

# **MUSICAL AND SOCIAL FACTORS AFFECTING ATTENTION REGULATION OF CHILDREN IN BAND PLAYING AND MOBILE MUSIC MAKING**

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<p>Tiivistelmä – Abstract</p> <p>This study focuses on attention and hyperactivity regulation of children in band playing and mobile music making. The study aims at finding the musical and social elements that help children to regulate their attention, and lead to positive social interaction. Within the mobile music making, stand-alone playing and pair work scenarios are analysed. Within the band playing, instructed and improvised playing are compared.</p> <p>This research is a multiple case study with four participants: two children with ADHD and two comparison children without ADHD. Non-participatory observation is applied as the main data collection method. The data, in the form of video recordings, is analysed both qualitatively and quantitatively. Attention regulation of the children is labelled with the following four categories: on-task behaviour, selective on-task behaviour, passive off-task behaviour, and hyperactive off-task behaviour.</p> <p>Essential elements contributing to improvement of attention regulation and reduction of inattentiveness and hyperactivity found to be sitting independently, far from other musical instruments. Another element improving attention regulation was clear (and repeated) instruction that was preferably given before the children were at close physical proximity to the devices or band instruments. Clarity of the instruction played a key role in all the musical activities, and lack of it reflected in hyperactive off-task behaviour. Role of the music making session instructors was found to be significant.</p> <p>The overall result is that all the children had mostly good attention regulation in all of the musical contexts. The quantitative time-course analysis shows that with ADHD children 94 %, and with non-ADHD children 93 % of the total time of the analysed excerpts consisted of on-task or selective on-task behaviour. In the band playing there was slightly more hyperactivity by the children with ADHD than by the children without ADHD. There was slightly more selective on-task and passive off-task behaviour by the non-ADHD children than by the ADHD children in the mobile music making situations.</p> <p>When comparing the different musical contexts, hyperactive off-task behaviour was seen slightly more in the band playing than mobile music making context, while passive off-task behaviour was more prominent in the mobile music making than in band playing. When the children were asked to improvise with band instruments, percussion instruments, and especially drum kits were found to be the most challenging musical instruments in relation to attention regulation.</p>	
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## **Introduction**

Music is a powerful tool and it can support children in their learning. The main purpose of this study is to investigate the attention regulation of children in mobile music making and band playing. The research aim is to find out whether there are some general elements that support the attention regulation of children in different music making scenarios.

In this multiple case study with four participants, the research objective is to determine which elements help to enhance the attention regulation of 10- to 11-year-old children in band playing and mobile music making. Comparisons between the four children and the two music contexts are made in order to find differences and/or similarities in attention regulation between them. The lack of research on this area motivated me to carry out the current research. Further, while most of the previous studies have concentrated on children as rather passive receivers of music, in the current study they are seen as active music makers.

The topic is of current interest, because in schools there is a growing number of challenges when different types of learners come together, and some of them have learning deficits. Problems in attention regulation have been linked to ADHD (Mash & Wolfe, 2010). Two of the participants of the current study have an ADHD diagnosis. This offers a further possibility to study whether some of the elements contributing to better attention regulation are specific to children with this deficit. The behaviour of these two children is compared to the behaviour of their two same-age peers. One goal of this research is to get information and ideas about how to best include the children with ADHD in collaborative music making.

When observing the children's attention regulation, mobile music making context is contrasted to band playing context. Within the mobile music making context, the different social contexts i.e. stand-alone and pair work in music making are differentiated and analysed. In a similar way, the band playing situations are further divided into instructed and improvised band playing for the analysing purposes. Within the mobile music scenario, JamMo software is used (UMSIC project).

The research material is collected through observation. The data consists of video recordings from 12 sessions of 45 minutes duration each. For the video analysis, each session is divided

into distinctive musical episodes: 1) JamMo stand-alone, 2) JamMo pair work, 3) Instructed band playing, and 4) Improvised band playing. Then, a 5-minute excerpt from each musical episode is extracted, and the children's behaviour is analysed both qualitatively and quantitatively. This permits both a detailed description of the music making sessions, as well as quantitatively classified information concerning different behavioural features.

This study is undertaken to investigate attention regulation of children in mobile music making and band playing. My aim is to measure changes in the children's attention, hyperactivity and passiveness, and answer the following research questions:

- 1) What musical/social elements help the children the most to regulate their attention and activity level?
- 2) What musical/social elements lead the children towards positive social interaction?
- 3) Is there a difference in children's attention regulation between mobile music making and playing band instruments? What kind of difference?
- 4) Is there a difference in attention regulation between children with ADHD and children without ADHD in mobile music making and/or in band playing? What kind of difference?

The value of this research topic is seen in that it aims to deepen the understanding about the attention regulation of children in music making. The study brings a new kind of perspective into the field of studying children (with ADHD) in relation to music, because it concentrates on the children's viewpoint instead of the teachers' or parents' viewpoint. The results can be used especially in the fields of music education and music therapy. By analysing the results one can identify the essential elements contributing to the children's attention and hyperactivity level in either an enhancing or deteriorating manner.

I start the theory section by presenting attention and hyperactivity regulation, because it is at the very core of this research. I also look at ADHD, for the reason that two of the participants have this deficit. I continue by describing musical and social factors that are essential in both band playing and mobile music making. I conclude the theory section by discussing technology-assisted music making. Then I move onto presenting the research methods and results, and finally close up the thesis with the discussion and implications for future studies.

# **1. Attention and hyperactivity regulation**

## **1.1 Attention, executive functions & self-regulation**

In the framework of the current research, self-regulation is an umbrella term, beneath which one finds attention regulation. The capacity to maintain focused attention is one of the abilities within self-regulation (Fonagy & Target, 2002). In this study the focus is on attention control in music learning environments. Next, I reflect on the relationships, similarities, and differences between attentive behaviour, self-regulation, and executive functions.

Self-regulation can be seen as the process consisting of three factors: knowledge, motivation and self-discipline. Self-regulated learners are mentally active learners who monitor and regulate their learning, and modify their thinking processes and strategies according to their learning goals when needed. (Westwood 2007). Gibson and Rader (1979) have described attentive behaviour as “alert” and non-attentive behaviour as “non-alert”. According to them, attention is defined as good when an individual is set and motivated to work for a certain goal and the perception fits well with the requirements of the task. Further, the person may have either internal or external motivation for completing the task. Internal motivation comes from the person himself and his goals, external motivation on the other hand could come for example from the teacher. For the behaviour to be perceived as self-regulated, the learner must be at least partly intrinsically motivated (Boekaerts, Pintrich & Zeidner, 2000, 533).

Self-regulation includes: 1) regulation of behaviour and emotions, 2) regulation of pro-social behaviour, and 3) regulation of cognitive behaviour. Regulation of behaviour and emotions means regulating one’s activity level and emotional expressions. The regulation of pro-social behaviour means that self-regulation can be seen as a part of social competence, and it serves as a basis for social relationships. Regulating one’s emotions and behaviour successfully is a requirement for pro-social behaviour. Pro-social behaviour is characterised by positive social or altruistic behaviour, leading to positive feelings, and adds interaction with others. (Aro, 2008; Aro & Laakso, 2011.)

Self-regulation and motivation have their basis in the cognitive development of an individual, and there are individual differences in the pace that self-regulation develops. It defines the

processes the learners use, how often and how well they apply them. (Boekaerts et al. 2000, 632.) Self-regulation can also be seen at different stages of a learning process. It is seen in how students get ready for learning, stay engaged with tasks, and alter their problem-solving strategies (Singer & Bashir 1999).

One more essential concept when discussing attention control is executive functions. They are cognitive self-directed actions contributing to self-regulation (Barkley, 1997). Executive functions include *abstract thinking, the ability to inhibit unwanted behaviour, the ability to act according to instructions or rules, the ability to multitask, the ability to move between tasks flexibly, and direct attention to a new task.* (Aro & Laakso, 2011). Executive functions are relevant to the current study because children and adolescents with ADHD often have deficits in one of several executive functions. The most common deficits are response inhibition, vigilance, working memory and planning (Martel, Nikolas & Nigg, 2007; Wilcutt et al., 2005).

For good self-regulation to develop, it is important that the children themselves have an active role in creating the learning sessions. They should have the possibility to set their learning goals, and to control and organise their own learning. Their choices and different actions should be self-determined and not controlled by others (Woolfolk, 2007; Boekaerts et al. 2000, 417.) Therefore the development process of JamMo software has included active participation of children.

## **1.2 Attention regulation**

As explained above, self-regulation is a broad concept including many separate abilities, one being being able to maintain focused attention. All in all, self-regulation has been defined as psychological processes in relation to goal-directed behaviour when there are no immediate consequences (Carver & Scheier, 1998), whereas the current research concentrates on observing and studying the children's behaviour in terms of their attention. Therefore, I selected to use the concept attention regulation for this particular research, despite the usage of the term self-regulation in the previous studies of the same project. I see attention regulation to reflect better the specific behaviours observed and analysed, and to describe the studied phenomenon more precisely.

There are theories aiming at explaining ADHD having its roots in improper executive functioning. Children with ADHD have been found to have problems with tasks that involve planning, organization, and self-monitoring. Further, impaired executive functions in ADHD have been found to relate to: 1) Organising, prioritising and activating, 2) Focusing, shifting and sustaining attention, 3) Regulating alertness, effort and processing speed, 4) Managing frustration and modulating emotion, 5) Working memory and accessing recall, and 6) Monitoring and regulating action. (Mash & Wolfe, 2010).

Individuals with ADHD have been found to have poorer attention regulation than individuals without ADHD. Brown (1999) has presented a “poor orchestration” theory, according to which the behaviour of people with ADHD often reflects inadequate executive skills. Brown states that ADHD includes the inability to activate and manage executive functions at the right time. The individuals with ADHD have challenges in sustaining attention to tasks, resisting distractions, re-engaging when disrupted, and inhibiting or delaying one’s response, while not choosing an immediate reinforcement such as a reward. (Barkley, 1997; Smith, 2006).

Also Russell Barkley has studied ADHD and developed a hybrid model of the deficit. In this model, ADHD is seen as primarily a deficit of executive inhibition. Barkley sees inhibition as primary to other executive functions. Other executive functions that Barkley mentions are 1) non-verbal working memory, 2) internationalization of speech (verbal working memory), 3) self-regulation of arousal and motivation, and 4) reconstitution. (Barkley, 1997.)

### **1.3 On-task / off-task behaviour**

Behaviour of children with ADHD has often been studied with the categories attentive and inattentive, or in-task behaviour and off-task behaviour. Off-task behaviour has been seen to reflect the learner’s disengagement from a learning experience. (Rowe, McQuiggan, Robison & Lester, 2009). Next, I discuss these different behavioural categories as well as time intervals used for analysing them.

Lahaderne (1968) used the dichotomy of attentive and inattentive for describing the pupils’ attention. The categories used in her study were the following: 1) “+” The pupil is attending to the area of focus, the subject to which the teacher had called attention. The pupil also had to



be attending to the prescribed activity, that is, the activity designated by the teacher. 2) “-“ The pupil was marked inattentive if he was not attending to the area of focus and/or the prescribed activity. 3) “?” It was uncertain to the observer whether or not the pupil was attentive. And 4) “0” The pupil’s attention was not observable.

In addition to on-task and off-task behaviours, Walonoski & Heffernan (2006) used gaming as a separate category, and Baker et al. (2004) analysed both inactivity and gaming the system as separate categories of behaviour. Of the different off-task categories, gaming the system has been found to have the strongest negative correlation to learning. (Baker, Corbett, Koedinger & Wagner, 2004.) Walonoski and Baker also made distinctions within the on-task behaviour. (Baker et al.: on-task, on-task conversation, off-task conversation, off-task solitary behaviour, inactivity & gaming the system, Walonoski et al.: on task with the tutor, on task with paper or teacher, on task but talking while working, off task and talking, off task and inactive, gaming).

Although off-task behaviour is often seen as solely negative behaviour and is associated with less learning, it has its advantageous side as well. It can for example serve the purpose of gaining adult or peer attention. In addition, through off-task behaviour the child may access more preferred activities or avoid undesirable activities. (Roberts, 2001). The off-task behaviour can also have different manifestations in different students’ behaviour. Sabourin et al. (2011) found that off-task behaviour indicated different transitions for frustrated and confused students. The frustrated students may use temporary off-task behaviour to distant themselves from the task for a while and in this way regain motivation for the task at hand.

The percentages of on-task and off-task form only a part of the research results. It is also important to analyse the quality of these behaviours. For example, the on-task behaviour on its own does not tell whether the person has succeeded in the task or achieved the goals. (Shaw & Lewis, 2005b). In contrast to many previous studies, in the current study I mark not only the frequency of off-task behaviour, but its nature as well. The nature of activity is divided into categories of participation, selective participation, non-participation (hyperactive), and non-participation (passive) (see 4.4. for detailed descriptions).

When studying on-task / off-task behaviour, different time intervals or time frames have been used. A 10-second observation interval was used by Handen et al. (1998) and Shaw et al.

(2005a). The observation interval meant that a period was labelled as off-task at any point when the off-task behaviour was manifested for more than three consecutive seconds. This way brief momentary off-task behaviour was looked at as insignificant. In a study by Sabourin (2011) time intervals in which several off-task behaviours occurred in succession were aggregated and considered as a single duration of off-task behaviour. In the current study, I use a “second-to-second” time course analysis method. The behaviour is labelled as on-task or off-task behaviour right away, without a duration requirement. No separate category of momentary off-task behaviour is used, and the behaviours are labelled as either hyperactive or passive/inattentive off-task behaviour.

#### **1.4 Attention Deficit Hyperactivity Disorder (ADHD)**

Two of the participants in the current study have Attention Deficit Hyperactivity Disorder (ADHD). Therefore in this section, I discuss ADHD, its diagnostic criteria, and possible causal factors, as well as treatment and interventions for this specific deficit.

Approximately 5 per cent of children have been estimated to have ADHD. (Lönngqvist, 2014). The male-female ratios are approximately 2:1 in children and 1.6:1 in adults. Children with ADHD have been defined to exhibit developmentally inappropriate levels of inattention and/or hyperactivity-impulsivity (American Psychiatric Association, 2013.) These manifest as problems with behaviour control, academic achievement, and peer relationships (DuPaul & Stoner, 2003). ADHD can be seen as *significant deficiencies in behavioural inhibition, sustained attention, resistance to distraction, and the regulation of activity level* (APA, 2013).

ADHD is defined as an extreme way of behaving in relation to a certain developmental stage that is presented in several contexts and that clearly causes problems for the ability to function. ADHD symptoms tend to be most prominent in the elementary school age. The three distinct types of ADHD are the inattentive type, the hyperactive-impulsive type, and the combined type. Of the different manifestations of the deficit, hyperactivity is the main one in preschool, while inattention becomes more prominent during elementary school. (APA, 2013.)

Self-regulation and executive functions, concepts presented in the previous chapter, have been seen as the major psychological factors contributing to ADHD. The dysfunction of self-regulation is seen as affecting especially the ability to delay one's behavioural responses, but also the more general inattentiveness (cognitive control) and hyperactivity (socio-emotional control) (Cutting and Denckla, 2003). In relation to the executive functions, response inhibition, vigilance, working memory and planning have been found to be the main impairments in ADHD children. (Wilcutt et al., 2005).

In addition to psychological factors mentioned above, also biological factors may predispose children to ADHD. The deficit is thought to be highly heritable, with its heritability being estimated as .60-.90. (Burmeister, McInnis & Zöllner, 2008; Faraone, Perlis & Doyle, 2005; Waldman & Gizer, 2006). When it comes to temperamental factors, *ADHD is associated with reduced behavioural inhibition, effortful control, or constraint; negative emotionality; and/or elevated novelty seeking.* (APA, 2013.)

Neurological studies have shown that the way the brain matures regionally is similar in children with and without ADHD (Shaw et al., 2007). However, the peak thickness of most of the cerebrum is attained later in the ADHD brain. The biggest delay has been found in prefrontal regions, essential for cognitive control, attention, and motor planning. (Shaw, Eckstrand, Sharp, Blumenthal, Lerch, Greenstein . . . & Rapoport, 2007.)

Further, the overall brain size, as well as two specific brain regions, the caudate nucleus and globus pallidus, of the individuals with ADHD are smaller, when compared with controls (Castellanos & Tannock., 2002; Kieling, Goncalves, Tannock & Castellanos, 2008, Genro et al. 2010). These brain areas are stimulated by dopaminergic neurons. According to the neurotransmitter dysregulation hypothesis (Genro et al. 2010) a dysregulation of the dopamine system in the central areas of the brain and noradrenaline and adrenaline in the locus coeruleus may be present in ADHD. In the earlier studies, these genes have been linked to the personality trait of thrill seeking (Benjamin et al. 1996, Ebstein et al. 1996.) and they impact brain areas associated with attention and executive functions. (Mash & Wolfe, 2010).

It has been stated that children with ADHD are less responsive to external stimuli and therefore need more stimulation for their brain in order to perform well cognitively and to

stay attentively on task than their peers (Shaw et al. 2005b, Farrell, 2009). More precisely, hyperactivity has been suggested to have its roots in under-arousal of the mid-brain, which then leads to inefficient inhibition of movements and sensations. According to the optimal stimulation model, the hyperactivity functions as a kind of self-stimulation, maintaining an optimal arousal level (Zentall & Zentall, 1983). The increased activity can also serve the purpose of gaining attention from teachers and peers, in other words, increasing environmental input (Abikoff, Gittelman-Klein & Klein, 1977). It has also been stated that nowadays some children may seek more and more stimulus, because of the high level of stimulation provided by media and the “rapid-fire” culture in general (Armstrong, 2006).

The treatment of ADHD can be seen as aiming to facilitate the child to compensate for the psychological deficits mentioned earlier, such as inattention, over-activity, impulsivity, or rule-following problems. Typical treatment for ADHD is a combination of medication and behavioural interventions. (Lönqvist & Aalberg, 2007). The medication together with behavioural strategies has found to be an optimal combination for enhancing social, academic, and family functioning (Conners et al. 2001). The most prominent type of medication used for ADHD is psychostimulants, such as methylphenidate. (Farrell, 2008). Methylphenidate can be used to reduce disturbing behaviour and to enhance the ability to concentrate. Such stimulants have been found to provide an improvement in 70 per cent of the children, by reducing on average 50 percent of the symptoms. (Genro et al. 2010). Behavioural interventions are typically applied together with medication, because this way the dose of medication can be reduced. On their own behavioural interventions are less effective than stimulant medication alone. (Farrell 2011).

Interventions for children with ADHD have been found to be most effective when they take place in naturalistic environments (Goldstein & Goldstein 1998) and therefore many of the interventions for ADHD have been studied in the school environment. Academic interventions can include modified teacher instruction, peer-mediated strategies, and computer-assisted instruction. (DuPaul & Weyandt 2006). In their meta-analysis of 80 school intervention experiments for ADHD, DuPaul and Eckert (1997) found that cognitive-behavioural treatment approaches were significantly less effective than interventions aimed at improving academic performance through the manipulation of the curriculum, or peer tutoring.

The effects of psychosocial treatment effects on academic achievement (e.g. school grades) or social skills (e.g. sustained peer relations) have been the focus in the Multimodal Treatment Study of ADHD (MTA Cooperative Group, 2004). In this study, the management strategies differed at the 14-month assessment so that the medication management and combination of behaviour modification therapy and medication management gained better results than the behavioural modification therapy or community comparison.

In addition to applying interventions directly aimed at the children, also the communication and collaboration between the family and teachers is of great importance. Special arrangements in day care and school environment, together with a chance to participate in a small group and having supportive services, are essential in supporting a child with ADHD. (Lönqvist, Henriksson, Marttunen & Partonen, 2011.) For example, psycho-educative groups for adults and children enhance the families' ability to adapt to the situation and to have control over their challenges. The aim there is to recognize both the problematic and the successful situations in the everyday life of these families.

## **1.5 Music interventions for ADHD**

Music is a powerful communicative tool. According to the model of Shared Affective Motion Experience, when we feel music, we feel not only sounds but also the presence of another person. (Overy & Molnar-Szakacs, 2009.) Due to the potential of music for self-expression and for creating the sense of belonging and interaction, it has been studied in relation to different deficits as well, including ADHD.

When studying which music therapy method(s) the music therapists use in the treatment with the early elementary school children with ADHD, Jackson (2003) found music and movement to be the mostly used method. Other widely used methods were instrumental improvisation, musical play, and group singing. Behavioural and psychosocial goals were mentioned as the main goals for the music therapy. Most commonly the therapists met the children in both individual and group formats or only in the group formats. In almost all cases music therapy was used in conjunction with other treatments, most often medication.

To this date, most of the studies on music therapy for people with ADHD have been comparison studies of people with and without ADHD. Other studies have concentrated on comparing music context to other sound environments. In the current study these two approaches are combined. The children with ADHD are compared to children without ADHD, and simultaneously the mobile music making is compared to band playing.

Previous music therapy studies with children with ADHD have suggested that background music (Pratt, Abel & Skidmore, 1995) and listening interventions (Montello & Coons, 1998) can be beneficial for reducing hyperactive behaviour and other unwanted behaviours. In contrast to these studies where the participants are seen as rather passive music perceivers, in the current study the participating children are active music makers. Music has also been contrasted to other sound environments in the previous studies. Abikoff, Courtney, Szeibel & Kiplewicz (1996) studied the ADHD and non-ADHD children under music, speech, and silence conditions. The children with ADHD were found to perform better in music condition than in silence or speech condition. This finding is linked to music being more appealing context, and the stimulation provided by music being more salient. (Abikoff et al., 1996, 243).

It has been suggested that people with ADHD require higher level of noise than other people for optimal cognitive performance. The optimal level is modulated by dopamine level, as is explained in the Moderate Brain Arousal Model. According to this model a moderate level of noise can be beneficial to cognitive performance, but interestingly, only in the case of ADHD. For children without ADHD, noise has the opposite effect and lowers their performance. (Söderlund, Sikström & Smart, 2007.)

It is important to remember that music has been found to have both positive and negative effects on children with ADHD. Pelham et al. (2011) found that while video distracted boys with ADHD in the classroom, the music did the same for some of the participants. Some participants benefited of music relative to no-distraction. All in all, music seems to be a powerful tool, affecting the children with ADHD in slightly different ways than children without ADHD. The current study aims at adding knowledge on how the children with ADHD and their learning could best be supported by music.

## **2. Musical and social factors of music making sessions**

There are some specific social and musical factors that are the focus of the current study. They are explained here.

### **2.1 Structure, instruction and feedback**

Children with problems in attention regulation need a well-structured environment, and the routines need to be clearly established. The child may have difficulties in remembering goals and behaving accordingly. When the child is aware of what and when is going to happen, (s)he has a good sense of control and reduced anxiety level and less impulsive behaviour. (Aro & Laakso, 2011.)

Good techniques with children with ADHD have been found to be providing good structure, short assignments with immediate feedback, clear directions and appropriate schedules of reinforcement. (Farrell 2008.) Similar findings were made also in the UMSIC music therapy pilot, preceding the current music therapy intervention study. Results of the pilot study showed that supportive features in giving instructions were clear and short instruction, supporting verbal instructions visually by showing a model, interactivity and peacefulness achieved by listening to children's ideas, and instructing the whole group simultaneously. (Saarikallio, Paananen & Erkkilä, 2010.)

Rewards and feedback have found to be especially important for children with ADHD. These children prefer small instant rewards (Carr, 1999.) and therefore the immediate reward that musical process often offers, is typically liked by them. (Rickson, 2006.) In the JamMo musical learning environment, the immediate rewards are given by the mentor within the software and by the adults, such as music therapist or teacher present in the learning situation. Group-administered rewards have been found to be as effective as individually administered rewards (O'Leary, Pelham, Rosenbaum & Price, 1976, DuPaul & Stoner, 2003).

## 2.2 Rhythm and motor skills

Rhythm is probably the most discussed musical feature in relation to ADHD. First of all, clear rhythm has been found to help the children with ADHD when creating music. To some extent internal structure and security can be enhanced by maintaining a steady beat (Montello & Coons, 1998). The steady beat can help the clients in music therapy to *control impulses, to bring order, and to promote feelings of safety and stability* (Bruscia, 1987).

All in all, rhythm is essential in both coordinating the mind (cognitive modality) and the body (psychomotor modality) (Montello & Coons, 1998). Children with ADHD often have problems with rhythmical structures. In the case of people with learning disabilities, such as attention deficits, internal arrhythmia or dysrhythmia can be found (Evans, 1986).

A sense of clear structure, especially important for children with ADHD, can be enhanced by structuring not only the music itself, but also the structure of the music making sessions. This way these children can predict what is going to happen next. When working with children with attention problems, it is a good idea to start the session with a task aiming at enhancing the group cohesion, before moving on the actual intervention. (Montello & Coons, 1998). In the current study, the sessions often start with a listening task, or a group activity such as djembe playing.

In the UMSIC music therapy pilot study, the inattentive and hyperactive behaviour was reduced by combination of physical closeness and rhythm-based activities. (Saarikallio et al. 2010.) In the current study, rhythmic tasks are carried out especially in the form of djembe playing in a group, and band playing (both structured and improvised) with different band instruments, lead by the music therapists. These rhythmic tasks are hoped to enhance the impulse control.

Decisions of using certain instruments also affect strongly the study interventions and their outcomes. The research by Montello and Coons (1998) suggests that the hyperactive children may become over-stimulated when provided with a large selection of musical instruments to play. Instrumental music making and improvisation brought challenges in attentive behaviour in the group setting of the pilot study. (Saarikallio et al. 2010.)



When it comes to motor skills, Zentall (1975) has found that the children's attention and performance may improve when they are allowed to move and participate motorically. *The creation of organized music, especially with peers in a group*, has been found to demand considerable attention and self-control (Rickson, 2006). Montello and Coons (1998) found that the students with attention problems concentrated better when the therapist worked with them one-to-one in contrast to a group setting. In the current study, the music therapists are available all the time for the four children studied. This way the situation is very different from the school context where there often are 20 to 30 children per one teacher.

The rhythmic and motor skill aspect as a challenge for children with ADHD has been discussed in this chapter. When comparing the two music scenarios present in this study; music making with mobile phone and playing band instruments, the requirements for motor precision are very different. Where the mobile music making requires fine motor skills, band playing requires also gross motor skills and strong movements.

### **2.3 Collaboration with peers and adults**

Music can serve as a social inclusive tool. According to Stadler Elmer et al. (2010), (musical) play increases group cohesion and decreases tensions within the group. The musical activities in groups have also been found to strengthen the co-operation on the non-musical tasks that follow (Wiltermut & Heath, 2009). It is of great importance that the collaborative way of music making is perceived as a tempting option for the children. Promotive interaction manifests in students promoting each other's success by helping, supporting, assisting, and encouraging each other's efforts to learn. (Klopfer, 2008.)

While emphasising the collaborative nature of mobile music making, it is also important to show individual achievements by marking which musical parts different participants have created. Benford et al. (2000) emphasise that in a collaborative task, the resulting effects must be clearly different from the effects that could have been achieved individually. Tanaka (2005) presents the concepts of immediacy, which provides the user a sense of agency, and distance representation, which distinguishes and gives sense to the partner's input.

In collaborative learning, peer as a tutor can be better than adult in a sense that differences in cognitive, social, and emotional abilities are smaller between same-aged children than between an adult and a child. Bloom (1984) found that one-on-one tutoring by a skilled peer was more effective than conventional (i.e. teachers' lecturing) and mastery learning (i.e. student/regulated) methods of teaching. As guidelines for applying peer tutoring following things should be mentioned: age-appropriate social interactions have to be fostered, clear instruction has to be given, and tutors have to be provided with feedback. (Barfield et al., 1998). It is important to expose the children to material that is challenging enough for them. (DuPaul et al., 1997).

Collaboration with a peer includes also challenges that have to be taken into account when creating the learning situations. In the case of the children with ADHD, their inadequate or variable self-application to tasks requiring sustained effort is often interpreted by others as laziness, irresponsibility, or failure to cooperate. (APA, 2013). Therefore, during the early elementary school years, peer rejection is linked with disruptive classroom behaviour, physical and verbal aggression, arguing, and initiating interactions in a disruptive manner. In general, children with ADHD are lower than their peers on social preference, experience more rejection, are higher on social impact and have fewer dyadic friendships (Hoza, Mrug & Gerdes, 2005).

Positive change in peer status, on the other hand, can be achieved with increased helping and following activity rules. (Mrug et al. 2007). Most social skill training programs aimed at excluded children have following aims: 1) to increase children's social knowledge. i.e. awareness of how their social behaviour affects others; and 2) to teach new pro-social skills believed to be deficient in the children's social repertoire. Active interventions using behaviour change agents, such as parents and teachers, and behaviour management procedures in the natural environment are essential to support changes in social behaviour and to promote improvements in social status. (Guevremont, 1990.)

The child's prosocial behaviour and emotional control can be enhanced by the model behaviour given by calm and empathetic adults. Adults present in the current study are two music therapists. I as the researcher observe the sessions from the separate observation room, without direct contact with the participating children. In mobile music making, the

teachers and music therapists are working as “enablers”. The musical content and software is ready for use, and these adults provide the children with the devices and basic rules for creating music.

Jones (1994, 19) has defined that the classroom teacher is like an “*environmental engineer*”, *one who arranges the learning environment for the child’s success and who encourages learning through that environment*. When the children are encouraged to participate by expressing their ideas and are more engaged in learning, the sustained attention may increase and more adaptive behaviour begin to take place. (Jones, 1994.)

When comparing the role of parents and teachers, it has been found that when doing assessments of child’s social competency, parents are often poor judges of the quality of their children’s peer relationships. Classroom teachers have greater opportunity to observe a child in a variety of situations with same-age peers and this way they usually have a good sense of the child’s social status within the classroom. Teacher ratings of children’s social behaviour have found to correlate quite highly with peer sociometrics and information obtained through direct observation. (Guevremont, 1990).

When it comes to help-seeking in the learning situation, it may happen that the teacher reinforces students’ participation habits by giving more directions and feedback for the ones who are actively seeking for help. Ryan et al. (2001) have found that help-seeking may be avoided by students with *low academic or social competence and low achievement, because it may be comprehended as a signal to their peers that they are not able to undertake some behaviors*. (Järvelä, Häkkinen & Lehtinen, 2006.) *In classrooms where teachers emphasize personal improvement and promote positive social relationships, concerns about help avoidance decrease*. (Ryan, Pintrich & Midgley, 2001).

One of the challenges when applying technology in the school context is that the teachers may feel intimidated because nowadays the students often have higher level of mastery when it comes to using the newest technological devices. (Ashworth, 2007). The willingness of teachers to use technology in their teaching can also be enhanced by providing them with sufficient support and training.

### **3. Technology-assisted music making**

#### **3.1 Technology as part of the learning environment**

A key factor when applying technology in order to enhance learning is how the technology is used as part of the learning environment. (Lehtinen, 2006). The technology should serve both the ones creating the content for the mobile environment or teaching with it, as well as the ones learning with the help of that content. (O'Malley et al. 2005). At their best, the adjustable learning technologies take into account the learner's level of self-regulation, and function in line with that. (Järvelä, 2006). When developing a learning software, it should be taken into account that the learner's behaviour changes during the learning process, and therefore the software should adapt to it and continue to supporting the learning.

When technology is used in learning, good self-regulation skills become even more important, because the learner has more decisions to make and has direct control over the learning situation. Self-regulation and attention can be challenged by the vast amount of information provided by the software. On the other hand, when well applied, the technology can support self-regulation, short-span motivation and situational interest of the learner. (Hidi & Berndorff, 1998; Järvelä 2006). The technology can do this by structuring the interaction processes and guiding to use certain learning techniques. (De Jong et al. 2004, Winne et al. 2006).

Technology may be used to enhance teaching and learning and to increase pupils' independence and autonomy. (Farrell 2009, 213). According to Shaw & Lewis (2005b), some of the advantages of using computers in learning are that they make it possible to work at an individual pace, and have in-built mechanisms that help the children to adjust their own performance. Further, they state that computers are essential in stimulating and motivating the children to stay attentive and to avoid impulsive responses. In collaborative learning with technology, in addition to passing on existing knowledge, also new knowledge is produced through social interaction. (Järvelä et al., 2006).

Technological learning environments have been said to add transparency of the learning processes, which is beneficial for learning. The learning process can be saved in the form of

documents or network conversations produced, or in the form of statistics based on log data. On the other hand computers allow children to work in a more contained and private manner, and the work is less accessible to others. From the viewpoint of the child, it is important that (s)he can just delete work and have no record of mistakes (Shaw & Lewis, 2005b.)

This far there has been a lack of research relating mobile learning to learning theories (Attewell & Savill-Smith, 2004). The success in mobile learning for learners with disabilities is based on appropriate match between learner, device, and purpose. Showing effects of mobile technology usage on children's academic or creative achievements is fairly difficult. However, as Smith (2008) states, a successful mobile technology project can be showed to support learners with specific needs and extend what was previously thought possible for a certain learner. Mobile learning can also motivate learners to focus more closely on tasks associated with learning, due to multi-sensory appeal and immediate rewards.

To this date, few studies have concentrated on studying the use of learning technologies with children with learning disabilities. The results by Shaw et al. (2005a) have showed that children with ADHD respond to computer games in a way that children without ADHD do not. Shaw and Lewis (2005b) found in their study the performance of children with ADHD to be context dependent. The participants with ADHD had more on-task behaviour on the computerised tasks than on the paper and pen formats. However, there was not an increase in the accuracy of responses in the computerised tasks. This is an important finding, because for effective learning to take place, it is not enough that the children stay interested or in-task, but there should additionally be increase in the things learned, or right answers achieved.

As a benefit of learning with computers, the parents of children with ADHD have mentioned that it allows the children with ADHD to feel they are successful. The computer games are also "property" of children and they can themselves control what to play as well when to play and when to stop. Reasons that parents found for children with ADHD enjoying this kind of learning were that computer games are fast-moving, colourful, interactive and challenging and provide constant stimulation. (Shaw, et al. 2005a.) However, it is important to remember that the problems that the child has faced in a traditional learning situation do not disappear by merely applying certain learning technology to that environment. In fact, with a new

learning environment there is a crisis of adaptation that challenges the learner's self-regulation.

There are general requirements for learning technology, but there are specific requirements when designing for ADHD. McKnight (2011) has emphasised that when designing for individuals with ADHD, there has to be a clear layout, where key features are easily distinguishable. It is also important that there are brief and clear instructions, and that consistency and routines are favoured while the possibility of surprises is minimised. The environment should be such that good behaviour and completion of tasks is rewarded, and that when using the software, it asks for input or suggests tasks, when the user has long breaks in the usage of the software. It is also mentioned that the technology should be shut away when not used. Further, ample rest periods and exercise breaks are recommended.

This far most of the research literature has concentrated on interface design rather than interaction design. However, because the technology has only extrinsic value, it would be important to study the effects the technology has on cognitive functions when it is applied in learning situations (Salomon et al. 1991, Iiskala & Hurme, 2006). According to the cognitive load theory, a task performed in a learning environment produces different types of load. The inner cognitive load is caused directly by the properties and the number of cognitive elements of a certain task. Other types of cognitive load are created by the learning environment and by task procedures. The limit is that the total amount of load consisting of inner, outer and related actions should not exceed the capacity of the working memory. (Lehtinen, 2006.) In JamMo learning environment the amount of cognitive load is restricted for example by using icons instead of words.

It has been found that technology can support learner's metacognition. (e.g. Campione et al. 1992, Lajoie 1993). This can be seen for example when the learner can affect the difficulty of the tasks and define when needing help. (Luckin & Hammerton 2002). Interestingly, technology can work as "an assistant", helping the learner to solve the kind of problems (s)he could not yet solve independently. This way it can provide help also for the teachers, when they are not capable of helping all the learners at the same time. (Iiskala & Hurme, 2006.) The technological learning environment can direct the learner as directly as possible to the purposeful actions relevant to the learning.

### **3.2 Music education technology**

Nowadays music plays an integral part of the everyday life of children and youth. Their musical experiences are not restricted to music classes or going to concerts, but include also digital music players, social networking sites, music videos, and game music. Mobile music making has become possible due to the rapid development of portable technology, which can be used in different environments and on the move. Mobile music making is one way of enabling the children to participate actively in creating music culture, not just passively perceiving it.

Music education technology, being one of the key concepts of the current study, can be defined as utilising music technology within educational settings. Music education technology aims at bringing something new to music education, but it does not aim at replacing music education with technology. (Ojala, Salavuo, Ruippo & Parkkila, 2006.)

When developing mobile music making technology, it is important to take into account social, cultural, and psychological aspects. Social aspect can be considered as enabling formation of social networks within the application. Multicultural environment can be taken into account by using visual information and icons instead of written language. A possibility to adjust the level of difficulty to an individual's cognitive skills reflects the consideration of psychological aspects. This far all these three aspects have lacked attention from the researchers. When they are properly considered and applied, music technology can be effectively used in heterogeneous groups for supporting the individual's psychological and social development. (Ojala 2006.)

The studies of mobile music making have concentrated in researching technological mobile innovations in academic settings, in order to show that they provide both technological and pedagogical solutions for educational purposes. The mobile music making may serve the aim of enhancing collaborative learning in connected classroom learning. (Kukulka-Hulme & Traxler, 2005.) The digital learning resources used in mobile learning are accessible also outside the formal learning context. Learning can be spontaneous and immediate, as well as flexible and personalised. Learners themselves have a lot of control over their learning. (Smith, 2008.)

Where mobile learning differs from more traditional forms of learning is that in the m-learning the learner is not at a fixed location, and the learning takes place via wireless mobile technologies, such as smart phones or laptop computers. (Kraut, 2013). In the mobile devices built-in microphones, touch or multi-touch screens, accelerometers, and magnetometers form a good basis for using these for mobile music making. JamMo as a musical learning environment utilises all these technical properties of the smart phone.

What then differentiates the digital technologies from other learning tools and their possibilities? Loveless (2002) has mentioned features of ICT such as provisionality, interactivity, capacity, range, speed and automatic functions. In JamMo loop composing game, provisionality can be seen as children's possibility to try different loops, make changes by adding and removing loops, and store their creations in the song bank. Interactivity can be seen in the form of the mentor that is giving advice and feedback for the user. According to Sharples (2000), the learning technology should be highly portable and available anywhere. This way the technology enables communication with peers, teachers, and experts. The technology should also be individual, adaptable, and persistent. The technology should be unobtrusive as well as useful and easy to use by novices.

Winters (2006) has presented four categories describing perspectives on mobile learning. The most prominent is the techno-centric perspective where mobile learning is seen as learning using a mobile device. When seeing m-learning as an extension of e-learning, the perspective is about its relationship to e-learning. M-learning can also be viewed as augmenting formal education, where the formal education is defined as face-to-face teaching. The fourth category is the learner-centred approach where the focus is on the mobility of the learner and on the learner's perspective, rather than on the mobile device. The m-learning is seen as communication in context. This view has been strongly affected by the research work by Sharples (Sharples, 2000; Sharples et al., 2002).

The topic of children and mobile music making raises the question of how to acquire the technical abilities needed. Is it necessary to learn certain things about music before doing music? One advantage of mobile music making can be that, compared to traditional musical instruments (Blaine & Fels, 2003a), it does not require a long and profound practise process of acquiring the skills needed for playing the instrument, but allows low entry-level usage.



Machover (2004) emphasises that children can learn music by doing music as performers, composers, and listeners. Blaine and Fels (2003b) agree with Machover's statements by saying that it is important to provide novices with *easily accessible music making experiences rather than a complex interface with built-in, upward capability for virtuosic expression*. A counterargument has been proposed by Wessel and Wright (2002) who state that many of the easy-to-use musical interfaces do not support continuous musical development, but instead after a while turn to have a toy-like character.

One can make a distinction between private and social music making. Although the music is part of our everyday life, it is often enjoyed and expressed privately rather than socially. When using music technology, *in most cases, music is created at each endpoint and uploaded for synchronization and reconciliation* (Tanaka, 2004). Despite the advantages of asynchronous learning, often it does not serve as the only musical learning environment, because it lacks the contact with other people, essential to all music learning and music making. Gurevich (2006) describes the potential of network technology in that it provides a tool and experience to people who would not otherwise participate in making music.

Nowadays music technology provides countless possibilities for creating music. However, few applications focus on enabling collaborative music making, sharing ideas, and creating music in real-time with others. Tanaka (2005) has discussed the theme of facilitating collective musical creativity. He has defined essential concepts of creating online music making communities. These are having shared goals, belonging to the shared experience, reciprocity among the users, engagement and recognizing one's own contribution.

Most of the music learning takes place in one-to-one, peer-to-peer interaction or one-to-many, many-to-one learning, possibly with a peer group lead by a teacher. (Ojala et al., 2006). The interaction in a learning environment can happen either 1) between the learner and the teacher, 2) between the learner and the peers, or 3) as self-directed learning between the learner and an adaptive learning environment. In JamMo environment, the emphasis is on the children's stand-alone (self-directed learning) and pair work learning with a peer. The teacher or music therapist is often present as a facilitator and is giving advice when needed.

### **3.3 JamMo as a mobile learning environment**

In the current study, band playing is contrasted with mobile music making with JamMo (Jamming Mobile). The JamMo software has been developed for 3 to 12 year-old children's mobile music making. With JamMo children can record their singing, play virtual instruments, use sequencer functions, and compose with loops. As a whole, the UMSIC project aims to creating an interactive mobile music making environment that supports collaboration and prevents negative forms of social interaction. The project aims at encouraging children in pair gaming and teamwork. (Paananen & Myllykoski, 2009.)

JamMo is designed playful for children aged 3-6 years and game-based for children aged 7-12. (Paananen & Myllykoski, 2011). The different levels of social interaction when creating music with JamMo are: stand-alone, ad hoc, public, and networked music making. In the current study, individual stand-alone work is applied in six of the sessions and the children worked in pairs with JamMo in three of the sessions.

JamMo has been developed on Linux Maemo 5 platform and it can be used both on Nokia N900 mobile phone and Ubuntu Linux laptops ( <http://jammo.garage.maemo.org> ). In addition to using WLAN and Bluetooth, a special PeerHood networking module has been developed for UMSIC middleware to provide seamless connectivity to nearby devices over different networking technologies. (Laakkonen, Kallonen, Heikkinen & Porras, 2009). The system structure of the software includes four modules: the Children-centric Usability Module (CHUM), the Cognitive Engineering Module (CEM), the General Middleware Services (GEMS), and the Musical Engineering and Authoring Module (MEAM). The MEAM component includes sound recorder, sound player, sequencer, midi editor, and sampler. (Myllykoski et al. 2009). The described component structure of JamMo can be seen in the figure 1.

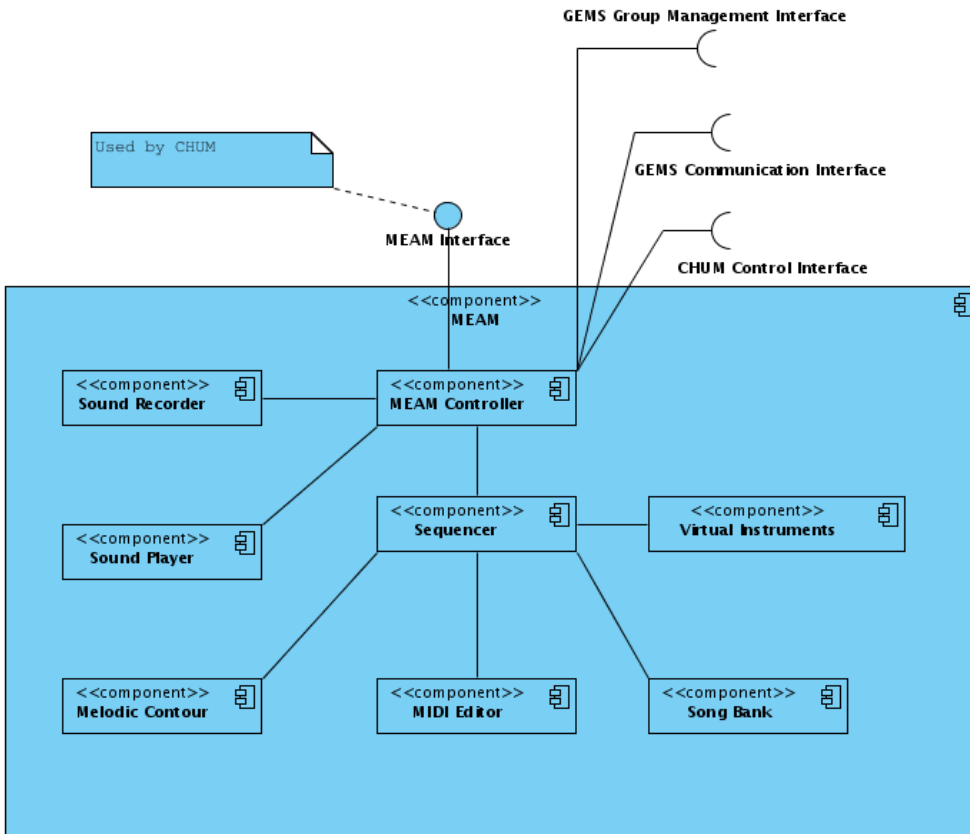


Figure 1: Component structure of JamMo (Myllykoski et al. 2009)

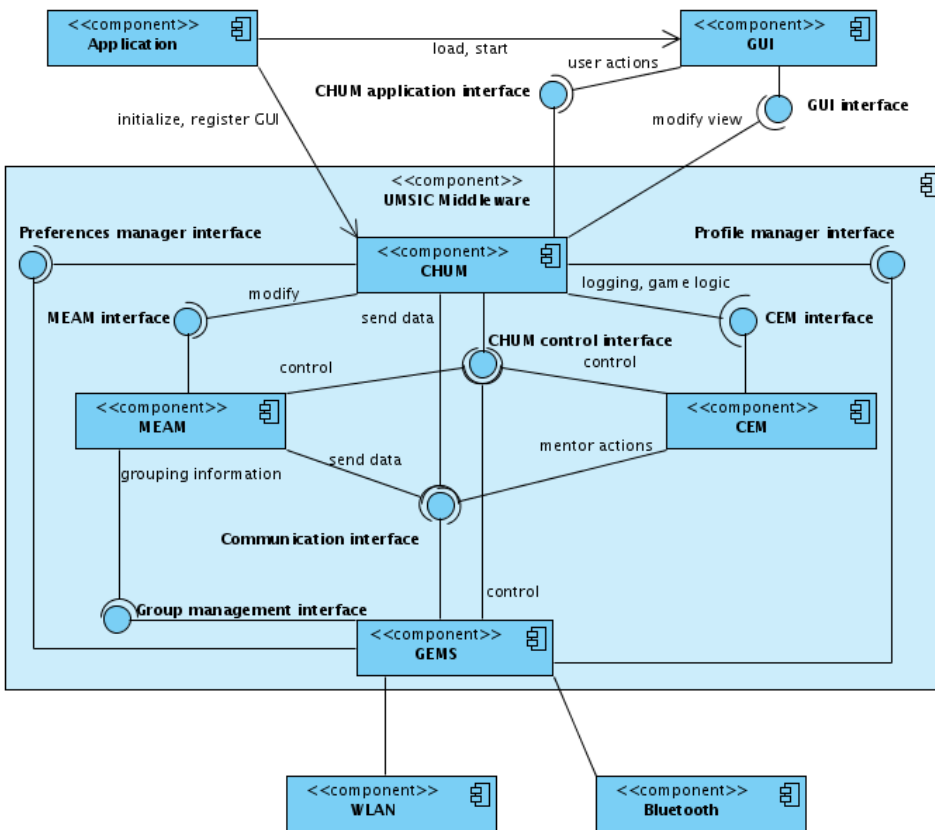


Figure 2: Subcomponents of MEAM (Myllykoski et al. 2009)

In the JamMo learning environment children can learn the basics of loop composing. During the current study, the JamMo 3-6 advanced composition game is used in the sessions 2 and 3. This game is primarily aimed at younger children than my target children. However, it was very useful for making the basic functions of the software familiar to the user, because the orientation games were not yet available. In this game there are three different themes the child can choose from when starting to compose: Animal World, Castle, and City. Within each theme, there is a backing track that cannot be edited and a loop track to which the child can add sound loops. Each loop is presented by a certain symbol according to the theme. The loops can be moved and removed, and the whole composition can be listened at any point of the composition process. After finishing the composition, it is saved on the song bank. (Laakkonen et al. 2009.) In the figure 3, one can see the JamMo loop composing with different loops on tracks, and the teddy bear mentor on the upper right corner.



Figure 3: JamMo composition game / loop composing: City theme

The JamMo 7-12 consists of: 1) stand-alone orientation games; for both standalone and collaborative work, 2) the sequencer including four virtual instrument interfaces (keyboard, drums, slider, jammer) and a playful loop machine, 3) the community and 4) the administrative software for teachers. The games include structured tasks, a mentor and a reward system (Paananen & Myllykoski, 2011). The JamMo 7-12 sequencer is used in seven of the eleven sessions. In four of these sequencer sessions, there is a backing track and one loop track, and in the next three sessions there is a backing track and four loop tracks available for the children.

Before the music therapy intervention, a music therapy pilot study was carried out. The aim of the music therapy pilot study was to create and test methods that could be used for analysing the behaviour and self-regulation of children with ADHD in musical interventions. The pilot study aimed at measuring the fluctuations in inattentiveness and hyperactivity of the children. Another aim was to find the elements that helped the children to concentrate, maintain optimal activity level, and positive social interaction. The main results found in the pilot study were that on-task behaviour was related to clearly structured tasks, rhythm-based tasks, singing, short instructions & modelling, and physical proximity. (Saarikallio et al. 2010.)

## 4. Research methods

### 4.1 Research objectives

The aim of the current study is to investigate attention regulation of children in different music conditions. Regulation of attention, hyperactivity of children with ADHD and their non-ADHD peers was studied at the music therapy clinic of the University of Jyväskylä. The research questions of the current study are:

- 1) What musical/social elements help the children the most to regulate their attention and activity level?
- 2) What musical/social elements lead the children towards positive social interaction?
- 3) Is there a difference in children's attention regulation between mobile music making and playing band instruments? What kind of difference?
- 4) Is there a difference in attention regulation between children with ADHD and children without ADHD in mobile music making and/or in band playing? What kind of difference?

Based on the previous research literature, the expected outcome is that children with ADHD would have more challenges in sustaining attention regulation than their non-ADHD peers. When comparing behaviour of the participants, concepts of minimal and maximal contrast are applied (Flick, 2007). The minimal contrast is predicted in the attention regulation between the two children with ADHD, as well as between the two children without ADHD. The maximal contrast is predicted when comparing the attention regulation of the children with ADHD to the attention regulation of the children without ADHD. When thinking of the different musical context, the minimal contrast is expected between the two JamMo conditions (stand-alone and pair work), as well as between the two band playing conditions (instructed band playing and improvised band playing). The maximal contrast is expected to be seen between the stand-alone JamMo composing and the improvised band playing. This is due to the fact that the stand-alone JamMo composing is the most structured of the musical conditions, and the improvised band playing the least structured one.

## 4.2 Study design

This research is a multiple case study with four participants; two children diagnosed with ADHD and two comparison children without ADHD, all attending fourth grade at elementary school. Non-participatory observation is used as the main data collection method. The data, in form of video recordings, is analysed both qualitatively and quantitatively.

As typical to a case study, this research is defined more by the object of the study than a particular methodology (Mertens, 2010). Due to the nature of case study, the aim is to examine a certain phenomenon occurring in a bounded context (Miles & Huberman, 1994). The study provides a detailed description of four children with ADHD in mobile music making and band playing.

This study provides an in-depth, precise, thick description (Geertz, 1993) of attention regulation of the children. By choosing to use a limited number of participants, the individual differences are emphasised and individual uniqueness and complexity valued highly. (Barker, Pistrang & Elliott, 2002). The study's qualitative nature is seen in that any typicality or generalisation beyond the cases studied is not pursued. Instead, the study describes these particular individuals in these particular contexts.

A case study often includes several different research methods (Laine, Bamberg & Jokinen, 2007). In social sciences, triangulation means using quantitative and qualitative methods in studying a certain behaviour from several standpoints in order to explain it in all its' richness and complexity, (Cohen, Mannion & Morrison, 2013, 195). In the current study methodological triangulation is seen in that both quantitative and qualitative methods are applied.

The strength of including qualitative approach in this study is that it presents a complete, detailed description of the music making situations and the children's behaviour. Furthermore, it provides contextual information, which might had been missed with studying solely the music making session with quantitative research tools. As in qualitative research in general, I am more interested in the music making process than the products of the process.

Quantitative methods, on the other hand, provide tools for classifying behavioural features, counting and analysing them. In data analysis the quantitative approach is applied by carrying out a time course analysis of the music making sessions. The study setting is a music therapy clinic, which means that the settings is arranged for the study and the children's behaviour is not observed in their natural setting. I study mainly the behaviour of the children (etic, outsider's point of view), not their own experiences or thoughts (emic, insider's point of view).

The study is carried out as non-participatory observation. I as a researcher do not participate the music sessions or interact with the children, and therefore objective portrayal of the situations is possible. This decision minimises the typical challenges of this approach, such as the chance for me getting too involved in the group, or affecting the participants' behaviour or the overall results (Stadler Elmer et al. 2010, 51). Present in the sessions are the children and the two music therapy students. I as the observer and analyser of the data am in a separate observation room. In the observation room, there is also the supervisor of the music therapy students, as well as at times some other music therapy students, who are observing these sessions as part of their master's level studies.

The data is collected through structured observation (Marks & Yardley, 2004). Systematic observation is carried out in a sense that specific behavioural codes, in this case the types and levels of attention regulation, are defined beforehand and then marked to the data. These labels serve as measuring instruments for this observational research. Mutually exclusive and exhaustive codes are used. This means that there is a code for every event and that only one code is associated with a specific event. (Bakeman & Gottman, 1997, 26.)

In the current study the observation and video recording are carried out at a continuous manner. I as the observer am constantly paying attention and recording when a specific event or change takes place in the children's behaviour. (Bakeman & Gottman, 1997.) The main interest is not on observing how often certain behaviour occurs, but rather on the time devoted to a particular type of behaviour.



### **4.3 Participants & intervention procedure**

Participants in the present study are two ADHD children and two non-ADHD children. The participants come from two local elementary schools, one ADHD child and one non-ADHD peer from each school (pairs A & C, and B & D). All children are 10-year-old boys studying at fourth grade. The children A and B are diagnosed with ADHD, but there is no information available for the research purpose concerning their possible ADHD medication, or type of the diagnosis (mainly inattentive, mainly hyperactive, or combination type).

The intervention sessions were carried out at the music therapy clinic at the Jyväskylä University during autumn 2010. Therefore, all the data reported in this study is primary data. Attention regulation of the children is divided into four categories: on-task, selective on-task, passive off-task, and hyperactive off-task.

The original plan was to carry out a music therapy intervention consisting of 12 sessions. First four sessions would have included JamMo stand-alone playing of the orientation games, next four sessions JamMo pair work with the Jammer and sequencer, and last four sessions JamMo playing in small groups within the workshop scenario (Paananen et al. 2010). However, due to the delayed development of the JamMo software, the initial plan had to be modified. Finally, 11 sessions (45 minutes each) are executed, nine of which include JamMo playing. The original aim was also to apply and study pair tutoring as a core teaching method in the intervention, but finally it is instructed only in one session. The contents of the music making sessions are defined in table 1.

JamMo 3-6 advanced composition game is used in the sessions 2-3, JamMo 7-12 sequencer with a backing track and one loop track in the sessions 4-7, and same sequencer with a backing track and four loop tracks in the sessions 8-10. In the 11th session, the children listen to their own JamMo compositions. Loop and backing track of the JamMo 7-12 could be used, but there were constant crashes with the software. As general notions could be mentioned that JamMo loop composing is executed mostly as stand-alone, and pair work with JamMos is included in three of the sessions. When the children are composing with JamMo together with a pair, they have one JamMo device in use with two styluses. Unlike in the classroom intervention, headphones are not yet used at the music therapy clinic context.

Session number	Content of the session	Children	Analysed
1	Djembes, drumkit, jam blocks (=instructed band playing)	A + C	A + C
2	Band instruments: instructed, JamMo in pairs	A + B + C + D	A + B + C + D
3	Band instruments: instructed, JamMo stand-alone	(A) + B + D	B + D
4	Band instruments: instructed, JamMo stand-alone	A + C	A + C
5	JamMo in pairs	A + B + C + D	A + B + C + D
6	JamMo stand-alone	A + B + C + D	A + B + C + D
7	Djembes & band instruments: instructed	A + B + C + D	A + B + C + D
8	Band instruments: improvisation, JamMo stand-alone	A + (B) + C + (D)	A + C (video data for B & D partially missing)
9	Band instruments: improvisation, JamMo stand-alone	A + B + C + D	A + B + C + D
10	Band instruments: improvisation, JamMo in pair + 1 stand-alone	A + C + (D)	A + C
11	Listening to own JamMo songs, Band instruments: instructed	A + B + C + D	A + B + C + D

Table 1. Content of the music making sessions. Child A = ADHD1, Child B = ADHD2, Child C = non-ADHD1 & Child D = non-ADHD2.

As described earlier, in addition to the JamMo stand-alone and pair work excerpts, instructed band playing and improvised band playing excerpts are analysed. In instructed band playing the children play together with the music therapy students songs that are part of the JamMo song repertoire. In improvised band playing the children play unstructured music, which either has a previously decided title or not. Band instruments used in the sessions are acoustic drum-kit, electronic drum-kit, piano, electronic piano, synthesiser, bass guitar, and MalletKat (MIDI percussion controller).

The sessions are lead by two music therapy students. Music therapy clinic as the environment was not familiar to the children prior to the music therapy intervention sessions. The school intervention sessions were later carried out in their own schools. The music therapy clinic could be seen as a good “compromise” between a laboratory and a natural setting. With the band instruments etc. the music therapy clinic seems to be somewhat similar to other kinds of

music education contexts. However, there are only four children present, different from most of the other music education situations. On the other hand, this specific environment gives structure that a totally natural context would lack.

The music making sessions are monitored and recorded with unobtrusive video cameras. The video shows the children’s behaviour, but their actions on JamMo devices per se can not be seen. In the observation room the observation is carried out with the visual information from these cameras.

#### 4.4 Data analysis

Section selection	Quantitative time-course analysis (Annotation)	Qualitative analysis
JamMo stand-alone JamMo pair work Instructed band playing Improvised band playing	Individual attention regulation of activity: - On-task behaviour - Selective on-task behaviour - Passive off-task behaviour - Hyperactive off-task behaviour	1) Description 2) Interpretation 3) Content analysis: Essential elements contributing to the reduction of hyperactivity and inattentiveness

Table 2. Data analysis process.

The ADHD intervention as a whole is a within-subject study, where each child’s behaviour is observed in social situations over time. Therefore, attention regulation of the same ADHD children is observed at the music therapy clinic context and in the classroom intervention (Pelamo, 2012). However, the non-ADHD peers whose behaviour is analysed, were different between the two interventions. All music therapy clinic sessions and music lessons at school are video recorded. The video data is analysed both quantitatively and qualitatively. Same behavioural codes for attention regulation are used in the analysis of both of these contexts. The music therapy intervention is observed and analysed by different grader than the classroom intervention. Thus, subjectivity and differences in the learning context have to be considered and the results of the two interventions are not directly comparable.

In the current study, qualitative analysis is combined with quantitative analysis in order to find essential elements contributing to the changes of attention regulation concerning on-task behaviour, selective on-task behaviour, passive off-task behaviour and hyperactive off-task behaviour (Table 2). At first a qualitative description of the sessions, including both the individual and group behaviour, is written during the initial recording situation at the music therapy clinic's observation room. This qualitative analysis is then broadened when afterwards watching the video recordings. In descriptive content analysis I identify and categorise reduction or increase of hyperactivity and inattentiveness.

The labels used in this quantitative time-course analysis concerning attention regulation are on-task behaviour, selective on-task behaviour, passive off-task behaviour, and hyperactive off-task behaviour. These variables were formulated together with the research group. In the music therapy pilot, a different assessment method was used, including three items: "appropriate", "adequate", and "chaotic". The variables used in the present study are defined as follows:

- 1) **On-task behaviour:** The child is concentrating on playing JamMo or band instrument, and follows the instruction.
- 2) **Selective on-task behaviour:** The child is concentrating on the musical activity and in JamMo context looking at the device, but is either a) having mild motor hyperactivity, b) having mild inattentiveness, c) having brief breaks in the playing, d) making frustrated comments about JamMo, or e) commenting on or listening to other child's musical activity when instructed to compose individually.
- 3) **Passive off-task behaviour:** The child is not doing what instructed, but is neither disturbing others. The child is either a) looking passively away from the JamMo/band instrument, or b) being physically phlegmatic.
- 4) **Hyperactive off-task behaviour:** The child is not doing what instructed, and is actively doing something else, such as a) playing another band instrument or JamMo than what instructed, b) paying attention to distractions, c) having clearly task-irrelevant motor activity (e.g. tapping on the table or chair) d) verbally commenting other topics than on-going musical activity, or e) verbally commenting to someone else than one's own pair or instructor.

For the video analysis, each session is divided into following musical episodes: 1) JamMo stand-alone, 2) JamMo pair work, 3) Instructed band playing, and 4) Improvised band playing. Then, a 5-minute excerpt from each mobile music making episode (stand-alone, pair work),

and a 5-minute excerpt from each band play episode (instructed, improvisation), is extracted. All the excerpts are started 30 seconds after the onset of the musical episode, or from the moment when each child has a musical instrument or mobile phone at hands, and the cameras have an unobstructed view of all the children. Data from the video recordings is quantitatively analysed with video analysis program Annotation ([anotation.en.softonic.com](http://anotation.en.softonic.com)) by marking time segments on the video.

A summary of the different music making scenarios:

**JamMo stand-alone** scenario: in five of the sessions

- Total duration analysed: 25 minutes

**JamMo pair work** scenario: in three of the sessions

- Total duration analysed: 15 minutes

**Instructed band playing** scenario: in six of the sessions

- Total duration analysed: 30 minutes

**Improvised band playing** scenario: in two of the sessions

- Total duration analysed: 10 minutes

The data exported from Annotation is further analysed in Excel. The duration of each code for each child and the overlap between musical activities (JamMo composing, playing band instruments) and attention regulation (on-task, selective on-task, passive off-task, hyperactive off-task), are calculated. In the analysis process, time-based percentages are used (Bakeman & Gottman, 1997), meaning the proportion of time coded i.e. "on-task behaviour". The data is then presented as charts representing the percentages of the certain types of attention regulation and / or musical scenarios in the observed sessions.

## **5. Results**

### **5.1 Elements contributing to attention and hyperactivity regulation**

After completing both quantitative and qualitative analysis of the children's behaviour in the band playing and mobile music making sessions it is now possible to conclude and discuss essential musical and social elements affecting the children's attention regulation and contributing to the reduction of their inattentiveness and hyperactivity.

As mentioned earlier, in the video analysis the children's behaviour, and more precisely their attention regulation, is divided into the categories of 1) on-task behaviour, 2) selective on-task behaviour, 3) passive off-task behaviour, and 4) hyperactive off-task behaviour (see the definitions on page 33). JamMo episodes are labelled according to their musical content, as either JamMo stand-alone or JamMo pair work, and band instrument episodes as either instructed band playing or improvised band playing. This way in addition to gaining general findings concerning the attention regulation of children, attention regulation can also be analysed between the ADHD children and non-ADHD children, between the mobile music making and band instrument playing, as well as between the different JamMo scenarios and band scenarios.

As results of the current study can be presented that an essential element contributing to improvement of attention regulation and reduction of inattentiveness and hyperactivity is clear (and repeated) instruction that is given before the children are at close physical proximity to the mobile phones or band instruments. Another important element enhancing attention regulation is found to be sitting independently, far from other musical instruments. It can be seen that if the children have musical instruments or mobile phones in their hands before the instruction is given, the off-task behaviour is likely to occur. Clarity of the instruction plays a key role in all the musical activities, and lack of it reflects in hyperactive off-task behaviour. The attention regulation is better, when the instructions are given to all four children at the same time and this way they do not have to wait for their individual instructions. Only a few times a child commented in a negative manner to the instructions given.

In all the musical activities the music therapy students have an active role, instructing the children, offering help, and demonstrating the usage of JamMo or a certain musical instrument. Role of the instructors is very significant especially because during the sessions the JamMo sequencer was not working properly and there was no virtual mentor yet available in the software. When using JamMo sequencer, the children frequently asked help from the music therapy students, who also came to offer help without asking.

Essential elements contributing to deterioration of attention regulation and increase of inattentiveness and hyperactivity are the choice of instrument and unstable software. Qualitative differences can be seen in the attention regulation depending on which instrument the children are playing. When playing a more simple percussion instrument such as a maracas or jam blocks, the children get more easily hyperactive than when playing the drum kit and practising a certain comp. The children with ADHD have more motor skill problems when playing the instruments than their non-ADHD peers.

The technical problems with software frustrates each child equally, and this frustration is expressed mostly through verbal comments, while the physical behaviour remains calm. Usually the technical problems lead to slight passiveness, and hyperactivity is seen very seldom. When the software crashes down, the child usually informs the music therapy student about it, and they reboot the device together. Soon the children learn to do this independently. Still, the music therapy students constantly come to offer help to the children, and provide encouraging feedback when the children manage to solve a technical problem.

A difference is found in attention regulation between mobile music making and playing band instruments. Band instruments seem to be challenging in regard to attention regulation. Both the instructed and the improvised band playing, lead more often to hyperactive off-task behaviour than JamMo playing. Hyperactive off-task behaviour is seen more in the band playing than mobile music making context, while passive off-task behaviour is more prominent in the mobile music making than in band playing.

Qualitative differences can be seen in the attention regulation depending on which instrument the children are playing. When playing a more simple percussion instrument than the drum kit, such as a maracas or jam blocks, the children get more easily hyperactive than when

playing the drum kit and practising a certain comp. However, during the breaks there is at times hyperactivity with all of the instruments.

## **5.2 Individual differences in attention and hyperactivity regulation**

The overall qualitative result of the current study is that all the children behave mostly in a tranquil and non-disruptive manner in all the musical contexts. No clear difference can be seen in attention regulation between the ADHD and non-ADHD children. This finding is supported by the quantitative analysis, which shows that with ADHD children 94 %, and with non-ADHD children 93 % of the total time of the analysed excerpts consists of on-task or selective on-task behaviour (Table 3).

When comparing attention regulation of the ADHD and non-ADHD children in mobile music making, it can be seen that there is slightly more selective on-task and passive off-task behaviour by the non-ADHD children than by the ADHD-children. In the band playing contexts there is slightly more hyperactivity by the child 1 with ADHD than by the other children (Table 3).

Both children with ADHD seem to have more motor skill problems than their peers in playing the drum kit, and also more problems in keeping the rhythm with other instruments. In the current study, rhythmic structures appear to be challenging especially for one of the participants (ADHD1). The non-ADHD child 1, on the other hand has been playing drums as a hobby, which can be seen in his music making.

As a qualitative observation can be stated that the children have different roles from each other in the musical activities. When composing individually with the JamMo, the non-ADHD child 2 is the most eager one to make comments about his own and his pair's composition, to play to his pair a loop that he finds interesting or amusing, or to help his peer when the software crashes down.

In the JamMo pair work situations the children have only one stylus per pair, and therefore turn taking is necessary. Often this leads to other child being in a dominant role, whether instructed or not. All in all, the pair 2 has more collaboration and communication than the pair



1 in the mobile music making situations. In one of the analysed stand-alone excerpts, the children are instructed to help each other, but no specific task is given. The non-ADHD children behave more in passive off-task behaviour than their ADHD peers in JamMo pair work sessions. In the first JamMo pair work session the therapist is constantly standing or sitting next to the children, advising and demonstrating the use of JamMo for them. In the pair 1 the smart phone is in the hands of the ADHD child throughout the whole excerpt analysed, while the non-ADHD is mostly just observing his pair and having more passive off-task behaviour. In the pair 2, the smart phone is in the hands of the non-ADHD child, but in this pair the children are both contributing to the composing process.

In one of the pair work sessions the analysed excerpt is preceded by a pair-tutoring demo by the music therapy students and a period of individual JamMo playing. The aim is that each child would learn to use loops from a certain instrument, and then teach his peer to use them. In the analysed period, in the pair 1 the non-ADHD child is instructed to act as a tutor to his peer, and in the pair 2 the ADHD child is instructed to advise his peer. In the pair 1, the tutee is mostly silent and following his peer's actions (passive off-task behaviour). In the pair 2, the tutee makes initiatives to help his peer and made suggestions to him (on-task behaviour).

In many occasions, the ADHD child 2 wanted to reassure that he had understood the given instruction. Other children were looking mostly at their musical instrument, while this child looked more at the music therapy students, and at times his gaze wandered around the room. Similar to the JamMo context, the non-ADHD child 2 was the most eager one to make comments about other's playing in instructed band playing situation. His feedback to others was always positive and encouraging.

In one of the improvisation sessions with band instruments, the musical improvisation has no theme. In the other analysed improvisation session, one child at a time is asked to give name to their upcoming improvisation. Similar to the instructed band playing activity, the ADHD1 child seems to be the most cautious one, and it takes him a longer time and more input from the music therapy student to come up with a song title.

In this study, collaboration is not seen much, mostly because the children's cognitive capacity needs to be in use for trying to manage with the unfinished software that is often crashing.

However, collaboration can be seen between the children when a pair is sharing one JamMo in a pair work situation. There are also some comments during the stand-alone sessions, but mostly the children concentrate on their own composing process. There is more interaction between the pair 2 than the pair 1. It seems that especially the non-ADHD 2 child creates collaboration with his peer. His actions can be defined as a small-scale promotive interaction, which means that the learners promote each other's success by helping, supporting, assisting, and encouraging each other's efforts to learn. (Klopfer, 2008.)

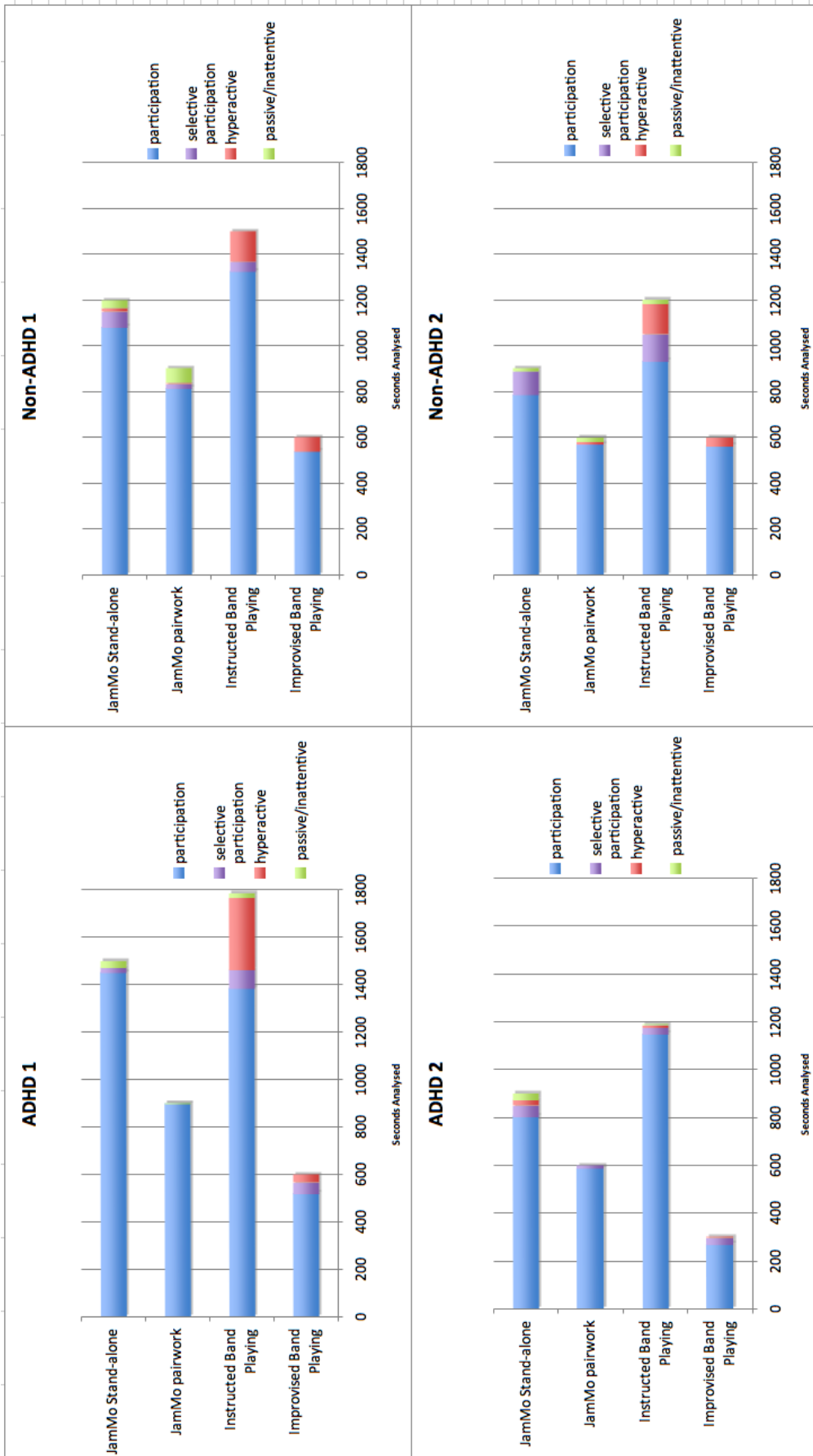


Table 3. Attention regulation of children in different musical contexts.

### **5.3 Attention regulation in different music scenarios**

When it comes to different music making scenarios, band instruments seem to be more challenging in regard to attention regulation than mobile music making. Both the instructed and the improvised band playing lead more often to hyperactive off-task behaviour than JamMo playing. Hyperactive off-task behaviour is seen more in the band playing than mobile music making context, while passive off-task behaviour is more prominent in the mobile music making than in band playing.

In both JamMo scenarios, 96 % of the overall time analysed consists of on-task or selective on-task behaviour (Table 4). However, there is more selective on-task behaviour in stand-alone than in pair work learning situation. In JamMo stand-alone scenario there is more selective on-task behaviour by the non-ADHD children than by the ADHD children. When composing individually, the children are usually sitting quite close to their peer. They are not using headphones, and therefore they are able to hear what their peer is doing. In a pair work situation there is only one sound environment audible for the pair.

The children behave more in a hyperactive manner in instructed band playing than in improvisatory band playing. The quantitative results of instructed band playing show that 88% of the behaviour of the ADHD children and 89 % of the behaviour of the non-ADHD children is on-task or selective on-task behaviour. When the children are asked to improvise with band instruments, percussion instruments, and especially drum kits, these are found to be the most challenging ones in relation to the attention regulation. A difference can be seen between the hyperactive off-task behaviour between the ADHD children and non-ADHD children in improvised band playing.

In instructed band playing the children have musically more restricted instructions than when improvising with band instruments. In on task-behaviour of an instructed band playing situation, the child does not necessarily play right notes, but he seems to do his best and concentrate on the musical activity. If the child actively plays something else than what is instructed, this is coded as hyperactivity. In improvised band playing, on the other hand, all kind of playing is coded as on-task behaviour, as long as it is done with the previously defined instrument and is not executed when verbal instructions were given.

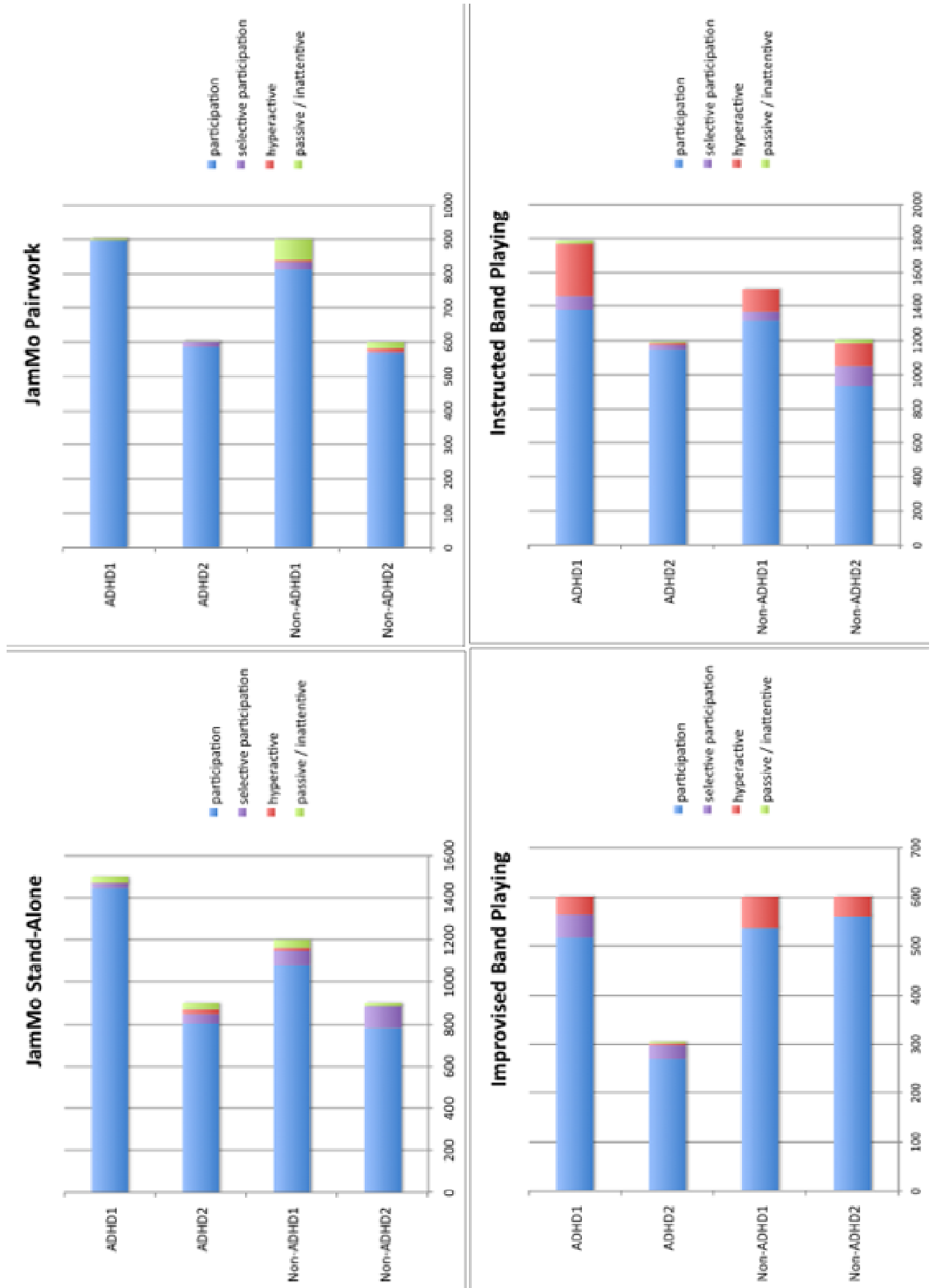


Table 4. Attention Regulation of all the children in different musical contexts.

## **6. Discussion**

The aim of this study was to define the differences and similarities in children's attention and hyperactivity regulation in mobile music making and band playing contexts. I wanted to see whether there are individual differences in the attention regulation of the children in these scenarios. It was also of research interest to find whether the children's attention regulation in mobile music making vary according to the social context i.e. stand-alone vs. pair composing. The further aim was to find out how the attention regulation of children with ADHD could be best supported in mobile music making context.

In this chapter, I discuss the main findings, implications and limitations of the current study. I also discuss the reliability and validity of the research process, as well as the research ethics. In the last part of this chapter I point out possible ideas for the future studies.

### **6.1 Discussion of the main results**

The essential elements contributing to better attention and hyperactivity regulation found in this study were sitting independently, clear instructions and active role of the music therapy students. The short and repeated instruction was preferably provided to all of the children simultaneously, and prior to having musical instruments or mobile phones at their hands. The music therapy students instructed the children, offered help, and demonstrated usage of the band instruments and the mobile software. Their role was emphasised when the software was crashing. These findings were in line with the results of the music therapy pilot study, where two of the main findings were that on-task behaviour was related to clearly structured tasks and short instructions and modelling. (Saarikallio et al. 2010).

Important elements contributing to deterioration of attention regulation and increase of inattentiveness and hyperactivity were the choice of instrument and the unstable software. Playing band instruments was found to be more challenging than mobile music making in regard to attention regulation. Both instructed and improvised band playing lead more often to hyperactive off-task behaviour than mobile music making. Passive off-task behaviour was more prominent in the mobile music making than in band playing.

When it comes to the different music making scenarios, one should remember that in band playing there were breaks between the songs, when the children were supposed to be quiet and listen to the instruction, but often they continued to play the musical instrument. When working with mobile phones, the children were allowed to create music for the whole period, and no quiet periods were required. Also the turn taking in pair work scenario of mobile music making should be clearly instructed in order to avoid the situation where one of the children dominates and the other child does not have an active role in the composition process. In the band instrument playing different choice of instrument might have affected the amount of off-task behaviour, but this should be further studied.

The results show that the children had different kind of roles from each other in the musical activities, especially in the pair work situations, where others had more dominant role. The non-ADHD2 child was making most comments, and encouraged other children. Another difference between the participants is that both of the children with ADHD had more motor skill problems than their peers, and rhythmic structures were found to be especially difficult for the ADHD1 child. All in all the children behaved mostly in a tranquil and non-disruptive manner in all the musical scenarios. No clear individual differences were found in the level of attention or hyperactivity regulation.

If both of these musical activities, mobile music making and band playing, are part of the same 45-minute session, band playing always takes place before JamMo composing. It should be remembered that the mobile music making is always individual or pair work, while band playing always takes place in a group. Another essential difference between these two musical activities is that band playing requires a lot of motor activity, while the mobile phone is held in one hand, and controlled by small and precise fine motor movements of the other hand. These factors can definitely affect the results.

Even though this study emphasises the importance of good attention regulation, it should be remembered that good attention regulation is not the main aim in education, but rather a step in the right direction, towards effective learning. Further, as Rowe et al. (2009) have pointed out, an important factor when analysing children's on-task/off-task behaviour is that *we cannot solely rely upon students' appearance of being engaged in the software as a reliable indicator of being on-task: we must also attend to their behavior in the virtual environment.* In

addition to observing the children's behaviour, in the future studies analysing the log data of the software would be important.

## **6.2 Reliability & validity**

One factor contributing clearly to the validity of the research is the study environment. Stadler Elmer et al. (2010, 52) have stated that *experiments carried out in a laboratory have the advantage to control for disturbing variables or eliminating them*. This way internal validity of the study increases, while external validity decreases. This means that the results cannot be easily generalised outside this bounded context and the particular people. (Dunbar, 2005). Music therapy clinic as the study environment clearly affects the nature of the results of the current study. The clinic was similar to the laboratory conditions, but on the other hand it resembled music classroom, due to the wide variety of music instruments available. There are also differences, such as the cameras recording the sessions. However, the cameras were fairly small and attached unobtrusively to the upper part of the ceiling. This way they required less attention than if separate cameras were brought to the space especially for these sessions.

Research collaboration was an essential part of this study. I worked as an observer and two music therapy students were leading the sessions. In the current study, the music therapy students were instructing the music making sessions. It was essential that the music therapists as well as me as the observer remained the same throughout the research process.

To minimise the observer influence, I as the observer was in the separate observation room. This way the music therapy students leading the music making sessions could concentrate on instructing and helping the children in music making, and they did not need to write any notes on the observed behaviour of the children. I was able to keep my role in non-participatory observation. When the software had bugs and was crashing, I handled the technical situation outside the music therapy clinic, after which the session leader went back to the session room. This way their and my role remained the same throughout the sessions, and I was able to avoid role conflicts. Although the children knew only about the presence of the music therapy students, and not about observers, they still paid some attention to the cameras. Therefore, one cannot deny the possibility of e.g. "Hawthorn-effect", in other words possibly presenting



themselves in a more positive manner and performing more socially acceptable behaviour. (Stadler Elmer et al., 2010, 51.)

In order to avoid the possible experimenter effects, meaning *the ways in which the behaviour, or even just the presence of the experimenter can influence participant responses* (Ellsworth & Gonzalez, 2007), one option would have been to leave the music therapy students who were leading the sessions, without information concerning which of the children had ADHD diagnosis. This way their knowledge could not have affected their own expectations, behaviour and/or the way they instructed the children or responded to their behaviour.

In the current study, in seven of the sessions both mobile music making and band playing were implemented. In six of these seven sessions, band playing preceded mobile music making. Only in the last session, where the children listened to the songs they had created with JamMo, this preceded band playing. Because of this systematic order of different music making scenarios, there is a possibility for order-effect to appear in the results. This means that the responses may either generally improve or generally deteriorate in a systematic manner. (Miller, 2007, 44.) The typical order of different scenarios could also be seen in a fatigue effect to appear (Dunbar, 2005, 17.) To avoid these effects, it could have been a good idea to vary the order of the music making scenarios.

### **6.3 Research ethics**

The research ethics of the current study are based on APA (American Psychological Association) Ethical Principles of psychologists and Code of Conduct (2003), and WMA (World Medical Association) Helsinki Declaration on medical research involving human subjects (1964, last revised in 2013). The major factors impacting the research ethics in the current study were retrieving a written consent from the participants, ensuring privacy and confidentiality throughout the research process, and providing debriefing after the study sessions.

The UMSIC project in Jyväskylä included the current music therapy intervention as well as school intervention (Pelamo 2012). All of these sessions were recorded on video. As APA ethical principles (2003) define, an informed consent has to be asked beforehand, whenever

the research involves recording voices or images of the participants. This way it can be ensured that the individuals are participating the study willingly. An informed consent was asked from parents of all the children participating in this study. This consent consisted of information concerning the project and its purposes, consent of using the material produced during the sessions, as well as information concerning privacy and confidentiality of the data processing.

At the end of each session the children were asked to fill a questionnaire concerning their thoughts and emotions during the session at the music therapy clinic. This together with the audit trails kept of the interaction with the children gave the research process transparency, and helped to identify possible challenges.

During the research process, confidentiality and privacy were assured by keeping the participants anonymous when observing the music making sessions and when labelling the data. No personally identifiable information was used in written or verbal reporting of the study. Coding was used as a technique to avoid personal identifiers entering the data. (APA, 2003). The children were named as ADHD1, ADHD2, non-ADHD1, and non-ADHD2. In the presentations and reports concerning the current study, names of the children, names of the schools they came from, or other personal information, was not mentioned in order to protect the confidentiality of the participants, as is instructed in APA principles (2003).

In the current study, video material of the music making sessions, and study data such as questionnaires, were saved and stored in such a way that only the project researchers had access to them. All of the music therapy students were aware that all the information concerning the music making sessions was confidential.

## **6.4 Research limitations**

ADHD children are a heterogeneous group, and it is clear that the results of this intervention offer a view of two unique ADHD individuals and their unique peers, who were all boys. Thus, there are limitations to how well the results can be generalised. Also the music therapy clinic as the study environment creates some limitations to what extent the results can be generalized, because parts of the behaviour can be specific to this particular environment. We

can only report short-term impacts of these specific individuals studied. On the other hand, the modest size of the research made it possible to create a thick and detailed description of the behaviour of these particular children.

The target children were diagnosed with ADHD, but there was no information available for the researchers concerning their possible medication, or type of the ADHD diagnosis (mainly inattentive, mainly hyperactive, or combination type). This is certainly a limitation, because it can affect the participants' observed behaviour. It would be of great importance to study more the differences in attention regulation of different types of ADHD in these and other musical activities. When knowing about the possible medication, it is worth considering whether to ask the participants to abstain from taking their prescribed medication prior to the testing, as has been made for example in the study by Shaw et al. (2005) .

As a limitation concerning the data analysis can be seen that there was only one person analysing the data. In the future studies, the inter-rater reliability could be achieved by using more than one researcher when analyzing the data.

A major obstacle in the current study was that the JamMo software was not working probably. There were constant crashes in the software, which caused disruptions in the music making sessions.

## **6.5 Implications for future studies**

Several different research paths could be taken in the future to deepen the knowledge about attention and hyperactivity regulation of children in different music making scenarios. Some of them are discussed here.

Reporting and analysing on-task/off-task distinction describes only the surface of the phenomenon, in this case the attention regulation of children. That is why it would be also important to analyse the antecedents and consequences of the certain behaviour. (Roberts, 2001.) Also studying the context of off-task behaviour can be of interest. In addition to attention regulation, it would be interesting to pay attention to interruptions, in-game / in-context communication between the children and out-game / out-context communication

between the children. Also, the moments when the software or device is not working properly could be looked at more carefully and analysed how these moments possibly affect the children's attention regulation.

It could also be taken into account that as Sabourin et al. (2011) have described, the off-task can also serve as beneficial for the learning process. In the current study, the off-task was divided into hyperactive off-task and passive off-task behaviour. In the future studies, it would be interesting to use a more detailed division within the off-task behaviour such as: on-task, on-task conversation, off-task conversation, off-task solitary behaviour, inactivity & gaming the system (Baker et al. 2004) or on task with the tutor, on task with paper or teacher, on task but talking while working, off task and talking, off task and inactive, gaming (Walonoski & Heffernan, 2006). In this kind of more detailed description of the behaviour, information acquired from the observational method could be combined with the log data from the software.

The role of the music teacher / music therapist should be further studied. The music therapy students as instructors had a significant role in this study. This was especially due to the fact that the software did not work properly, and the virtual mentor was not yet available. Help-seeking could be studied by observing how and when the child asks for help from the teacher/ music therapist/ virtual mentor/ peer. In the current study, qualitative observations were made in relation to this topic. In the future, it could be a good idea to analyse their role and the significance / effects of instruction in more detail. As Pelamo (2012) has mentioned, it could also be of future research interest to see how the (music) teachers at school experience the use of technology-assisted learning environments, or how the use of these technologies possibly changes the role that the teacher has in the classes. She also points out that one could study whether the use of these technologies changes the teacher's attitudes toward different kinds of learners.

In the future the virtual mentor should be the one advising, providing feedback and encouraging the children. The virtual mentor would be with the child at every step of the composition process. Now the session leaders helped the children always when asked, and even when not asked to, but naturally they were not able to give feedback simultaneously to all children. It would be interesting to know, whether there would had been more difference

in attention regulation between the ADHD and non-ADHD children without the therapist constantly present and offering help. It would be important to see the kind of situations where the children are making all the decisions without an adult giving instruction or feedback.

It would be interesting to study their behaviour at an informal context, such as at home when they are using the device either independently or with their friends. This way one could also compare the more formal form of music making to the informal music making.

When thinking about possible next steps, it would be interesting to have more participants and a longer intervention. One research idea is that mobile music making could possibly be used as part of a music therapy process, when working with children with ADHD. Mobile music making can also be implemented in schools in many ways, especially now when the Finnish national curriculum encourages to do that (Opetushallitus, 2014).

It would be important to study more carefully the motor aspect and its' impact on the attention regulation of the children with and without ADHD. Playing any band instrument requires a lot more gross motor activity than playing a mobile device, which is controlled by fine motor finger movements. Both children with ADHD seemed to have more motor skill problems than their peers in playing the drum kit, and also more problems in keeping the rhythm with other instruments. It would be interesting to study further, whether there is a correlation between the attention regulation and playing certain instruments.

Collaboration and the social aspect of mobile music making in general, should be paid more attention to in the future studies. It would be interesting to further compare the stand-alone scenario of mobile music making to pair-work, such as peer-tutoring, and to group work and to the mobile music making in the classroom with the whole class. Peer-tutoring should definitely be applied in the future studies, although it unfortunately could not yet be applied in the current study due to the postponed development of the software. The most applicable peer tutoring strategy would probably be the one in which dyads consist of a tutor without disability and a tutee with disability. However, I find it important that also the children with ADHD have the possibility to act as tutors after sufficient amount of experience with the software.

In the current study, ADHD subtypes were not differentiated. In the future research, it might be a good idea to contrast the inattentive subtype of ADHD to the hyperactive subtype of ADHD, and pay attention to how these two differ when seen in the context of mobile music making. Also possible gender differences would be an interesting topic for a future study. As has been earlier mentioned, ADHD has been estimated to be 3 to 6 times more common in boys than girls (Lönqvist et al. 2011). It would be interesting to see, whether there would be differences in the results when studying also behaviour of girls with ADHD.

It could be of research interest to study whether the time of the day affects attention regulation. In the current study, the children came to the music therapy clinic always in the middle of their school day. Also the role of medication on attention regulation in music making, discussed in the research limitations, should be taken into account in the future studies. Often the children with ADHD use the medication especially during the school day, and therefore the time of the day when the study is carried, may affect the results concerning the children's attention regulation.

It would be important to have information concerning the users' previous experience on music technology. In the case of using software designed for smart phones, the experience of using these devices should be asked from the participants. Also in the case of JamMo, the experience of using music technology might affect for example the manners, and the pace at which the children get use to creating music with its loop-based sequencer.

One should remember that the musical development does not necessarily proceed hand in hand with the general development of a child. Further, each child has his/her individual developmental path when it comes to musical abilities, in the same way as cognitive and social development. This raises the question that would it be possible to form the child groups studied in some other way than purely according to their age? Maybe the children's musical development, cognitive development, experience on using music technology etc. could be taken into account when forming the study groups and control groups.

In this study, musical and social elements contributing to enhanced attention regulation and hyperactivity regulation were recognized. The research provided new information concerning attention regulation of children in different types of music making. The study provided in-

depth description of these individuals, and offered general guidelines for further studies. This study had a novel viewpoint to attention regulation, because it viewed children as active music makers and applied a software that had child-centered design. The results can be applied for example when bringing mobile music technology to music classes in schools and when helping children with learning deficits in music therapy.

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