines for semi-structured interviews as set out by Leech (2002). Leech asserted that one of the strengths of semi-structured interviews is that they provide an opportunity for the respondents to assume the role of expert and inform the research. In order to facilitate AT's mother in 'having her say' the questions were open-ended, offering her an opportunity to speak quite generally

about various aspects of AT's behaviour and engagement with music. Questions that were posed during this interview are included in Appendix B.

The data gathered from this interview was expanded through informal correspondence with both of AT's parents via regular emails and discussions that took place at AT's weekly lessons. The content of these discussions mostly concerned AT's musical progress from week to week, but also referred to other aspects of her development, learning and behaviour.

A further source of contributing evidence was the regular correspondence that was conducted with AO during the research process. This also occurred via email and weekly discussions wherein AT's musical progress was discussed in a more 'technical' manner. This afforded the opportunity to project some personal reflections and contextualise them according to the perspective of AO, who as AT's teacher, could offer insights into AT's musical development from a different perspective.

School Observation

An informal observation of AT's behaviour in her school environment took place.[6] The purpose of this observation was to gain a general idea of AT's behaviour and disposition outside of the context of her music lesson, and to examine her social interactions with neuro-typical peers. The duration of this observation was two hours during which time AT was engaged in a reading exercise and a physical education class.

3.3.4 Data Analysis

Video Analysis

The analysis phase of this project was primarily concerned with video analysis which was used to monitor AT's musical progress, and to identify themes and patterns as they emerged in each weekly lesson. While specific research questions were never imposed, the main areas of musical development that were observed, were selected according to the assumptions about music and WS that had been

[6] At the time of this study, AT was attending mainstream school. However, her parents have indicated that they believe her needs and abilities would be better catered for in special education, and are pursuing a suitable educational path for her.

extracted from the existing literature (as outlined in Chapter 2). These included the processing of pitch (specifically absolute pitch abilities) and rhythm, as well as AT's general engagement with music. In addition to this, as the observation phase progressed, AT's apparent facility with harmony, and her emerging creative ability and improvisatory skills prompted these aspects of musical development as further areas for potentially informative inquiry. The video observations were also used to judge the degree to which AT appeared to possess musical savant ability. With repeated viewings of each recorded lesson, it was possible to track AT's progress with specific pieces of music, and the extent of her creative output, as well as her technical progress.

Her musical output was also considered in the context of theories of musical cognition, specifically the WCC account (Frith & Happé, 1994) to investigate the extent to which this theory may be applicable to WS (see Chapter 4). Observations were made with regard to AT's approach in processing pitch and harmony, and her approach to forming internal representations of pieces of music, as well as her approach to drawing, in order to speculate about the degree to which local and global processing styles appeared to be implemented respectively. In addition, Ockelford's (2007b, 2008, 2010) 'MPM' model was examined via a musical analysis of AT's creative reproduction and improvisatory output (see below). Musical episodes that were judged to be particularly interesting or insightful were transcribed and prepared for musical analysis, as outlined below.

The effectiveness of different teaching and learning strategies was also observed during video analysis. These observations were expanded on via correspondence with AO, wherein his approach to teaching was discussed with particular attention to what teaching strategies were most successful, and where he believed the emphasis, in teaching, must lie to ensure the optimum path to AT's overall musical development.

Musical Analysis

Musical analysis was utilised to analyse AT's performance and progress with specific pieces of music, as well as her improvisatory output. Initially, a general analysis was conducted to broadly gauge the extent of AT's ability and how this developed over the course of the study. This was

undertaken by observing selected moments of her musical output, which were judged to be revealing in the extent to which they exhibited her abilities in the domains of absolute pitch, rhythm, harmony, creative reproduction, and improvisation. Her efforts were then evaluated in the context of what is already assumed about musical ability and WS.

The next phase of analysis was conducted with reference to Ockelford's (2007b, 2008, 2010) 'Music Processing Module' (MPM) model, as outlined in Chapter 2, which is based on the premise that musical analysis of an individual's musical output provides sufficient evidence for a number of assumptions to be generated about the cognitive processing that is involved in such efforts. The MPM model includes seven elements that are involved in the processing and production of music:

1. to draw on short-term memory traces, using their "tags" to recreate the relationships between them wherever possible;
2. to call-up an (indicative) multidimensional style system from long-term memory that is congruent with the elements in the short-term memory *bundle*, to provide a framework into which they can be slotted;
3. to select items or features from long-term memory that fit within the evolving style system (albeit with modification) and that would potentially fill the lacunae occasioned by limitations of short-term memory;
4. to transform these as necessary, through the addition, deletion or modification of material;
5. to synthesise the selected elements, integrating them "vertically" (harmonically) and "horizontally" (melodically) within the unfolding matrix of pitch and perceived time;
6. to create new material within the style system, as required, in order to provide links between given material, fill potential gaps and ensure short-term coherence;
7. to track and direct the musical narrative simultaneously at different architectonic and hierarchical levels to ensure longer-term coherence.

   (Ockelford, 2007b)

This model was investigated with respect to AT's approach to creative reproduction of a specific piece of music, 'Für Elise', and interactive improvisation.

- Analysis of AT's creative reproduction

The main piece of music that emerged as being significant in AT's development throughout the observation phase was 'Für Elise'. AT's progress with this piece was observed in order to discuss a number of aspects of her musical development. Her approach to creative reproduction was analysed in the first instance to generate preliminary evidence with regard to the extent to which it was governed by a MPM. A number of steps were undertaken in analysis, which was dictated by the aforementioned seven elements set out in the MPM model.

First, specific musical 'tags' were identified in the original score, and AT's week-to-week progress was analysed to evaluate the extent to which such 'tags' facilitated the reproduction of the piece. The 'tags' were identified according to their perceived salience in the context of the overall melodic narrative and harmonic structure. In order to investigate the second element of the MPM model, observations were made regarding AT's ability to activate an appropriate style system in long-term memory into which such 'tags' could be slotted, in an effort to produce as faithful a reproduction of 'Für Elise' as possible. The third element was considered by analysing AT's inaccuracies in reproduction, and judging their coherency and function within the greater context of the piece, in order to speculate about the nature of the musical *bundle* she had stored in long-term memory. This led strategically to an investigation of the fourth element of the MPM model, which entailed an analysis of AT's use of specific musical material, accurate or otherwise, and the manner in which she transformed and modified this in order to reproduce the piece as coherently as possible. Specific 'errors' were analysed by observing the extent of the inaccuracy, and the measures that were taken, if any, to correct them. The fifth element of the MPM model was examined by observing AT's accuracy in reproducing parts of the piece to a given accompaniment, and by evaluating her understanding of the global structure of the piece. This was analysed by paying particular attention to her knowledge of the relationships between particular sections of the piece, and her sensitivity to the given

accompaniment. The next step in analysis entailed observing the level of creativity that was involved in AT's reproductions of 'Für Elise', and her ability to borrow musical material that she had encoded from sections of 'Für Elise', and insert it coherently. Finally, an overall judgement was made of her ability to track and manipulate the musical narrative of 'Für Elise'. This was judged according to her perceived understanding of the piece in its global form.

By monitoring AT's progress with 'Für Elise', it was also possible to evaluate the impact of the role of practice, and AO's teaching strategies, on her musical development. Furthermore, it facilitated an observation of changes in her motor-coordination and finger dexterity as the study progressed. This was judged according to improvements in fluidity and dexterity.

- Analysis of AT's improvisatory output

A detailed musical analysis was carried out on one particular musical improvisatory episode. A similar approach was taken in analysis to that outlined above. Each element of the MPM model was investigated to ascertain if AT's improvisatory musical output provided further evidence for the presence of a MPM. More specifically, each 'decision' she made musically, was analysed in the context of an ostinato harmonic accompaniment that was provided by AO. Her decisions were judged according to their 'coherency' as dictated by commonly accepted rules of western diatonic music, on a harmonic, melodic, and rhythmic level. Again, attention was paid to her apparent 'errors' (musical utterances that were judged to be less accurate in the context of the given accompaniment), and the measures that were taken to correct and resolve such 'errors'. By analysing the 'fit' of AT's improvisation, from bar to bar, and in terms of overall narrative and structure, it was possible to evaluate her ability with regard to each of the seven musical abilities that are governed by the MPM. This in turn facilitated an evaluation of the extent of her overall inherent understanding of the rules and principles of western diatonic music, her developing musical ability and the extent to which she presents as a musical savant.

Interview analysis

The interview that was conducted with AT's mother was analysed with the intention of gaining a more complete perspective of AT's character, in order to judge her interactions, both musical and otherwise, as accurately as possible. In addition, the interview was used to gain insight into the level of support and encouragement that AT received in her home environment, and how this may have been involved in her developing musical ability.

Potential issues during the analysis phase of the research process included the tendency to seek out evidence that favoured the overall premise of the project, while neglecting to acknowledge disconfirming evidence. In order to address this issue it was necessary to be aware of the impact of researcher bias, and to triangulate between all sources of evidence. AT's parents and AO were consulted before reporting the findings as they are presented in this dissertation. Efforts were made to ensure that this report provides an accurate portrayal of AT, and her musical ability and development as demonstrated during the observation phase.

3.4 Conclusion

The purpose of this chapter was to outline the research methodology that informed this study, and the procedure that was employed throughout. In sum, a single-case study design was employed as it appeared to be the most effective approach to investigating the topic of this study. This chapter has highlighted the strengths and weaknesses of this approach and the efforts that were made to implement it as successfully as possible. This chapter has also described the participants, and their respective roles in this study. Chapter 4 and Chapter 5 will delineate in more detail how various aspects of AT's musicality were assessed and monitored over the course of the study, with an analysis and discussion of some of the findings that emerged.

Chapter 4: Investigating current assumptions about music and Williams Syndrome

4.1 Introduction

The literature review that was presented in Chapter 2 outlined some of the current assumptions about musical abilities in the WS population. Chapter 3 described the manner by which the current study was approached to investigate and critique some of these assumptions, and to integrate the findings to describe AT's musical development holistically. This chapter will comprise a discussion of some of the aspects of AT's musical development, and the implications that these observations may have on current assumptions regarding music and WS. The first section will be concerned with outlining observations that were made with regard to AT's engagement and affinity with music. The second section will address pitch – specifically the issue of absolute pitch (AP) in WS, after Lenhoff et al. (2001) – and harmony processing abilities, and the implications that the findings of this study may have for the WCC account of cognition (Frith & Happe, 1994). Finally, this chapter will also include a discussion of the rhythm abilities that were demonstrated by AT, after Levitin and Bellugi (1998).

4.2 AT's musical engagement

One of the strongest current assumptions about musicality and WS is that individuals with WS present with a particularly strong affinity and emotional involvement with music. Indeed, this was evident in the case of AT. It was possible to draw this conclusion based on the data that was gathered during the interview that was conducted with AT's mother, as well as by observing her enduring motivation and dedication during each weekly piano lesson. This was further supported by the observation that took place in AT's school, which was utilised to compare her behaviour and general disposition inside and outside the music lesson environment.

Prior to the commencement of this study, AT had received very little formal musical input. However, her mother noted that her engagement with music was evident from infancy, recalling that

as an infant, AT was always fascinated with sound and music. She exhibited signs of hyperacusis[7] early on, becoming "obsessed" with sounds, and with toys that made sound. She was also extremely sensitive and avert to particular sounds, to the extent that her mother couldn't use a blender or a hoover when AT was nearby. AT's mother noted that this sensitivity has since eased considerably as AT has learned to tolerate more sounds. AT's mother recalled how

> "The only way she would eat in the early years was if we were watching TV and an ad came on, because it was louder, there is music and that's when she would open her mouth and…we would need to take that chance to kind of feed her...She would perk up the moment an ad came on. It was just the music..."

Having undertaken research into WS, AT's parent's were also aware of the link between WS and musicality, and were eager to explore this in their daughter. They recalled that, when she was five years old, she often became engrossed by a toy piano that they had at home, once playing something that sounded like 'Twinkle Twinkle Little Star'. They decided at this point to begin her formal musical education. However, on this occasion, AT attended only two piano lessons before giving up. Reflecting on the brevity of this engagement, AT's mother commented that she was too young, that there was "no comprehension", and that the teacher "didn't know how to deal with her". This was the extent of her formal musical education until she commenced piano lessons with AO, which coincided with the beginning of this study.

Neither of AT's parents have been musically trained, nor, according to them, are practising musicians in any regard, apart from a short period when AT's mother, as a child, played the harmonium. When asked about the musical involvement of their extended family, AT's mother commented "nobody in my family, except for my [first] cousin who plays the guitar very well...Other than that no musicality really...' However, she also stated that she herself is "addicted to music", emphasising that AT was exposed to a wide range of musical genres from an early age and has grown up surrounded by (mostly western) music. In describing AT's informal engagement with music, her

[7] Hyperacusis is 'an abnormally strong affective response to certain categories of sounds' (Hopyan et al., 2001).

mother emphasised her enduring obsession with particular songs, and how she can "latch onto one song...and listen to it a thousand or fifteen hundred times". She implied that AT seeks out repetition and pattern in music, more so than in other aspects of her life, and commented that "with music she is totally focused". During the interview, AT's mother contrasted her ability to concentrate on music with her difficulty in other areas such as numeracy and literacy.

AT's mother's reports of AT's musical involvement provide strong evidence that she is typical of WS in the intensity with which she engages with music. This assumption was supported by observing her energy, focus and motivation during each weekly lesson which was considered remarkable for such a young student. During lessons, AT often played for periods as long as 25 minutes without taking any break, never appearing to tire of playing the same music repeatedly. Even when AO sometimes suggested that she take a break and listen while he played something, she often either sang along or asked if she could play. Over the course of this study, her focus appeared to strengthen, with concentration improving each week. Indeed, this varied from week to week and was presumably influenced by external factors to some extent. However, by Lesson 24, she appeared to be focused on the music for the entirety of the lesson, which was considered an impressive feat, particularly compared to her concentration in the school environment which is discussed below. It was evident, from her bright and cheerful disposition each week, that she enjoyed each lesson, which was marked by spontaneous bursts of laughter, often in response to some musical expression played by AO. This was also confirmed by her parents who often commented that AT was "a different girl" during her weekly lesson, and implied on a number of occasions that it was the only weekly event for which she became animated.

Indeed, this was further supported by the observation that was conducted at her school where it emerged that she seemed a lot less focused and interested in an alternative education environment. In a class of approximately thirty peers, it seemed that AT was rather withdrawn from the general classroom activity. Her enthusiasm in responding to the teacher's instructions was much less than that observed in her weekly piano lessons. While she continued to exhibit signs of high sociability with her peers, she appeared a lot less confident in the school classroom environment, often looking to

others for guidance in following instructions from the teacher. It appeared that her impairment had more of an impact in this environment, as she faced certain tasks with less competence and confidence than that observed in her weekly piano lessons. She also appeared more distracted in the school environment. For instance, during a reading activity, she spent little time looking at the book, and appeared to lack focus in this activity. It is worth noting that my presence on this occasion may have had an impact on her behaviour, and there were moments when she looked to see where I was. Nevertheless, this observational exercise was useful as it enabled an evaluation of the extent of her focus and enthusiasm for musical endeavours in the context of her overall disposition.

In sum, it emerged quite strongly that AT maintained an extremely strong and enduring engagement with music, and the evidence from this case study is consistent with Levitin et al. (2004) in this regard.

4.3 Processing of pitch and harmony – Evidence of a cognitive processing style

4.3.1 AT's AP abilities

Following a critique of the literature that reported findings of the pitch processing abilities of individuals with WS (Lenhoff, 2001, 2006), AT's pitch processing abilities were observed during this study in order to explore this area further. In particular, attention was paid to her absolute pitch (AP) ability, and how this was manifested throughout her early musical development. It emerged early in the observation phase that AT did possess AP, and this was confirmed by an informal test that was conducted by AO in Lesson 13 (see Excerpt 1). This test was introduced as a game in which AO asked AT to close her eyes while he played a series of notes on the piano, asking her to repeat each note after him. The 'game' unfolded as follows (Table 4.1):

Table 4.1. Results of a 'game' which tested AT's absolute pitch abilities.

Test Pitch – Played by AO	**AT's Response**
B flat 4	C5
C4	C5
G4	E5 – C6 – A5 – G5
A4	A5

These results report an accuracy score of 50%, if the third note, G, is discounted, because it took four attempts for AT to replicate it. However, AT's AP abilities appeared stronger than this, which is better evidenced by the video Excerpt 1. According to the 'zygonic formula of intentionality' which was devised by Ockelford (forthcoming), and utilised to calculate the probability that a child has AP following a scenario similar to the one outlined above[8], one can assume that AT does indeed possess this ability. It is speculated that her miscalculations, when responding to the first and third pitch, were due, in part, to her developing awareness of where the pitches are physically and spatially located on the keyboard, not her inability to hear and match the exact pitch. This is supported by her responding to pitches by playing them in an octave different to that in which AO played, suggesting that she processed each note according to its absolute and distinct properties, and not to any relative pitch associations. This is known as octave equivalence (Rakowski, 1993 as cited in Ockelford, forthcoming) and is typical of AP possessors.

Her AP abilities were further demonstrated later in the same lesson when she spontaneously started to play with a tone chime – the notes of which are pitched in a high register. After playing a number of notes, AO then played a note, A, on the tone chime and asked her to find the same note on

[8] Ockelford (forthcoming) outlined a scenario, similar to the 'game' in which AT participated, wherein a student imitated two pitches out of six that were played by the teacher. Using the 'zygonic formula of intentionality', Ockelford concluded that the probability of these results occurring is low (7%), and so the likelihood that this student has AP is very high (93%). Based on these calculations, and AT's response score of two out of four (discounting the third trial), it is possible to conclude that she too possesses AP.

the piano (Excerpt 2). AT immediately responded by playing A in a lower register. Again, her decision to play in a lower register to that of the pitch stimulus is evidence of her ability to hear the absolute properties of a pitch. AO continued testing her in a similar manner, the results of which were as follows (Table 4.2):

Table 4.2. Results of second informal test for absolute pitch abilities.

Test pitch – played by AO on tone chime	**AT's response – played on piano**
A	A
A	F-B-A
D	D
E	G-F-E
F sharp	F sharp
G sharp	G-A-G sharp
A	A

Her inaccuracies in this instance, for the second, fourth and sixth pitches, were again judged to be a result of her imperfect awareness of where each note is located spatially on the piano. Her immediacy in response, as can be seen on the video excerpt, suggests that her AP abilities are perhaps stronger than that represented by these results. Her ability to match pitches to the tone chime also suggests that her ability in this regard is not limited to pitches that are presented in a piano timbre. Based on the evidence presented here, AT is in fact considered to possess exceptional AP abilities, which may not be fully realised at this early stage of her musical education. This evidence also suggests that her auditory processing may be more advanced than her visuospatial processing, as it was speculated that her inaccuracies during this exercise were attributable to her visuospatial impairment.

With reference to the AP literature, AT's case supports the notion of an increased prevalence of AP in the WS population (as proposed by Lenhoff et al., 2001). However, AT's case is also evidence that it is not necessary to label pitches in order to possess AP. Evidently, AT possesses this

ability despite her inability to match pitch stimuli to categorical verbal labels. This has implications for current assumptions about AP, as well as the methodological measures that are used when testing for this skill. While Lenhoff's conclusions were based on participants' abilities to label pitch stimuli, it appears a more accurate and inclusive measure, that does not rely on the ability to verbally label pitches, may be necessary to evaluate the significance of this skill in the WS population.

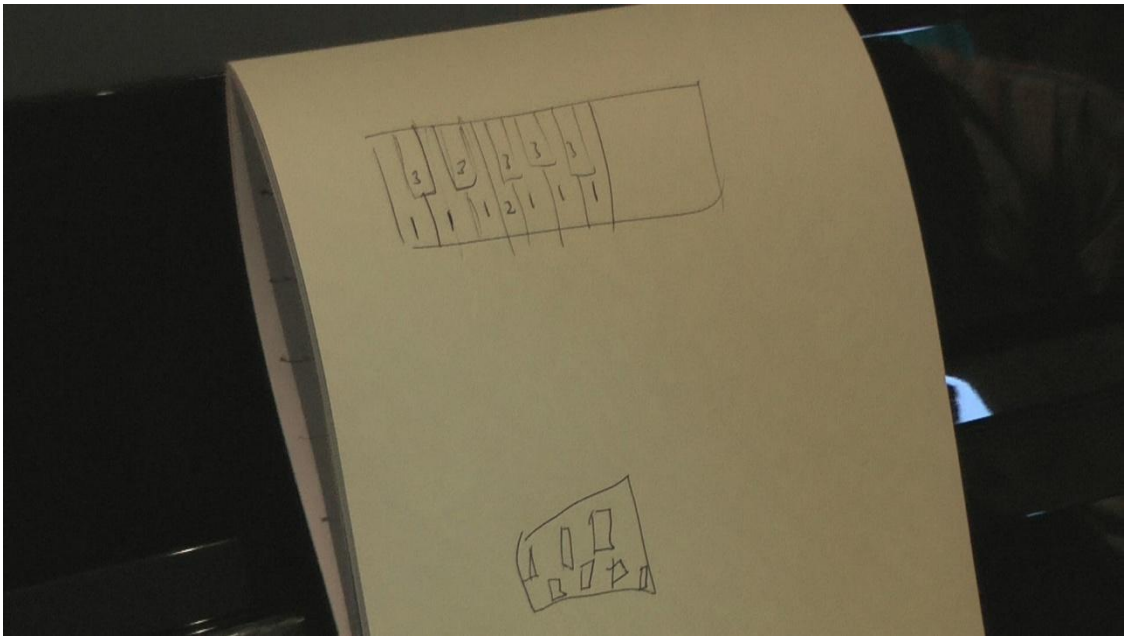
Furthermore, these results have implications regarding the notion of a 'critical period' for acquiring AP, in the general population as well as the WS population. Lenhoff (2006) surmised that the normal critical period of age 3-6 may be extended in the case of individuals with WS. Indeed AT's case could be utilised as support for this as she did not begin her formal music education until she was seven years old. However, if AP can be acquired before the ability to label pitches, as is suggested by the results reported here, it is difficult to ascertain exactly when such abilities are manifested during musical education, if not before this even commences. It may be more useful to consider AP as a skill that is learned in early childhood due to an extreme sensitivity to sound qualities, which AT exhibited as reported by her mother's recollection of her behaviour during that period. This sensitivity may have arisen as a result of the delayed development of language – both comprehension and production - acting as a compensatory device as has been suggested by Miller (1989), which facilitated AT in relating to the world in non-linguistic ways. It is hence speculated that formal musical education is only required in order to realise AP in musical terms.

AT's AP abilities also provide support for her emerging savant profile as this skill is considered necessary for the development of savant musical ability. When her exceptional ability in pitch processing is considered alongside her impairment in other cognitive domains, it appears that she presents with developing savant potential, according to accepted definitions of savant syndrome (see Chapter 2). Due to the lack of a standardised measure or criteria to evaluate savant ability, it is difficult to make a definitive judgement in this regard. However, it is evident that AT's musical ability, at least in the domain of pitch, is particularly strong in the context of her overall cognitive profile. This was investigated in other aspects of her musical development and will be discussed further in Chapter 5.

4.3.2 Implications for cognitive processing in WS

AT's AP abilities also have implications regarding her cognitive processing. The WCC account (Frith & Happé, 1994) of cognitive processing was outlined in Chapter 2, with regard to how it has been employed to explain the high incidence of AP in autistic populations. This theory is based on the premise that individuals with autism maintain a local processing bias when attending to stimuli, facilitating them in hearing the unique qualities of individual pitches, rather than processing pitches relative to other pitches (globally), which is more common in the neuro-typical population. AT's case offers an opportunity to investigate if the WCC theory may similarly be applied to WS. The 'game' that is outlined above has revealed that AT does indeed possess AP abilities. However, it does not provide strong evidence of a local processing bias beyond this as it did not include a component that would require global processing. However, a local processing bias was further evidenced in Lesson 2, when AT demonstrated her approach to drawing (see Figure 4.1 below). AO sketched a picture of one octave of a keyboard to demonstrate the correct fingering for playing a chromatic scale. AT responded voluntarily by replicating this drawing, but in her own style. Her drawing demonstrates how she processed and reproduced the visual stimulus by attending to each individual component that was presented in AO's drawing rather than integrating it into a perceptual whole or 'gestalt'. By drawing a frame similar to that in AO's representation, in which she drew a number of individual keys that appeared to bear little relationship to each other or to their location on the keyboard, it appears that a local processing style was implemented. This is typical of the drawing abilities of individuals with WS as reported by Rondan et al. (2008).

Figure 4.1. Drawing of keyboard by AO (top), and an attempted imitation by AT (bottom).



This suggests that a local processing bias does prevail in AT's case, at least in the visual domain, and, along with the increased incidence of AP in WS, warrants further investigation into the applicability of the WCC account to explaining this skill in the WS population. However, it is worth noting here that AT also demonstrated her ability to process music in a global sense, particularly in her approach to harmony, a musical component which hasn't yet been investigated in any great detail with the WS population – see below.

4.3.3 AT's approach to harmony

Further evidence of AT's cognitive processing style was generated from an observation of her approach to the harmonic elements of some musical pieces. On several occasions, after hearing the performance of a piece by AO, she opted to reproduce the bass line rather than the melody. This may be interpreted as evidence of both local and global processing in operation concurrently – local in the sense that her ability to attend to each individual bass line pitch may have facilitated her recall, and global in the sense that she was capable of attending to the entire piece in terms of its harmonic structure. Her ability to process and reproduce harmony was observed as early as Lesson 2, when AO was demonstrating five-finger scale exercises, using a harmonic accompaniment to anticipate a

modulation to the key a semitone higher for each repetition of the scale. For instance when modulating from C to C sharp, AO played a C augmented chord, introducing the dominant harmony (G sharp) of the next key. AO modulated to each subsequent key in a similar fashion. After hearing several repetitions of this pattern as demonstrated by AO, AT attempted to replicate, playing the five-finger scale with her right hand, and seeking out notes with her left hand in an attempt to replicate the harmony that AO had played earlier (see Excerpt 3). The video excerpt provides strong evidence that she had processed AO's demonstration in both a local and a global sense, suggesting that she could hear the augmented harmony of each scale internally, after each repetition.

AT's ability to process harmony was also demonstrated in her reproduction of the bass lines of a number of pieces, one of which was 'Somewhere Over the Rainbow' (Arlen & Harburg, 1939). AO performed this piece (in the key of E flat major) during Lesson 8, after which a recording was uploaded onto YouTube to facilitate AT's learning. The following week, when AO suggested that they played 'Somewhere Over the Rainbow', AT began to pick out a bass line in the lower register of the piano (see Excerpt 4). She was playing in C major and it was not very clear what she intended to do. AO started to play the melody in E flat major (as he had done in the previous week) to remind her of the tune but AT stopped him and instructed him to start on C, while she continued to pick her way through a bass line in C major. It seemed that she had assimilated the overall harmonic structure of the piece rather than just the melody, and she was eager to reproduce this harmonic bass line. AT's mother informed us that, in fact, she had played several different arrangements of 'Somewhere Over the Rainbow' to AT during the previous week, which explained why she had learned the piece in a different key. Her eagerness to play the bass line, rather than the melody, in the first instance, demonstrates AT's keen sense of harmony, and the facility that she has in reproducing that harmony. It is evidence of a very strong auditory processing ability and sense of inner hearing, as it appeared that she had internalised the entire piece with all its component parts. Her ability to reproduce both the harmony and melody of a given piece suggests that she had processed this piece globally, attending to the overall structural features as well as the local features. By insisting that AO started the melody on a particular note (C), it appears that she had remembered a particular version of the tune according to

the absolute values of both the melody notes and the harmony notes. Therefore, she had also processed the piece at a local level. So, from an observation of this short extract, one can extrapolate that both local and global processing styles were employed in the learning and recall of a piece of music.[9]

In addition, AT's progress with 'Für Elise' – which will be discussed in greater detail in Chapter 5 – revealed that she had successfully internalised the entire structure of the piece according to its distinct sections and harmonic framework, implying her ability to employ global processing strategies. Having observed evidence of both local and global processing in AT's musical processing and production, it is speculated that she may be flexible in her processing style, utilising the most effective style dependent on the task. This is consistent with Deruelle et al. (2005), who reported evidence of an equivalent ability to process both local and global elements of musical stimuli in individuals with WS.

Apart from the implications that AT's observed approach to harmony has, regarding the way in which she cognitively processes music, it is also in line with recent findings reported by Mazzeschi et al. (2011), which suggest that savants tend to process musical textures from the bottom up, attending to the bass notes in the first instance, unlike non-savants who more typically attend to the higher notes. Based on this, it appears that AT's tendency to process and reproduce the bass lines (rather than the melodies) of some pieces provides further support for her emerging savant profile.
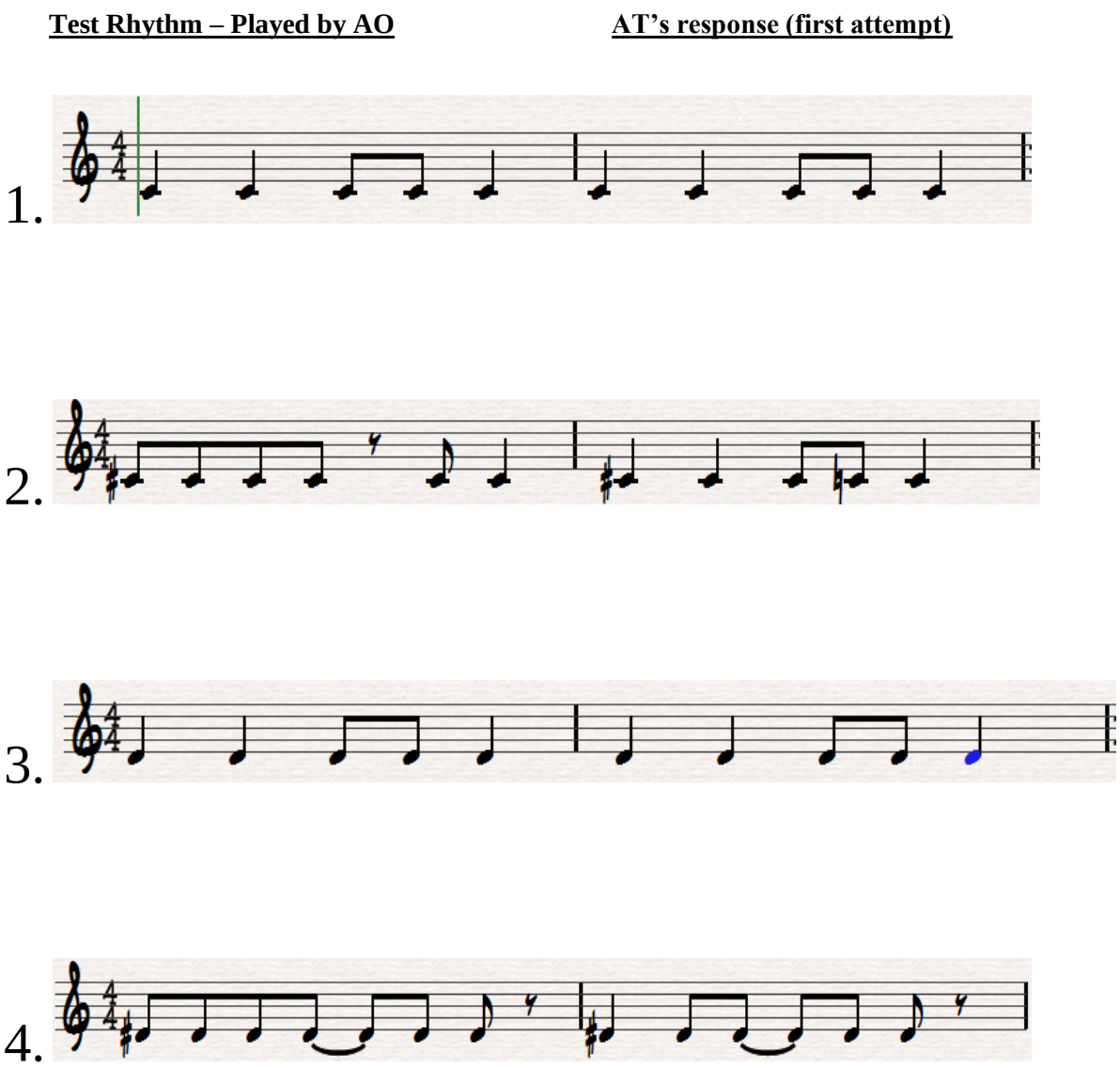
4.4. AT's rhythm abilities

One of the strongest findings with regard to musicality and WS, as outlined in Chapter 2, is an apparent enhanced ability with rhythmic aspects of music. To reiterate briefly, Levitin and Bellugi (1998) reported that WS participants performed as well as a control group with an echo-clapping task. In addition, the WS participants' errors were judged to be more rhythmically compatible than the control group's errors, suggesting music as a relatively spared, and perhaps even enhanced area of

[9] A transcription of another reproduction of a bass line is included in Appendix C – 'Sailing' (Sutherland, 1972) – This further demonstrates AT's ability to hear and process a piece in its entirety, while also exhibiting her remarkable facility in reproducing this music from memory.

cognitive functioning in the WS participants. The current study provided an opportunity to explore this further in a single WS subject. Indeed, in Lesson 2, it emerged that AT possessed a similar natural strength in rhythm abilities, also producing what were judged to be musically compatible errors, and supporting the aforementioned findings. Her rhythm ability was judged in the first instance according to an exercise that was initiated by AO in Lesson 2, in which he played short one-finger rhythms on the piano, after which AT attempted to repeat each rhythm (see Excerpt 5). This exercise was transcribed and is presented in Figure 4.2 below.

Figure 4.2. Evidence of AT's rhythm abilities. AT's response is notated in the second bar of each trial.



It is evident from this exercise, that AT's responses were inaccurate as often as they were accurate. However, in each trial she produced a rhythmically compatible response maintaining the boundaries of the 4/4 time signature set by AO, and including in her rhythms mostly crotchets and quavers, similar to AO. In trials 2 and 3, she responded immediately, playing her rhythm as if it was beginning on the downbeat of the next bar within a phrase. This is consistent with the findings reported by Levitin & Bellugi (1998), whose participants demonstrated a similar ability to conserve metre throughout this task. Admittedly, the exercise that is presented here was a short musical utterance, the results of which may not yield great insight into AT's overall musical ability. Furthermore, her apparent 'success' with this task may have been facilitated by AO's responses to her responses. For instance, in the third trial, AO replicated the inaccurate rhythm that AT had played in the previous trial, which may have facilitated her immediate and accurate response in this instance. However, this episode provided a valuable picture of AT's natural rhythmic abilities at the very early stages of musical education, that are wholly consistent with the rhythmic abilities of other WS participants (Levitin & Bellugi, 1998).

AT's rhythmic facility was further evidenced in her playing over the duration of the observation phase of this study. Particularly during periods of musical interaction with AO, AT demonstrated her ability to take cues according to the temporal framework of particular pieces, and at times opted to clap along while AO played, strongly maintaining the rhythm.

4.5 Conclusion

This chapter has attempted to yield an insight into some aspects of AT's developing musical ability, and the extent to which the findings in this instance are consistent with current assumptions about musicality and WS. Indeed, the aforementioned evidence supports the notion of an increased prevalence of AP in the WS population, as well as a relatively enhanced rhythm ability. This chapter has also considered the enhanced harmony skills as exhibited by AT, warranting further research into this domain which may potentially be another area of relative strength in WS. Furthermore, AT's approach to processing harmony may be representative of the strategy that is typically employed by

musical savants. The evidence presented here also enabled an investigation into the cognitive processes that were in operation while attending to specific musical components. AT's case suggests that it may be possible to discuss the higher prevalence of AP in WS in terms of the WCC account (Frith & Happé, 1994). This account could potentially be adapted to account for a more flexible cognitive style, acknowledging the ability to also process stimuli globally in WS. The findings presented here have also suggested that AT possesses developing savant musical ability, which will be discussed further in Chapter 5. The next chapter will also continue to explore the cognitive processes that appear to be implicated in AT's developing musical ability.

Chapter 5: Analysis and Discussion of AT's Creative Reproduction and Improvisatory Output

5.1 Introduction

Chapter 4 presented some of the findings that emerged with regard to AT's developing savant musical ability, and the implications that these may have for current assumptions about musical abilities in the WS population. It also considered AT's case in terms of the cognitive processing styles that may be implicated in WS, with an analysis and discussion of her musical ability in the context of the WCC account of cognition, (after Frith and Happé 1994; Happe & Frith, 2006). The latter half of this chapter will continue to observe the cognitive processes that appear to be implicated in AT's musical development, this time investigating the presence of a 'Music Processing Module' (MPM) in working memory, as delineated by Ockelford (2007b, 2008, 2010 – see Chapter 2 and Chapter 3). To reiterate briefly, this model is built on the premise that when individuals are producing music, whether it is a reproduction of a piece or an improvisatory utterance, they strive, first and foremost, to produce something that makes musical sense according the rules that are inherent in the given style system. The MPM contains musical fragments and structures which are accessed and retrieved to produce something that is musically coherent within a given style system. This chapter will consider two areas of AT's musical development – creative reproduction and interactive improvisation.

The first section will comprise a somewhat general analysis of her progress with a well-known pre-composed piece. This will be utilised to discuss her developing musical ability on a number of accounts. These include the possibility of the involvement of a MPM in this endeavour, and also factors which have had an impact on her musical development including the role of practice and the teaching strategies employed by AO to support her. The latter section of this chapter will pursue a more detailed musical analysis of AT's improvisatory output, which will be primarily concerned with ascertaining if AT's case supports the notion of a MPM in working memory. This analysis and discussion will also provide an opportunity to evaluate further the extent to which AT may be considered a musical savant.

5.2 Creative reproduction of a pre-composed piece - 'Für Elise'

Throughout the observation stage of this study, AT attempted, and succeeded, to play several pre-composed pieces, some of which were discussed in Chapter 4. Many of these pieces were introduced by AO. However, during Lesson 3, her mother informed AO that AT had been listening to 'Für Elise' (Beethoven, 1865) and attempting to play it at home during the previous week. AT proceeded by playing the opening melody of the A section[10],[11] (see Appendix D). Her performance on this occasion, although imperfect, was impressive considering she had not yet received any formal guidance in playing it (see Excerpt 6). 'Für Elise' subsequently assumed a substantial role in AT's developing musical ability, in terms of the proportion of time and focus that was devoted to it in each weekly lesson. It was therefore possible to observe and consider several aspects of AT's developing musical ability by monitoring her progress with this piece. Attention was paid to the role of practice, the effectiveness of AO's teaching strategies, and the effect of her improving finger strength and dexterity on her performance. A detailed summary of AT's week-to-week progress with this piece, and the way in which she approached it and worked on it with AO during each weekly lesson is outlined in Appendix E. By monitoring her progress with 'Für Elise', it was also possible to speculate on the potential involvement of a MPM. This section will analyse specific snapshots of AT's performance of this piece over the course of this study, in order to discuss some of the factors which appeared to impact on her musical development.

5.2.1 Role of Practice

A longitudinal observation of AT's progress with 'Für Elise' provided an opportunity to consider the role of practice in the case of her developing musical ability. Indeed, it is widely endorsed that deliberate practice is a crucial factor in the development of musical skill (Ericsson et al., 1993; Sloboda et al., 1996). It was difficult to evaluate AT's practice routines for practical reasons.

[10] It is useful to consider this piece in terms of its form for the purpose of this discussion. 'Für Elise' is composed in Rondo form (ABACA), in which the opening section, A (bars 1-24), is repeated several times, with contrasting episodes, B (bars 25-39) and C (bars 62-84), played in between each repetition (see Appendix D).
[11] The opening melody, (bars 1-5), was identified as one of the main melodic 'tags' which facilitated AT's reproduction of 'Für Elise' according to the MPM model, due in part to its perceived salience in the context of the piece, as well as its prevalent use in media and advertising which potentially provided a degree of reinforcement for this melody.

AT's parents reported that she would generally practice for approximately thirty minutes per day, which is considered substantial for a student of her age, and at such an early age of musical education. AT's parents also commented that 'Für Elise' consumed the majority of AT's practice efforts, reporting that she is 'addicted' and 'obsessed' with this piece. They reported that when practicing, AT often utilised video clips of performances of this piece on YouTube, to facilitate her learning. This is important in the context of the MPM model, and AT's progress with 'Für Elise' during Lessons 12, 13, and 14.

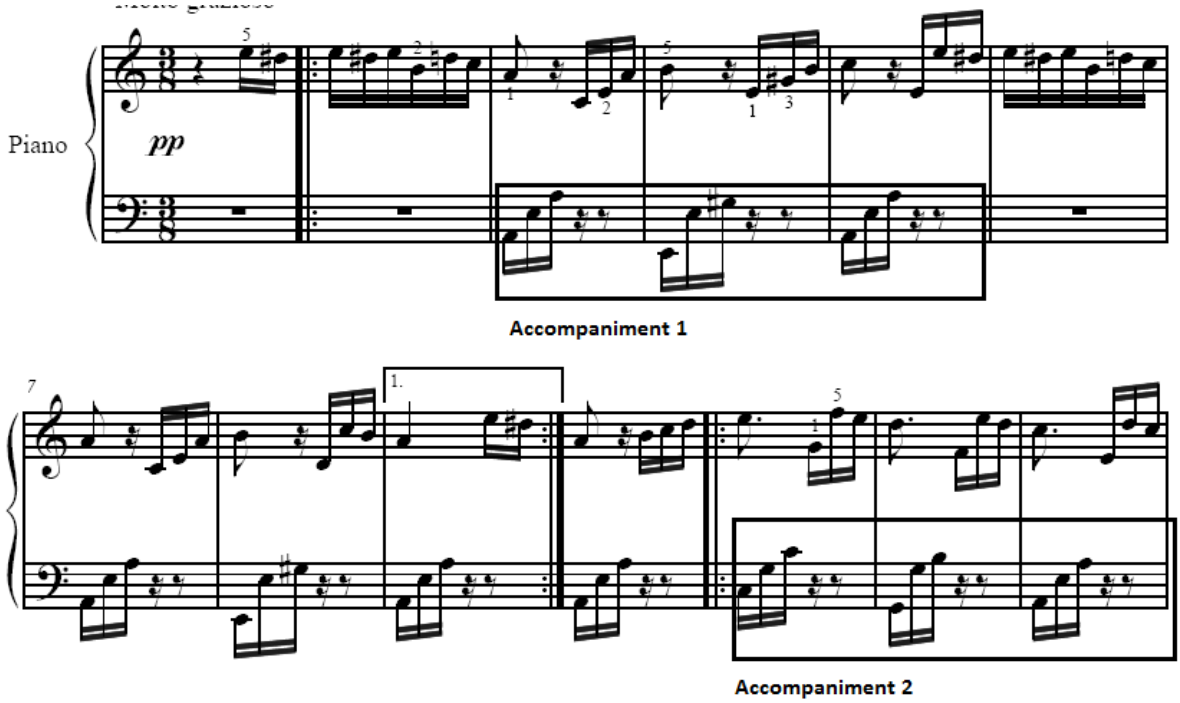
During Lesson 12, AT consistently played the left-hand accompaniment of bars 11-13 (and their repetitions) inaccurately, despite having played these bars accurately in previous weeks. Instead of playing arpeggios in C major – G major – A minor (Accompaniment 2 – see figure 5.1 below), she replicated the accompaniment figure of previous bars: A minor – E major – A minor (Accompaniment 1) (See Excerpt 7). Interestingly, AT's father informed us that they had not had internet access at home during the previous week, which had limited AT's access to YouTube, disrupting her practice routine. In Ockelford's model (2007b, 2008, 2010), he discusses the determining factors when reproducing a piece of music from memory, two of which are salience and reinforcement. Presumably, AT was not exposed to the same degree of reinforcement, through repetition of 'Für Elise' usually accessed on YouTube, which contributed to her errors in playing from memory. In order to compensate for her imperfect recall she, apparently unwittingly, filled the void by borrowing material from an earlier section of the piece. Presumably, she intuitively knew that the borrowed material would create a musically coherent reproduction - which it essentially does as the progression in A minor continues to bear some harmonic relation to the melody in bars 11-13. This implies that a MPM may be involved in this instance. The material she borrowed can be assumed to have contained a salient quality, in accordance with the MPM model, because of the presence of this accompaniment figure from the very beginning of what is arguably the most memorable melodic fragment of the piece (bars 1-5).

Notably, AT did not attempt to perform 'Für Elise' at any stage during Lesson 13, at which time the family had still not recovered their internet access. While this may be coincidental, it is

tempting to consider this as a consequence of the increasing lack of reinforcement available to AT during the two weeks preceding Lesson 13, especially considering her efforts in Lesson 14, at which time the internet access had been recovered in AT's home. During Lesson 14, AT appeared more eager and confident when working on 'Für Elise'. Although she repeated the aforementioned error once, she corrected it in a later repetition and continued to play this section accurately thereafter.

Apart from creating an opportunity to speculate with regard to the potential presence of a MPM, the aforementioned events of Lessons 12, 13, and 14 are evidence that practice is a crucial factor in the development of musical ability. While the aforementioned musical episodes were somewhat minor in the context of AT's overall musical development, they reveal the impact that deliberate practice, or a lack thereof, can have on one area of musical development.

Figure 5.1: AT played Accompaniment 1 in the place of Accompaniment 2 during Lesson 12. Extract taken from http://www.forelise.com/media/for_elise_sheet_music.pdf (accessed on 1-8-2011).



5.2.2 Role of AO's pedagogical support

It was possible to assess the rate at which AT's improving technique was facilitating her reproduction of this piece by observing her longitudinal progress with 'Für Elise'. Undoubtedly, her

observed improvement in playing this piece may be attributed to her increasing familiarity with it as a result of exposure, reinforcement and practice. However, it also emerged that her performances became more competent and confident over time as her fingers appeared to grow increasingly stronger and more dextrous. This was further facilitated by AO's approach to working with AT on this piece, which reflected his approach to teaching in general.

During each weekly lesson, AO never imposed a strict agenda, rather allowing AT to dictate the proceedings of the lesson – which often resulted in a lengthy passage of playing 'Für Elise'. Paying close attention to AT's efforts with this piece, it appeared that AO was intent on understanding AT's internal representations of the piece, in order to facilitate her in realising it in sound. He encouraged her to play with both hands and responded to any consistent errors by demonstrating, rather than instructing, how to perform the piece more accurately. AO placed particular emphasis on fingering, encouraging AT to use all her fingers and thumbs when playing. Indeed, it took some time for AT to follow this advice, as she often played using only a few fingers. However, by Lesson 24, it appeared that AO's enduring encouragement on this point had taken effect as she played the A section, with both hands, using the fingering that had been repeatedly demonstrated by AO in previous weeks. This ultimately resulted in a more fluid performance of this section (see Excerpt 8). Undoubtedly, the improvement in AT's finger strength and dexterity was also a consequence of the finger technique exercises that AO encouraged each week. These mostly consisted of five-note scale exercises, where again the emphasis was on fingering.

Regular correspondence with AO provided an opportunity to reflect on his approach to teaching in this context. From the onset, it appeared that his priority was to imbue a sense of enjoyment and trust into the music lesson environment, instilling AT with confidence to explore and express her musical voice through whichever music she wished, while, also, allowing her to familiarise herself with the spatial layout of the keyboard. Encouraging her to be creative wherever possible, AO, also, ensured a steady input of technique throughout. During one discussion, AO stated how he considers this aspect of teaching as crucial, and his teaching strategy is to "squeeze the technique in" whenever he sees an opportunity to do so. For instance, when AT attempted to play the descending chromatic

figure (bars 82-84) in the C section of 'Für Elise', AO used this opportunity to teach her the correct fingering for chromatic scales. Similarly, in the improvisatory episode that is outlined below, AO identified the fact that AT's improvisatory output was largely based around the scale of C major, and exploited it as an opportunity to teach her the scale of C major, with correct fingering, thereafter encouraging her to practice this over the following weeks. An emphasis on developing the ability to 'think in sound' appeared to be inherent in AO's approach to teaching. Apart from introducing the written score of 'Für Elise' on one occasion (Lesson 7), AO did not incorporate any aspects of reading notated music into his lessons – which at any rate may not have been appropriate due to AT's literacy difficulties. Instead he encouraged her to 'learn by ear', as is inherent in the folk music tradition, facilitating this learning with visual demonstrations, some of which were recorded and uploaded onto YouTube to facilitate her learning at home. It emerged that AO's teaching strategies were well suited in AT's case, as evidenced by her progress with 'Für Elise'.

5.2.3 AT's progress and emerging savant ability

An overall observation of AT's progress with 'Für Elise' enables one to broadly gauge the extent of her musical development over the duration of this study. Excerpt 6 portrays her initial attempt to perform the A section of this piece during Lesson 3. Here, it appears that she has familiarised herself with the opening melody, though her performance appears to be impeded by her impaired motor-co-ordination skills, and her limited familiarity with the spatial layout of the keyboard. It emerged early on, during Lesson 6, that AT had apparently internalised the entire structure of the piece beyond the A section, when she voluntarily moved on to the B section picking out the melodic figure in bars 33-37. Her decision to jump from the end of the A section to bar 33, suggests that the figure that is situated in bars 33-37 was perhaps more accessible to her than other fragments of this section: bars 33-37 may have been 'tagged' to facilitate recall, in accordance with the MPM model. AT's awareness of the global structure of this piece was further evidenced in Lesson 7 when AO played the C section, prompting AT to accompany him with a repeated A in the bass register, after which she accurately continued to play the bass line, demonstrating that she was familiar with the harmonic progression of this section. Her apparent understanding of the piece in its

entirety from such an early stage was considered remarkable, and revealing in the sense that it strongly supported the notion that AT possesses savant ability. Having apparently internalised the entire structure of 'Für Elise' long before she could play it, AT demonstrated that her approach to learning music is different to the way most children learn. Instead of proceeding from symbols, through motor patterns to sound, as is typical of most musical education contexts, AT constructed an internal understanding of the piece. In order to realise this internal musical representation in sound, AT was undoubtedly facilitated by her AP abilities which enabled her to map her aural representation onto the piano, with the support of AO who demonstrated the optimum motor patterns for achieving this.

As the weeks progressed, AT became more accomplished at playing the A section hands together, with the left-hand part getting gradually more in synchronisation with the right-hand part as her fingers strengthened. During Lesson 24 (the final lesson that was recorded during the observation phase of this study), AT delivered a relatively fluid and confident performance of the A section (Excerpt 8) revealing her greatly improved technical facility since the previous observation. Her performance in this lesson is a good indicator of her achievements since the beginning of her musical education. As well as accomplishing a great deal in terms of technique and control, it is evident here that AT had developed a strong sensitivity to tempo and dynamics, responding to AO accordingly, and initiating changes in these musical features within her own performance.

AT's progress with 'Für Elise' is regarded as remarkable, considering that that she began playing this piece, in the first instance, without any guidance. Undoubtedly, her progress was facilitated by AO's tuition thereafter, as well as her apparent obsession for, and eagerness to repeatedly practice this piece. That she achieved an expressive and confident performance of, at least part of, what is a relatively difficult piece, is a remarkable feat and further supports the notion that she possesses developing musical savant ability.

The above analysis provides preliminary evidence of the presence of a MPM. This will be discussed in greater detail in the next section.
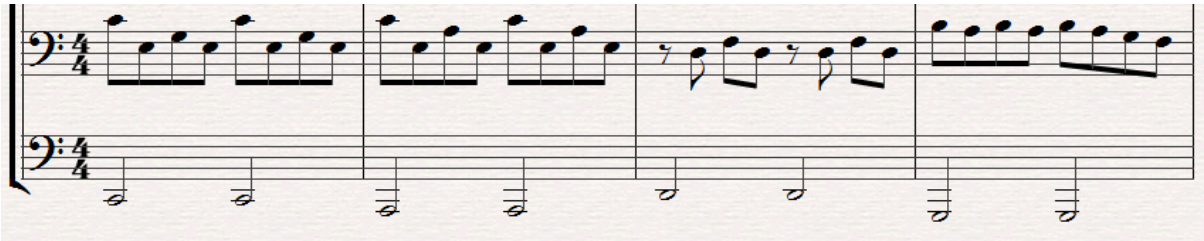
5.3 AT's improvisatory output – Evidence of a MPM?

Some of AT's weekly lessons included periods of improvised 'play' music wherein AO played an ostinato accompaniment which provided AT with an opportunity to explore her creative musical voice. One sample of this improvisatory output, which occurred during Lesson 12 (see Excerpt 9), has been transcribed (Appendix F) and analysed with reference to Ockelford's (2007b, 2008, 2010) model of musical processing, which postulates the existence of a 'Music Processing Module' (MPM), as outlined in Chapter 2 and Chapter 3.

The following analysis and discussion is based on the apparent musical decisions that AT made in 'real time' when improvising to a given accompaniment. Before continuing with this analysis and discussion, it is imperative to note the limitations that are inherent in the assumptions that have been derived. The conclusions that are outlined below are based on one's speculative observations as regards the decisions that AT made when improvising a melody, and how these appear to have been governed internally. Due to AT's inability to reflect meta-cognitively on her approach to improvisation, it was not possible to confirm these assumptions. It is necessary to note that the musical narrative as it is analysed and presented here, may never have been envisaged by AT, and has been to some extent constructed as a result of analysis.

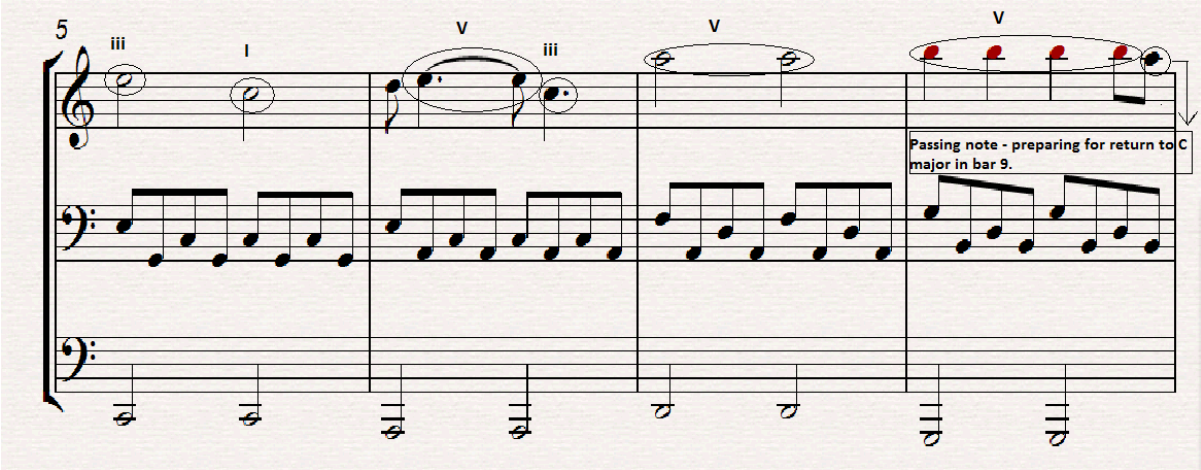
To put this particular sample of AT's musical creativity in context, Bar 1 was played after two repetitions of the ostinato played by AO. This ostinato consisted of the chord progression I-vi-ii-V in C major (See Figure 5.2) variations of which AO had played on previous occasions to accompany AT. Therefore it can be assumed that she was relatively familiar with this harmonic progression.

Figure 5.2: Ostinato accompaniment provided by AO.



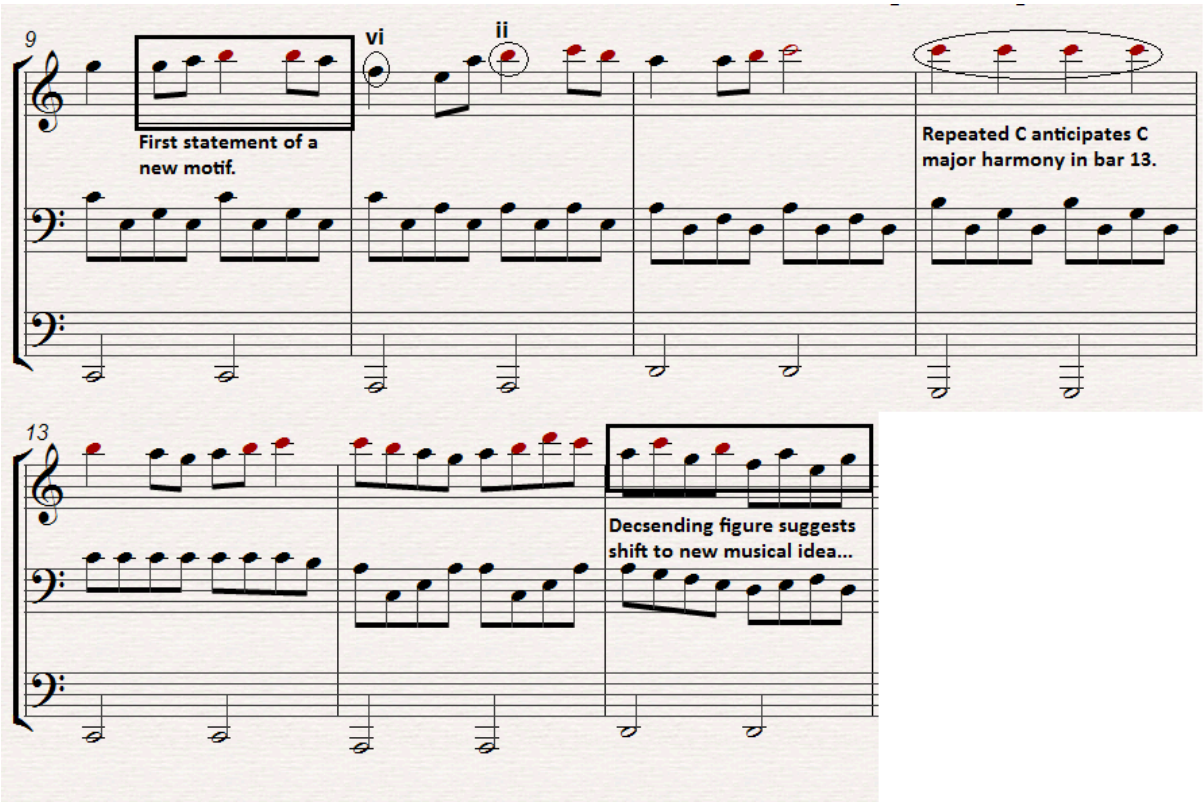
Bars 1-4 appear to be relatively exploratory in terms of what AT contributed to the interaction. Having familiarised herself with the harmonic progression, and apparently extracted from this that the progression was built temporally over a four-bar cycle, she experimented with some notes, perhaps 'getting her bearings' in relation to the harmonic structure of this improvisation, and familiarising herself with the physical location of notes on the piano. In bar 5, she played an E minim (the third degree of the scale of C) on the downbeat, as AO reintroduced the 4-bar cycle with a C major chord. Upon hearing how this 'made sense' in relation to the accompaniment, she seemed to anticipate the change in harmony to A minor in bar 6 and repeated the E, followed by a C (the fifth and the third degree respectively in A minor). Bar 7 was similarly coherent as she played a repeated A (the fifth of the given harmony – D minor) in the upper register, with a solid rhythm (perfectly in time with AO's accompaniment). She continued into bar 8 with similar harmonic consistency, playing repeated B crotchets, which 'made sense' alongside the G major harmony provided by AO. Evidence that she had grasped the repetitive 4-bar cyclical structure of this musical utterance can be seen in the passing note (A) that she played at the end of bar 8, leading in a descending stepwise movement to G, just in time for the reintroduction of the C major chord. Bars 5-8 (Figure 5.3) demonstrate how AT possessed a strong internal understanding of western diatonic harmony, and how she utilised this understanding in creative improvisation to produce something that would be musically coherent, as defined by the rules of this musical system. By playing notes that are generally accepted to be particularly strong (e.g. degrees 3 and 5 of the relevant scales), with a fitting rhythm, she built a firm foundation upon which she could creatively explore for the duration of this interactive improvisation.

Figure 5.3: Bars 5-8, the circled notes are labelled according the degree of the given harmony that each note represents. AT's improvisation is notated on the treble clef, AO's accompaniment on the bass clefs.



Bars 9 – 14 (Figure 5.4) present the introduction of a new musical idea. Having consolidated the C major harmony by playing a G on the downbeat of bar 9, AT, then, introduced a short ascending and descending motif which she developed over the next five bars. AT's playing in these bars suggest that she was still in an exploratory mode as she experimented with this short sequence, using different combinations in a bid to fit with the accompaniment. Rhythmically, she co-ordinated perfectly with the regular 4/4 accompaniment, alternating between crotchets and pairs of quavers. Harmonically however, some of her choices were slightly more obscure than in the previous bars (for example, in bar 10, on beats 1 and 3 – considered to be the strongest beats in 4/4 time – AT played F and B, or the sixth and second degrees respectively of the A minor scale that was implicated in the accompaniment), and one can surmise that she was aware of this in bar 12 when she resorted to playing a repeated C , anticipating that this would anchor her melody with the support of the C major harmony that she was expecting in the next bar. However, in bars 13 and 14, she re-attempted her short motif, this time leading into a descending 2-note sequence in bar 15 which appeared to suggest a shift to a new musical idea.

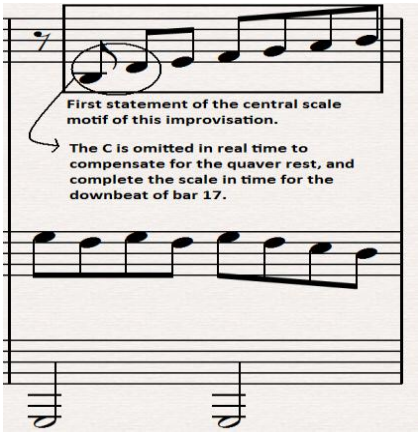
Figure 5.4: Bars 9-15, AT stated and developed a motif, suggesting a shift to a new idea in bar 15.



Bar 16 (Figure 5.5) is particularly interesting in the context of this analysis. Here, AT introduced the main idea of this interaction. Having played nearly all of the previous bars in the upper register, she jumped down to the B below middle C and played an ascending scale. Presumably, the quaver rest at the beginning of bar 16 was not intended but resulted from the time it took for AT to physically move her hand from the G nearly two octaves higher in the previous bar. Starting the scale on B, AT then skipped to D, ascending with quaver notes to land on C on the first beat of bar 17, and, to coincide with the change back to C major in the accompaniment. The decision to omit the C in the ascending scale is revealing in the extent to which it supports the notion of a MPM. One can assume that AT had intended to fit the entire 8-note scale into bar 16, in order to coincide with AO at the beginning of the next bar. However, after playing the B, she realised that she had misjudged her starting note, and decided instantaneously to omit the C in order to reach her target in the next bar. This demonstrates her awareness of the structure of the western diatonic scale and how this has been stored as a fragment in her MPM, as well as the speed with which she could access this fragment and recalculate in real time. In a bid to introduce a new musical idea to this interaction, one that she
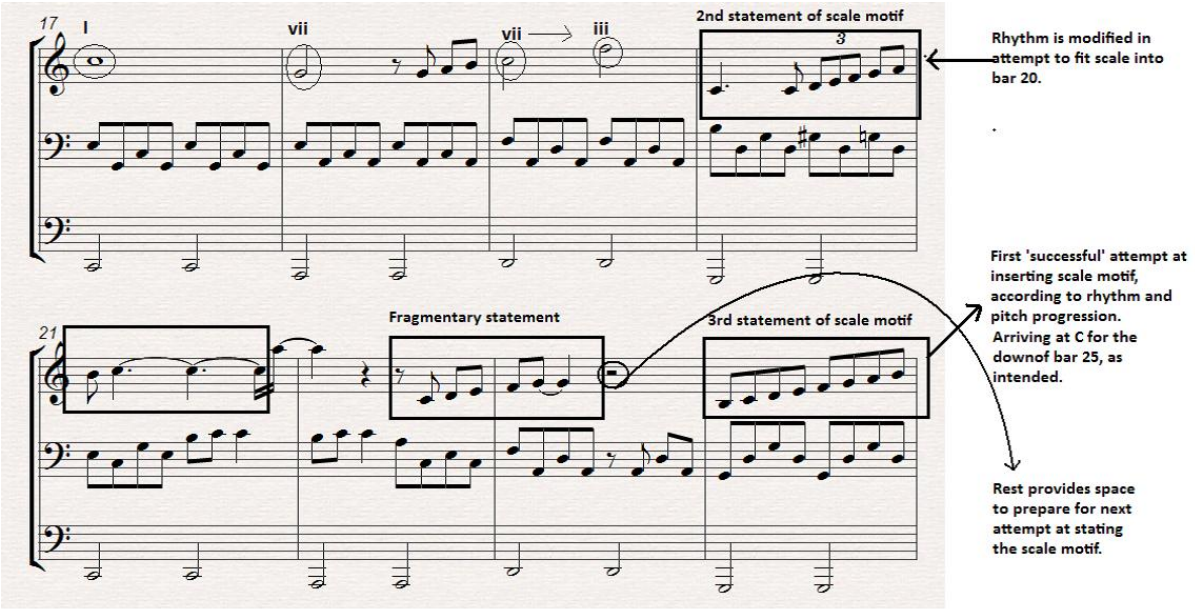
anticipated would fit coherently with the given accompaniment, AT retrieved this fragment and modified it in order to fit temporally within the harmonic structure. Having succeeded in inserting this fragment, AT employed this scale figure as the central motif for the remainder of the interaction.

Figure 5.5: Bar 16



In bars 18 and 19 (Figure 5.6), it appears that AT decided to vary her musical idea somewhat. Playing a G minim over AO's A minor harmony in bar 18, she created the impression of A minor 7 harmony. Theoretically, this more dissonant harmony made less 'sense' than in previous bars where she consistently selected degrees 3 and 5 of the given harmonic scale. In the second half of bar 18, she took a short fragment of the scale of C, perhaps in a bid to create a more consonant sound by utilising material that had previously been successful in doing so. However, by landing on C on the downbeat of bar 19, AT was again contributing to a minor 7 harmony (D minor7). This time, however, she resolved with an F (third degree of the scale), creating a more consonant harmony than in the previous bar. The trial – and – error nature of this interaction provides further evidence of AT's MPM at work. As she retrieved fragments from her MPM, upon hearing the various pitches and their relation to the harmonic progression, she was able to utilise her inherent knowledge and understanding of western diatonic music, to manipulate her improvisation, and to resolve her 'errors', in order to produce something that made strong musical 'sense'.

Figure 5.6: Bars 17-24, AT explores ways in which to present her scale motif.



AT returned to her scale motif in bar 20, this time modifying the rhythm. It appears that upon hearing the G major harmony, she intended to complete the scale in time to land on C on the downbeat of bar 21, when the C major harmony was reintroduced. However, as the first half of bar 20 was taken up with a dotted crotchet C and a quaver C, she decided instantaneously to follow this with a triplet and a pair of quavers in order to compensate and fit as many notes of the scale into this bar as possible. AT didn't manage to fit the entire scale into the temporal space that she apparently intended, being forced to play a B in bar 21, before arriving at a sustained C. The bars that follow this (21-23) may be interpreted as a space that was utilised to recalculate her motif and ascertain how best it should next be inserted. By choosing to play a sustained C in bar 21, followed by A which is tied over into bar 22, AT apparently chose to remain safely within the boundaries of the harmonic accompaniment for these two bars while she mused over how next to manipulate her material. This 'space' also conveys the level of maturity that was present in AT's approach to music-making, and the confidence that she possessed in making these musical 'decisions'.

She reiterated a fragment of the scale motif after a crotchet and a quaver rest in bar 22, after which she left more space with a minim rest, presumably in anticipation of the next bar which contained the G major harmony into which she intended to insert her motif in its entirety. This time

she succeeded in completing the entire scale starting on B, with an even quaver rhythm, landing accordingly on C on the downbeat of bar 25. According to this analysis, bars 24 and 25 are the exemplar of AT's intentions in this improvisatory interaction, in the sense that she had introduced this scale motif, varying it to test its compatibility with the accompaniment, and after a number of trials succeeded in inserting it in a manner that was most musically coherent. After this, she left substantial space, playing sustained C notes, before repeating the motif over the G major harmony (bar 28 – Figure 5.7). Presumably, at this stage she had established the harmonic structure of this interaction, anticipating the G major and C major harmonies on each repetition of AO's ostinato, and rendering these the most suitable bars in which she should play her motif. This time, AT played an upbeat – G – in bar 27, leading into the scale in bar 28. It appears that again, she misjudged her starting note and in order to fit in all the notes of the scale, resorted to playing a pair of semiquavers, to ensure that she landed on C at the start of the next bar as intended. This was AT's penultimate utterance during this interaction after which she did not play for two bars, and appeared to suggest to AO to bring the interaction to a close with a final fragmentary statement of the scale motif in bar 32 (Figure 5.8), which ended on the tonic C.

Figure 5.7: Bars 25–28

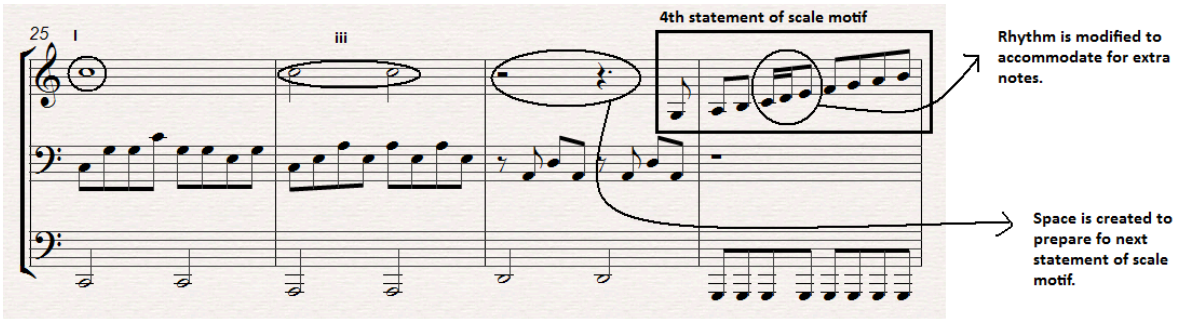
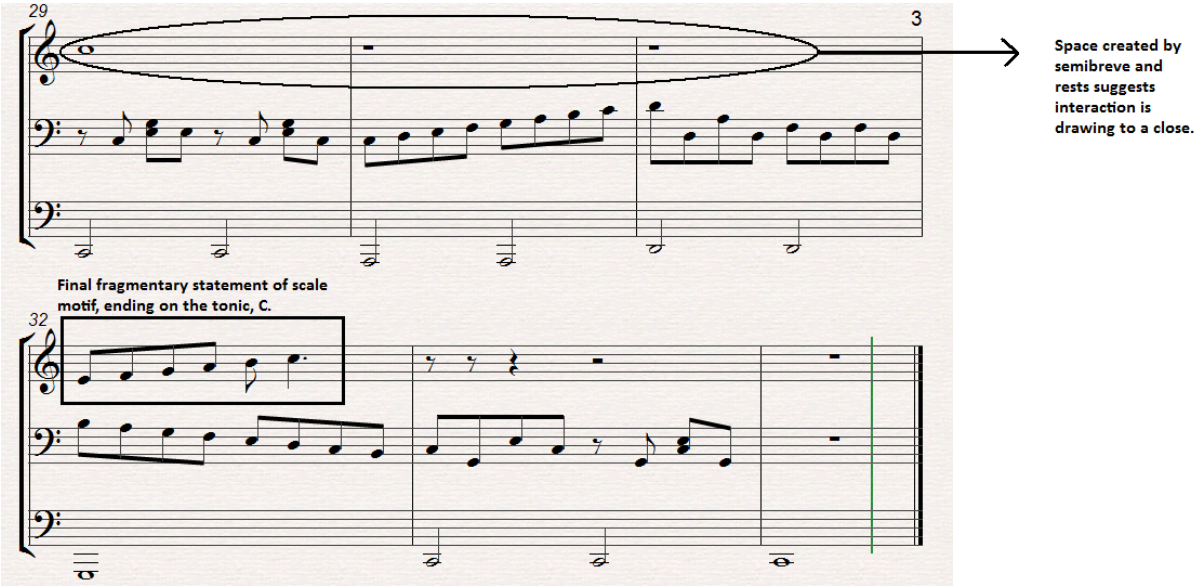


Figure 5.8: Bars 29-34



This relatively brief improvisatory episode has yielded great insight into AT's approach to creative musical improvisation, an analysis of which has afforded an opportunity to derive assumptions with regard to her cognitive functioning. Indeed, this analysis strongly supports the presence of a MPM in operation during such a task, and suggests that the over-ruling principle that governed AT's choices in producing this improvisation was a drive towards musical coherence. This is evidenced by her apparent efforts to produce consonant harmony, and her attempts to correct errors in this bid, in accordance with the rules of western diatonic music. In terms of the seven elements that are outlined in the MPM model (see p. 35), there is evidence of each of them in operation during this episode of interactive improvisation.

Firstly, it can be assumed that AT was drawing on short-term memory traces, with the use of "tags", by observing her repeated attempts to express the central scale motif of the interaction, and the spaces in between each statement, which often consisted of passing material that appeared to anticipate its next statement. Secondly, she appeared very capably, to call up an appropriate style system from her long term memory to accommodate the manner in which she wished to insert these "tags". This is evidenced by her ability to remain firmly within the temporal and harmonic boundaries provided by AO, suggesting that she has a strong understanding of the style system that was in operation. There is also evidence of AT's ability to accomplish the third item outlined in the MPM

model. This was observed in her approach to filling the bars between statements of the scale motif, wherein she often played notes that bore some direct relation to the harmonic accompaniment. For instance, in bars 21 and 22, where it appears that AT was re-examining the material she held in her short-term memory, she filled a void with sustained notes that she knew would 'fit' as was dictated by the information she held in long-term memory. The fourth element of the MPM model was demonstrated by her ability to manipulate her material, with use of addition, deletion, and modification in order to express her musical voice as coherently as possible. Strong evidence of this lies in the manner by which she omitted notes (bar 16) and altered the rhythm (bar 20) of the scale motif in order to achieve an intended level of musical coherence. AT's ability to 'synthesise the selected elements, integrating them "vertically" (harmonically) and "horizontally" (melodically) within the unfolding matrix of pitch and perceived time' (the fifth MPM element), is evidenced by her ability to co-ordinate very accurately within the 4/4 timeframe that was provided by AO. Moreover, her apparent awareness of the harmonic structure of this interaction allowed her to select material that would fit "vertically" with AO's accompaniment, which was apparently governed by an endeavour to produce consonant harmony, as well as to decide when would be the optimum moment, harmonically, to insert the scale motif. Similarly, she was able to express her music very accurately, melodically speaking, incorporating a scale motif which contained its own inherent melodic narrative. Even before this motif was introduced, AT explored material in such a way that seemed to be suitably integrated (bars 9-11).The sixth element of the MPM model requires the creation of new material within the given style system. AT's exhibited the ability to do this when shifting from the musical idea that was explored in bars 9-12 to the scale motif which was introduced in bar 16. She provided a link with a descending figure in bar 15, which ensured short term coherence by filling the gap between the two differing musical ideas. Her aforementioned decision to play sustained notes, which created a consonant harmony, in bars 21 and 22, are also evidence of her inherent drive to ensure coherence.

It appears that the only element of MPM model that AT did not accomplish was the seventh one which required her to 'to track and direct the musical narrative simultaneously at different architectonic and hierarchical levels to ensure longer-term coherence'. An observation of this

improvisation in its entirety reveals that there did not appear to be a global narrative in operation. Rather, it seems that AT was more concerned with directing the musical narrative within each four-bar cycle, than with constructing an overall narrative. Instead of striving to achieve long-term coherence, her priority lay with producing short-term coherence from bar to bar in the context of the I-vi-ii-V progression.

This analysis strongly supports the presence of a MPM and its influence in AT's systematic approach to creative improvisation. By observing her improvisatory output with reference to Ockelford's model, it has also been possible to evaluate the extent of her ability in this domain. That she was well-equipped to accomplish six of the seven tasks, apparently unwittingly, included in this model, after only twelve weeks of formal music education, suggests that she possesses exceptional musical ability, particularly in the context of her overall cognitive phenotype. This conclusion is also supported by referring back to Brophy (2002) – see Chapter 2 - who reported that neuro-typical children of AT's age utilised repeated rhythmic and melodic patterns, with their improvisations containing little evidence of larger structures such as phrase organisation or motivic development, characteristics described as indicators of process-orientation (as defined by Kratus, 1996). AT has demonstrated that she is more advanced than this when improvising and has at least achieved the third level of Kratus' model - product-oriented improvisation. This further supports the notion of AT's developing musical savant ability.

5.4 Conclusion

The purpose of this chapter was to portray an overall impression of AT's musical development by observing her progress with a specific piece of music. This analysis enabled an observation of the role of practice, and the importance of suitable teaching strategies, as they were involved in this case. AT's progress with 'Für Elise' also provided preliminary evidence of the involvement of a MPM. This was expanded with the analysis of an improvisatory episode, as presented here. It is concluded that AT's case presents strong evidence in support of Ockelford's

model. The evidence presented in this chapter has also facilitated an evaluation of AT's musical development in general, and the extent to which she appears to present with a savant profile.

Chapter 6: Conclusions and Implications for Future Research

In writing this dissertation, I have endeavoured to portray, as comprehensively as possible, the experience of a single WS participant at the beginning of formal musical education. A single-case study design has enabled a rich investigation into this subject area, the findings and implications of which are manifold. This chapter will comprise a discussion of the main conclusions that have been extrapolated from this study, and the implications that these have for current psychological assumptions, as well as future research directions.

6.1 Evaluation of research design

As this study was the first of its kind, it provided an opportunity to evaluate the effectiveness of single-case study design in investigating this subject area. Indeed, this design proved effective in facilitating a holistic exploration of AT's musical ability and progress. By observing her musical development in its entirety (rather than isolating one or two aspects), and from a number of different perspectives, it was possible to draw conclusions about her musical ability in the context of her overall cognitive ability and behaviour. Undoubtedly, there are limitations inherent in this research design, some of which were evident during this particular study.

It is possible that the results that have been presented here may have been influenced by researcher bias and the rapport that I developed with AT and her family, and AO, over the course of the study. However, as I have been aware of this, I am confident that such an influence has been minimal. A further limitation of this study is the extent to which AT may be representative of the WS population. It is always difficult to generalise following the results of a single-case study. However, as was stated from the outset, this study was never intended to produce generalisable results. Rather, it was anticipated it would generate useful information that could be considered within the context of what is currently understood about a relatively under-researched subject area. A further difficulty that emerged in reporting AT's case, was implicated in how the written report of this study was presented. Due to space limitations, it was not possible to discuss all aspects of her musical ability and progress,

and therefore it was necessary to select appropriate material in a bid to portray her case as accurately and comprehensively as possible.

The research design employed in this study has facilitated a valuable opportunity to monitor, longitudinally, the early manifestations of savant musical ability in a rare population. Having reflected on the research design that was employed in this instance, it is speculated that further research of a similar kind may be useful, and enable a comparison of cases wherein it may be possible to draw some more definite conclusions about the musical abilities of both individuals with WS and savant syndrome.

6.2 Implications for current understanding of music and WS

One of the primary rationales of this study was to examine some of the current assumptions in this research domain, in the context of AT's case. Chapter 4 outlined and discussed some of the results that emerged that are directly related to existing findings. In sum, AT's case provides strong evidence that a natural affinity with music can be linked to WS. Her case also supports the notion that there is a higher prevalence of AP amongst the WS population, as well as an enhanced rhythmic ability. These findings promote the notion of relatively 'spared', or enhanced, musical abilities in WS participants, as has been previously suggested.

AT's case also afforded an opportunity to critique the notion of a critical period for the acquisition of AP, and the manner by which this has been assessed. It appears that this issue lacks clarity, as a result of differing definitions of AP, and ineffective measures for testing this, particularly in the context of cognitive impairment. The current study has suggested that, based on an observation of the early manifestation of AT's AP abilities, AP was acquired before she ever commenced formal musical education, facilitating her remarkable progress as documented here. It is suggested that her AP ability may be in someway attributable to her language impairment, and the resulting extreme sensitivity to sound which she exhibited in early childhood (see below). It appears that the educational support provided by AO enabled her to utilise her AP ability in a musical context. Therefore, it is suggested that the notion of a 'critical period' should be considered with caution.

This study expanded on current assumptions as regards the cognitive style that is implicated in WS, or more specifically, the relative applicability of the WCC account (Frith & Happe, 1994) to WS. It appears that AT demonstrated incidents of both local and global processing, as evidenced respectively by her AP ability and drawing ability (local), as well as her tendency to process the harmonic components of music and her apparent ability to internalise the entire structure of a piece before ever playing it (global). This suggests that AT exhibits a flexibility in her cognitive style, which may be representative of the cognitive style that is implicated in WS. It is suggested that the WSS account may be useful in understanding some aspects of cognitive processing in WS if it is adapted to account for this flexibility.

Much of the evidence derived from AT's case is in support of current assumptions about musical ability and WS, as mentioned above. It also emerged in this case that she exhibited relative strengths in the processing of harmony, and in the domain of creative improvisation, neither of which have previously received much attention in the WS literature. AT's apparent strength in these areas continues to support the notion of 'spared' musical ability, and encourages further investigation into the extent of such abilities in individuals with WS. However, it is worth noting that her facility with harmony and improvisation may be more indicative of her emerging savant profile, making her case even more exceptional and less generalisable to the WS population. If this is the case, her musical progress may contribute to the current understanding of musical savant syndrome, as discussed in the next section.

6.3 Implications for current understanding of savant syndrome

AT's case presents only the second formal investigation of the musical savant abilities of an individual with WS (to the best of my knowledge). Furthermore, it is the first case that has observed the emergence of this ability at the very early stages of formal musical education.

It is necessary to note that it was difficult to evaluate the extent of AT's 'savant' ability due to the lack of a standardised criteria or measure. Therefore, the conclusion that she is a musical savant is based on a judgement that was derived from an observation of her musical ability and progress over

the course of this study. However, based on the widely accepted definition of savants (see Treffert, 2010), it was possible to conclude quite confidently that the musical ability demonstrated by AT, as reported here, is indeed representative of savant syndrome particularly when judged in the context of her cognitive impairment. Furthermore, in terms of what is assumed about savants' psychological characteristics, AT demonstrated many of the intrapersonal catalysts that are considered important in the development of this level of ability. Undoubtedly, her tendency to become obsessed with certain pieces, and her affinity with the repetition of such pieces facilitated her development. In addition, it is speculated that her remarkable motivation for music may result, partially, from the positive reinforcement that she receives from her parents and AO in praise and encouragement. In this sense, AT is similar to many of the autistic savants who have been discussed in the literature. However, her case provides an opportunity to consider this condition in the context of an alternative impairment, WS. It is speculated that further investigation into the savant abilities of individuals with WS may generate important information about a potential link between WS, autism, and savant syndrome.

The findings that have emerged from this study have generated implications for current assumptions about savant syndrome. Savant syndrome is often associated with language impairment, and, interestingly, language is assumed to be an area of relative strength in WS. However, AT possesses specific language impairment alongside WS, as well as an emerging savant profile. This supports the notion of a link between language impairments exhibited by savants, and their exceptional abilities that develop in other cognitive domains, as a result of a compensatory process as suggested by Miller (1989) and Selfe (2011). This may also have implications for current thinking on the relative association or independence of cognitive domains.

An observation of AT's musical progress also revealed that she attends to some aspects of music, using strategies that may be specific to musical savants. For example, the way in which she attends to the harmonic bass lines of pieces appears to align itself with recent findings that musical savants process chords from the bottom up (Mazzeschi et al., 2011). This may be one strategy that savants employ to internalise and reproduce music so effectively. It is speculated that by attending to the harmonic structure when processing musical stimuli, it is easier to create an internal representation

of an entire piece into which other musical components may be integrated. This then facilitates recall, which is undoubtedly assisted by the use of AP. Further inquiry into the strategies employed by savants when processing and producing music, may generate important findings about the nature of savants'ability.

6.4 Implications for musical cognition

Apart from speculating about the applicability of the WCC theory (Frith & Happé, 1994) to AT's case, this study also examined Ockelford's 'Music Processing Module' (2007b, 2008, 2010). Chapter 5 has discussed AT's case in the context of this model in some detail, leading to the conclusion that her case provides strong evidence of a MPM, which operates in working memory during various musical activities. Ockelford proposed that his model is relevant to musical cognitive processing universally. While AT's case provides evidence of the presence of a MPM, it is difficult to ascertain if this can be considered representative of the entire population. As Baddeley noted that the musical savant Derek Paravicini's brain had most likely developed in a different way from most people (June, 2011), one could speculate similarly about AT. However, Baddeley also alluded to the issue of neural plasticity and the many hours of practice that may have had an impact on Paravicini's brain structure. In AT's case, considering the early stages of her musical education, her accumulated practice is a lot less, suggesting that this is not responsible for the presence of a MPM. In sum, AT's case has generated supporting evidence for Ockelford's model, as derived from an analysis of her musical output. Although the universality of this mechanism is inconclusive based on AT's case, it nonetheless encourages further investigation into the potential involvement of the MPM in musical processing and production in other individuals.

6.5 Practical Implications

One of the main findings of importance for teachers of individuals with WS or savant syndrome is the fact that, not only do they appear to have a relatively enhanced ability in producing music, but also in processing music. This was evidenced by AT's apparent ability to internalise the entire structure of 'Für Elise' before she ever played it. This implies that teachers must be mindful of

students' aural representations of music, and seek to proceed from these internal representations, through facilitating the motor coordination skills required to map these spatially onto a keyboard, to realising the music in sound. Certainly, in AT's case, one of the main factors which impeded her musical expression was her impaired motor-coordination. It is suggested that, in aiming to improve finger strength and dexterity, teachers will facilitate a more competent musical expression in students with WS. An observation of AO's teaching strategies when supporting AT revealed that it is important to aim for an improvement in technical proficiency by relating this to the material that the student has already appeared to have internalised, and promoting improved technique as a means of producing this music more competently.

The observation of specific strategies that are employed by musical savants when processing music, such as their apparent tendency to process music from the bottom up, may also carry practical implications. Firstly, this information is important for those who are responsible for nurturing savant skills, as it may suggest how best to develop such skills. Secondly, it may be possible for non-savant musicians to incorporate such 'savant-specific' strategies into their own musical learning, potentially facilitating the development of expert musical skill. This possibility encourages further research into the strategies employed by musical savants.

This study also alluded briefly to the extra-musical benefits that appeared to emerge as a consequence of AT's formal musical education. AT's case provided evidence for improved motor-coordination (finger dexterity) and spatial awareness, as well as increased confidence and self-esteem[12]. Unfortunately due to space limitations, it is not possible to delineate any further in this regard but it is worth noting that this study provides evidence of the great value of tapping into the musical potential of an individual who may struggle in other aspects of life due to a particular impairment.

[12] Her improved confidence and self-esteem was evidenced by reports from her parents that she was receiving positive feedback in school about her exceptional musical ability, which was promoting her self-esteem and confidence when in the company of her neuro-typical peers.

6.6 Final reflection

This study has proved worthwhile in terms of the findings that it has generated. It encourages further inquiry into the supposed link between music and WS, and suggests that music may be an area of unrealised potential in many individuals with WS. Having been fortunate enough to observe AT's savant musical ability emerge and develop over the duration of this study, I am keen to pursue this line of inquiry further. AT's case had revealed that the area of music and WS is an interesting one, and has the potential to yield further fruitful psychological, and musicological, insights.

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APPENDIX

APPENDIX A

TABLE OF RECORDED LESSONS

Lesson 1		Lesson 11	
Lesson 2		Lesson 12	
Lesson 3		Lesson 13	
Lesson 4		Lesson 14	
Lesson 5		Lesson 15	
Lesson 6		Lesson 16	
Lesson 7		Lesson 17	
Lesson 8		Lesson 18	
Lesson 9		Lesson 19	
Lesson 10		Lessons 20-23	
		Lesson 24	

Lessons that were recorded during the observation phase are marked with shaded boxes.

APPENDIX B
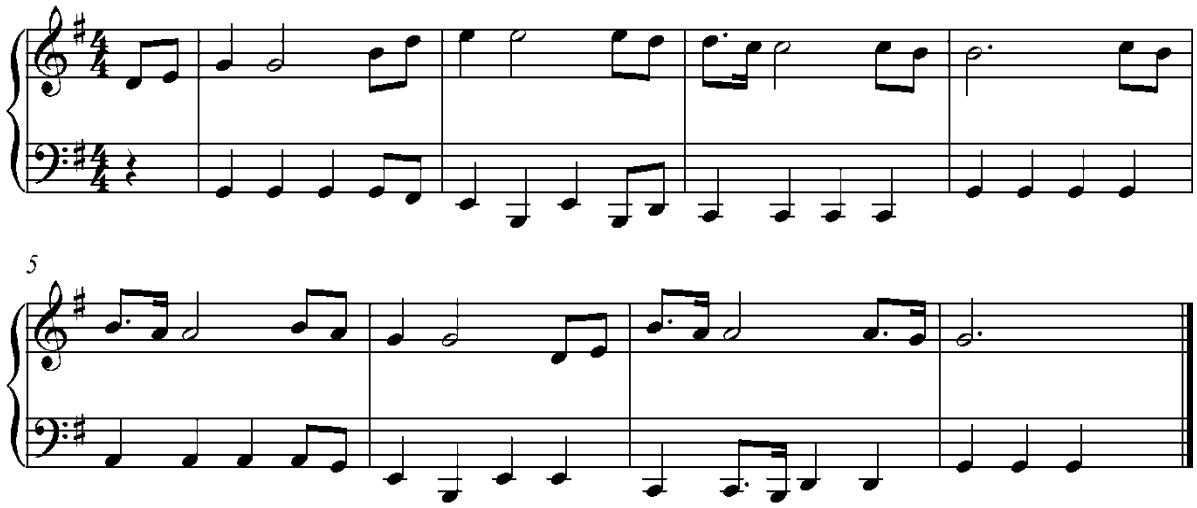
SAMPLE INTERVIEW QUESTIONS

- Can you please tell me about AT when she was a baby?
- Can you describe her general engagement with music prior to the commencement of formal music education with AO?
- Were you aware of the enhanced musical abilities that have been reported in some individuals with WS?
- How and when did it come to your attention that AT may be musical?
- Does music run in the family?
- Can you pleases describe AT's practice routines at home?
- Have you noticed any changes in AT's behaviour since she began working with AO?

APPENDIX C

TRANSCRIPTION OF BASS LINE PRODUCED BY AT – ‘SAILING’

Sailing*



*'Sailing' – (Sutherland, 1972)

The melody (transcribed in the treble clef) was played by AO during this reproduction; The bass line (transcribed in the bass clef) was produced by AT.

APPENDIX D

‘FÜR ELISE’ - SCORE

Bagatelle in A minor WoO 59

"Für Elise"
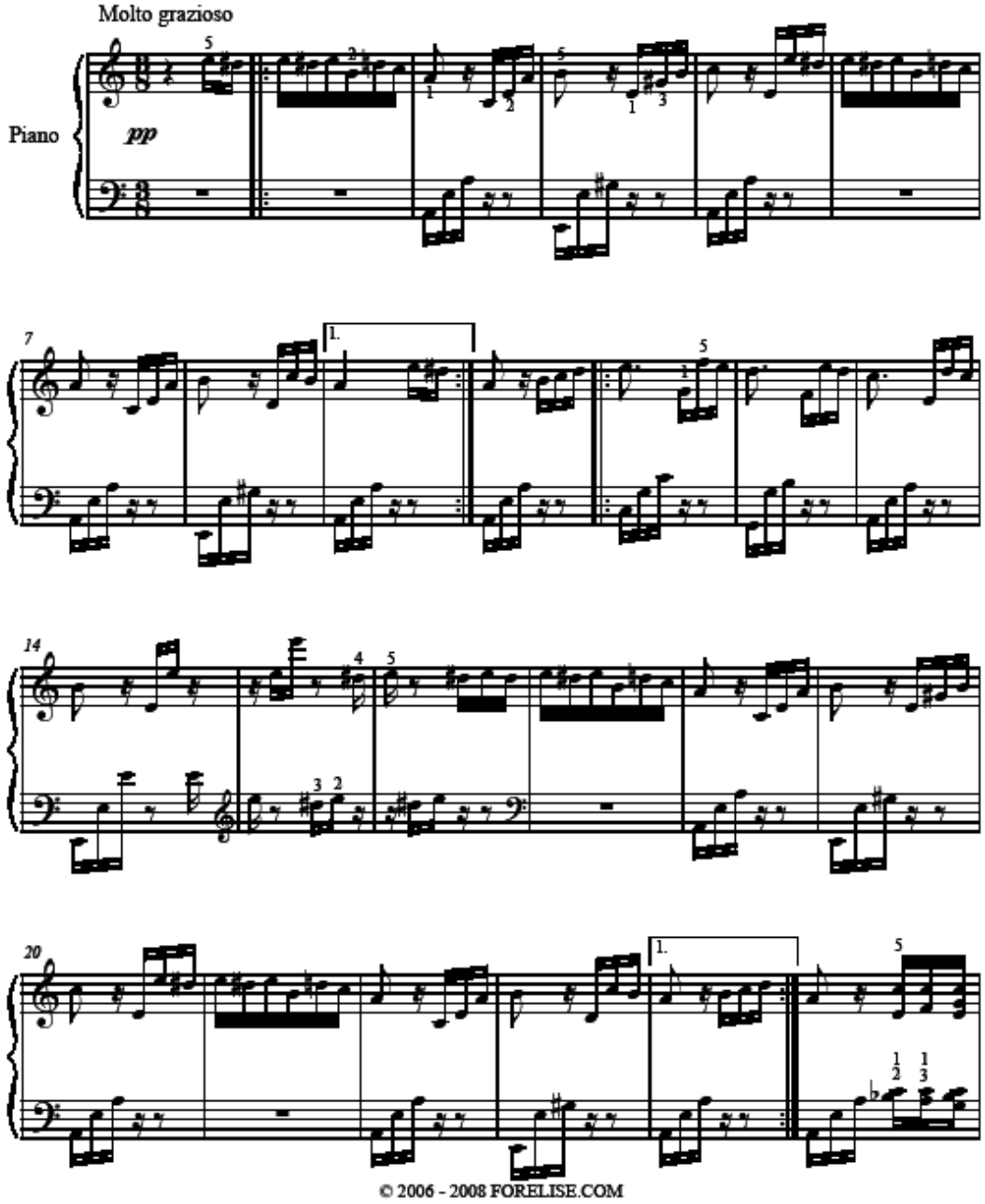
forelise.com

Ludwig van Beethoven
1770 - 1827
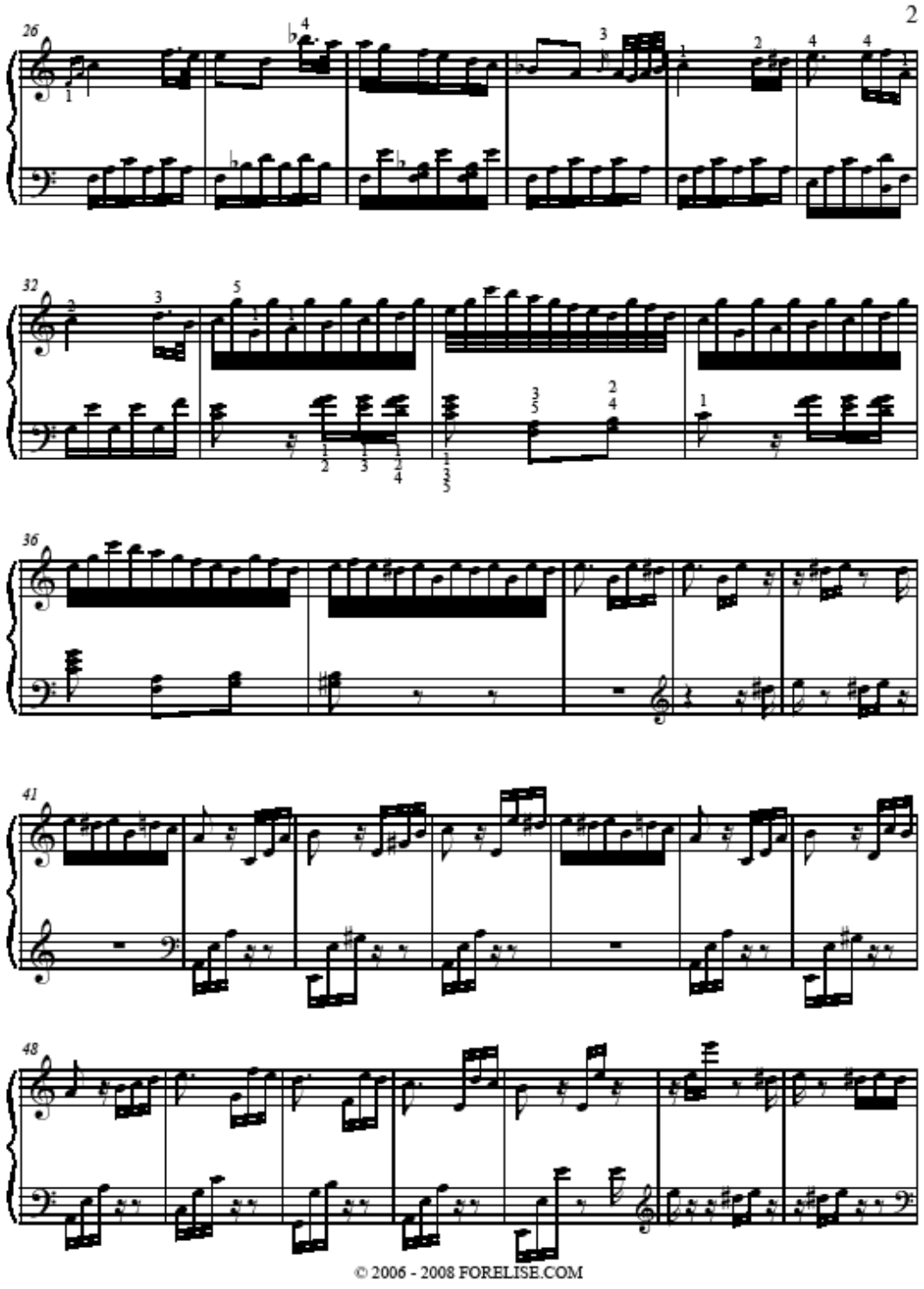
"Für Elise"
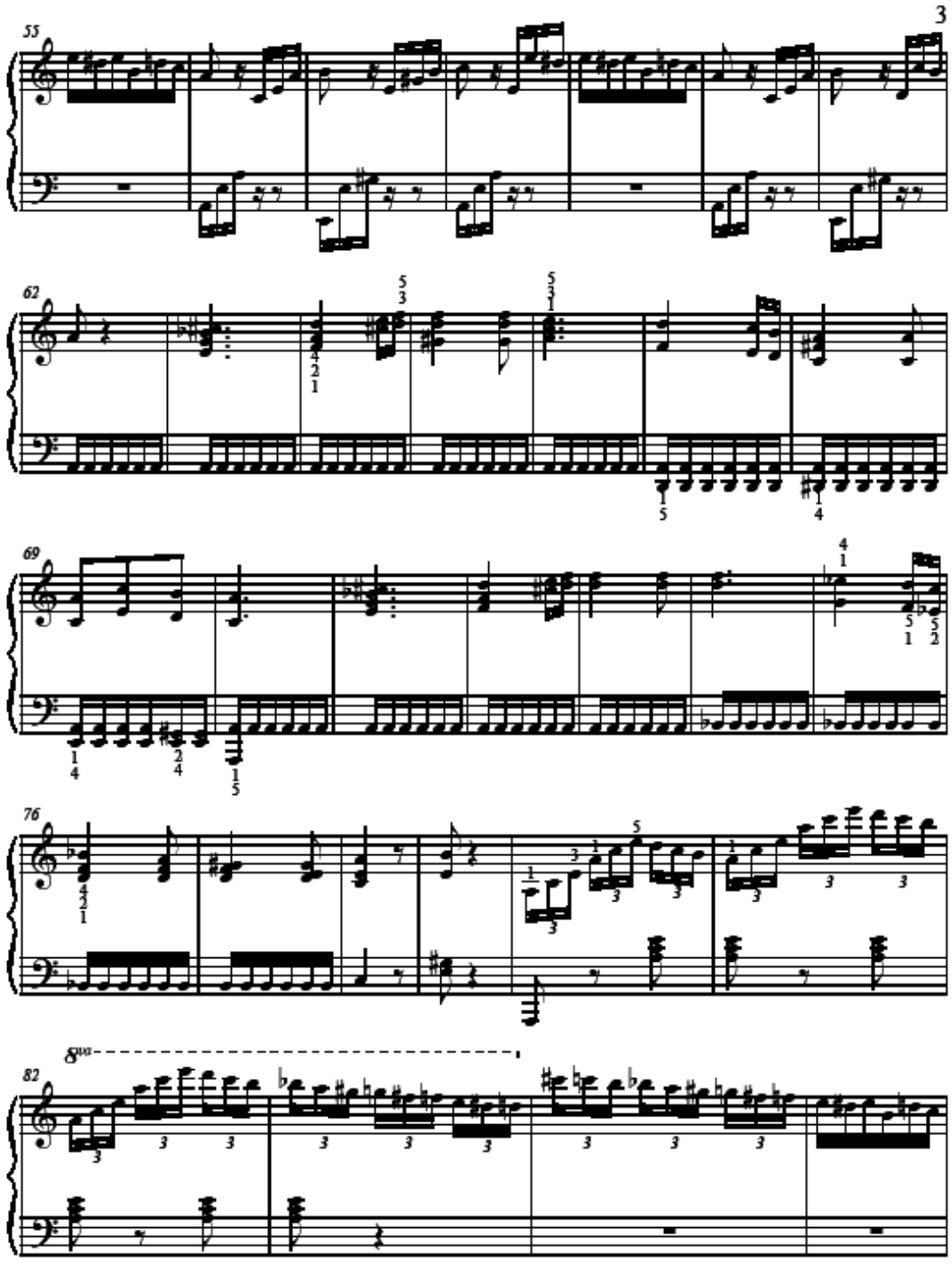
Bagatelle in A minor WoO 59

Ludwig van Beethoven
1770 - 1827
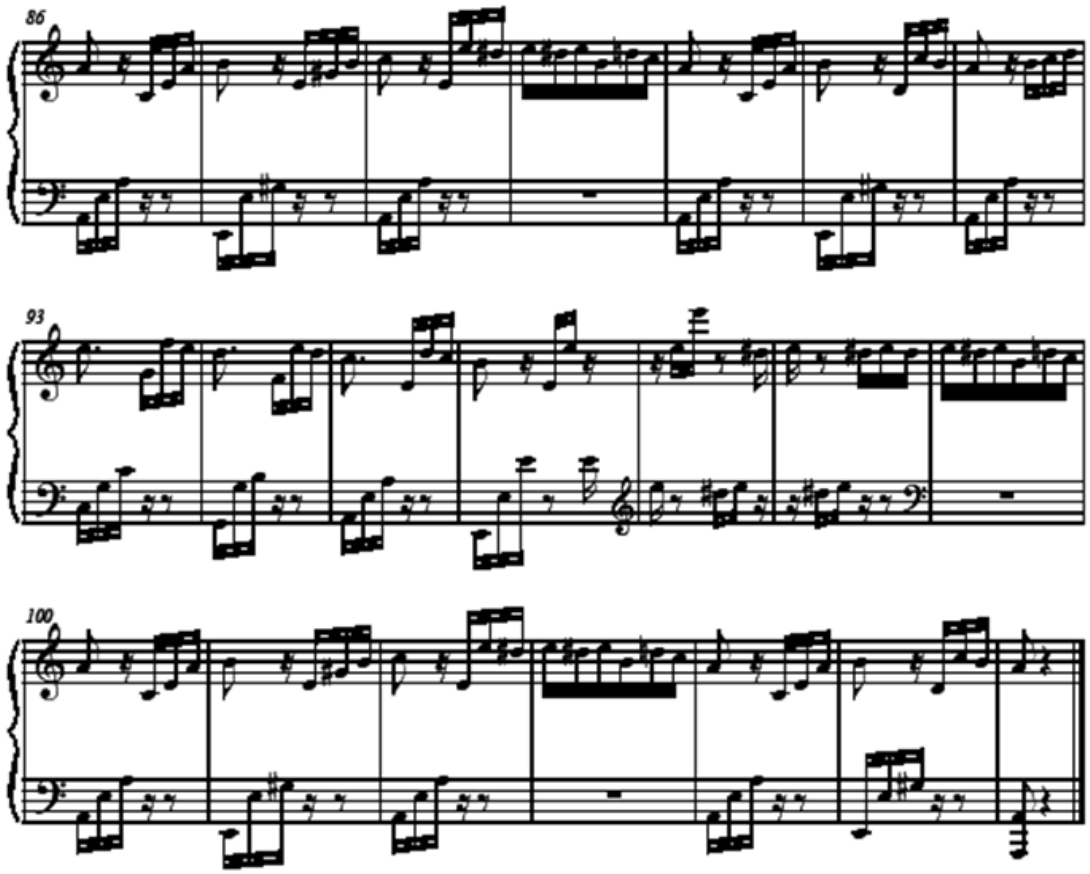


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2
26
32
36
41
48
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Extracted from http://www.forelise.com/media/for_elise_sheet_music.pdf (accessed on 1-8-2011).

Rondo Form:

A – Bars 1-24

B – Bars 25-39

A – Bars 40-61

C – Bars 62-84

A – Bars 85-106

APPENDIX E

AT'S WEEKLY PROGRESS WITH 'FÜR ELISE'

Lesson	
3	• AT attempted to play the opening melody (A section- prompted by her mother who said that she had been playing the tune during the week after seeing and hearing the piece on YouTube) • Used both hands to play the melody (A section) • Several errors as she found the notes all of which were self-corrected • AO encouraged AT to use all her fingers, especially her thumb, and later demonstrated how to play this section with correct fingering • AO joined in with left-hand accompaniment for which AT left space – appeared to have also internalised this accompaniment
4	• AT played the melody of the A section quite fluently, using most of right-hand fingers, but also using left-hand to play some notes • Errors were all self-corrected by AT • AO demonstrated the left-hand accompaniment of the A section and attempted to guide AT's left-hand over this section • AT didn't always play phrases in order – often repeating the first phrase several times before moving on
6	• AT played the right-hand part of the A section using both hands – she did not user her thumbs in the way that AO had demonstrated • AT skipped from the end of the A Section to Bars 33-37 (B Section) – Played slowly using index fingers of both hands – Had taught herself this section during the previous week after seeing and hearing it on YouTube • Played with errors, but coherent within the overall structure of the piece • AO played the earlier bars of the B Section after which AT attempted to replicate him • Played several repetitions of the A section, skipping to bars 33-37 (omitting opening bars of Section B); She sometimes left space for AO to play the bars she was omitting • Played Fur Elise continuously for 25 minutes
7	• AO introduced AT to the sheet music, pointing out the notes of the A section, and playing hands together • AT played the A section melody using her right hand only, including her thumb • AO demonstrated the first arpeggio (A minor) in the left-hand accompaniment (A Section); AT picked out notes for the next E major arpeggio; She continued to play the left-hand part using both hands, not up to speed, but appeared to be familiar with the harmonic structure • AO encouraged correct fingering in the left hand • AT attempted the A Section hands together • AO played the B and C Sections; He demonstrated a repeated bass note (A) in the C Section which AT resumed playing, finding the right notes as the harmony changed • AT attempted to play the right-hand melody of the B Section at a slower tempo, and with errors, but outlined the melody coherently and demonstrated that she had internalised the structure of the piece; she appeared to be particularly familiar with bars 33-37, which she played with index finger of both hands (not in tempo) • First attempt at outlining melody of the C Section, even attempting bars 80-84; AO helped
8	• AT attempted to play the C Section; AO helped to guide her fingers over 2-note chords, as her fingers were not strong enough to hold the hand shapes required • AT played the A Section hands together – more fluent than previous weeks although her left hand was slower than her right hand • AO played the C Section prompting AT to play bars 83-84 (descending chromatic scale)
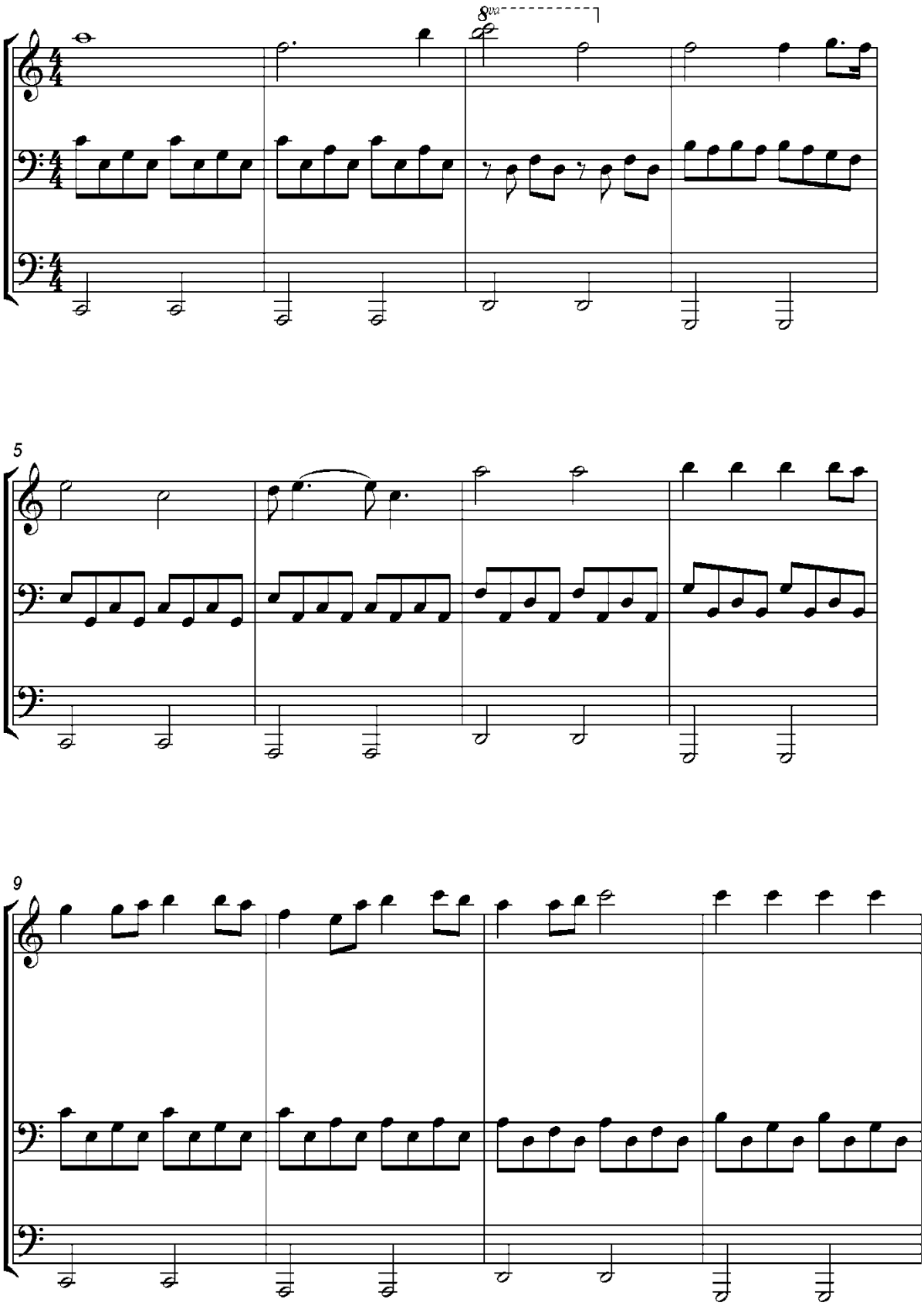
	• AO encouraged her to use all her fingers and thumb
9	• AT played the A Section hands together; Her left hand was not quite up to tempo but had improved since on previous weeks • AT sketched the melody of the B Section at a slower tempo and with errors • AT's fingering for the A Section had improved since previous weeks – she used all fingers and thumb • AT often skipped from the A Section to the C Section (omitting Section B); Appeared eager to play block chords • AT Consistently made the same error (as is previous weeks) – Playing B instead of E (e.g. Bar 15) – reflects her viuospatial impairment
12	• AT attempted to play the C Section – played 2-note chords with AO's help (sign of fingers strengthening) • AT started to use correct fingering for descending chromatic scale (Bars 83-84) • AT played A section hands together; Improved fingering, Left-hand and right-hand parts were more in synch than previous weeks • Played bars 11-13 (and repeats of these bars) with incorrect left-hand accompaniment: Played arpeggios in Am, E, and Am (replicated left-hand in bars 3-6), instead of C, G and Am (may be due to lack of internet at home this week, which resulted in less listening)
13	• Did not play Fur Elise but played an improvisation that appeared to derive from opening melody of the A Section • Still no internet at home
14	• AT's father informed us that they had recovered their internet access at home • AT played the correct left-hand accompaniment throughout the A Section while AO played the right-hand melody • AT played the melody of the A Section very accurately • AT played the A Section hands together – she repeated the left-hand error that she had made in Lesson 12 (played bars 11-13 with the accompaniment part of bars 3-6); She corrected this error on a later repetition
16	• While playing the melody of another piece with AO (who played an accompaniment in B major), AT introduced the opening melody of Fur Elise • AT played the A Section hands together
17	• AT played the A Section hands together; More fluent and confident than previous weeks • Skipped to the C Section and asked AO to play the right-hand part while she played the repeated bass note
18	• AT played several repetitions of the melody of the A Section while AO accompanied; Very good use of fingers and thumb • AO prompted her to attempt the right-hand part of the C Section but she asked him to play it instead while she played the repeated bass note • AT played the A Section hands together; More accurate and fluent than previous weeks
19	• Did not play Fur Elise
24	• AT played the A Section hands together leading into the C Section in which AT played the bass line, and AO played the melody. • AT demonstrated sensitivity to changes in tempo and dynamics • Very good use of fingers and thumbs. When playing the A Section, hands were in synch and playing was confident and fluid
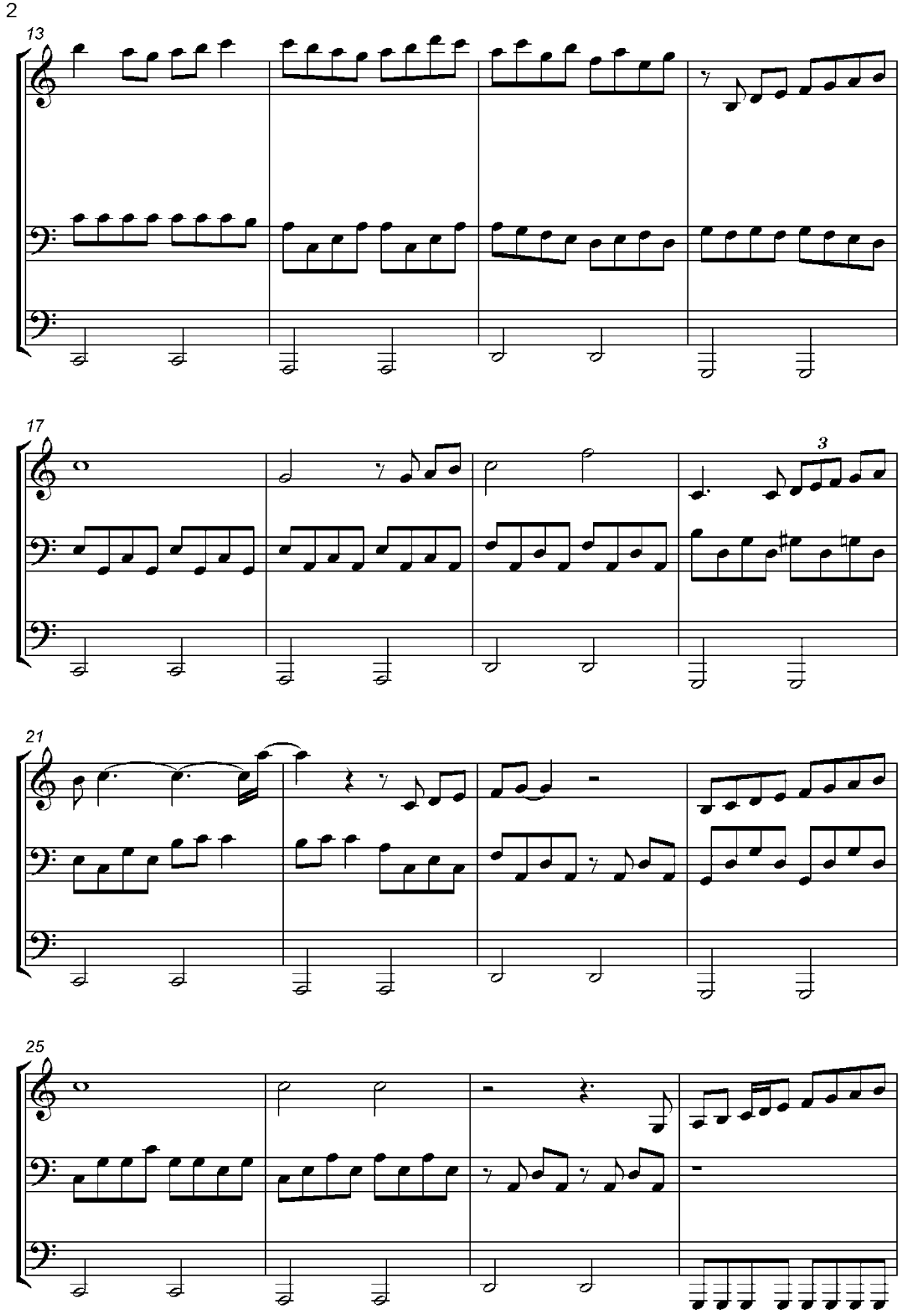
APPENDIX F
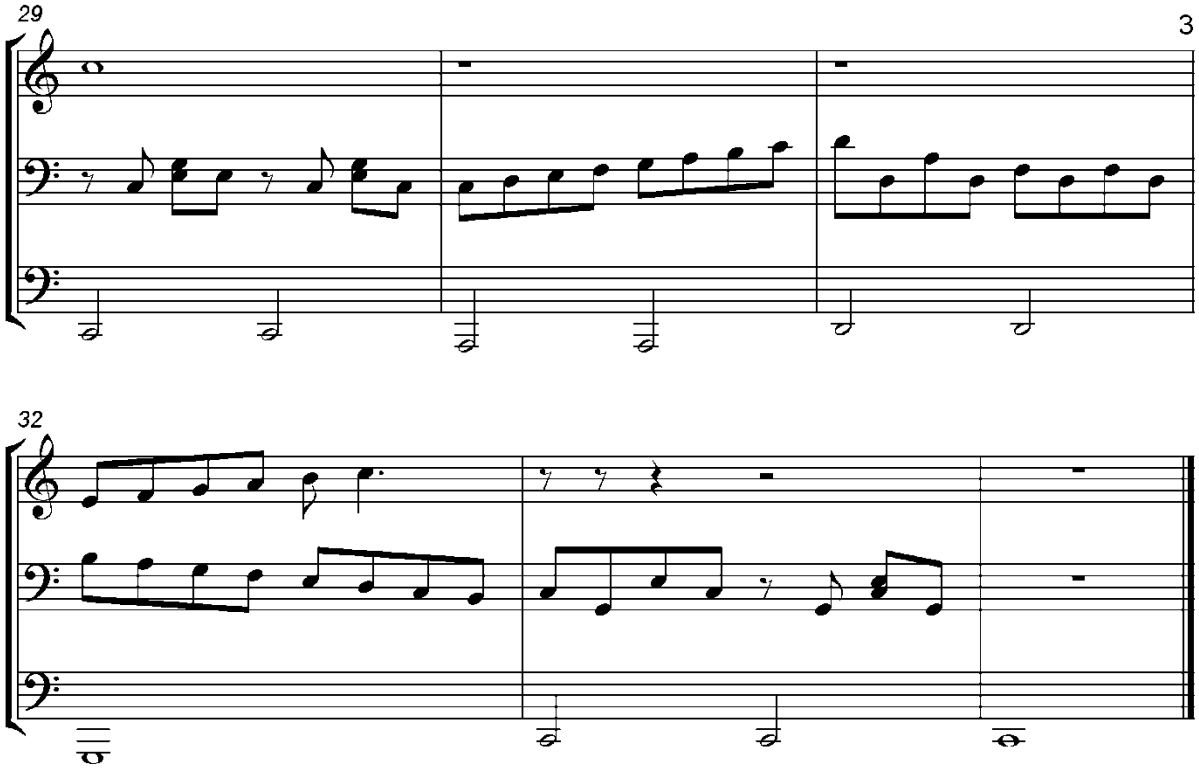
TRANSCRIPTION OF AT'S IMPROVISATION – LESSON 12

AT's Improvisation *

(Lesson 12)




2
13
17
3
21
25



*The bass ostinato played by AO is notated in the bass clefs; AT's improvised melody line is notated in the treble clef. Rhythm and timing is approximate in some places to accommodate for the interactive nature of this musical episode (see Excerpt 9).

APPENDIX G

LIST OF VIDEO EXCERPTS

1. **Absolute pitch #1**
   Informal test for absolute pitch directed by AO during Lesson 13.

2. **Absolute pitch #2**
   Further evidence of AT's absolute pitch ability is provided by her ability to match pitches played on a tone chime by AO to notes on the piano.

3. **Harmony – Lesson 2**
   Evidence of AT's ability to process harmony, and an early attempt to reproduce it.

4. **Somewhere Over the Rainbow – Bass line**
   AT's reproduction of the bass line of this piece during Lesson 9.

5. **Rhythm**
   Early evidence of AT's rhythm abilities as she attempts to replicate one-finger rhythms during Lesson 2.

6. **'Für Elise' – First attempt (Lesson 3)**

7. **'Für Elise' – Lesson 12**

8. **'Für Elise' – Lesson 24**

9. **AT's Improvisation – Lesson 12**
   .