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Embodied Musical Experiences in Early Childhood

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A thesis submitted in fulfilment of requirements for the degree of
Doctor of Philosophy

The University of Edinburgh

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Declaration

I hereby declare that this thesis, submitted in candidature for the degree of Doctor of Philosophy at the University of Edinburgh, and the research contained herein is of my own composition, except where explicitly stated in the text, and has not been previously submitted for the award of any other degree or professional qualification at this or any other university.

Ana Paula Ramos da Rocha Almeida

22 July 2015

Abstract

Embodied Music Cognition is a recently developed theoretical and empirical framework which in the last eight years has been redefining the role of the body in music perception. However, to date there have been very few attempts to research embodied musical experiences in early childhood. The research reported in this thesis investigated 4- and 5-year-olds' self-regulatory sensorimotor processes in response to music.

Two video-based observation studies were conducted. The first, exploratory in nature, aimed to identify levels of musical self-regulation in children's actions while 'playing' in a motion-based interactive environment (Sound=Space). The interactive element of this system provided an experiential platform for the young 'players' to explore and develop the ability to recognise themselves as controlling musical events, and to continuously adapt their behaviour according to expected auditory outcomes. Results showed that low-level experiences of musical self-regulation were associated with more random trajectories in space, often performed at a faster pace (e.g. running), while a higher degree of control corresponded to more organised spatial pathways usually involving slower actions and repetition.

The second study focused on sensorimotor synchronisation. It aimed to identify children's free and individual movement choices in response to rhythmic music with a salient and steady beat presented at different tempi. It also intended to find the similarities and differences between participants' repertoire and their adjustments to tempo changes. The most prominent findings indicate that children's movements exhibited a resilient periodicity which was not synchronised to the beat. Even though a great variety of body actions (mostly non-gestural) was found across the group, each child tended to use a more restricted repertoire and one specific dominant action that would be executed throughout the different tempi. Common features were also found in children's performance, such as, the spatial preference for up/down directions and for movements done in place (e.g. vertical jump).

The results of both studies highlight the great deal of variability in the way pre-schoolers regulate their own sensorimotor behaviour when interacting with music. This variety of responses can be interpreted as underlining the importance of the physical nature of the cognitive agent in the perception of music. If this is indeed the case, then it will be crucial to create and develop embodied music learning activities in early years education that encourage each child to self-monitor their own sensorimotor processes and, thus, to shape their experiences of linking sound and movement in a meaningful and fulfilling way.

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Preface

Some of my earliest memories as a child are those in which music listening would make me burst into spontaneous dance. The intense feeling of being literally ‘moved’ by every single melodic or rhythmic nuance and the profound sense of immersion still resonates with me today. Music was movement and movement was music!

Strangely enough, this strong connection and creative embodied expression would soon be challenged by my first formal music lessons. Not only was I invited to constrain the nature of my movement but also to reduce it to a conventional repertoire of gestures. Inevitably, I was ‘forced’ to recognise the existence of two parallel musical universes in my life, the one that was internally driven and the other that dictated and externally structured my bodily experience. Whereas the first made me feel complete, the second often gave me a sense of physical disconnection with the music.

Many years later, while working with babies, toddlers and children in educational and artistic contexts, I gradually became aware of children’s spontaneous movement choices to music and of how that rich information often passed unnoticed to educators. Moreover, adults (parents and teachers) also tended to predetermine the embodied musical experiences of the young movers by directly suggesting them a set of actions that ought to be performed. Body movement was thus viewed as a functional tool (a means to an end) with a low level of individual agency.

With the aim of partially unveiling the hidden meanings of children’s self-regulated behaviour while interacting with music, I decided to pursue a PhD that culminates today in the present thesis. This whole process necessarily implied overcoming some challenges, namely, acquiring the ability to verbally articulate, describe and analyse the potential correspondences between two non-linguistic modalities (music and movement). Moreover, and most importantly, it was fundamental to create the appropriate musical environment for the young movers to make spontaneous sensorimotor choices in a confident and comfortable way.

With all this in mind, the findings of this project truly are expected to provide meaningful information to educators that could then shape and impact positively the music learning experiences of young children.

While writing this last paragraph it becomes clear that the completion of this project is just the ‘first step’ of a long and exciting journey in this area of knowledge that I am so passionate about. And as John Dewey (2004) once said, “the self is not something ready-made, but something in continuous formation through choice of action” (p. 336).

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Introduction

Over the last few years, a growing body of literature has begun to focus on the idea that the body plays a central role in human cognition. This proposal has directly challenged the classical disembodied approach of cognition that viewed perception and action as fundamentally separate and un-situated (Varela, Thompson & Rosch, 1991). Recent advances in neurosciences, particularly those focused on the mirror neuron system, have been providing strong evidence supporting a common code between sensory (e.g. auditory) and motor systems and thus suggesting a close coupling of perception and action (Cook et al., 2014).

Recently, an embodied account of music cognition (Leman, 2008) argued that the body is a natural mediator between the brain/mind and the environment. Moreover, it suggested that a body-in-action tends to constrain music listening experiences. The hypothesis that body specificities and sensorimotor capabilities can shape an agent's perceptual and meaning-making processes while interacting with the (musical) environment seems particularly relevant when considering a developing young child (Thelen & Smith, 1994; 2006).

Studying action effects on auditory perception in early childhood necessarily implies assuming 'body movement' as a carrier of musical meanings. In other words, the young listener's movements are claimed to be directly connected with the structural features and expressive qualities of the music. If this hypothesis is accepted as true, then identifying and describing the embodied responses of children to music is fundamental to understanding their perceptual experiences.

Even though there is a consistent body of work using movement to understand music perception in early childhood (e.g. sensorimotor synchronisation tapping studies), most studies tend to focus on the accuracy of the performance and opt to control and prescribe the repertoire of actions that support the research task (e.g. Provasi &

Bobin-Bègue, 2003). Very little is currently known about these perceptual mechanisms when the focus is on the process/content of the movement and when children are given the opportunity to self-regulate their own listening experiences by making spontaneous choices of body movements. By using the latter approach, it should be more possible to explore individual differences and similarities regarding the embodied nature of children's music perception.

Considering this research gap, the present thesis proposes to investigate self-regulatory sensorimotor processes in early childhood. It aims to identify and describe the 4- and 5-year-old children's free choice of movements when interacting with music, particularly in 'movement-inducing-music' and 'music-inducing-movement' situations.

Thesis Structure

Chapter 1

This chapter provides an introduction to the multidisciplinary nature of the work that will be examined in the rest of the thesis. Four main sections are presented. The first offers an overview of the embodied cognition paradigm by describing and reflecting on some of its central claims, such as perception-action coupling. The second section focuses on the 'cognitive agent', more specifically, on young children who are undergoing significant changes in terms of motor development. Within this context, dynamic systems theory receives particular attention. The third section describes an embodied account of music cognition that constitutes the central theoretical framework of the present thesis, and integrates the information previously addressed. Finally, in the fourth section two distinct situations are considered within this paradigm, namely, 'musical instrument playing' and 'sensorimotor synchronisation to a musical beat'. With regard to the latter paradigm, a process-oriented approach is described in detail as an alternative to the dominant outcome-oriented approach. In

order to conduct such type of research an appropriate methodology needs to be designed and thus it is also discussed in this section. Brief concluding comments then follow.

Chapter 2

This chapter presents an exploratory, observational study (study 1) focused on the experiences of musical self-regulation of a small group of 4-year-olds within Sound=Space (S=S), an interactive musical environment responsive to people's location in space. More specifically, it describes the research design developed and the choice of thematic analysis as the method to analyse the movement data (video recorded).

The results regarding children's self-regulated movements and 'playing' experiences in S=S show that the 4-year-olds use a varied repertoire of actions during their exploration of different musical/sound and spatial stimuli. These spontaneous movement choices of the young participants are described and classified as distinct experiences of musical self-regulation – the ability to self-monitoring behaviour and to recognise oneself as controlling the auditory outcomes of one's actions. Low-level experiences of musical self-regulation are characterised by children's continuous and constant locomotion, executed at a fast pace, and also by their use of circular spatial pathways. On the other hand, high-level experiences of musical self-regulation involve a discontinuous locomotion at a slow pace, a readiness to stop travelling through space and the use of straight pathways. Moreover, the young movers also tend to adjust their position in space, return to a previous location and repeat a short spatial sequence. The use of these specific navigational strategies by some participants, suggest their predictive and self-corrective behaviour, and a potential clear recognition of their agency and their role as 'instrument players' (moving *to produce* music/sound rather than moving *in response* to music/sound). Following the description of these results a brief discussion is then provided.

The focus of this study on self-regulatory sensorimotor processes in young children while interacting with music ('movement-inducing-music' situation) is also

considered in study 2 but now with regard to children's spontaneous movement choices in a 'music-inducing-movement' situation.

Chapter 3

Chapter 3 focuses on the design of study 2, conducted to identify and describe the free movement choices of a group of 4- and 5-year-olds to a rhythm-based music stimulus with a strong accented and regular musical beat, in a semi-controlled situation within a naturalistic setting. In particular, this chapter addresses the ethical guidelines regarding research with young children and describes the procedures adopted accordingly. Additionally, it also considers decisions about video recording and equipment setup. Finally, the last section describes the musical stimulus, and particularly discusses its music-induced movement potential and the rationale behind the musical tempi chosen for the study.

Chapter 4

In this chapter the observational method used in study 2 is described in detail, with a closer examination of the two approaches (naturalistic observation and structured video observation) that were adopted at different stages of the research. Moreover, in the following main section a rationale is provided regarding the data analysis method, particularly the category system (coding scheme) chosen, which was partially influenced by the Laban Movement Analysis system.

Chapters 5, 6 & 7

Chapters 5 and 6 present the results of study 2 regarding, respectively, the 4- and 5-year-olds' self-regulated movement behaviours to rhythm-based music. Both chapters are focused on three main aspects of movement. The first refers to periodicity and synchronisation, the second describes the repertoire of body actions observed, followed by a third section that addresses the body and spatial components of the movements executed.

Results from this study show that participants of both ages exhibit a clear spontaneous periodicity in response to a strong accented and steady beat, even though their movements are not synchronised. Interestingly, the 4- and 5-year-olds also reveal individual movement speed adjustments to the different musical tempi presented.

Other main findings show the signature of each child's choices of movements and their preference for a small repertoire of body actions, in particular, for one of them which is consistently performed throughout the game and in response to the different tempi. However, the uniqueness of participants' choices is also characterised by clear similarities when considering body and spatial components. In terms of the Body category, children reveal their preference for whole-body movements, with a particular emphasis in the lower-body unit with a gradual integration of the upper-body in the case of the 5-year-olds. Moreover, most actions use a simultaneous phrasing, that is, all body parts move at the same time.

With regard to the Space category, children's body actions are mostly done in place, particularly focused on up-down directions, at times combined with other spatial directions, and characterised by a high-level height and a mid-reach space (i.e. at elbow distance from the body midline).

The next chapter (Chapter 7) presents a discussion that combines the findings from both age groups.

Chapters 8 & 9

Chapter 8 provides a general discussion of the main findings of both studies 1 and 2. It also briefly reflects on the methodological and analytical approaches used in order to facilitate young children's self-regulatory sensorimotor processes and to identify/describe their spontaneously exhibited repertoire. Additionally, this chapter addresses the limitations of the work, reflects on the implications for practice and suggests future research directions. In the final chapter (Chapter 9) concluding comments are then provided.

Chapter 1

Literature Review

1.1 Introduction

In 2008, an embodied account of music cognition claimed that the body plays a central role in musical meaning formation (Leman, 2008). The musical mind was considered to be fundamentally embodied given that perception and action are closely linked. This hypothesis was supported by evidence from neuroscience showing that motor systems are often activated during music listening. Moreover, cognition in general can be considered to be not only dependent on the physical features of an agent's body but also on the dynamic interactions developed with the external world (Clark & Chalmers, 1998).

The assumption of 'body as constraint' (Shapiro, 2011) inevitably suggests that music listening is shaped by the agent's corporeality and also by his/her repertoire of sensorimotor skills. One implication of this hypothesis is that different bodies will necessarily experience musical/sound events differently. As follows, it can be suggested that young children undergoing significant motor developmental changes will recognise different opportunities to act compared to older children or adults. Moreover, some developmental theories (Thelen & Smith, 1994) argue that even within the same age range the uniqueness of sensory-motor associations may also be seen.

Very recently it has been proposed that the effects of action on music perception can be explained by a bidirectional flow of information, from perception-to-action and from action-to-perception (Maes, Leman, Palmer & Wanderley, 2014). In line with this view, two specific musical situations with young children will be further addressed in this chapter. The first ('movement-inducing-music') refers to playing in an interactive musical instrument situation, whereas the second ('music-inducing-

movement’) considers sensorimotor synchronisation to a musical beat. The latter will also make the distinction between two research approaches, in particular, the outcome-oriented and process-oriented approaches. Finally, the chapter will end with some concluding comments.

1.2 Embodied Cognition

Cognition is said to be embodied “when it is deeply dependent upon features of the physical agent, that is, when aspects of the agent’s body beyond the brain play a significant causal or physically constitutive role in cognitive processing” (Wilson & Foglia, 2011). The foundational idea entails that the body is not peripheral to meaning-making; on the contrary, the mind is grounded in experiential processes of sensing and acting. An embodied approach to cognitive science tends to reject traditional accounts that dismiss bodily mechanisms of motor control and sensory processing from the fundamentals of knowing. As follows, standard assumptions such as modularity, mental representation and nativism are often criticised.

Based on computational models of human cognitive processes, the classical paradigm treats neural structures or modules as domain specific and genetically hardwired in the brain, functioning hierarchically from low-level to high-level processing. Accordingly, the flow of information is unidirectional, going from sensory inputs (perception), moving to the central neural system (cognition) and ending with a behavioural output (action). By way of illustration, stair climbing presupposes that the agent perceives and collects multimodal information about the challenge, waits for the data to be processed in the brain and finally executes a successful climbing action. Inevitably, by claiming that cognition is essentially encapsulated in the brain and operating in a modular way, this classical model evokes the Cartesian dualistic division between the mind – the central command of operations – and the body as a mere mechanical executor. As a consequence, the processes of perception and action are clearly separated (Thagard, 2014).

Mental representation is a basic theoretical construct of cognitive science about the human information encoding process. It refers to hypothetical internal symbolic structures that represent and code multiple inputs from external reality.

Representational structures in the mind are also considered highly abstract with quasi-linguistic properties (a syntax and semantics) and rule-driven by a system of symbols identical to computer data structures. Thus, the meaning of the concept ‘stairway’ can be universally attributed to different types of stairs. The information conveyed by this mental and abstract representation implies its independence from a particular modality, since it excludes the physical and functional characteristics of the referent (e.g. different rise height of steps will require a different body movement organisation). In this sense, the meaning of any representational concept is dissociated from the perceptual and motor systems and, thus, from bodily experience. Another principle of mental representation involves the propositional organisation of knowledge, suggesting that the meaning of words will arise from the storage, retrieval and interconnection of purely internal information. As a result, in this classical cognitive science account, motor programs are instructed by internal representations independent from external environmental structures. Bodily actions are thus unable to affect and shape cognitive processes (Thagard, 2014).

In sum, this “classical sandwich model of the mind” (Hurley, 2001) – *perceiving-thinking-acting* – implies that the “sensory information received from the external world is perceived, translated into a syntactic code of meaningful symbols, and processed according to a systematic set of rules. Then, body movements and other sorts of behaviour are considered as mere outcomes of these higher-level, formal symbol manipulations” (Maes, Leman, Palmer & Wanderley, 2014, p. 1). Inevitably, two assumptions are made: “that the causal flow between perception and action is primarily linear or one-way, and that they are merely instrumentally related to each other, so that each is a means to the other” (Hurley, 2001, p. 1).

Even though at present it is generally accepted that cognition develops as a result of an ongoing interaction between what is innate (‘nature’) and what is learned (‘nurture’), those who are more inclined to support the nativist view recognise that the internal structures and processes underlying development are hardwired, complex traits that unfold over time in a seemingly predictable way. External processes (beyond-the-brain phenomena) are assumed to contribute only slightly to the acquisition and development of these structures. An embodied cognitive science, on

the other hand, will focus on the dynamic interplay between the sensorimotor processes of the agent and the world that will bring forth an embedded and situated cognition.

The hypothesis that perception and action processes are functionally intertwined will now be addressed through a brief description of the common coding theory (Hommel et al., 2001; Prinz, 1997), supported by some references to empirical evidence from neuroscience.

1.3 Perception-Action Coupling

1.3.1 Common Coding Theory

Common coding theory has been an influential framework defending a strong link between perception and action. It specifically claims that “perceived events and planned actions share a common representational domain” (Prinz, 1997, p. 129), or in other words, that “the planning or execution of an action, and the mere perception of the (multi-)sensory consequences of that action, are similarly represented (coded) in the brain, thereby recruiting both sensory and motor brain areas” (Maes et al., 2014, p. 2).

Given that perception and action processes are said to be functionally interwoven, sensory information is a means to motor performance and vice versa. This process implies shared sensory-motor representations, or so-called internal models (Arbib & Rizzolatti, 1997; Kawato, 1999; Wolpert et al., 1995) intended to describe the bi-directional link between perception and action (inverse and forward interactions). In other words, these models are used by the nervous system to predict the environmental changes produced by goal-directed actions.

An internal *forward* model (action → perception) predicts the sensory outcomes of a planned or executed action (*perceptual resonance*), which could imply a rapid error detection when the predicted feedback does not match the resulting output. An internal *inverse* model (perception → action) behaves contrarily and estimates from

incoming sensory information the motor commands necessary to produce that specific sensory state (*motor resonance*).

The discovery of the mirror neuron system (MNS) in primates (Gallese et al., 1996; Rizzolatti et al., 1996) and subsequently demonstrated to be present in humans has provided neurophysiological evidence to support the common coding theory and thus the direct matching hypothesis between perception and action. ‘Mirror neurons’ are a set of neurons that are activated both when a goal-directed action is executed and when that same action is merely observed and performed by another agent. Consequently, this resonance mechanism may allow the subject to recognise and understand the meaning of their own actions as well as the intention of others’ actions, thereby contributing to inter-individual communication (Fadiga et al., 2005; Molnar-Szakacs & Overy, 2006).

The shared neural activation patterns activated while both seeing and performing a goal-directed action have been well studied and documented (c.f. Cook et al., 2014). However, with the discovery of audio-motor mirror neurons (Gazzola et al., 2006; Kohler et al., 2002) the modal possibilities of this mechanism were extended and constituted a new research interest. The confirmation that a specific set of neurons is activated both when executing an action and when hearing the corresponding auditory outcomes, provided “evidence for a human auditory mirror system” (Gazzola et al., 2006, p. 1824) and thus for the existence of a common coding as hypothesised by Prinz (1997) and Hommel et al. (2001). This implies that the possibility of representing observed goal-directed actions through the associated sounds produced during the execution of that action, indicates that the motor system can be accessed by the auditory system and vice versa.

This co-activation and bi-directionality of auditory and motor systems, specifically in music processing, has been a central topic of many recent studies in cognitive neuroscience (e.g. Bangert et al., 2006; Molnar-Szakacs & Overy, 2006; Stewart et al., 2003; Zatorre et al., 2007) through the use of passive and active (e.g. tapping) listening tasks or by using musical or motor imagery (e.g. Zatorre & Halpern, 2005). In these studies musicians represent “a valuable population” given they reveal “the

functional plasticity elicited by music training in somatosensory, auditory, and motor cortices, as well as the anatomical differences in areas involved in music-related behaviours” (D’Ausilio, 2007, p. 5847).

In sum, neuroscientific studies provide strong evidence in support of a common representational domain (code) between perception and action. Moreover, the co-activation of both sensory (e.g. auditory) and motor systems is explained based on a bidirectional flow of information from action to perception (*forward* internal model) and from perception to action (*inverse* internal model).

Considering that a cognitive agent is situated in the world, the integration of perceptual and motor mechanisms will now be considered from an ecological and enactive viewpoint, by specifically addressing two of the most influential historical concepts: ‘affordances’ (Gibson, 1986) and ‘enaction’ (Nöe, 2006; Varela, Thompson & Rosch, 1998).

1.3.2 Ecological and Enactive Approaches

1.3.2.1 Gibsonian Theory of Affordances

James J. Gibson (1986) challenged the classical paradigm of cognitive science by proposing an ecological frame of reference to perception. The environment (ecologically available information) became the foundation for perceptual processing instead of *internal symbolic representations*. According to Anthony Chemero (2003) the “primary difference between direct and inferential theories of perception concerns the location of perceptual content, the meaning of our perceptions. In inferential theories of perception, these meanings arise inside animals, based on their interactions with the physical environment. (...) In direct theories of perception, on the other hand, meaning is in the environment, and perception does not depend on meaning-conferring inferences” (p. 181).

At the core of Gibson’s (1986) approach is the notion of *affordances*, broadly defined as ‘all possibilities for action’ available in the environment to an agent. The theory of affordances supports Gibson’s explanation of how the environment

suggests opportunities for particular kinds of behaviour. An affordance comprises three specific attributes. The first entails that it is invariant and thus does “*not change* as the need of the observer changes. The observer may or may not perceive (...) [it], according to his needs, but (...) [the affordance is] always there to be perceived” (Gibson, 1986, p. 138). The second attribute, emphasises that an affordance exists relative to the agent’s action capabilities. For instance, a stairway affords ‘climbability’, an opportunity for a specific behaviour, but not to a person in a wheelchair who lacks the climbing ability. Finally, the last fundamental attribute implies that the existence of affordances is independent of the agent’s ability to perceive them as a possibility to act. In short, on the one hand affordances are objective and measurable properties because their existence does not depend on an agent’s experience (meaning, interpretation), but on the other hand they are inherently subjective since they need the individual as a frame of reference. Hence, agent and environment are mutually connected.

According to Joanna McGreener and Wayne Ho (2000) there are still two other attributes of affordances that Gibson mentions, but never in a direct way. The first one consists of a binary feature, in other words, affordances may or may not exist for a particular individual (e.g. a mug could be graspable or not to a particular agent). The second attribute refers to the possibility of affordances being nested and therefore composed not just by one but by several opportunities to act. For instance, a book affords reading but it also involves holding or flipping.

In the past decades there has been an ongoing debate about the meaning of affordances, elicited by Gibson’s (1986) unclear definition of the concept specifically regarding the dialectic tension of objectivity and subjectivity in ecological perception. Even though for present purposes this controversy will not be addressed, it is important to point out that many post-Gibson proposals have considered affordances as properties of the environment but taken/adopted relative to the agent and, more specifically, to his or her capabilities to perceive and use them (cf. Chemero, 2003; Michaels, 2003). However, disagreements arise when answering the questions, such as, ‘do properties of the environment exist without an agent?’, ‘if

affordances exist relative to the agent, do they need to be complemented by some properties of that agent?', and if so, 'what constitutes these relevant properties?'

By rejecting the former premise that considers affordances as agent-relative properties of the environment, Chemero (2003) tactically avoids the controversy. The theory that is alternatively proposed argues that "affordances are relations between the abilities of animals and features of the environment. As relations, affordances are both real and perceivable but are not properties of either the environment or the animal" (p. 181). This affordance is the relation between one's abilities and some features of that particular situation. For the purposes of this thesis the relational nature of affordances will be the one adopted when addressing this Gibsonian concept. The following definition of Joel Krueger (2014) describes it in a very clear way:

"When I speak of affordances (...), I mean simply action possibilities in a perceiver's environment that are specified *relationally*, that is, both by (1) particular structural features of the environment and things in it, as well as (2) the repertoire of sensorimotor capacities the perceiver employs to detect and respond to these structural features. A perceiver, in virtue of being embodied in a particular sort of way – and possessing an accumulated history of environmental interactions – will experience affordances as furnishing different sets of interactive possibilities" (p. 2).

To summarise, a Gibsonian theoretical approach to perception proposes an ecological alternative to the internal model of the world previously defended by cognitive science. It is based on the concept of *affordances*, initially defined as opportunities for action provided by the environment to the individual and characterised by being independent from the agent's ability to recognise it or perceive it, even though relative to his or her capabilities. Throughout the years several attempts have been made to clarify and develop the meaning of this notion. The proposal that will be considered for the current project assumes that "affordances are neither properties of the animal alone nor properties of the environment alone. Instead, they are relations between the abilities of an [agent] and some feature of a situation" (Chemero, 2003, p. 191).

1.3.2.2 Enaction

The enactive approach to cognition was firstly introduced by Varela, Thompson and Rosch in their seminal book *The Embodied Mind* (1991). These authors criticised traditional computational models for viewing cognition as internal symbolic representations of pre-existent information available in the world. In this account, individuals were expected to passively receive sensory inputs from their environment and then translate them into mental representations. As a result, the outcome of these sequential steps would be the execution of a pre-specified action.

Varela et al. (1991) presented and developed an alternative framework which placed strong emphasis on the concept of enaction ('in action'). Its founding idea argues that organisms experience and understand their world by acting and interacting physically with it. They are considered autonomous agents, not passive receivers of pre-given external information, able to actively bring forth or *enact* their own cognitive domain. This entails that what and how individuals think will be shaped by the way they act, that is, by their situated experience. It is now important to point out that unlike Gibson's (1986) perceiver-independent nature of affordances, the enactive program purposefully evokes an experiential view of the world.

Continuing the previous reasoning, one fundamental assumption of Varela, Thompson and Rosch's (1991) is that cognition depends on individual sensorimotor capacities and on their ongoing interactions with a particular context (e.g. a dog will play with a ball differently from a human being). As a result "sensory and motor processes, perception and action, are fundamentally inseparable in lived cognition" (Varela et al., 1991, p. 173). This structural coupling of brain-body-environment implies that 'knowing' depends essentially on the bodily engagement of the agent with the world, rather than being affected by predictable and predetermined situations or personal construals. According to Alva Nöe (2006), a strong supporter of an enactive view for visual perception, "perceiving is a way of acting. Perception is not something that happens to us, or in us. It is something we do. (...) Perceptual experience acquires content thanks to our possession of bodily skills, *what we perceive* is determined by *what we do* (what we know how to do; it is determined by what we are ready to do. (...) [We] *enact* our perceptual experience" (p. 1).

In sum, *enaction* conveys the idea that organisms are not passive receivers of input from the world but they bring forth their cognitive experience through dynamic interactions within a given situation. If what one perceives is connected with what one is capable of doing, then individual sensorimotor abilities will have a meaningful impact on the experience of knowing.

Both the theory of affordances and the ecological concept of enaction defend the idea that cognitive processes, more specifically, perception is deeply dependent on the agent's actions and interactions with the world. As a consequence, the specificities of the body agent and its sensorimotor skills are claimed to constrain the perceptual information. This body-as-constraint hypothesis will now be specifically addressed in section 1.4.

1.4 'Body as Constraint'

One way "to articulate the Embodiment Thesis further is to specify the nature of the dependence of cognition on the body: what particular significant causal or physically constitutive roles does the body play in cognition?" (Wilson & Foglia, 2011). Three hypotheses regarding the body's significance in cognitive processes are considered by Larry Shapiro (2011), namely, conceptualisation, replacement and constitution. The goal of the first hypothesis is "to show that bodies determine, limit and constrain" (Shapiro, 2011, p. 202) the way an agent conceives its world (e.g. Nöe, 2006), whereas the second hypothesis claims that traditional computational and information-processing approaches to cognition are irreparably flawed and should be replaced with dynamical, ecological descriptions (e.g. Thelen & Smith, 1994). The third hypothesis asserts the existence of an extended mind and thus discusses whether what happens outside the brain is an integral part of cognitive processing, or whether it merely causes a cognitive process to occur (e.g. Clark, 2008).

The three themes as described above, that is, conceptualization, replacement, and constitution, correspond to three broad strands of research within embodied cognition. Even though they may at times overlap, for the purposes of this thesis the conceptualisation hypothesis will be specifically addressed from this point forward. The main reason for this decision concerns the fact that the other two hypotheses

would expand the topic of embodiment beyond the scope of the present research and, consequently, make the notion of body-as-constraint more peripheral.

The conceptualisation view entails that the body and sensorimotor skills of an agent function as a constraint to the nature and representational content of cognitive processing (e.g. embodied perception). In other words, there is a “connection between the kind of a body an agent possesses and the concept it is capable of acquiring” (Shapiro, 2011, p. 112). One implication of this claim is the explanation of cognitive variability by appealing to the body variability of the agents. According to Shapiro, conceptualisation “predicts that at least some differences between types of body will create differences in conceptual capacities. Different kinds of organism will ‘bring forth’ different worlds” (p. 112).

Given that cognitive processes are functionally dependent on “the properties of the body and the unique styles of (...) interaction that particular kinds of body afford” (Shapiro, 2011, p. 204), one could argue that some forms of cognition will be easier than others depending on the bodily characteristics an agent has. Moreover, in this line of thought “embodied agents will diverge their understanding in identical situations in virtue of the differences in affordances they recognise” (Shapiro, 2011, p. 102). In sum, the features of the body (e.g. size and weight) and the repertoire of sensorimotor skills of the agent are said to partially determine affordances.

The main criticism pointed out by Shapiro (2011) of the conceptualisation hypothesis is the fact that sometimes the interpretations of the data cannot be tested. “To discover whether the body really does limit conceptions of the world in the sense that conceptualisation implies may require that we test the conceptual abilities of differently embodied organisms. Perhaps further work on canonical and mirror neurons will create progress in this direction” (p. 206).

Even though this alleged ‘weakness’ is acknowledged, the conceptualisation thesis (‘body as constraint’) seems particularly relevant when studying young children as cognitive agents that are undergoing significant developmental changes. The hypothesised dependence of perceptual processes on the repertoire of motor skills

entails that young children will ‘bring forth’ a distinct conceptual world from older children and from adults given their developmental differences.

Considering this line of thought, the next section will now present some general considerations about motor development, followed by a short description of some historical theoretical frameworks, with a particular focus on the dynamic systems theory (Thelen & Smith, 1994), one of the most influential proposals.

1.5 The Developing Child

1.5.1 Motor Development: General Considerations

Over the years there has been much controversy over the definition of *motor development* (Payne & Isaacs, 1999) which has now become a recognised academic field of human behaviour and considerably more independent from the interrelated affective and cognitive domains. For its simplicity and succinctness, the following definition of *motor development* will be used: “a continuous change in motor behaviour throughout the life cycle, brought about by interaction among the requirements of the task, the biology of the individual and the conditions of the environment” (Gallahue & Ozmun, 1998, p. 3).

Even though ‘growth’ and ‘development’ are terms often used interchangeably, one should be reminded of its subtle differences. Physical growth involves the “increase of an individual’s body or its parts during maturation” whereas development entails “changes in an individual’s level of functioning over time” (Gallahue & Ozmun, 1998, p. 14), that is, a continuous process of adaptation to gain or maintain competence throughout the life cycle. Another relevant distinction that should be made and clarified is between ‘maturation’ and ‘experience’. When understood from a biological view maturation entails that the qualitative changes that facilitate the individual’s progress to higher-levels of functioning are primarily innate (genetically predetermined) and resistant to external factors. It is then “characterised by a fixed order of progression in which the pace may vary but the sequence of appearance of characteristics generally does not” (p. 15). On the other hand, experience refers to the environmental factors that may affect the emergent patterns of behaviour and thus

“alter the appearance of various developmental characteristics through the process of learning” (p. 15). After long debates over the years, the interdependence of these two concepts was recognised and ‘adaptation’ became the term commonly used to address the dynamic interplay between individual and environment.

Another important foundational principle within this area of knowledge is that developmental processes are not age-dependent but age-related. The artificial distinction between different age periods (chronological classification) should be considered as a mere approximate estimate of developmental levels throughout the lifespan. Otherwise, overreliance on age periods may compromise notions such as of continuity, specificity and individuality. Each person “has a unique timetable for the acquisition and development of movement abilities. Although the ‘biological clock’ is rather specific when it comes to the sequence of movement skill acquisition, the rate and extent of development is individually determined and dramatically influenced by the performance demands of the task itself (Gallahue & Ozmun, 1998, p. 6).

1.5.2 Historical Theoretical Frameworks

Various explanations of human development, in particular motor development, have been proposed throughout history, either adopting a product-oriented approach or a process-oriented approach (Gallahue & Ozmun, 1998; Payne & Isaacs, 1999). While the former focuses on the end result and outcome of the individual’s performance (e.g. how high someone can jump), the latter is interested in explaining the underlying processes causing changes in motor behaviour over time. In other words, the process-based approach emphasises the movement itself, paying very little attention to its outcome. The normative/descriptive period (1946-1970s) of research represented the product-based approach. It specifically aimed to “describe the mechanics of various age stages of movement skill acquisition and developing normative criteria for a variety of motor performance measures [norm-referenced standardized tests]” (Gallahue & Ozmun, 1998, p. 8). The maturational period (1930s-1945) and the process-oriented period (1980s-present) represent the process-based approach. Even though they share the same general perspective on motor

development there are significant differences that should be pointed out. Whereas the older account was concerned with the underlying biological processes governing maturation, the more recent one constitutes a major influence on motor development studies conducted today and it aims to explain the processes causing change in motor behaviour or motor skill development throughout life.

Various theoretical frameworks have supported the study of human development, each one affecting the understanding of motor behaviour. Most of these models tended to adopt one of the perspectives that will now be briefly described. The phase-stage theory to development (e.g. Erikson, 1982/1998) claims that universal age periods, organised by phases and/or stages, are defined by specific and fixed types of behaviour. This necessarily implies that there is a sequential progression that cannot be rearranged, even though stages could be skipped. Gallahue & Ozmun (1998) pointed out that this theory “focuses on broad-based changes rather than narrow or isolated behaviours” (p. 27). The developmental-task approach (e.g. Havighurst, 1972) has a different conceptual proposition, emphasising predictability of later success or failure based on how the individual performs at an earlier stage, without necessarily trying to describe the typical behaviour at a specific age. As follows, a developmental task is “an important accomplishment that individuals must achieve by a certain time if they are to function effectively and meet the demands placed on them by society” (Gallahue & Ozmun, 1998, p. 29). The viewpoint of the third theoretical framework is the developmental milestone approach (e.g. Piaget, 1953). Developmental milestones share some common features with the developmental tasks, however, instead of putting the emphasis on the individual’s achievements that will make him or her successfully adapt to the environment, this approach “refers to strategic indicators [convenient guidelines] of how far development has progressed” (p. 29). In sum, developmental milestones, as well as the phase-stage developmental approach, are more descriptive than predictive. Nevertheless, instead of a clean transition from one stage to another they understand “development as a continual unfolding and intertwining of developmental processes” (p. 29).

Throughout history, development has been commonly considered a hierarchical process suggesting that “the individual proceeds from general to specific, and from

simple to complex, in gaining mastery and control over his or her environment” (Gallahue & Ozmun, 1998, p. 45). This gradual progression towards more sophisticated levels of development is a shared feature between all the three theories previously described. Interestingly, their focus tends to favour the affective and cognitive behaviours of the individual over motor development, which is only indirectly mentioned.

Ecological theories on development, such as Dynamic Systems Theory (Thelen & Smith, 1994), represent new alternatives to understand human development by bringing a special attention to the motor domain. According to Gallahue & Ozmun (1998), even though there is the need to *describe* development as a product (individuals’ typical phases/stages, developmental milestones and developmental tasks), it is also fundamental to *explain* the underlying processes of these changes of behaviour. By being both descriptive and explanatory, the ecological paradigm is said to represent a viable theoretical framework to motor development (Gallahue & Ozmun, 1998). In this way, one of the most influential developmental perspectives within this ecological framework will now be described in detail.

1.5.3 Dynamic Systems Theory

Dynamic Systems Theory is a contemporary theoretical approach devised by Esther Thelen and Linda B. Smith (1994, 2006; Smith & Thelen, 2003) to the study of human development. Its qualitative principles derive from biology but especially from the ‘complex and nonlinear systems’ in mathematics and physics, and are “specifically [applied] to perceptual, motor and cognitive development in infants and early childhood” (Thelen & Smith, 2006, p. 259). However, these authors envisioned that DST could ultimately be used as a grand theory across many other different disciplines. In general terms, DST proposes a paradigm shift in cognitive development by revaluing the role of bodily mechanisms in the meaning formation process and, consequently, by critically challenging more traditional views in this field of study.

Many of the central questions in cognitive development derive from Jean Piaget (1953), a psychologist who emphasised the sensorimotor origins of thought by

inquiring how the abstract reasoning skills of adults emerge from ‘pure’ bodily activity in early life. For dynamic systems theory this tight coupling between action, perception and cognition is the structural foundation of development, however, Thelen and Smith (e.g. 1994) argue that the grounding of mental activity in sensorimotor experiences does not only emerge in an “initial state but [occurs] throughout life” (Thelen, 2000, p. 4). Instead of viewing development as a pathway toward the abstract in which perceiving and acting are mere bystanders, DST proposes an embodied and enactive experience of cognition – ‘knowing by doing’.

By defending perception, action and cognition as an integrated unity that cannot be partitioned, dynamic systems theory emphasises the fundamental role of experience in the meaning-making process and, thus, categorically rejects nativism as a viable paradigm to understand development. The more traditional model of nativism implies that one’s skills and abilities are pre-programmed, or in other words, genetically hard-wired into the brain at birth. Information from the world is thus processed by a neural system that dictates what movements the functional and executory body system should perform (input-output framework). In this sense, the central command (brain) becomes the single deterministic cause of behaviour.

One fundamental implication of a Piagetian and nativist view in cognitive development is that the process of change consists of a pre-specified set of instructions which unfold over time, that is, a linear and stable progression toward adult forms of logical thinking. The inherent predictability proposes fixed sequential stages and milestones of maturation and, hence, tends to describe universal types of behaviour (e.g. timetables for children’s motor skills acquisition). Inevitably, knowing ahead of time how developmental changes will materialise implies that children’s actions and their subjective experience will not interfere with the outcome in a relevant way. This and other key features that distinguish DST from more traditional nativist theories will now be described.

As previously stated, Thelen and Smith (1994, 2006; Smith & Thelen, 2003) devised an alternative paradigm based on the principle that knowing is not what one *has* but what one *does*. This means that a perceptual-motor development is the foundation for

an embodied and enactive knowledge of mind. For DST ‘self-organisation’ and ‘multicausality’ will constitute the core of a developmental change. The basic premise is that developing children are complex systems which integrate numerous individual components or subsystems (e.g. neural system, musculoskeletal system, visual system, auditory system) and are open to a complex environment. Without an executive agent or programme these parts are coherently coordinated to produce an organised behavioural pattern, as it happens with other complex systems in nature. This “coherence is generated solely in the relationships between the organic components and the constraints and opportunities of the environment” (Smith & Thelen, 2003, p. 344). Therefore, a self-organised process implies that none of those multiple components has causal priority, instead they all cohere to bring forth an ordered behaviour. Inevitably, this implies that from a theoretical point of view there are infinite ways in which these elements can combine. However, despite this large degree of freedom and range of potential emerging patterns, the system tends to be attracted or ‘prefer’ only few modes of behaviour (Thelen & Smith, 2006). For instance, even though a young child could select many different actions from her repertoire in order to cross the room, she ends up finding the most efficient solution – a self-assembled pattern – to respond to that challenge.

The theory proposed by Thelen and Smith (e.g. 1994) also puts a new emphasis on time. Unlike Piagetian approaches, self-organisation predicates the spontaneous emergence of coherent behavioural forms, in other words, the emergence of new patterns that are not fixed and known ahead of time but assembled in the moment. Therefore, development is not deterministic and timeless but a fluid process inscribed in time and space. Although behaviour emerges in real-time, every new state depends on the previous one and will constitute the starting point for future states. This continuity in time, evoked by the term ‘dynamic’ itself, entails that processes of change occur over different levels (from molecules to cultural contexts) and timescales (from milliseconds to years). A skill may then be learned after a few seconds, hours, days, months or years, suggesting that the way each child behaves is not only deeply dependent “on the immediate current situation but also on his or her

continuous short- and longer-term history of acting, the social situation, and the biological constraints he or she was born with” (Thelen, 2005, p. 259-260).

As mentioned above, for DST development consists of a self-assembling process of patterns of behaviour in response to the requirements of the task and based on the biological possibilities of the child in that moment. Behaviours can be stable for a period of time as optimal solutions for particular challenges and thus easily induced and frequently performed (habituation and learning). However, at a certain point new behaviours will emerge as an opportunistic gathering of the components, and the old patterns will become less preferred and available. For instance, when babies are able to stand by themselves and confident enough about shifting their weight, it is likely that the walking pattern will gradually become their favourite way of transport. Nonetheless, it is common to see these young children regress to crawling when the surface is less familiar or when they want to move rapidly in order to reach an object in space. “The crawling pattern does not disappear—indeed, adults may choose to crawl under certain circumstances—but it is supplanted by the more efficient upright mode” (Thelen, 2005, p. 264).

According to DST assumptions, the loss of stability is what facilitates the formation of new self-organised patterns. This transition to new forms of behaviour will imply children’s discovery of the optimal and situated solutions for them at the time. However, stability is not an immutable end-state but a dynamic process. It is determined by how tightly the elements are combined and, at the same time, by their flexibility to shift and rearrange in order to benefit the situation. For change to arise, the system necessarily has to drop stability so that the multiple elements are free to create novel and adaptive patterns of behaviour and, in due course, to regain the momentary loss of stability. A highly stable state may indicate though that a system may not be open to change, and that a particular behaviour is being resistant to perturbations. In this case, it may be necessary to provide the adequate input to destabilise the old pattern and encourage the child to look for new solutions (Thelen, 2005).

DST argues then, that development implies an alternated sequence of events with different degrees of stability. When an old pattern is no longer coherent and stable, the system will find a more efficient one. For example, a steep hill may gradually challenge a climber to make adjustments and small changes to his or her gait style. If the inclination reaches a critical point then climbing on all fours may become the optimal pattern to respond to that particular situation. According to Thelen and Smith (2006), this is a nonlinear phase shift. Only when the control parameter (inclination of the hill to climb) has reached a threshold, that is, a critical value of stability, a qualitative shift may occur. Considering the dynamic interplay between the real-time behaviour of a child, her specific activity history and of the situated task it “is difficult, maybe impossible, to predict the outcome of the process for any child in any particular situation” (Thelen, 2005, p. 260). This exploratory, opportunistic and function-driven approach to development contradicts and aims to replace the uniform, linear, rule-driven predictability and orderly progression defended by traditional Piagetian and nativist views.

Dynamic systems theory focuses on development at the individual level. It acknowledges the uniqueness of each child, more particularly, the specificity of body characteristics, motor skills and abilities. This implies that children follow unique trajectories since individual movement challenges have to be overcome. They must find solutions that best suit them in the context of the dynamic interplay between their biological predisposition, movement history and situated task at a given moment. Even though at a very global level similar developmental outcomes may arise, due to a common human biology and body design, behaviour seems less deterministic when using a magnifying glass. The ‘messiness’ of a more detailed and context-dependent level exposes variability and, thus, individual differences in development. According to Smith and Thelen (2003) there “is considerable indeterminacy within processes that have globally similar outcomes” (p. 347). Therefore, “a good developmental theory must encompass all outcomes, individual and atypical, as well as universal and typical” (Thelen, 2005, p. 259).

Exploration and selection are thus key agents of developmental change. Over time each child explores a wide range of sensorimotor experiences which will ultimately

lead to the discovery and selection of a viable and flexible solution to meet the demands of a particular task. This exploratory process allows the child to carve out individual and unique pathways by learning to calibrate movements and by trying varying degrees of motor control. By excluding the idea of pre-specified knowledge defended by previous traditional models, Thelen and Smith (2006) question “how can a learner who does not know what there is to learn manage to learn anyway?” (p. 286); does a child need to be informed a priori about the learning tasks and goals in order to find out what needs to be learned? According to these authors, their sensorimotor studies with infants provide evidence that at a very early age children are already skilfully able to spontaneously discover the tasks, as well as their respective solutions, through exploration (trial and error) and constant repetition. In some cases, different children with distinct starting points ended up converging to similar outcomes. Based on their empirical studies with infants, Thelen and Smith (1994, 2006; Smith and Thelen, 2003) are implicitly proposing a model in which children are empowered to self-regulate their own developmental change and learning experience.

In short, dynamic systems theory claims to be an alternative paradigm for understanding cognitive development. By rejecting traditional models (nativism and Piaget-based views), which are accused of encapsulating knowledge in a pre-programmed genetic linear sequence of events, Thelen and Smith (e.g. 1994) propose instead an embodied approach in which cognition, perception and action are dynamically coupled. Development is hence described as a ‘soft’, flexible and real-time assembly of multiple internal components (children’s unique biological heritage and their history of activity) and external (a task and its supporting environment). New patterns will emerge at an individual level, even though at a more global level universal forms may be identified. Each child self-regulates their own learning and developmental process, in response to the opportunities and constraints of the challenge, by spontaneously exploring a range of possible stable movement solutions which will ultimately lead to an optimal and efficient behaviour. Although DST has emerged from questions and research focused on perceptual motor topics (e.g.

locomotion in infancy), Thelen and Smith (e.g. 1994) argue that this all-encompassing theoretical framework should be applied to other fields of study.

1.5.4 Hourglass Model

Considering the various conceptual formulations previously discussed, Gallahue & Ozmun (1998) propose that there is still a need to devise a theoretical model specifically for motor development that could combine the propositions of Erikson, Piaget and Havighurst and the ecological perspective (e.g. dynamic systems theory). This integrative view would attend to “what people are typically like at particular age periods (description) and (...) [to] what makes these characteristics occur (explanation)” (p. 79). Differences in motor behaviour would also be studied considering the transactional process between factors within the individual (biology), the environment (experience) and the task itself (physical/mechanical). The viewpoint from which motor development would be observed could either adopt a process-oriented approach or product-based approach, implying that one could choose to study the underlying changes in behaviour (form and mechanisms) or the performance of behaviour (skills), or both.

Gallahue & Ozmun (1998) propose a lifespan hourglass model to motor development regarding a series of sequential phases and stages in association with approximate age periods of development. In the ‘early reflexive’ and ‘rudimentary movement’ phases (in utero-2 years) hereditary aspects are recognised as the primary factor for development. However, despite this sequential progression individuals’ rates of development may differ. The next phase is identified as the ‘fundamental movement’ (2-7 years) during which there is an increased efficiency, enhanced coordination and improved control of movements in children. Finally, the last phase corresponds to a ‘specialised movement’ (7 years to adulthood) when children are able to refine their skills. With the aging process there is a ‘turnover’ of the hourglass supported by both hereditary and environmental factors. One should be aware that these stages are flexible and they are just “a convenience to facilitate the observation and understanding of the motor development of young children” (Malina, 2004, p. 54).

1.5.4.1 Fundamental Movement Phase – Early Childhood

Considering the focus of this thesis on early childhood, only the fundamental movement phase will be considered. According to Gallahue & Ozmun (1998) “this phase of motor development represents a time in which young children are actively involved in exploring and experimenting with the movement capabilities of their bodies. It is a time for discovering how to perform a variety of stabilising, locomotor and manipulative movements, first in isolation and then in combination with one another. Children who are developing fundamental patterns of movement are learning how to respond with motor control and movement competence to a variety of stimuli. They are gaining increased control in the performance of discrete, serial and continuous movements as evidenced by their ability to accept changes in the task requirements. Fundamental movement patterns are basic observable patterns of behaviour. Locomotor activities such as running and jumping, manipulative activities such as throwing and catching, and stability activities, such as (...) one-foot balance are examples of fundamental movements that should be developed during the early childhood years” (pp. 83-84). It is important, however, to note that these abilities and skills are not only maturationally determined but also influenced by the task and environmental aspects (e.g. opportunities for practice, encouragement, setting).

The fundamental phase is composed of three sequential stages which may overlap. In the initial stage (~ 2 & 3 years of age) the child tries for the first time to execute a fundamental skill. This attempt is characterised by improper sequencing of the parts of that skill, by poor spatial and temporal integration of skill movements and by poor rhythm and difficulties in coordination. At an elementary stage (~ 3 & 4 years of age) children show greater control and rhythmical coordination and the temporal and spatial elements are better synchronised. However, although movements are better coordinated they are still restricted, exaggerated and inconsistent. During the last stage, the mature stage (~ 5 & 6 years of age), there is an increased efficiency, enhanced coordination, an improved control of movements and a greater force production. According to Gallahue & Ozmun (1998), “Although some children may reach this stage primarily through maturation and with a minimum of environmental influences, the vast majority require opportunities for practice, encouragement and

instruction in an environment that fosters learning. Failure to offer such opportunities makes it virtually impossible for an individual to achieve the mature stage of a skill within this phase and will inhibit further application and development in the next phase” (p. 85).

In sum, the previous sections have addressed the alternative embodied paradigm to classical cognitive science by describing a series of interrelated theoretical frameworks and concepts. This began with a presentation of the hypothesis of a common coding between perception and action, based on internal bidirectional models (*forward* and *inverse*), that has been supported by neuroscientific evidence specifically concerning the mirror neuron system (e.g. Cook et al., 2014). A ‘situated body’ was then considered through the description of two central notions of ecological perception (affordances and enaction) which defended the idea that perceptual processes emerge from a dynamic interaction between an embodied agent and his/her environment.

Moreover, the hypothesis of a body-as-constraint to perception was additionally discussed, which implied the assumption that body specificities and sensorimotor capabilities shape the way each individual agent perceives. In this line of thought, young children’s motor development was addressed as a potential perceptual constraint. Dynamic Systems Theory (Thelen & Smith, 1994) received special focus, particularly the idea that children self-organise their own learning while exploring the opportunities and limitations provided by the tasks and environment. This framework also highlighted that rather than an inbuilt and fixed motor program, young children’s actions tend to emerge at different times and in unique ways. Finally, it was also mentioned that the fundamental phase of motor development, that is, early childhood, as described by the hourglass model of Gallahue & Ozmun (1998), will be the only one to fall within the scope of the present thesis.

The following sections will now address embodied cognition and sensory-motor integration, specifically in young children, from a musical perspective.

1.6 Embodied Music Cognition

Embodied Music Cognition (EMC) is a theoretical and empirical framework devised by Marc Leman (2008) that proposes an alternative paradigm to the traditional account of Music Cognition. Instead of defending an offline computational model based on an internalised analysis of musical structure and perceived patterns (e.g. rhythm, melody, harmony), Leman envisions bodily-based activity supporting an online musical meaning-formation process. According to his view, the human body becomes the legitimate mediator between the brain/mind (musical intentionality and signification) and the physical world (moving sonic forms that afford action). This idea represents a gradual transition in cognitive science from music merely seen as physical sound to music as experience.

Following this line of thought, Leman's (2008) 'embodied musical mind' presupposes a continuum of sensorimotor experiences ranging from lower-levels of awareness and understanding to higher-levels of inferential processing. This implies that the EMC paradigm does not dispense with mental representation as other more radical approaches to embodiment do (e.g. Gibson, 1986; Varela et al., 1991). One could argue that this suggests a compatibilist approach to embodied cognition and, hence, Leman's theoretical framework can be considered an extension of the music cognition paradigm rather than a clear-cut schism. Moreover, to understand the embodiment thesis underlying the EMC account, it is fundamental to "specify the nature of dependence of cognition on the body", that is, "what particular significant causal or physically constitutive role does the body play in cognition?" (Wilson & Foglia, 2011). In Leman's (2008) paradigm the body is viewed as a *distributor* for cognitive processing. This means that the "agent's body functions to distribute computational and representational load between neural and non-neural structures, (...) [that is], parts of the body and even the beyond-the-body environment" (Wilson & Foglia, 2011).

In EMC the assumed structural coupling of brain/mind-body-environment is analysed from an ecological viewpoint which uses 'direct perception' and 'inference' as two distinct but coexistent notions. The Gibsonian theory of direct perception

(Gibson, 1986) defends the idea that inferential processes are unnecessary since the organism is able to directly perceive the action possibilities provided by the environment. As Leman (2008) points out “it is not the physical properties that are perceived, nor the awareness of the sensing of those properties. Rather, what is perceived is the action-relevant value [affordance] of the energy that causes these sensory features” (p. 52). On the other hand, Brunswik’s lens model as described by Leman (2008) argues that the individual is unable to perceive directly those opportunities for action available in the environment and, thus, he or she needs to access it through judgement and inference. While direct perception evokes attunement to musical information, that is, the direct perception of its action-relevant properties, the lens model involves “awareness, evaluation, interpretation and description of the perceived cues” (p. 52). Again, by adopting a compatibility view Leman aims to develop his own embodied framework based on the cornerstone principle of Gibson’s theory of direct perception – perceptually guided actions – in dialogue with Brunswik’s lens model based on inferential processes and on judgement. This compatible view will also be the one adopted by the present research.

The principle that perception and action are tightly coupled necessarily presupposes cross-modal interactions between different sensory modalities. For instance, an intimate connection between the auditory and motor systems implies dynamic transfers of meaning from one modality to another, supported by an online communication with the environment. For Leman (2008) the body represents the natural mediator between these multi-layered, and two-way, interactions. It “transfers physical energy up to a level of action-oriented meanings, to a mental level in which experiences, values and intentions form the basic components of music signification” (p. iv). As follows, one could assume that body movements are able to express, imitate, help to clarify and understand musical content and its underlying structure. “Nonlinguistic descriptions, such as body movements in response to music, rely on the transfer of sonic moving forms to motor moving forms. The motor modality is then the expression of the original auditory experience and, as such, it can be considered a description of the original music with the body” (Leman, 2008, p. 21).

By acknowledging that music perception is based on the agent's experience, EMC proposes an action-based approach to musical-meaning formation and signification. Instead of a passive and 'disembodied' perceptual processing, a direct involvement with music through action should be recognised. As a result, body movement becomes an essential component to describe and communicate corporeal experiences of music. Unlike the traditional linguistic (e.g. musicological interpretations) and symbolic (e.g. musical score) descriptions that provide an indirect engagement with music, embodied articulations (e.g. tapping to a beat) are an indication of a direct corporeal musical experience. "A motivation for considering forms of music description that differ from linguistic descriptions is that many people do not engage with music in terms of narrative reflections or interpretations of music's intentions. They seek access to music for the sake of its capacity to get into behavioural resonance [that is, corporeal engagement]" (Leman, 2008, p. 18). Corporeal articulations constitute a direct description of the moving sonic forms since the latter have a direct physical impact on one's body. Therefore, musical signification arises from a body in action (corporeal signification) and not from passive thinking (cerebral signification). In this sense, "if moving sonic forms engage subjects in a process of corporeal signification, then it is very likely that body movement [more specifically, perceptual and sensorimotor mechanisms] provides the key for an alternative nonlinguistic description of music" (Leman, 2008, p. 19). However, it is important to emphasise that movement activity is difficult to access via linguistic descriptions, mainly because of one's limited awareness of motor activities. Leman suggests that alternative ways of describing body movement should be developed in order "to fully capture the corporeal aspect as an aspect of meaningful signification" (p. 18). The author also states that "linguistic descriptions can [also] be based on these body movements" (Leman, 2008, p. 19). In this way, it can be claimed that well established systems of movement observation and analysis, such as Laban Movement Analysis framework (described in Chapter 4), could be effective qualitative tools representing a compromise between verbal and corporeal descriptions. Nonetheless, this implies specific training in order to be able to establish those correspondences, that is, an embodied understanding of the linguistic terminology which is directly connected to a particular corporeal experience.

Moreover, what constitutes the limitations on the interpretative value of a nonverbal description is what makes it universally accessible. According to Leman, “moving sonic forms share human corporeality” (Leman, 2008, p. 21).

The point of view from which one expresses musical experience implies different types of description. Leman (2008) mainly emphasises the distinction between the first-person and second-person descriptions, and briefly mentions the third-person approach. This latter descriptive type is defined as being about the measurement and analysis of someone else’s movement, implying the perspective of an uninvolved observer. The first-person and second-person descriptions refer specifically to the individual who is directly involved in the lived experience. In the first case descriptions result from subjective interpretations which are essentially linguistic/symbolic-based (e.g. ‘I felt that the tempo of the music was very fast’), whereas in the second case the musical experience is nonverbally articulated through bodily behaviour. This corporeal articulation entails that the “moving sonic forms move and have physical impact on our bodies. Moving sonic forms do something with our bodies, and therefore have signification through body action than through thinking” (Leman, 2008, p. 17).

Given the action-based approach to musical signification, corporeal articulations (second-person description) will constitute the primary focus of EMC. According to Leman, they express an embodied understanding of the world, in particular, of moving sonic forms and thus different levels of intentionality and awareness. Corporeal intentions may include action as ‘moving along with music’ as well as movements planned and prepared in advance such as dance routine.

Three distinct indicators of embodied musical involvement and awareness (or corporeal intentionality) are considered in EMC, reflecting differing degrees of ‘perception-action coupling’. It is suggested that an action-based understanding of music entails a hierarchical sequence from synchronisation, to embodied attuning and finally to empathy, levels that may also simultaneously coexist. This sequence reflects a continuum from a low-level of sensorimotor resonance to higher-levels of musical-meaning formation and signification. Synchronisation to a beat constitutes

the most basic experience of corporeal intentionality and awareness, followed by a more reflective state identified as embodied attuning which is directed to more complex structural features such as melody, harmony, rhythm, timbre. Finally, empathy reflects corporeal articulations of intended feelings, affects and emotions expressed by moving sonic forms. Given the scope of the present research, only sensorimotor synchronisation to a beat understood as a low-level reflective response to music will be considered. This decision is based on the fact that this embodied behaviour is the one recognised as an ‘automatic’ and overt response in listeners, as the next section will now address.

1.6.1 Spontaneous Synchronisation to a Musical Beat

Leman (2008) establishes the difference between synchronisation as a spontaneous phenomenon, the lowest level of sensorimotor intentionality or goal-directed action, and ‘inductive resonance’. This latter term refers to “the use of movements for active control, imitation and prediction of beat-related features in music” (Burger et al., 2013, p. 1), as opposed to a more unpredictable, almost unreflective and seemingly effortless movement behaviour. Nonetheless, despite the distinct degree of awareness in inductive resonance, synchronisation to a beat is still envisaged as a corporeal articulation associated with low-level sensorimotor processes and, thus, of low-level mechanisms of musical meaning-formation and signification.

EMC claims that an individual’s tendency to move in a synchronised way to the beat (e.g. tapping or bouncing) reflects the direct impact of physical energy of the sound on the human motor system (Leman, 2008). As follows, the beat is recognised to be “the most natural feature for synchronised movement because it appeals to fundamental biomechanical resonances” (p. 112). Consequently, this most basic metric feature of rhythm could be considered the first step to get people bodily involved in music and, thus, one of the first overt corporeal expressions of a real-time musical meaning-formation. According to Leman, the beat is the trigger that alerts the listener “to be ready to follow along with the music” (p. 112).

As previously stated, in many circumstances synchronised responses are spontaneously performed as if the listener was not in control of his or her own

actions and, hence, momentarily deprived of agency. This direct way of being immersed in sound energy and experiencing the ‘here and now’ interaction with the beat, is what Leman (2008) identifies as the listener’s low-level of intentionality and involvement. As follows, one could argue that these spontaneous actions are in fact “intentions-in-action” (Searl, 1983) rather than prior intentions, since they seem not to be deliberate, planned or formed in advance of the action.

As opposed to a more self-aware situation of ‘I am moving’ to music, this quasi-entrancing state tends to induce the experience of ‘being moved’ by music. Accordingly, it could be argued that the sensation of not being directly responsible for eliciting the action is the result of a strong resonance effect caused by “predictions of local bursts of energy in the musical audio stream, in particular to the beat and the rhythm patterns” (Leman, 2008, p. 96). This strong feeling of being attuned to and ‘plugged’ to the beat can be disrupted as soon as processes of reasoning or interpretation become involved which will inevitably contribute to “break the magic spell” (Leman, 2008, p. 5). For this reason, EMC claims that an effective corporeal articulation and intentionality must find the right balance between awareness and immersion.

It is important to point out though, that a synchronised behaviour to a beat could be spontaneously elicited in two different scenarios. In the first scenario, the one addressed by EMC theory, sensorimotor synchronisation occurs when movement is self-initiated in response to music-induced movement. However, a second scenario could also be envisaged, in which synchronised behaviour is also spontaneously performed during a ‘moving along’ activity but the initiation of the movement itself results from an external invitation to move. Even though the movement is not self-initiated, spontaneous synchronisation occurs. It is also important to clarify that in neither of the scenarios are individuals specifically instructed to follow the beat.

In sum, EMC proposes a compromise between a strict embodiment thesis and the mental representation of music cognition. It does that by assuming the body as a distributor of information between the brain/mind and the environment (moving sonic forms). This mediation process is theoretically influenced by the ecological

paradigm (dialogue between Gibsonian direct perception and Brunswik's inferential lens model) which defends perception-action coupling. This principle is the cornerstone of Leman's action-based approach. The possibility of transferring meaning directly from the physical energy of sound to the embodied musical mind presupposes that body movements are then able to articulate musical understanding. Through that corporeal description it becomes possible to identify different degrees of musical involvement or intended acts, ranging from low-levels of sensorimotor mechanisms (synchronisation) to gradually more complex inferential processes (embodied attuning and empathy).

Having established the EMC paradigm as frame of reference, the next section will now reflect specifically on the effects of action on music perception. It will start by briefly describing the difference between classical and embodied cognitive perspectives when addressing perceptual mechanisms. Then, it will consider a very recent theoretical framework based on a common coding hypothesis, and related internal models, that distinguishes between two different research approaches that aim to explain the influence of action on how music is perceived. Associative learning is also a central concept in this proposal, and will be discussed.

1.7 Embodied Account of Music Perception

1.7.1 Two Cognitive Paradigms

Music perception as (disembodied) cognition “can be described in terms of an abstract pattern processing model that is independent from the physical carrier (body, hardware) of the processing” (Leman & Maes, 2014, p. 83). This more classical perspective is based on one's ability to discern and anticipate the patterns that emerge from listening to music and its inherent structural features (e.g. melodies or rhythm). As follows, these emergent patterns of perception “are compared with previously stored knowledge and used to generate expectations about music. The

degree of match between the expected and the newly perceived pattern may then generate an outcome that is further processed by the motor system” (p. 82).

Only recently research has challenged this classical ‘sandwich model’ and begun providing solid empirical evidence to support perception as embodied cognition (Leman & Maes, 2014), specifically by showing the strong link between music perception and body movement. “The focus is less on [symbolic] representations of structure and more on representations of interactions that allow structures to be exploited in an expressive, emphatic and gestural way. Consequently, the idea that the brain works as an auditory sponge in relation to music can no longer be maintained” (p. 87).

In sum, this embodied account of music perception implies an inherent dependency of cognitive processes on constraints imposed by the environment (acoustics), the specificities of the agent’s body (e.g. auditory system) and repertoire of sensorimotor skills. “The embodied music cognition paradigm changes our understanding of music perception in the sense that we consider music perception from the viewpoint of interaction rather than from the viewpoint of perception without action” (Leman & Maes, 2014, p. 87).

1.7.2 Action Effects on Music Perception

Maes, Leman, Palmer & Wanderley (2014) have recently advanced a theoretical framework “that captures the ways in which the human motor system and its actions can reciprocally influence the perception of music” (p.1). It is founded on common coding theory (Hommel et al., 2001; Prinz, 1997) which defends the position that goal-directed actions (planned or executed) and the perception of the sensory outcomes associated to the performance of those actions, share a similar code, thereby recruiting a sensory-motor brain network. This shared neural substrate between perception and action has been, as previously described, substantiated by studies in music neuroscience, specifically those related with human mirror neuron system (e.g. Molnar-Szakacs & Overy, 2006).

Maes et al.'s (2014) framework postulates that action and perception become integrated through associative learning processes. This associative hypothesis proposes that “through systematically repeated experiences, sensory events are associated with particular motor acts and excitatory links between both are created, resulting in the development of ‘internal models’” (p.3). As follows, the activation of a sensory representation will automatically co-activate the associated motor representation (internal inverse model – *motor resonance*). Similarly, when performing a planned or executed action the corresponding sensory representation will also be automatically triggered (internal forward model – *perceptual resonance*). According to Maes et al. (2014), focusing on both of these internal models (inverse and forward) “can provide a comprehensive view on how the human motor system and its actions influence music perception” (p. 2).

1.7.2.1 Inverse Modeling Process (perception → action)

Inverse models imply that listening to music results in the co-activation of motor commands which are often overtly expressed in body movements. In this way, the direct-matching hypothesis (*motor resonance*) assumes that the “recruitment of the body into the process of music listening causes a connection to be made between the music and the expressive qualities inherent to the movements that the music induces” (Maes et al., 2014, p. 5). In other words, this account entails that people are in resonance and, quite literally, being ‘moved’ by music. A series of empirical studies (e.g. Burger et al., 2013; Toiviainen et al., 2010) have supported this proposal by demonstrating that specific acoustic features of music are coherently translated into body movements.

1.7.2.2 Forward Modeling Process (action → perception)

According to Maes et al. (2014) “embodied accounts typically refer to inverse modeling to explain action effects on music perception” (p. 2). However, very recently a new alternative to this more ‘traditional’ embodied approach in EMC studies has been encouraged. Instead of focusing on “how the body resonates with the music” a forward model addresses “how predicted sensory outcomes of planned or performed actions can be projected onto the perceived music” (p. 2).

An appeal to a greater investment in the use of this forward model to explain the effects of action on music perception is based on the argument that “despite the explicit focus on the human body and body movements” of studies using internal modeling processing these “do not consider the musical mind as fundamentally embodied” (Maes et al., 2014, p. 1), given that their “findings do not exclude the possibility that movement responses to music are mere peripheral epiphenomena resulting from central cognitive processes” (p. 1).

Studies specifically interested in explaining how changes in body movements influence the perception of structural and expressive features of music have now been proliferating (e.g. Maes & Leman, 2013; Phillips-Silver & Trainor, 2005), and more specifically “how sensory predictions can either attenuate, facilitate or disambiguate auditory perception” (Maes et al., 2014, p. 5).

To summarise, an embodied approach to music cognition recognises the fundamental role of perception-action coupling as opposed to the classical cognitive account that assumes them to be separate components. Inspired by the ‘common coding’ hypothesis, Maes et al. (2014) have recently proposed a theoretical framework in which bidirectional internal models, emerging from associative and repetitive learning processes, are adopted by researchers to explore/explain the effects of action on music perception. Whereas inverse models (perception to action) allow prediction from sensory input of the motor commands required to produce a specific state (*motor resonance*), forward models (action to perception) allow estimation of the desired outcome from a goal-directed action (*perceptual resonance*).

Empirical evidence has been provided in support of both types of internal models, however, in recent years there has been an increased interest in the use of forward modeling processes specifically because they represent an alternative to the ‘traditional’ account of embodied music cognition (inverse modeling processes) that considers the listener’s musical mind to be fundamentally embodied. Despite this trend Maes et al. (2014) states that “a focus on both inverse and forward modeling

processes can provide a comprehensive view of how the human motor system and its actions influence music perception” (p. 2).

Considering this theoretical framework, the following sections will now address two different situations based on sensory-motor associative experiences in early childhood. The first is a ‘movement-inducing-music’ situation that specifically addresses children’s self-regulated exploration of motor commands required to play an interactive ‘musical instrument’ (perceptual resonance). And the second is a ‘music-inducing-movement’ situation in which children move along to rhythm-based music (motor resonance).

1.8 Movement-inducing-music

Learning how to play an instrument is a representative example of sensory-motor association given it implies a close link between action and music perception. It is also a goal-directed action given that the goal of the instrument player is to produce a specific sound.

“However, in order to reach that goal, one first needs to obtain knowledge about the relationship between the actions afforded by the musical instrument, and the auditory consequences of these actions. This knowledge is gradually acquired by exploring and manipulating the possibilities afforded by the instrument using (at first) arbitrary actions that lead to (at first) unexpected auditory events (...). In that process of exploration and interaction, one systematically and repeatedly associates performed actions with heard sounds, and internal models are developed as a result, capturing the relationship between actions and sound” (Maes et al. 2014, p.4).

This associative learning experience which is based on exploratory and interaction processes through the use of repetition, is necessarily dependent on the player’s recognition of his/her *agency*. The concept of agency is defined as “an action (of one’s own); an action that one is in control of; an action that one is performing with a certain degree of effort; and as action that one is performing freely” (Bayne, 2008, p. 183). To have a sense of agency implies having a strong internal locus control, which means that when people act they believe they are the cause or the author of their own actions (*something that you do* rather than *something that happens to you*). In other words, the agents consider that events result primarily from their intentional behaviour and thus feel that their acts are under their control and not subject to any

external circumstance. As follows, agency or self-regulation within a context in which one is exploring and learning how to play a musical instrument could be defined as ‘the ability to recognise oneself as controlling sound/musical events and thus to self-monitoring behaviour’. This entails that a young player will have to become aware of how s/he may exert (intentional) control over the musical instrument.

As stated by Leman (2008), an “important aspect of technology-based mediation is concerned with interactivity. Playing a musical instrument is an interactive activity, and the musical instrument can be seen as the technology which mediates between human mind (musical ideas) and physical energy (music as sound)” (p. 138). These interactive music systems (Rowe, 1993), defined as interfaces between humans (e.g. input = body movement) and digital technology (e.g. output = music), may constitute ideal tools for young children to explore and develop sensory-motor associations while learning how to play them. For the purposes of this specific research only interactive musical environments (motion-based) will be considered.

The learnability of this type of ‘musical instrument’, or the degree to which a system is easy to learn and use (Murray-Browne, 2012), could be considered an advantage for very young players. Unlike more conventional instruments, interactive environment interfaces do not necessarily require a great amount of time to develop a reasonable proficiency. As follows, a rewarding musical outcome can be generated just by using simple and basic motor commands. Moreover, the tension between being right or wrong can be diluted given that ‘mistakes’ are less likely to happen and when they do the auditory consequences can still often be pleasant.

By removing some of the physical and technical constraints of acoustic instruments, interactive musical environments tend to make the experience of music-making more accessible and thus increase the motivation of young players. In other words, the computer assumes the difficult technical tasks to allow the performers to focus on the expressive content of their actions. However, it is important to state that “making things easy for novices often seems to limit the potential for more advance users” (Murray-Browne, 2012, p. 96). In that sense, when choosing to play these alternative

instruments one should be aware of the advantages but also of the limitations in terms of providing access to more complex processes of music-making.

The degree of movement freedom that these interactive musical environments can provide to their players, necessarily implies that the set of motor commands to be used is less deterministic than the ones required to play a more conventional instrument. This particular feature makes enactive interfaces specifically appropriate tools/settings to observe children's sensory-motor associations when freely exploring their musical self-regulation and the motor commands necessary to control musical/sound events.

Another key feature of these interactive musical environments is the fact that they afford actions that are similar to those used when someone is merely moving to music. In other words, the distinction between the nature of sound-producing movements and accompanying movements is blurred (Dahl et al., 2010, p. 48), especially because of the overreliance on auditory feedback and the absence of a corresponding haptic feedback. As follows, the same type of body action (e.g. walking) could be executed either as a response to the music perceived (*motor resonance*) or as a planned motor input aiming to generate a specific sensory state (*perceptual resonance*) which could reveal a higher-level experience of musical self-regulation. This possibility consequently requires the user to make a choice in terms of his/her identity within the interactive space, that is, by either assuming the role of a *listener* that moves along with the music, or the role of a *player* that moves in order to affect the musical environment.

Motion-based interactive musical environments are often used in performances, art installations (Dahl et al., 2010) and also in one-time workshops (Almeida et al., 2009). To my knowledge, they have never been specifically used in continuous educational workshops and with the purpose to observe young children's self-regulated associative (learning) experiences. Moreover, very little is known about what constitutes the repertoire of actions performed when exploring and learning the motor commands required to play this type of instrument, and in particular, the experiences of musical self-regulation underlying each child's individual discovery.

In sum, in a ‘movement-inducing-music’ situation in which young children explore and learn how to play an interactive musical instrument, motorically accessible, a sensory-motor associative learning is expected to occur. However, firstly the players will have to recognise themselves as agents able to control musical/sound events within the interactive space. The gradual recognition of this musical self-regulation will then help them to define the role of their movement choices, either as music-accompanying actions or as music-producing actions. By identifying the emergent repertoire of children’s self-regulated responses in a ‘movement-inducing-music’ situation (instrument playing), the aim is to reflect and contribute to some extent to an understanding of how action can affect music perception in early childhood.

In the following section a different situation will now be addressed, more specifically, a situation in which music elicits motor responses. The concept of ‘groove’ and the musical predictors of movement will first be defined and described, before considering sensorimotor synchronisation to a musical beat from an outcome-oriented and process-oriented viewpoint.

1.9 Music-inducing-movement

1.9.1 ‘Groove’, a Sensorimotor Phenomenon

Any study aiming to understand children’s spontaneous movement choices to music has necessarily to consider a stimulus with the potential to elicit movement. The selection of a ‘moving along’ piece of music becomes even more relevant if the act of moving is an integral component of the instructions (e.g. ‘move as you wish’) and not a self-initiated process. In order to support and engage the young participants in an enjoyable and seemingly effortless movement experience and, consequently, contribute to the spontaneity of their selection of repertoire, it is fundamental to understand what constitutes a suitable music stimulus.

In the last nine years the concept of ‘groove’ has been described in psychology as the quality of music that affects people’s willingness to move or dance (Janata, Tomic &

Haberman, 2012; Madison, 2006; Madison, Gouyon, Ullén, & Hörnström, 2011; Stupacher, Hove, Novembre, Schütz-Bosbach, & Keller, 2013; Witek, 2009). Madison (2006) was the first researcher to operationally define this sensorimotor phenomenon as “wanting to move some part of the body in relation to some aspect of the sound pattern” (p. 201). This movement compulsion was also recognised by participants on a survey who highly rated the statement “groove depends on the extent to which the music makes you want to move” (Janata et al., 2012).

The tight links between the auditory and motor systems are no longer surprising in neuroscience research, as mentioned previously, with numerous studies suggesting that listening to music excites motor areas of the brain (e.g. Zatorre, Chen, & Penhume, 2007). Stupacher et al. (2013) seems to bring even more emphasis to this connection by recently showing that groove is “especially powerful at activating the motor system via auditory-motor coupling” (p. 134). Considering that high-groove music increasingly engages the motor system it seems pertinent to identify the specific musical features that maximise that experience, since musical styles and genres seem independent from it (Madison, 2006).

1.9.1.1 Musical Predictors of Movement

Rhythm is pointed out as the most relevant musical predictor of groove, especially if the most basic metric level – the beat – is salient and, thus, perceivable (e.g. Iyer, 2002; Janata et al., 2012; Madison, 2006; Pressing, 2002; Madison et al., 2011). These “bursts of energy in the musical audio stream” (Leman, 2008, p. 96) are referred to as being directly responsible for spontaneous movement induction (Leman, 2008; Madison et al., 2011). A high degree of percussiveness, particularly through the use of drums (Gaston, 1956; Iyer, 2002; Pressing, 2002; Van Dyck et al., 2010) is also recognised to be one of the causes of beat salience. In sum, an emphatic and clear pulse preferably shaped by percussion (e.g. drums) tends to encourage individuals to move.

Rhythmic regularity constitutes another important groove-inducer (Madison et al., 2011; Stupacher et al., 2013; Witek, 2009). According to Madison et al. (2011) an ongoing and steady beat, underlying other metric levels, facilitates movement

towards an anticipated impact. This suggests that by confirming listener's expectations a repetitive sequence elicits a reasonably accurate temporal and spatial prediction. The prospects of entrainment increase even more if the beat is strongly accented and, thus, clearly perceivable (Burger, Thompson, Luck, Saarikallio, & Toiviainen, 2013; Madison et al., 2011). As a result, one could contend that a resilient and salient beat supporting a rhythmic pattern may encourage children to move in a relatively periodic and synchronised way. Moreover, its predictability could also have an impact on how confidently children move and self-regulate their individual choices of repertoire.

Danielsen (as cited in Witek, 2009) argued that groove-based music tends to evoke a circular experience in the movers by immersing them into an "eternal present" (p. 574). Repetitive rhythmic sequences with a strong beat are regularly used as catalysts for trance states, or altered states of consciousness, not only in traditional cultures but also in other contexts, such as, electronic dance music (Iyer, 2002; Witek, 2009). This experience implies that movers tend to use fewer attentional resources and that actions feel more automatic. It is probably the sensation described in the Authentic Movement practice as 'being moved' as opposed to a more reflective state of 'I am moving' (Pallaro, 2009). Leman (2008) has also associated a low-level of corporeal intentionality and awareness with beat synchronisation.

The situatedness and circular experience of rhythm seems also to be connected with the concept of the 'return-beat' (Taiwo, 1998), which is defined as "the body's internal experience of a perpetual return to the place from where we can feel the root pulse" (p. 164). This curved sensation of rhythm implies an "outward-going" beat extended from the body centre followed by an "inward-going" beat (p. 164). This is said to be different from a more linear and less embodied experience conveying a unidirectional sensation (outward-going beat).

Considering the musical predictors of groove described so far, the selection of a movement-inducing piece should include percussive rhythmic material, with a strong and steady beat in order to immerse children in an effortless movement experience and, thus, increase the spontaneity of their behaviour.

‘Being in the groove’ shows many similarities with the immersive experience of *flow* defined by Csikszentmihalyi (1990) as “the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost for the sheer sake of it” (p. 4). Studies investigating the affective experience of groove-based music have also found that most participants reported feeling positive emotions (Madison, 2006; Janata et al., 2012; Witek, 2009).

As suggested above, repetition of the same rhythmic material with high beat strength has the potential to facilitate synchronisation since the mover is likely to anticipate when and where the impact will occur. The spontaneous compulsion to move in response to stimulative music, and possibly to meet the predictive beat, is also said to elicit positive feelings. However, the experience of groove and flow could be undermined if predictability is too high (Stupacher et al., 2013; Witek, Clarke, Wallentin, Kringelbach, & Vuust, 2011). One strategy to diminish the monotony effect of repetition and, consequently, to promote an optimal groove state in the listener is to use the right level of rhythmic complexity (Witek et al., 2011).

The pace of music (the tempo) is also recognised as potentially affecting willingness to move. Evidence shows that a fast tempo is more likely to encourage action than a slower tempo (e.g. Janata, Tomic & Haberman, 2012) However, it is important to emphasise that fast tempo is a relative concept since a specific metronomic marking may correspond to a fast pace experience for an adult but not necessarily to a child. This difference is often assessed and explained through research into individuals’ spontaneous motor tempi (Drake, Jones & Baruch, 2000; Provasi & Bobin-Bègue, 2003). Additionally, the experience of a fast tempo is often connected with positive affect (Van der Zwaag et al., 2011).

Syncopation is another recognised tool of groove (Stupacher et al., 2013; Witek et al., 2014) with the potential to lower predictability and introduce variety to the rhythmic sequence. The *Oxford Grove Music Online Dictionary* defines syncopation as the “regular shifting of each beat in a measured pattern by the same amount ahead of or behind its normal position in that pattern”. If this feature carries a moderate

degree of complexity, then the established tension between the accent structure of the underlying beat and the syncopated phrase could potentially induce movement. It is important, however, to make sure that syncopation is enhancing the feeling of the beat and not compromising it. According to Snoman (2004) “all dance music makes use of syncopation” and in electronic dance music this is no exception since it is “often a vital element that helps tie the whole track together” (p. 44). “High levels of syncopation” also characterise other music and dance styles such as the West African tradition (Pressing, 2002, p. 288).

The evidence provided so far shows that ‘groove’ has the power to induce body movements in listeners, in particular when a regular and salient musical beat is present. As follows, the next section will now focus on the dynamic interaction between young children – agents with specific body constraints and perceptual motor skills – and a periodic accented beat. This process will be addressed within the context of sensorimotor synchronisation (SMS) defined as “the coordination of rhythmic movement with an external rhythm” (Repp & Su, 2013, p. 403) ranging from structured finger tapping actions to free whole-body movements.

1.9.2 Sensorimotor Synchronisation to a Musical Beat

Considering the scope of this thesis, SMS literature specifically focused on early years will now be briefly reviewed. It is important, however, to be aware that very few studies have addressed this topic and, according to Eerola et al. (2006), an “important reason for the absence of evidence of synchronisation during early childhood is the problem of acquiring reliable data with very young children” (p. 403). Those who attempted to overcome this challenge, seem to have opted by one of two different ways to study SMS phenomenon from a developmental point of view. As follows, the first part of this section will consider an ‘outcome-oriented approach’ to sensorimotor synchronisation research and the second part will describe studies in line with a more ‘process-oriented approach’.

1.9.2.1 Outcome-oriented Approach

Research from this perspective tends to focus on the accuracy of children’s SMS, that is, on how well actions are temporally coordinated with a predictable external

beat. Findings have shown that infants are able to respond spontaneously to a rhythm stimulus and also to tempo changes, even sometimes in an asynchronous way (Phillips-Silver & Trainor, 2005; Zentner & Eerola, 2010). As children grow older the ability to synchronise to a beat gradually improves, especially if the tempo occurs near their spontaneous motor tempo (Drake, Jones & Baruch, 2000; Eerola et al., 2006; Fitzpatrick, Schmidt & Lockman, 1996; Getchell, 2007; McAuley, Jones, Holub, Johnston & Miller, 2006; Provasi & Bobin-Bègue, 2003). However, synchronised responses are still not perfectly accurate in preschool years and are considerably more variable than in adults (e.g. Drake, Jones & Baruch, 2000; McAuley, Jones, Holub, Johnston & Miller, 2006; Provasi & Bobin-Bègue, 2003).

For some researchers immaturity in terms of motor control and developmental stage can partially explain the inaccuracy of synchronised behaviour in young children, which does not necessarily reflect the lack of interaction between auditory and motor systems (Trainor & Hannon, 2013). This view suggests the ‘body as constraint’ hypothesis in music cognition since it defends the idea that perceptually guided actions (e.g. the embodied articulation of metric structure of rhythm) are dependent on the agent’s sensorimotor capabilities. The conceptualisation hypothesis (Shapiro, 2011) becomes even clearer when young individuals with motor impairment are considered. In Whitall et al.’s (2006) study 7-year-old children with developmental coordination disorder (DCD) tended to exhibit more variability in SMS (tapping task) than a control group composed of normally developing children.

In short, research in this field has been providing empirical evidence that supports the thesis that body is a constraint to sensorimotor processes. Developmental differences between various cognitive agents suggest that adults are expected to synchronise better than children, older children better than younger children and normally developing children better than children with a developmental coordination disorder or other motor disorders.

As mentioned earlier, the outcome-oriented approach in SMS research is concerned with how precisely children’s movements match the beat. Studies addressing this question tend to share similar methodological procedures. One fundamental strategy

consists in verbally instructing children, as young as 2.5 year-olds (Provasi & Bobin-Bègue, 2003), to follow the beat. This means that an a priori goal-directed action is encouraged instead of a spontaneous sensorimotor synchronised action. Additionally, the type of body movement supporting synchronisation is also prescribed. In this way, children refrain from freely selecting their preferred pattern(s) of body coordination within their own repertoire. Tapping is the action often suggested in this type of study (e.g. McAuley et al., 2006) and, in more exceptional cases, clapping and walking (Getchell, 2007).

All of these suggested patterns are gestural movements which imply a localised corporeal articulation of the beat, significantly different from a whole-body experience in which all body parts seemingly emphasise the accentuation. Another important aspect is the use of an explicit and unambiguous metronomic beat as the stimulus, as well as the use of a controlled laboratory setting. Finally, there is frequently vague information given about the specific duration of the task and about how much time children actually spend in the research setting.

Interestingly, SMS studies with infants encompass specificities that require some adjustments to the experimental procedures previously mentioned. Since verbal instructions are not adequate in the case of very young participants, researchers have to rely on spontaneous rhythmic responses (intentions-in-action). This also presupposes that patterns of motor coordination will be freely chosen and self-regulated by infants and not predetermined by an adult. However, it can be argued that this ‘freedom’ is relative since their position is planned beforehand by the researcher. Usually, babies sit on their parent’s lap and are held by their waist (Phillips-Silver & Trainor, 2005; Zentner & Eerola, 2010).

Some have attempted to introduce changes in this outcome-approach to SMS research in early childhood. This is true in the case of Eerola et al. (2006) who claimed that “typical data collection methods are often motorically too demanding, require too much concentration, or are otherwise unattractive to young children” (p. 473). They also argued that the tapping paradigm is inadequate and an intricate motor task more appropriate for an adult than for a child. Finally, the authors suggest

the need for a “more suitable synchronisation task [which] would take into account the psychomotor and cognitive skills of young children, and capitalise on behaviour that they are known to exhibit spontaneously” (p. 473).

Eerola et al.’s (2006) research represents an intermediate position between the outcome-based approach to SMS and a more process-oriented argument. Even though measuring accuracy is still the main focus of this study, by promoting spontaneous sensorimotor synchronisation to the beat, Eerola et al. (2006) are allowing pre-schoolers to control their own choices of movement and, potentially, to embrace their preferred patterns of body coordination. This is a significant statement that highlights individuality and the self-regulatory process of SMS in developing children, which until now had received very little attention in this field of study. It can be contended that Eerola et al.’s findings and methodological procedures contribute to set the foundations of a content-based account of sensorimotor synchronisation.

1.9.2.2 Process-oriented Approach

As discussed above, most outcome-oriented sensorimotor synchronisation research uses the lens of accuracy to understand young children’s behaviour in response to the beat. In most of these studies synchronisation is part of the instructions, meaning that participants are directly asked to follow the beat (metronomic or musical beat). Additionally, not only are children invited to move in a synchronised way but they are also informed about how they should move. In other words, the actions which support synchronisation are predetermined and, in most cases, consist of hand or finger tapping. As a result, this prescribed gestural repertoire tends to constrain children’s responses to one body part, emphasising a localised corporeal experience. It is also important to mention that studies typically concerned about measuring individuals’ synchronisation capabilities use an experimental design as well as a controlled laboratory setting, often unfamiliar to children. Moreover, the duration of these tasks which for the sake of young participants’ motivation and fatigue prevention ought to be very short, is usually not clearly mentioned.

If, instead of focusing on the ‘outcome’ of SMS, a process-oriented approach is used, then new insights may emerge in this field of study. Looking at SMS as a ‘process’ entails that synchronisation can be understood beyond the notion of precision and, in this way, other aspects can be attended to, namely to the contents of the behaviour. Understanding ‘what’ types of movements or patterns of body coordination support children’s synchronised responses could highlight alternative research themes in SMS, such as, of individuality and self-regulation. Unlike the previously discussed paradigms, a process-oriented approach relies on spontaneous synchronisation, implying that children are not instructed to follow the beat. In this sense, a rhythmic movement may or may not occur, or be executed in a perfectly synchronised way. Moreover, given that children are invited to move freely to music, their actions are no longer constrained to a predetermined form of movement. This will inevitably allow them to fully explore a varied palette of spontaneous bodily responses ranging from gestural to whole-body movements and, in this way, to naturally discover their sensorimotor preferences to the musical beat which, in part, could also reflect their individual developmental stage.

Since children are invited to ‘move-as-you-wish’ instead of ‘move-to-the-beat’, a careful selection of music stimuli is fundamental to ensure, firstly, that participants are willing to move (groove effect) and, secondly, that spontaneous synchronisation can be induced. This necessarily implies the choice of music-induced movement with an explicit and unambiguous steady beat. Additionally, it is important to provide a context where children feel safe to move at ease and, consequently, free to explore their repertoire of synchronised responses. By making sure that children are familiar with the setting, as well as with the researchers, potential inhibited behaviours could be partially overcome.

Assuming that this process-oriented approach represents a viable alternative to understand SMS in early childhood, more specifically in preschool years, it is important to acknowledge that very few studies have been conducted from this viewpoint. In fact, it appears that only three key studies to date (Eerola et al., 2006; Moog, 1976a, 1976b; Sims, 1985) outline some of the foundational principles of this approach, even though other research could also be referenced as complementary

(e.g. Gluschkof, 2006; Rodrigues, 2012). In this way, it is of interest to firstly describe in chronological order these three seminal studies and then to refer to their similarities in terms of findings and methodologies. Ultimately, it will be also relevant to point out aspects within this area of knowledge that still need clarification or that have not yet been addressed.

Moog (1976 a, 1976 b) conducted an extensive observational study (direct and real-time observation) aiming to describe the development of musical behaviour in infancy and early childhood. Movement responses were an integral part of his research which could be considered one of the earliest naturalistic descriptions of young children's spontaneous and synchronised movements to music. Looking specifically at the 4- and 5-year-olds' performance, Moog found that the spontaneity of their repetitive movements decreased with age, as well as the variety of their responses. With reference to this last point, a special mention is made to the decline of whole-body actions and to the gradual rise of gestural movements, such as "clapping" and "swinging one leg up and down" (Moog, 1976b, p. 125). In addition to the description of children's types of movements, this study also aimed to evaluate how well coordinated their actions were to the musical stimulus. According to Moog, synchronisation gradually improved with age even though accurate responses were only maintained for a short period of time. The most successful patterns of body coordination with the beat were described as being gestural, as well as 'simple' and 'repetitive'. Finally, Moog stated that adjustments to tempo changes were very challenging and only a few children were able to alter the speed of their movements. In addition, maintaining that new tempo was not an easy task for most of the participants (1976b).

Sims' (1985) video-based observational study aimed to identify the 'creative' movement responses of pre-schoolers (3-5 years of age) to music and classify them into four predetermined categories (locomotor movements, axial movements, small motor and no movement). Moreover, it also intended to describe the rhythmicity of the performed actions and children's reactions to musical changes (e.g. tempo). The results indicated that children's repertoire of movements was evenly distributed among all categories. However, once age level was considered then locomotor

movements were increasingly higher in the 5-year-olds compared to the younger participants. Interestingly, a brief comment in the discussion section suggests that individual differences were also observed in terms of participants' movement preferences. Sims (1985) states that "while several children displayed a large variety of movements, most subjects tended to use just a few different movement patterns" (p. 52). Another important finding was that rhythmic movements were similarly used by the 4- and 5-year-old children and the latter exhibited actions that were more often in synchrony with beat. Nevertheless, all participants "did not, or possibly, could not, match the beat with much accuracy or frequency" (Sims, 1985, p. 52). Lastly, Sims states that rhythmic movements seemed to vary according to the tempo of the musical pieces and depended on the beat salience.

Eerola, Luck and Toiviainen' (2006) conducted an experimental study, with naturalistic concerns, which aimed to measure the synchronisation capabilities of pre-schoolers (2- to 4-year-old children) to a musical piece presented in different tempi. The types of movements performed were analysed based on video recordings and periodicity was measured using an optical motion capture system. The research findings revealed that hopping, swaying and circling constituted the main categories of the movements observed and in all of them there was an underlying periodicity. Even though these regular responses were clearly exhibited, no evidence of accurate sensorimotor synchronisation could be observed except in a very few cases and for a short period of time. Another relevant result showed that children presented little, or no adaptation at all, to changes in the musical tempo.

In sum, these three studies using different methodologies not only examined spontaneous SMS of pre-schoolers from an accuracy viewpoint, but they also attempted to describe and categorise the types of movements which supported that behaviour. In terms of synchronisation their findings indicated that 4- and 5-year-olds exhibited periodic movements that were frequently not synchronised with the musical beat. Whenever beat-matching occurred it would last for a very short period of time. Additionally, children with 5 years of age tended to be more accurate than younger movers. These studies also showed that preschool children did not tend to adjust the speed of their periodic movements to tempo changes.

Since children were not instructed to follow the beat in any of the above studies, it can be argued that the periodicity underlying their movements constituted a spontaneous SMS response, even if not perfectly matching the metric structure of the stimulus. Additionally, different body action types were observed to support the embodied articulation of a regular beat, ranging from gestural to whole-body movements. This seeming diversity of movements, freely chosen by the young children, makes one question whether assessing SMS using a prescribed action, such as hand or finger tapping, is in fact the most adequate procedure. It can perhaps be assumed that such an imposition of motor behaviour will prevent children from making a more individual and natural selection of movements in response to the beat.

Understanding SMS from a process-oriented approach tends to highlight the importance of the contents of synchronisation movements. This entails understanding how different types of actions, spontaneously elicited, convey a particular and individual embodied experience of the beat. Moog (1976a, 1976b), Sims (1985) and Eerola et al. (2006) all attempted to study SMS phenomenon partially from this perspective and, in order to induce spontaneous and free choices of movement in pre-schoolers, they used a specific set of methodological procedures which will now be critically addressed.

The first aspect that may influence how at ease children feel moving to music, within a research context, is 'familiarity'. Interestingly, each one of these studies chose a particular type of setting that seems to suggest varying degrees of familiarity. Moog (1976a, 1976b) conducted his observational study in the children's homes (Moog, 1976a, 1976b), whereas Sims (1985) chose a nursery and Eerola et al. (2006) a laboratory. Even though 'home' is the familiar setting par excellence, it could be reasonably contended that the apparent unfamiliarity of other settings could be overcome by promoting a gradual acclimatization, for example, by inviting children to pay regular visits to the setting before data collection and by promoting playing activities non-related to the study which could develop positive experiences in that particular space.

If the level of familiarity with the setting may help children to feel more comfortable to move, one could defend that advantages may also arise from a familiar relationship between the young participants and the researchers, who in some cases will be observing them directly. Even though it is not clear how well children knew the researchers of these three studies, reports of children's inhibited behaviour during observation sessions and data collection (Eerola et al., 2006; Moog, 1976b) may constitute an important clue. In a very explicit way, Eerola et al. (2006) explained that one of the reasons why a great number of participants "expressed little or no movement in the laboratory" was "possibly due to a number of novel elements [such as] surroundings, new people, etc." (p. 474).

A second aspect that could affect children's free choices of movement is the type of instructions used and the way they are conveyed. Even though all the three studies aimed to promote the move-as-you-wish criterion, which by its own nature implies eliciting free movement expression and excluding as much as possible the influences of others, imitational factors between were not completely omitted, since the children were observed in a group setting. Inevitably, this makes it possible to question how genuinely 'spontaneous' the actions observed and described were.

Moog (1976b) stated that when children were too reluctant to move and the initial instruction ("you are allowed to move around" or "would you like to dance to it") failed, a more direct encouragement was used, such as, "go on, clap" or "go on, tap on the table" (p. 126), complemented by the adult's demonstration. Moog also added that those who responded to the first "command" were "simply being obedient" (p. 126), suggesting that children were not necessarily completely at ease to move and to make genuine free choices of movement. Considering the nature of these instructions and the explicit suggestions of repertoire, it becomes difficult to accept that the movements described in this particular study constitute clear evidence of a spontaneous selection of actions performed by pre-schoolers. Moreover, it would be even more difficult to argue that these movements represent a spontaneous SMS to a musical beat.

In Sim's (1986) study, some imitation effects might also have occurred, particularly, if the warm-up in which children were individually invited to participate prior to the data collection is considered. That process implied asking each participant to move "various parts of the body" (p. 47) and, in this sense, one could claim that the implicit routine may have somehow influenced children's free choices of movement during the musical task itself.

Some of the procedures and instructions used by Eerola et al. (2006) also indicate that children's movements might have been informed by others' behaviour and verbal suggestions. In order to assure that actions would remain within the perimeter of the measurement area, Eerola et al. (2006) invited the young participants' "to walk in a circle" (p. 474) before moving along with the music. Parents and an early childhood expert were also instructed to directly intervene by using verbal "encouragement" or persuasive "examples" (p. 474) which one could presume to be bodily demonstrations. Another point that could have potentially undermined the spontaneity of young participants' movement choices in this study, is the fact that the children already knew the music they were moving to. According to Eerola et al. (2006), the "music was familiar to most children as they had listened to the same track in their early childhood music lessons" (p. 474). This necessarily entails that these previous experiences with their teacher and peers could have potentially 'contaminated' the repertoire of movements exhibited during data collection. Finally, the lyrics of the music which aimed to "[inspire] children to dance with the animal characters of the song" could also have interfered with the types and quality of movements that children would naturally choose.

If spontaneous rhythmic responses to music are to be elicited, that is, without children being asked to follow the beat, then the choice of an adequate stimulus is of great significance. In this sense, instead of using just a simple metronomic beat the three studies aforementioned decided to include actual pieces of music. Interestingly, only Eerola et al.'s (2006) study explicitly referred to the selection of movement-inducing music, that is, a stimulus that would enhance in participants the willingness to move. However, this does not necessarily imply that the 'groove' quality was absent from the stimuli used in the other two research projects. Another curious point

is that none of these three studies discussed a priori the importance of having a beat that was sufficiently salient to facilitate synchronisation with its periodic structure, even though SMS aimed to be observed or/and measured. It is also significant to mention that only Eerola et al. (2006) discussed the importance of using a suitable tempo for children to move along with the beat. This is likely to be related with the fact that studies on the topic of tempo preferences in children (e.g. Drake, Jones & Baruch, 2000; Provasi & Bobin-Bègue, 2003) only started to be researched after Moog's (1976a, 1976b) and Sims' (1985) studies.

Sensorimotor adjustment to changes in tempo was also an important component of these studies. While one study used only one musical piece presented in different tempi (Eerola et al., 2006), the other two decided to select various pieces, each one representing a distinct tempo, which could also include gradual changes in speed (Moog, 1976a, 1976b; Sims, 1985). If these options are compared, it can be suggested that using the same piece with different tempi would likely facilitate a clearer observation of children's specific responses to tempo changes. Playing various pieces of music with different tempi allows for children's performances to reflect not only adaptations to tempo but also to the influence of other music structural features within the stimulus.

In terms of movement description and categorisation, the studies used distinct strategies. Moog (1976b) did not actually classify the types of actions observed in children's performance, but decided to simply describe them. According to his list it is possible to verify that participants' repertoire of movements included both gestural and whole-body movements, however, actions constrained to one body part were clearly preferred (e.g. 'swinging one leg up and down', 'tapping on the table', 'nodding the head'). Moreover, movements tended to be less varied in the 5-year-olds' than in the 4-year-olds' group. Again, it is worth mentioning that most of these actions were not spontaneously performed by pre-schoolers, since Moog verbally suggested some of them whenever he felt children were reluctant to move.

Unlike Moog (1976a, 1976b), Sims (1985) classified participants' movements by devising categories "used by movement and dance educators" (p. 48), some of them

referred to in Gallahue's (1998) book *Understanding Motor Development*. The categories considered, were 'locomotor movements' (travelling through general space), 'axial movements' (stationary movements using whole-body actions), 'small motor movements' (stationary movements using gestural actions) and 'no movement'. Underlying these categories there is the assumption of a tight connection between the number of body parts used in the movement (one or more) and how general space is accessed (travelling or not travelling through space). This entails that, for instance, 'running' will always belong to the locomotor category. However, this classification may become inadequate when paradoxical situations such as 'running in place' occur, that is, when a locomotor action by nature, for instance, is not used to locomote and access general space. Lastly, one relevant aspect that still needs to be mentioned about Sims' (1985) study is that, unfortunately, the types of actions observed were not included in the research paper which means that only the percentages of each one of the four categories is known.

Even though both Moog's (1976a, 1976b) and Sims' (1985) studies address sensorimotor synchronisation, neither of them attempts to establish a direct connection between the repertoire spontaneously chosen by children and the embodied experience of the beat that the movements performed seem to suggest. In other words, these researchers do not explicitly identify those responses as patterns of body coordination that articulate the beat in a particular way. Eerola et al. (2006) attempts to overcome this gap by, firstly, devising three general categories of actions and then by measuring periodicity in each one of those groups. Despite the fact the rationale behind the categorisation is not explicitly presented, it seems that space is the unifying concept. Nevertheless, it is important to point out some apparent incongruences in this classification.

While two of the categories are based on peri-personal space (space closely surrounding one's body) and mainly concerned with spatial directions, the third one is defined by general space (space that one accesses through locomotion) emphasising spatial pathways. The peri-personal space categories correspond to 'hopping' (up-down motion) and 'swaying' (left-right motion) and the general space category is identified as 'circling' (circular spatial pathway). The latter category is

ambiguous because its designation does not inform the reader about the type of action that is used to perform the circular pathway. As a result, one could easily argue that circles can be executed while hopping and, furthermore, that this particular pathway could actually be a result of the initial instruction ('walk in a circle') given to children prior to data collection. Finally, it is important to mention that periodicity was found in all categories and that most children were 'hoppers', which seems to indicate a specific spatial preference to experience the beat (up-down motion).

In short, despite the valuable attempts to categorise children's movement performance in response to the beat it seems that there are still points that need to be clarified and developed. Firstly, there is the need to define precisely the frame of reference from which the categories emerge and maintain coherence throughout. In this respect, the use of categories from a qualitative movement analysis system (e.g. Laban Movement Analysis framework) which has already proved to be an efficient resource in this type of research should be considered. Even more so, it facilitates an in-depth analysis by using both simple and complex categories and subcategories of movement. Secondly, very few attempts have been made to understand the content of each child's free movement choices. In other words, little attention has been given to the patterns of body coordination (e.g. jumping) spontaneously chosen and performed, as a specific bodily and spatial experience and articulation of the periodic structure of the beat of each individual (body-as-constraint viewpoint). Thirdly, the information provided by Moog (1976a, 1976b), Sims (1985) and Eerola et al. (2006) about children's movements responses to music should be read with caution whenever the lens of 'spontaneity' is applied. As previously argued, some of the methodological procedures used in these studies may make one question the degree of freedom of children's choices. Nevertheless, these studies constitute a fundamental and valuable reference in the study of a process-oriented approach that is now being devised in SMS research in preschool years.

1.10 Conclusion

The embodied account of music cognition (Leman, 2008) is a recently developed theoretical and empirical framework which in the last eight years has been redefining

the role of the body in music perception. Instead of a mere passive executor of central commands (mind), as defended by a traditional computational approach, the body and its sensorimotor system are claimed to be causal or constituent parts of grounded perceptual experiences. Empirical evidence from different areas of knowledge, particularly from cognitive neuroscience (e.g. MNS studies), have been providing unequivocal support for the embodiment argument by validating the common coding hypothesis and thus the existence of an auditory-motor coupling.

An ecological approach to perception argues for a dynamic interaction between an embodied agent and its environment (affordances). Additionally, supporters of enaction claim that *what one perceives* is in fact *what one does* and *what one knows how to do*. These arguments are compatible with the conceptualisation hypothesis (Shapiro, 2011) which defends the proposal that the way an agent conceives of the world is constrained by his perception-action systems in accordance to the changing environmental demands. As follows, it is expected that different kinds of bodies with specific sensorimotor skills may recognise different musical affordances and thus distinct opportunities to act.

Motor development has been pointed out in this chapter as a potential constraint to young children's enactive music perception. According to the dynamic systems theory (Thelen & Smith, 1994), the acquisition of motor skills is not based on pre-programmed sequential stages (universal types of behaviour) but emerges from the unique experiences of a child, from continuous self-organisation and from adaptive responses to the opportunities and challenges provided by the environment.

A theoretical framework within EMC has been recently proposed (Maes et al., 2014) suggesting that inverse (perception-to-action) and forward (action-to-perception) internal models provide a comprehensive explanation of how action influences music perception. In line with both of these models, two sensory-motor associative experiences ('movement-inducing-music' and 'music-inducing-movement') were considered, with a specific focus on children's spontaneous choice of movements and self-regulatory processes, aspects that remain very much unexplored in embodied music cognition research.

The first associative experience concerns ‘musical instrument learning’, specifically through the use of mediation technologies (motion-based interactive musical environments). It has been argued that its technical accessibility and the requirement of a basic and simple set of motor skills, offering an immediate rewarding auditory outcome, have the potential to increase children’s motivation and facilitate the exploration of sensory-motor associations while playing. Moreover, the emergent repertoire of actions may also contribute to the understanding of experiences of musical self-regulation in early childhood and, consequently, provide useful information about action-based effects on music perception.

The second associative experience concerns ‘sensorimotor synchronisation’ to a musical beat, one of the best predictors of groove, and addresses two distinct approaches regarding the study of this specific behaviour in early years. An outcome-oriented approach constitutes the main research trend mostly focused on determining how accurately children coordinate their actions with the beat. Specific methodological procedures – usually implemented in a controlled laboratory setting – are consistently adopted, namely, instructing the young participants to follow the beat, prescribing the type of action to support synchronisation (often tapping, a fine motor skill) or using a metronomic beat as stimulus.

Rather than paying attention to the end result of children’s performance, a process-oriented approach focuses on the content of the movement that is shaping the synchronised response. Methodologically, it is characterised by an invitation to move freely to a music-induced movement and thus to facilitate spontaneous choices of repertoire. It also aims to make the research setting as familiar as possible to the young participants and to create very short and enjoyable data collection sessions.

Very few studies fall within this last approach, and those that do, have not involved a detailed analysis of the movements exhibited in response to the beat and to potential musical changes (e.g. tempo adjustments). More importantly, they fail to address the uniqueness of each child’s performance and thus the similarities and differences between participants when listening to the same stimulus (body-as-constraint hypothesis). Considering this scenario, I propose to investigate spontaneous choices

of body movements to music in pre-schoolers using a process-oriented approach and aiming to fill these gaps.

In sum, previous research has failed to investigate some key concerns regarding embodied musical experiences in early childhood. Those major concerns, which will be specifically addressed in the present thesis, are stated in the following questions:

- What constitutes the sensorimotor repertoire of young children when interacting with music and when invited to self-regulate their own behaviour (process-oriented approach)?
- What constitutes the similarities and individual differences of their spontaneous repertoire of movements?

In the next chapters two different studies will now be presented: a ‘movement-inducing-music’ situation (musical instrumental learning) and a ‘music-inducing-movement’ situation (sensorimotor synchronisation to a musical beat). Central concepts such as sensory-motor associative experiences, children’s free choice of actions and self-regulatory processes will be transverse to both investigations. Finally, it is expected that the results could contribute empirically to the EMC framework and to an understanding of the bidirectional influence of body movements on music perception.

Chapter 2

Study 1 - Experiences of Musical

Self-regulation

2.1 Introduction

In recent years, body movement has gradually become a central focus in music research (e.g. Toiviainen, Luck & Thompson, 2010). The existence of a common code between auditory and motor systems, widely investigated by neuroscience studies (e.g. Zatorre et al., 2007), constitutes nowadays a strong argument for perception and action coupling. Moreover, the hypothesised influence of action on music perception and vice versa (e.g. Maes et al., 2014), suggests that the agent's body movements when engaging with music are able to shape and affect his/her perceptual and meaning-making processes, as well as the opposite. If, additionally, the body-as-constraint thesis (Shapiro, 2011) is considered then one could assume that any interaction with music is deeply dependent on the agent's body and sensorimotor capabilities (e.g. stage of motor development) and also on the opportunities for action that the environment offers to that cognitive agent (e.g. musical affordances).

Having this frame of reference in mind, the present exploratory study aims to identify and classify self-regulatory body movements of 4-year-old children when engaging with music, more specifically, when exploring their self-regulation (i.e. ability to self-monitoring behaviour and recognise oneself as controlling musical/sound events) within Sound=Space (S=S), a motion-based interactive musical environment (IME) responsive to individual's location in space.

This particular IME was chosen because of its technical accessibility (and learnability) in terms of the motor commands required to produce a rewarding

auditory outcome. Given that only a basic set of sensorimotor skills is needed to manipulate this instrument, and that these skills are already part of young children's repertoire, S=S seemed an ideal platform to observe children's exploratory movements and 'playful' choices within this musical/spatial environment.

That said, the use of S=S will necessarily consider a 'movement-inducing-music' situation in which children's actions are able to generate music/sounds (i.e. 'playing an instrument' situation). However, this possibility must be *recognised* by the movers when exploring this motion-based 'musical instrument'. As follows, it can be argued that *high-level experiences of musical self-regulation* refer to children's assumed role as 'players', mainly through the use of music-producing movements (goal-directed actions), whereas *low-level experiences of musical self-regulation* refer to children's assumed role as 'active listeners', mainly through the use of music-accompanying movements.

Considering the exploratory nature of this study, thematic analysis was chosen as an appropriate qualitative method to support the identification of movement patterns/categories regarding children's embodied interactions with music. It could also be argued that this method constitutes a valuable preliminary analytical stage (e.g. generation of categories) for a subsequent category-based structured observation (e.g. coding schemes). However, for the purpose of the present study this systematic approach, which would imply the quantisation of movement data, will not be considered.

2.2 Participants & Ethical Procedures

A total of 10 healthy young children participated in the research, conducted in the Laboratory of Music and Communication in Infancy (LAMCI) at the FCSH-University Nova de Lisboa, Portugal. The young participants were assigned to two groups according to their availability on the specified dates for the four observational sessions. However, this decision was not based on a comparative experimental design (treatment group versus control group) but rather in order to restrict the number of children in each session. As a result, each participant had more time to

explore the musical activities individually and I was also able to manage the group more easily by myself.

Group 1 had 6 participants (2 male and 4 female) of 4 years of age (range 50-55 months, mean age 54.2) and group 2 had 4 children (3 male and 1 female) also of 4 years of age (range 49-55 months, mean age 51.4).

Postcards promoting the research sessions were distributed within the university and in several Nurseries in the surrounded area (Figure 2.1). To enhance recruitment possibilities additional publicity was achieved through social media. Given the limited number of places available in the study, admission was based on a first-come, first-served basis.



Figure 2.1: Promotional postcard of the Sound=Space workshops

Written informed consent was sought from parents prior to data collection. Details about the research were provided, particularly concerning the aim of the study, the main procedures, the video recording process and the issues regarding protection of privacy and confidentiality of all participant data. Furthermore, parents were also informed that they were free to discontinue their children's participation at any time.

Children also gave their informed consent verbally before the first observational session and were assured that they could stop participating in the musical activities at any time and without any repercussion.

2.3 Materials

The present investigation was conducted in a laboratory, however, the choice of this well-controlled environment was solely based on the logistical advantages it provided to observe children's behaviour interacting with the technology. Firstly, I was authorised to set up all the necessary equipment and leave it for a period of approximately two months. And secondly, the lab's accessible location (city centre) and parents' free parking during the sessions contributed greatly to the success of the recruitment and data collection stages.

A large studio and an observation room were used in the study. The studio was approximately 9 m x 9 m, and within this space an interactive musical system ("Sound=Space") was installed to define an area in which the musical activities with the young children would take place. The floor was covered by interlocking black soft foam mats and the walls surrounded by curtains for acoustical purposes. Dividing the studio and the observation room was a one-way mirror which allowed parents to observe their children during the sessions without being seen from the studio by darkening the observation room. This specific space also provided a comfortable waiting area for the participants and their parents.

2.3.1 Sound=Space

Sound=Space (S=S) "is an electronic musical 'instrument' [created by Rolf Gehlhaar in 1985] that is 'played' – usually by several people at the same time – by moving around in an empty space surveyed by an ultrasonic echolocation system that very accurately measures the positions and movement of people within that space" (Gehlhaar, Girão, Rodrigues & Almeida, 2008, p. 104).

This particular motion-based interactive musical environment was chosen as a research tool not only for reasons of convenience, given that I already knew how to operate the system and had previously conducted S=S workshops with young children (Almeida et al., 2009), but primarily because of its accessibility. In other words, the 4-year-olds were able to 'play' this 'instrument' by freely moving around the room and by using their own familiar repertoire of movements. Therefore they did not have to learn new motor skills in order to produce a rewarding musical

sound, as other more traditional instruments often require. However, it is important to clarify that S=S is not a gesture-based control system that translates children's motor expressiveness into sound (e.g. velocity of movement = musical tempo) but rather a system that gives auditory feedback to children's position in space. Nonetheless, this does not mean that children refrained from moving expressively in this space.

Another important reason for choosing this specific interactive interface over others is its reliability. Unlike other more recent systems, this historical electronic 'instrument' has been used numerous times throughout the years in performances, installations and workshops which means that its limitations are well known and any potential technical problem could be more easily overcome by the researcher.

The Sound=Space setup for this study was composed of 8 ranging units (ultrasonic sensors), 1 ranging unit box, 8 music stands to support the ranging units, 8 jack-jack cables, 1 MIDI cable, 1 sound card (M-Audio Fast Track Pro 4 x 4 Mobile USB Audio/MIDI interface with Preamps), 2 Sony loudspeakers, 1 Sony Vaio laptop PCG 7F1M series, 3 extension chords and one small table (see Figure 2.2).



Figure 2.2: Sound=Space setup at the large studio at LAMCI (Lisbon). Photo from Luisa Ferreira 2009.

The space used for the Sound=Space installation was 6 m x 6 m, considered sufficient for 4 to 6 children to comfortably move around in simultaneously. The 8

ranging ultrasonic units were set up along two adjacent sides of the square area (4 on each), looking inwards, and with a minimum separation distance of 1 metre, creating a grid as Figure 2.3 shows.



Figure 2.3: The classical Sound=Space installation (Almeida et al., 2009, p. 1199)

This set of ultrasonic sensors starts by detecting the precise position of movers in the space. Then, the measurements collected by each ranging unit are sent to a computer programmed “to convert them into sounds via a synthesizer and/or sampler” (Gehlhaar et al. 2008, p. 104) through the use of Max/MSP software. Recently, an update of the system made it compatible with Ableton Live (version 7) which enabled me to compose for $S=S^1$.

2.3.2 Video and Other Supporting Equipment

The sessions were recorded using 1 Canon Legria HF R28 9 camcorder (32GB dual flash memory), equipped with 1 small wide-angle lens that provided a greater depth of field and would ensure that participants’ movements were properly framed. It was decided that the camera’s position would be fixed, supported by 1 mid-size tripod, and strategically located in one of the corners of the studio to “emphasise regulation and uniformity in data collection and analysis” (Jewit, 2012, p. 13).

¹ For more detailed information about the technical specifications of Sound=Space, please see Gehlhaar (1991) and Gehlhaar et al. (2008).

Ten colourful floor cushions were distributed in one side of the room and used by children whenever they needed to stop moving and rest. Moreover, 10 place mats and 24 round colourful coasters (PANNÅ Ikea) were employed as visual props in some of the musical activities.

2.4 Stimulus

The concept of *Music topologies* is fundamental to understanding Sound=Space. It consists of spatially distributed sounds or musical functions that determine the type of interactive control available to the ‘player’ and consequently the musical environment to be manipulated and experienced.

For the purpose of this study only the *passive* topology type was considered, given that it was the only form of control available in the S=S version in use at the time. This topology implies the simple triggering of sound(s), with a predetermined duration, by moving in a specific spatial area to which that sound(s) has been assigned (Gehlhaar, 1991; Gehlhaar et al. 2008). The effect is like someone walking across invisible keyboards spanning the space.

This particular musical topology is to some extent deterministic considering that the music-making possibilities of the mover are limited to “those sounds [synthesised or sampled] that have been 'mapped' onto the space by the program” and, before that, by a composer (Gehlhaar et al., 2008, p. 103). In other words, even though the player is able to control musical events, there is an underlying spatial composition (‘sound map’) that had been, to a greater or lesser degree, pre-programmed. However, it can be argued that the deterministic quality of this passive topology is partially diluted by the fact that sound maps can be preprogrammed in so many ways and, as a result, provide an infinite number of ‘playing’ experiences to the users.

Other characteristics of this passive topology type (‘keyboard’) are further described below.

“The passive instrument is silent if no one plays it. When it is played, it responds absolutely predictably, always in precisely the same manner. In

this instrument, standing in precisely the same spot will always produce the same sound(s). A sequence of movements repeated precisely with unvarying speed will, in the long run, produce the same sequence of sounds (...)" (Gehlhaar, 1991, p. 66).

A passive topology consists of "a variable number of 'keyboards' stretched throughout two-dimensional space" in which each "keyboard is associated with the beam or a part of the beam of a ranging device and triggers a pitch with a specific duration" (Gehlhaar, 1991, p. 67). Furthermore, the "range of each keyboard- the number of keys, the intervals between them and their order - for both pitch and duration are entirely flexible" (p. 67) as well as the size of the keyboard and of each individual key. All this information is preprogrammed and pre-specified before the player uses S=S.

When the system is being used, each key will respond promptly with the corresponding pitch and duration and will repeat that event as long as the key is being 'pressed'. "Once triggered, a pitch will always last its full duration before another can be triggered on that same keyboard; long durations cannot be broken off" (Gehlhaar, 1991, p. 67).

2.4.1 Spatiotemporal Stimuli

For this study different versions of passive topologies² were used as spatiotemporal stimuli to encourage children to explore their sense of musical self-regulation - their ability to self-monitoring behaviour and to recognise themselves as controlling musical events within an interactive environment. This selection included a classical repertoire of musical topologies, composed by Rolf Gehlhaar, and sound maps which I had particularly designed for these observational sessions. Moreover, each one of the spatiotemporal stimuli was associated with specific activities, which will be described in section 2.5.

² From this point onwards the concept of musical topologies will only refer to passive topologies. Moreover, it will also be used interchangeably with the expression of 'sound maps'.

The classical repertoire for Sound=Space is characterised by complex and rich spatial compositions. Each one of the 8 ‘keyboards’ is divided into numerous short ‘keys’, organised in terms of pitch. The sounds used in each topology focussed on melodic (e.g. Harp topology) or rhythmic content (e.g. House Music topology) and adopted different instrumental timbres and textures (e.g. Orchestra topology). Given the richness of these spatiotemporal stimuli, a dense and seemingly immersive musical environment experienced by the mover.

The new repertoire of topologies was created to support activities specifically focused on discriminative listening. This implied having very simple compositions in which the space was scarcely ‘populated’ with sounds (i.e. a reduced number of ‘keyboards’ and a very restricted number of ‘keys’ – between 2 and 6). Moreover, it also entailed using sound objects (concrete references) in most of the topologies to facilitate children’s associative experiences between space location and sound. In other sound maps, musical references supported these activities.

Classical repertoire of musical topologies	New repertoire of musical topologies
<p style="text-align: center;">Harp House Music Marimba Orchestra Pan flute</p>	<p style="text-align: center;">Animal farm Drum set Funky band Crazy bird</p>

Table 2.1: Repertoire of musical topologies used in the Sound=Space workshops (Appendix A.1 – A.9)

In sum, these spatiotemporal stimuli (see table 2.1 above) consisted of a diverse set of musical topologies that aimed to encourage a wide range of embodied musical experiences in the young children and thus allow them to explore their musical self-regulation in different ways and always with rewarding auditory outcomes.

2.5 Procedure

Both groups of 4-year-olds participated in 4 Sound=Space workshops. These sessions took place every week for a period of one month (4 weeks per group) and each one lasted approximately 45 minutes. The sessions were scheduled according to the availability of the lab and the working hours of the parents.

In every session children were invited to leave their personal belongings in the observation room and to take off their shoes before entering the studio. Parents and children were also informed that water would be provided before and after the sessions, as well as some biscuits and juice. In order to avoid interruptions, each workshop only started when all participants had arrived. Parents then stayed in the observation room³ and children were invited to join me (called the ‘facilitator’) in the large studio.

All the workshops had a similar structure, involving activities in which 4 or 5 different musical topologies were explored. Some of these activities were deliberately repeated from session to session in order to help the children’s learn the locations of the sounds within the space and, consequently, to enable them to express their musical self-regulation through choosing movements to create particular combinations of sounds.

The structure of each workshop was based on two different types of activities that were alternated during the session. The first type consisted of ‘free exploration’ or goal-less activities in which children were invited to move freely in space for an ‘unlimited’ amount of time and without having to follow any predefined rules. This enabled them to self-regulate the exploration of the sound map and to make spontaneous movement choices accordingly. The second type of activities involved a

³ The only exception was session 1 in which parents were also invited to actively participate in the activities. This decision aimed to make children feel safe, comfortable and familiar with the ‘facilitator’ (myself), the other children and the setting. Being in the company of their parents also encouraged them to participate in each task and, by doing so, to get accustomed to the musical challenges that were presented in the following sessions. Moreover, this also represented an opportunity for parents to observe and play with their children, and to understand how Sound=Space operated as an interactive system.

‘guided discovery’ or goal-driven approach in which participants would play very simple games. More specifically, they were challenged to move in space in order to find the location of sound-targets (either any sound or a specific sound). Even though children had to achieve a goal, they were still able to self-regulate their sensorimotor experiences given that neither the repertoire of movements nor the spatial trajectories were specifically prescribed. During these games I provided some general feedback on the auditory effects of the actions performed (e.g. “Why was this particular sound triggered? What do you need to do in order to play this sound again?”). This ‘guided’ exploration aimed to enhance the 4-year-olds’ awareness of their position in space and the sound(s) produced.

In both ‘free exploration’ and ‘guided discovery’ activities children were invited to move either individually or as a group. Whereas in the first type of activities time was divided equally between individual and group performances, in the second type individual performances were mostly encouraged. This decision was based on the fact that having several children moving at the same time in S=S while attempting to find sound-targets seriously compromised the success of the activity. Put differently, it was very difficult, or almost impossible, for each child to recognise their own ‘musical identity’ and agency in S=S and thus to know whose spatial position was actually triggering the sound-targets. During these individual performances the remaining children just observed. However, and even though group activities did not benefit the observation of individual behaviour in S=S, they were important to create different dynamic moments during the workshop.

The classical repertoire of musical topologies was used in both types of activities whereas the new sound maps were specifically adopted and designed for the goal-driven activities (games). The former densely ‘populated’ the space with many different organised sounds, providing a rich and sophisticated musical environment for children to be immersed in. On the other hand, the new topologies involved ‘larger keys’ and thus fewer sounds per ‘keyboard’, more silent spaces and, overall, provided a simpler spatial composition that enabled the children to locate and trigger sounds more easily and accurately.

As previously explained, free exploration activities (goal-less) and guided discovery activities (goal-driven) were alternated during the workshop. Each one of the topologies, classical or new, would then be used in association with either a specific or different activities. However, despite the different possibilities and combinations a similar structure was maintained across the four sessions. This consistency enabled children to gradually understand the functionality of the instrument (control commands), its technical demands and learn the necessary motor skills to control it through exploration.

Each one of the sessions was organised around the notion of auditory-spatial associations. The activities and the respective musical topologies provided different experiences to the children that would reinforce the sound object-location association and thus enable a more effective control of musical events in S=S. The purposes underlying the musical activities developed are now described below.

1. **‘My presence and position in space affect what I hear’**. Some of the initial activities aimed to encourage children to recognise their control in Sound=Space or, in other words, to acknowledge that their movement choices in space would affect the musical outcome (auditory feedback).
2. **‘There are sound and silent areas in space’**. The young participants were challenged to identify both of these types of areas and then to trigger either sound or silence.
3. **‘The same sound is always in the same location’**. Other activities would focus on consistency, that is, on reinforcing the functional principle that a specific position in space would always trigger the same sound (or silence), independently from the trajectories explored by the mover.
4. **‘There are different sound objects in space’**. Some goal-driven tasks invited children to discriminate sound objects in space which would imply knowing the sound map beforehand and then differentiating the spatial location of each sound-target.
5. **‘Different spatial pathways correspond to different musical sequences’**. Some specific activities intended to challenge the young participants to create

‘signature pathways’ by deciding how to organise and ‘play’ a sequence of musical events in space.

In the tables below a more detailed description of the free exploration activities (goal-less) activities (table 2.2) and guided discovery (goal-driven) activities (table 2.3) used in the Sound=Space workshops is provided. It is important to clarify at this point that I never revealed to the children or explained explicitly how the interactive system worked. Instead, the young participants were encouraged to explore and discover how to ‘play’ this ‘musical instrument’ which implied learning how to self-monitor and effectively control their movements in the interactive environment.

Free exploration				
Activity	Individual / Group	Description	Purpose	Musical Topologies
<i>Move-as-you-wish</i>	Individual	Each child is invited to move freely in space for an undetermined amount of time before the next child’s turn.	<ul style="list-style-type: none"> . To increase each child’s familiarity with the sound map(s) . To encourage them to self-monitor and control their actions in Sound=Space . To allow each participant to recognise that their presence and movements in different areas in space will somehow affect the musical outcome 	Funky Band Harp House Marimba Pan Flute (all ranging units were turned on)
<i>Move-as-you-wish</i>	Group	Children are invited to move freely and at the same time across the space for a specific amount of time.	<ul style="list-style-type: none"> . To engage children in a collective self-regulated movement . To provide a richer experience of each musical topology given that sounds would be simultaneously triggered 	Funky Band Harp House Marimba Pan Flute (all ranging units were turned on)

Table 2.2: Description of the ‘free exploration’ activities

Guided discovery				
Activity	Individual / Group	Description	Goals	Musical Topologies
<i>Where is sound?</i>	Individual	Each child is invited to move in S=S and to mark on the floor the location of any sound that is triggered by their passage. Once those places are properly identified with round colourful coasters, the child is invited to 'play' her sound trail and encouraged to find different ways of playing it (e.g. moving from one side to the other; staying longer in one of the marks and less in the others). Throughout this process children are also able to make the necessary adjustments to their marks if they notice that a sound location was not properly identified.	<ul style="list-style-type: none"> . To gradually increase children's sensitivity to auditory feedback. . To evoke a 'keyboard' image in S=S through the use of visual aids that could help reinforcing the association between space location and sound (pressing the same 'key' = triggering the same sound). . To gradually unveil the control commands of the interactive system to the children 	Marimba Harp (just 2 ranging units were turned on which created areas of sound and silence)
<i>Move & Freeze</i>	Group	Children are invited to move simultaneously in space. When the leader of the group (previously selected by the facilitator) decides to move everyone has to move and when he stops everyone has to 'freeze'.	<ul style="list-style-type: none"> . To discriminate the auditory outcomes of different actions . To learn some basic control commands in S=S: (1) by moving from place to place one will trigger different sounds (e.g. sliding across the different keys of a piano keyboard) and (2) by staying in place one will repeat the same sound (i.e. pressing the same piano key). 	Marimba Harp (all ranging units were turned on)
<i>Sound & Silence</i>	Group/Individual	Firstly, children are invited to find out how to make silence in S=S, then they will have to discover different ways of making silence and, finally, they must create a musical sequence that alternates sound and	<ul style="list-style-type: none"> . To explore and discover additional basic commands that will increase children's control of the 'musical instrument'. 	Marimba Harp (all ranging units were turned on)

		silence. During this guided exploration children are also encouraged to explore different height levels.		
<i>Detective work: find one specific sound in space</i>	Individual	Each child is invited to find and mark on the floor by using round colourful coasters, specific sound-targets.	. To differentiate different sounds and respective spatial locations in S=S (discriminative listening)	Crazy bird Animal Farm Drum Set (all ranging units were turned on)
<i>Let's play together</i>	Group	One specific sound-location, visually marked on the floor, is assigned to each child. As a group they must decide when each player has to play their own sound and when he has to stop playing it. In order to produce an interesting musical result they must listen to the auditory feedback of each other's movements and work as a team.	. To be able to self-monitor a collective musical outcome and group choices.	Drum Set (all ranging units were turned on)

Table 2.3: Description of the 'guided discovery' activities

During the course of each workshop I had to find the right balance between leading an engaging session for the young children, operating the interactive system effectively and prevent potential technical disruptions. These procedures specifically required constant use of the computer in order to switch from one musical topology to another, as well as to occasionally turn on or off some of the ranging units. As a result, all necessary operations had to be made very discretely and fast while presenting the next activity to the children and ensuring the flow of the session.

2.6 Data Analysis

After completing Sound=Space workshops and thus video data collection, a thematic analysis was used in accordance to Braun & Clarke's (2006) guidelines. This well-

known method for qualitative analysis involved “identifying, analysing and reporting patterns (themes) within data” (p. 79) which provided insight into the phenomenon under investigation – children’s musical self-regulation in a motion-based interactive environment.

The theoretical freedom that characterises thematic analysis implies that this method can be used within distinct theoretical frameworks (Braun & Clarke, 2006). For the specific purposes of this exploratory study, thematic analysis was considered as an advantageous qualitative method that could contribute to clearly identify key movement themes from children’s interactions with Sound=Space.

Following this decision, other consequent choices had to be clearly made prior to the data analysis. One of those choices referred to what was considered a ‘theme’. According to Braun & Clarke (2006), “a theme captures something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set” (p. 82)⁴.

In the present research ‘prevalence’ does not imply the frequency at which a theme occurs or the space/size it takes within the data set (quantifiable measures) but, and most importantly, whether it captures meaningful aspects that could inform the overall research question. Even though ideally a theme should have a series of occurrences across the data set, the number of repetitions may not determine its significance in understanding the phenomenon of interest. As follows, the research question and judgment will be crucial to manage the prevalence of a theme in this flexible analytical method.

A rich and detailed analysis of the whole data set was used in order to reflect the information in the entire data set accurately rather than only one particular aspect. “This might be a particularly useful method when you are investigating an under-researched area, or when you are working with participants whose views on the topic

⁴ The concept of ‘data set’ will refer to all 8 Sound=Space sessions whereas the concept of ‘data item’ will be associated to each individual session.

are not known” (Braun & Clarke, 2006, p. 83). Moreover, an inductive thematic analysis (data-driven) was chosen to identify themes grounded in the data set itself rather than a more deductive and theoretically constructed approach (analyst-driven). The investigation started with a broad research question that was refined and evolved during the coding process.

Considering that thematic analysis tends to focus on only one of two possible levels (semantic or latent), it was decided that the semantic level was the ideal choice for this study. This entailed looking at the explicit meanings of the data set and thus “not looking for anything beyond what a participant has said, or what has been written” (Braun & Clarke, 2006, p. 84). However, even though latent themes requiring a high degree of interpretation were not considered, the process of analysis ideally involves “a progression from description, where the data have simply been organised to show patterns in semantic content, and summarised, to interpretation, where there is an attempt to theorise the significance of the patterns and their broader meanings and implications...often in relation to previous literature” (p. 84).

In sum, the theoretical freedom of thematic analysis provided the necessary flexibility to determine the perspective from which children’s key movement patterns (themes) would be identified, analysed and reported.

2.6.1 Thematic Analysis Guidelines

The clear guidelines proposed by Braun & Clarke (2006) were adopted to structure the different phases of the thematic analysis that were carried out in this study. The first phase provided an opportunity for me to becoming familiar with the raw data which, in practical terms, started with a transcription of the audio-visual recordings into a textual format, a common procedure in thematic analysis given that words constitute the basis for coding.

Transcription often involves the representation of language (what people say) in a written form, with occasional references to non-verbal cues (what people do). However, in the case of this research non-verbal behaviour was the essence of the data which necessarily implied having to ‘translate’ and transcribe wordless

information (movement descriptors) into a linguistic repertoire (verbal descriptors). There were several underlying challenge to this procedure, particularly the fact that the textual records would depend entirely on the observation skills of the researcher and on the appropriate 'interpretation' of the behaviour under scrutiny. However, some have argued that to some extent transcription is "the researcher's data" because it is "a selective process reflecting theoretical goals and definitions" (Ochs, 1979, p. 44). With all this in mind, I aimed to provide a rich detailed description of children's movement behaviour, staying as faithful to the original as possible.

Once the audio-visual recordings were transcribed into text format, the familiarisation with the data (transcripts) continued with repeated and attentive reading of the content.

The second phase of the thematic analysis involved generating a list of initial codes, essentially descriptive, within the data set. These data-driven codes were firstly identified and then matched with the meaningful units of transcript that characterised those codes. It was decided that all data extracts would be coded but not in a mutually exclusive way or, in other words, different codes could be assigned to the same text unit.

Once the coding of data extracts was completed across the entire data set, the third phase of the analysis involved identifying broader patterns or themes. The dominant factor for determining those main categories was the identification of similarities and differences between children's movement behaviour clearly manifested in the coded extracts. The most relevant coded units were then combined into different possible themes. Throughout this process different mind maps were devised which gradually gave "a sense of the significance of individual themes" (Braun & Clarke, 2006, p. 90) and enabled "thinking about the relationship between codes, between themes and between different levels of themes" (p. 89).

The fourth phase required reviewing and refining the prospective themes at two different levels. The first level involved checking each theme in relation to the corresponding coded extracts, to ensure that they would form clear and coherent

patterns. Through this process it was possible to identify overlapping themes, which were reworked and consequently merged or converted into sub-themes. Once a satisfactory thematic map was devised (further presented in Figures 2.4 and 2.5), a second level of reviewing could then take place. This also involved rereading each individual theme but now in relation to the entire data with the purpose of determining how accurately those meaningful patterns reflected and represented the entire data set and thus children's movements. By the end of this process the researcher "should have a fairly good idea of what [their] themes are, how they fit together, and the overall story they tell about the data" (Braun & Clarke, 2006, p. 92).

The penultimate phase of this method consisted of naming, defining and further refining the themes. This ensured that the essence of each individual theme and the specificities of the data they captured were clearly identified. A detailed analysis was written reporting the significance of themes themselves and in relation to other themes, as well as in relation to the research question. Throughout this refining process themes-within-themes were identified that helped not only to simplify more complex categories but also in "demonstrating the hierarchy of meaning within the data" (Braun & Clarke, 2006, p. 92). After a clear definition has been generated for each one of those themes and subthemes, clear and concise names were devised that would allow a reader to immediately grasp their meaning.

2.7 Results

Considering that the Sound=Space sessions were made up of 'free exploration' (goal-less) activities and 'guided discovery' (goal-driven) activities, it was decided that children's responses in both these situations were independently analysed. For this reason, two different thematic maps were devised.

2.7.1 Thematic Map 1: Experiences of Musical Self-regulation in 'Free Exploration' Activities

Analysis provided only one key theme - 'low-level experiences of musical self-regulation' - which were divided into several other subthemes as shown in Figure 2.4 below.

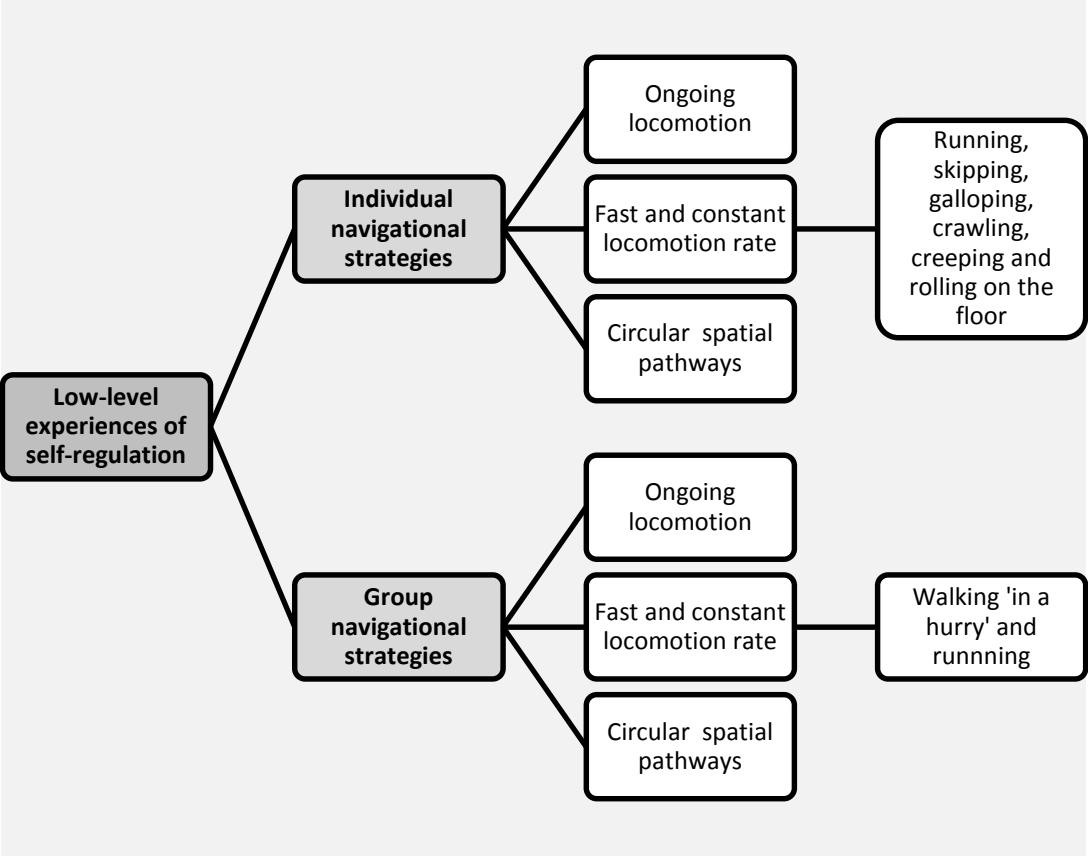


Figure 2.4: Thematic map 1 – Experiences of musical self-regulation in ‘free exploration’ activities in Sound=Space

Low-level Experiences of Musical Self-regulation

This theme considered movement responses that revealed a low sensitivity of participants to auditory feedback. In other words, some of the navigational strategies chosen (i.e. determination of position and direction in S=S) suggested that children did not aim to control and manipulate the musical events in a purposive way.

The following subthemes will now describe the movement responses of the 4-year-olds in an individual movement situation and in a group movement situation.

Individual Navigational Strategies

An *ongoing locomotion* was one dominant feature observed across the group of participants. Once children were invited to move individually and freely in S=S they would immediately start travelling through space. Moreover, locomotion would only stop when the young participants became tired or when the facilitator decided to intervene after few minutes of uninterrupted exploration, by inviting them to go back to their seats.

Children's individual navigational strategies were also characterised by a *fast and constant locomotion rate*. More specifically, their travelling actions were faster than their normal walking pace and executed at a fairly regular speed. These body actions included *running, skipping, galloping* (high height level), as well as *crawling, creeping and rolling on the floor* (mid and low height levels). Furthermore, during the move-as-you-wish activities the 4-year-olds would use *circular spatial pathways* within the delineated area of S=S.

Examples of these individual navigational strategies can be seen in the following excerpts and respective video clips.

“G1P2 enters the surveyed space and starts running in large circles anticlockwise, close to the limits of the S=S square area. [The Pan Flute topology is ON]. Sounds are triggered by the child's passage. She then leaps and deliberately falls on the floor. Silence is created. G1P2 rolls to one side and then to the other side. After few seconds she stands and starts running once again in large circles anticlockwise. Sounds are triggered. She then decides to change direction and run clockwise. Few seconds after she skips and gallops. The young child returns back to running until she falls on the floor (sign of exhaustion). Silence is immediately created. She keeps moving by rolling to one side and to the other. G1P2 stands up energetically and immediately runs in large circles anticlockwise. Sounds are triggered. Soon after she begins to skip (heavy breathing). After 2 minutes of exploration the facilitator says that she only has few more seconds to move before going back to her seat. G1P2 keeps skipping and then she starts rolling on the floor once again. Silence is created. The facilitator thanks G1P2 for her performance and informs her that it is time to get back to her seat. G1P2 decides to cross the room by rolling towards her cushion” (Appendix B.1).

“G2P4 enters the room and runs in large circles anticlockwise, close to the S=S delineated area. [The Harp topology is ON]. Sounds are triggered by the child's passage. After almost 1 minute he decides to change direction and run clockwise. (The movement becomes clumsier and the child tired).

The facilitator then says that he is free to seat down at any time. After few seconds he then falls and ends his performance” (Appendix B.2).

Group Navigational Strategies

When all participants were invited to explore S=S at the same time, they immediately got involved in an *ongoing locomotion* that was only interrupted by external intervention. In other words, given that children tended to keep moving uninterruptedly I had to ask them to stop after few minutes of exploration in order to prevent fatigue from compromising the following activities.

The movements performed in a group situation evidenced a *fast and constant locomotion rate*, which implied that they were faster than the normal walking speed of the 4-year-olds and evoked a sense of regularity. Even though in the very beginning of the move-as-you-wish activities children attempted to perform different actions from each other and with different speeds, these responses would soon converge to one dominant action, particularly *running*, executed at a similar speed. Finally, *circular spatial pathways* were the trajectories mostly explored.

“G1P1, G1P2, G1P3 and G1P4 immediately start moving in circles once invited to explore freely the space [Marimba topology is ON]. Sounds are triggered while they locomote. G1P1 starts by running clockwise but soon joins the rest of the group and moves clockwise. Whereas G1P1, G1P2, G1P3 decide to run in larger circles at a fairly regular and fast speed, G1P4 chooses to walk ‘in a hurry’ in very smaller circles in the centre of the room (Appendix B.3).

2.7.2 Thematic Map 2: Experiences of Musical Self-regulation in ‘Guided Discovery’ Activities

The analysis of children’s movement responses in Sound=Space revealed two key themes: ‘low-level experiences of musical self-regulation’ and ‘high-level experiences of musical self-regulation’, each one with their respective subthemes (Figure 2.5).

It is worth remembering that ‘guided discovery’ implied goal-driven activities (e.g. finding a sound or specific sound-targets in space). Moreover, even though these activities relied on children’s sensorimotor self-regulation (intrinsic feedback), the

facilitator would occasionally highlight the auditory effect of children’s spatial choices and navigational strategies.

Finally, it is also important to clarify that ‘guided discovery’ activities were individually performed (one child at a time), with the remaining participants observing and waiting for their turn.

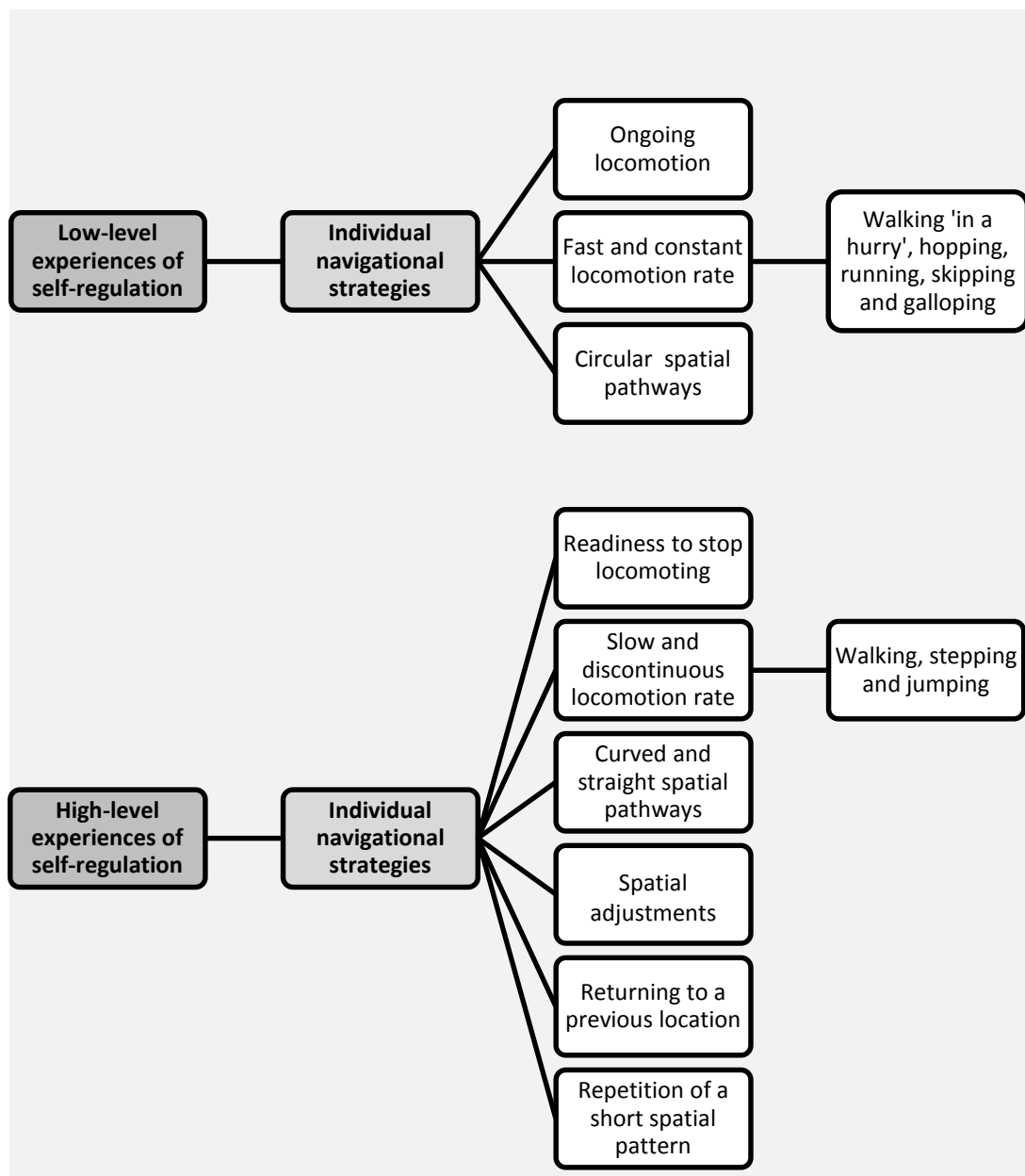


Figure 2.5: Thematic map 2 – Experiences of musical self-regulation in ‘guided discovery’ activities in Sound=Space

Low-level Experiences of Musical Self-regulation

This theme refers to the low sensitivity of the young movers to ‘perceive’ their musical identity in S=S and thus to recognise themselves as agents of a dynamic musical environment in which they are immersed in. In other words, the navigational strategies used in this frame of reference suggest that children seemed not to be aware of the auditory effects of their actions.

Individual Navigational Strategies

The low-level experiences of musical self-regulation are characterised by an *ongoing locomotion*, particularly in response to challenges in which children had to individually find and mark the location of specific sounds. This type of response suggested that children did not stop their locomotion even when the desired sound was triggered by their passage and, therefore, were not able to identify and assign a visual mark to the location of the sound-target(s).

Navigational strategies in individual performances were represented by a *fast and constant locomotion rate* and supported by body actions such as *walking 'in a hurry', hopping, running, skipping and galloping* executed at a fairly regular speed. Furthermore, children would also explore *circular spatial pathways* and would often move very close to the perimeter of the sensorised space. This necessarily implied they continuously covered the same area.

“G1P3 is invited to find the spatial location of drum sounds [Drum Set topology is ON]. The child starts by galloping. Sounds are consequently triggered. She stops for very few seconds. (G1P3 seems to look for the facilitator’s approval). Then she decides to run and hop continuously in a large circle anticlockwise while drum sounds are being constantly triggered by her passage (Appendix B.4).

High-level Experiences of Musical Self-regulation

This theme addressed a greater sensitivity of the young participants to the auditory consequences of their actions within the motion-based interactive musical environment. And, in some cases, they even predicted the auditory effects of their actions and took corrective measures to achieve an expected result. As follows, the

navigational strategies described below involved some degree of control and awareness of a feedforward-feedback loop, necessary to ‘play’ S=S in a more efficient way. However, this type of behaviour was sporadically observed and was only evidenced in the performance of a few children.

Individual Navigational Strategies

Children’s revealed a *readiness to stop walking* once specific sound-targets were triggered by their passage. Moreover, their actions comprised a *slow and discontinuous locomotion rate* as the next two excerpts and respective video clips exemplify.

“G1P2 starts walking slowly in space in a straight pathway. [Marimba Topology is ON]. She stops her movement immediately after the first sound is triggered and promptly marks it on the floor with a round coaster. She looks at the facilitator for approval. [The facilitator encourages her to keep searching for more sounds]. The child walks a little bit faster in her tip toes. Then she slows down slightly her speed and moves clockwise in a curved pathway. Another sound is triggered and the child immediately stops locomoting. She confirms its location and conveniently marks it on the floor. G1P2 starts walking at a slower speed. Then she decided to stop in some locations to stamp her feet on the floor. (The child seems to think that by exerting a certain amount of pressure on the floor, sounds will be triggered). The facilitator encourages her to continue exploring the space” (Appendix B.5).

“G1P4 walks in the surveyed space at a normal pace (clockwise). [Animal Farm topology is ON]. She then stops when a sound is trigger [rooster]. G1P4 marks the location with a place mat that has the image of the animal found. The facilitator supports her decision. Then she resumes walking until she finds another sound [pig]. This location is conveniently marked on the floor. (It takes her some time to find the appropriate place mat). The facilitator encourages her to find one last sound. G1P4 starts walking again and immediately stops locomoting when she triggers a sound [sheep]. Then she places the respective place mat on that precise spot. Finally, the facilitator encourages her to confirm the location of all the sounds found” (Appendix B.6).

The discontinuity and momentary interruption of the locomotor behaviour would occur either when participants were ‘carefully’ assessing the space or once they had identified and marked on the floor the location of the perceived sound. Furthermore, the body actions chosen by participants’ in this context were *walking, stepping and jumping*. Whereas walking and stepping were performed primarily to support the

task of finding-sounds-in-space, jumping seemed to be used with a different function. More specifically, children would often jump on the spot and in a specific location to confirm the success of their findings.

“After marking on the floor a sequence of sounds G1P2 jumps from coaster to coaster after being encouraged by the facilitator to verify if the sounds had been correctly identified. [Marimba topology is ON]” (Appendix B.7).

“G1P1 is lying on the floor. He then stands and triggers one sound. Marimba topology is ON]. The child then jumps repeatedly in place until he informs the facilitator that he would like to look for other sounds in the room. The facilitator praises his decision. He finds other sounds while moving in a straight pathway. He then adjusts his position and continues locomoting by hopping” (Appendix B.8).

Another navigational strategy suggesting a greater control of one’s musical experience in S=S was the use of *straight spatial pathways*. This particular type of trajectory and spatial directionality seemed to reveal a more focused and goal-oriented approach in the young participants.

“G1P1 walks slowly (and cautiously) in space searching for sounds. [Marimba topology is ON]. A sound is triggered. He stops and marks it on the floor with one coaster. He continues walking in a slightly curved pathway which soon becomes a clear straight pathway. G1P1 adopts a ‘sweeping’ technique to find the remaining sounds. (This implies being patient and very methodical). Once he finds them he stops and marks their location on the floor” (Appendix B.9).

“G2P2 starts to walk and seems caught by surprise by the sound. [Orchestra topology is ON]. He stays in place for few seconds until the facilitator encourages him to search for more sounds. He then walks in a straight pathway while sounds are being triggered” (Appendix B.10).

Spatial adjustments consisted of deliberate corrective actions to ensure that a sound-target had been accurately identified and marked on the floor. Moreover, few children also seemed to intentionally *return to a previous location* where a sound had already been triggered and identified.

“G1P2 walks at a fast pace until she triggers one sound [Marimba topology is ON]. She quickly adjusts her position in order to trigger that sound once again. The child jumps in place for few seconds. Then the facilitator challenges her to keep ‘playing’ sound (i.e. silence should be avoided). Moreover, different sounds should also be triggered. (G1P1, G1P3 and G1P4 are actively playing together in one side of the room. The facilitator seems disturbed by their activity and tries unsuccessfully to calm them down). G1P2 keeps jumping while gradually moving to her left in a straight pathway. This trajectory stops when she reaches one of

the ranging units. Then she decides to jump back to her initial position while triggering different sounds along the way” (Appendix B.11).

One last navigational strategy reflecting a high-level experience of musical self-regulation was the *repetition of a short spatial pattern*, which consequently would produce a repeated sequence of sounds, as if pressing alternately different keys in a piano keyboard.

“After finding and marking visually a sound trail, G1P2 decides to play it. [Marimba topology is ON]. She moves back and forward from one specific mark to another. Consequently, she triggers the same sequence of sounds” (Appendix B.12).

“G1P2 plays the sounds previously identified by running several times from one side to the other of the coasters trail. [Marimba topology is ON]” (Appendix B.13).

2.7.3 Additional Information

Even though it was not specifically included in these thematic maps, during the activities children seemed to establish a clear connection between ‘stillness’ (stopping the movement and staying in place) and ‘silence’. When challenged to stop ‘playing’ sound without leaving the delineated area of S=S, children would promptly freeze their movements. This natural embodied affinity had to be deconstructed throughout the sessions given that, by design, ‘staying in place’ in S=S corresponded to the ‘repetition of the same sound’. Silence, on the other hand, would involve ‘changing height levels’ (from standing to lying) or simply by leaving the sensorised space.

“The whole group is lying on the floor. There is silence. (The challenge is to move around the room without triggering sound). Children start creeping. A sound is triggered because G1P2 decides to sit up. They all freeze their movements and wait for the sound to stop. Then they continue creeping until the feet of G1P2 triggers sound once again. This child immediately says that it was her fault. Children all freeze for few seconds. The facilitator then counts to three, claps and asks them to stand up. When children stand, sound is triggered (as if the same marimba bars were being struck repeatedly). The facilitator then claps once more and asks them to lie down. Silence is created” (Appendix B.14).

An interesting behaviour occurred during one collective game, with a predefined navigational strategy and sound location. The challenge implied that each one of the

4 children had to move back and forward in a straight path between two specific places and thus decide when to make silence and when to play their own drum sound and rhythm pattern. Each child had their own specific silence location (position A) and sound location (position B). Their decisions showed an interesting group playing dynamic and musical result, as the following extract and video clip show.

The facilitator counts to 4. All children run at once to their respective sound location (position B). The whole drum set and underlying rhythmic patterns are played. G2P2 decides to make silence and runs back to his initial position. Three children remain playing their drum sounds. G2P3 then resolves to run to his position A (silence), while G2P2 chooses to play back his drum sound. G2P4 gives up playing his sound and goes back to position A. G2P1 and G2P2 remain playing. G2P1 returns to her initial position and G2P4 decides to play once again his drum sound. G2P3 and G2P2 return to position A (silence) at the same time. G2P4 is the only one playing. Then he decides to perform a somersault which implied that sound was interrupted. Almost as a reaction G2P1 and G2P2 return simultaneously to their position B to play the drums. G2P4 returns to position A while G2P1 imitates his somersault. Soon after he returns to position B (drums). G2P2 decides to make silence (position A). Immediately G2P3 returns to position B to play his drum sound. G2P1 executes a somersault once again. G2P2 decides to play once more his drum sound while G2P1 and G2P3 return at the same time to their position A” (Appendix B.15).

One final additional aspect regarding both thematic maps was the clear engagement of the 4-year-olds in the Sound=Space sessions. In some situations this implied a complete immersion of participants in their moving experience, evidenced by their decision to move in space for relatively long periods of time (approximately 3 minutes), especially in ‘free exploration’ activities, and also by their insistence on keeping moving even after being told that it was someone else’s turn.

2.8 Discussion

This exploratory study set out with the aim of investigating and describing the self-regulatory musical activities of young children. More specifically, it intended to identify levels of musical self-regulation in the 4-year-olds’ actions while ‘playing’ in a motion-based interactive musical environment responsive to the individual’s location in space.

Even though in recent years there has been a growing interest in the effects of action on music perception within the Embodied Music Cognition framework (e.g. Leman, 2008; Maes et al., 2014), strongly supported by neuroscientific findings on auditory-motor coupling (e.g. Zatorre, Chen & Penhume, 2007), still very little is known about what constitutes the repertoire of self-regulatory movements of young children when interacting with music. Identifying these spontaneous choices of actions may offer suggestive evidence for connections between specific sensorimotor repertoire and embodied music listening skills in early years.

The use of an enactive or action-driven interface provided an experiential and ‘playful’ platform where children were able to explore and develop the ability to recognise themselves as controlling musical events and to subsequently adjust their movement responses to achieve expected auditory outcomes. In other words, the choice of an interactive musical environment enabled the children to become aware of the auditory effects of their actions and encourage them to self-monitor their embodied experiences while ‘playing’.

Sound=Space was the interface selected for the study, not only for reasons of convenience but because it met some fundamental requirements, such as having an inbuilt feedback loop structure. This loop implied that once the child became aware of his/her agency (ability to control musical events) and had a goal in mind (sound-targets) s/he would then act in order to achieve it. In a following stage the child would assess the effect of his/her action on the environment (interpret the output) and compare the result with the goal. This comparative process would consequently lead the child to his/her next action and the cycle would start all over again.

Given that S=S is not a gesture-based interface but an environment responsive to the individual’s location in space, this implies that the control of musical events was not dependant on the expressiveness of children’s movements but rather on ‘where’ they decided to position their bodies in space and for how long, as well as on the trajectories they used to move from place to place. This means that the navigational strategies adopted by the young participants and the spatial information generated was associated with specific auditory signals in each ‘sound map’ provided for

exploration. As follows, the associative strength between ‘sound’ and ‘space’ underlying children’s movements and spatial choices, in part dependent on short term spatial memory (remembering different locations as well as spatial relationships between them), would define the embodied listening experience of each individual child.

This specific motion-based interactive environment was also considered age-appropriate to the young children, particularly because of the motor skills required to effectively manipulate it. Unlike the traditional musical instruments (e.g. violin or piano), involving a refined use of small muscles, S=S encourages locomotion and thus the use of gross motor skills, which in developmental terms was considered more accessible to the 4-year-olds. This necessarily meant that the young ‘players’ would be able to control their performance based on a familiar repertoire of movements that they had already mastered. Furthermore, even though these ‘gross motor skills’ naturally involve less precise and accurate movements, the musical outcome provided by S=S, would still be very rewarding. As Rolf Gehlhaar (1991) pointed out, this “creative musical resource...provides easily accessible control over interesting musical sound” (p. 14).

Findings showed that across the group of 4-year-olds a varied repertoire of navigational strategies was performed, suggesting different experiences of musical self-regulation and self-awareness regarding auditory feedback (i.e. strength of association between sound and space). *Low-level experiences of musical self-regulation* (in thematic maps 1 and 2) encompassed sensorimotor responses characterised by what seemed to be a diminished sensitivity to the auditory effects of their actions (i.e. decreasing associative strength between sound and space). In this frame of reference the quality of children’s attention revealed a more passive embodied listening behaviour (‘I am moving to the music’), which consequently implied that sounds were more likely to be ‘triggered’ rather than ‘played’. *High-level experiences of musical self-regulation*, on the other hand, involved a sensorimotor behaviour characterised by seemingly enhanced sensitivity to auditory

feedback (i.e. increasing associative strength between sound and space). The quality of children's attention suggested that they were not only reacting to events but in some cases anticipating the desired auditory outcome. Moreover, they also seemed to have used discriminative listening skills to identify and differentiate specific musical events in S=S. It seemed that sounds were not merely 'triggered' but deliberately 'played' (active embodied listening behaviour) - 'I am *moving* the music'. This particular experience of musical self-regulation could also indicate children's use of a more sophisticated set of listening skills and a deeper understanding of the feedback loop in S=S. However, these high-level experiences were only sporadically observed and in movements executed by very few children.

Low-level experiences of musical self-regulation were identified in goal-less activities, in which children would freely explore the space (thematic map 1), and goal-driven activities requiring their participation in games and thus a more guided exploration (thematic map 2). Whereas in the first situation children's choices would solely rely on intrinsic feedback (sensorimotor self-regulation), in the second situation this feedback was partially enhanced by extrinsic information coming from the facilitator, in order to focus participants' attention on auditory feedback and thus reinforce associative learning (cause/action-effect/sound).

The navigational strategies characterising this specific level of musical self-regulation presented clear similarities in 'free exploration' activities (individual and group performances) and 'guided discovery' activities (individual performance), with only few differences noted. More specifically, children showed a clear preference for a continuous and constant locomotion performed at a fast pace using circular pathways. Interestingly, in individual performances, especially when no goal had to be achieved, the repertoire of body actions was more diverse than in a group situation in which responses tended to converge to one particular action (often running), suggesting an imitation effect. It is also worth pointing out that the same navigational strategies characterising these low-level experiences of musical self-regulation were used in both goal-less and goal-driven activities, indicating that non-discriminative listening skills were adopted independently from the task.

But why do these specific navigational strategies constitute low-level experiences of musical self-regulation? The answer to this question relies on the fact that the navigational strategies used did not appear to facilitate children's awareness of auditory feedback in this particular interactive system or 'instrument', that is, their ability to recognise the auditory effects (output) of their actions (input). An ineffective control of S=S implied a decreasing associative strength between a participant's location in space and the sound produced. Even though one cannot discard the possibility of children recognising their 'musical identity' in these situations, the use of an ongoing and faster locomotion rate than children's normal walking pace, would very likely prevent them clearly identifying and discriminating sounds in order to achieve a specific auditory result. Circular pathways performed at a faster pace also seemed to suggest the use of a less focused and a seemingly 'automatic' spatial orientation, which would only enable children to trigger the sounds in that particular spatial trajectory.

High-level experiences of musical self-regulation were only observed in goal-driven activities (thematic map 2) in which participants - one at a time - were invited to freely explore the space while identifying the location of specific sound-targets. The navigational strategies associated with this type of experience were characterised by a discontinuous locomotion, slower than children's normal walking pace, by participants' readiness to stop travelling through space and also by their use of straight spatial pathways. Moreover, throughout their performance children also made adjustments to their position in S=S, they would return to a previous location and repeat a short spatial sequence.

These movement responses constituted high-level experiences of musical self-regulation because they seemed to enable a more effective control of musical events in S=S. The use of a slow locomotion rate (e.g. walking or stepping) increased the possibility of children finding and discriminating sound-targets. This argument is strengthened by participants' readiness to promptly stop locomoting once a sound or a group of sounds (targets or not) were triggered. As a result, this sense of caution and alertness tended to make locomotion less fluid when compared to the locomotor behaviour characterising low-level experiences of musical self-regulation.

One could also argue that those who travelled in curved and straight pathways at a slower speed seemed more focused on finding sounds in the space than those involved in circular trajectories, often executed at a faster pace. Children's adjustments to their position in space, or to the marks already placed on the floor, also suggested a self-correcting behaviour informed by auditory feedback. An increased awareness of agency could also be observed in participants' decision to deliberately return to a particular location in order to 'play' a sound or a group of sounds previously identified (confirmatory procedure). Finally, their intention to repeat a short spatial sequence which would consequently produce a repetitive sound pattern - as if playing alternately different keys of a piano keyboard - also suggested the use of more discriminative music listening skills.

Given that high-level experiences of musical self-regulation were less recurrent and involved a small number of children (2 out of 10), it can be suggested that more sessions would potentially have increased the number of occurrences of these more sophisticated embodied responses across the group of participants and thus enhance associative learning. Some technical limitations of the system itself could also have had an impact on children's behaviour on very few occasions. More specifically, at times the ultrasonic sensors would detect something in space where no-one was there ('phantom') and trigger a sound or a set of sounds apparently in a random way, making children a little bit confused. Even though Sound=Space served the purposes of this study, in future research it would be interesting to use a similar system or an updated version of S=S, that would combine its responsiveness to individuals' position in space with other control parameters (e.g. correspondence between amount of activity in space and volume). However, this decision should not ever compromise the degree of movement freedom that would allow children to use a familiar repertoire of actions, appropriate to their individual stage of motor development, or their ability to self-regulate their own choices in an interactive space.

In sum, this study identified a repertoire of self-regulatory actions (navigational strategies) performed by children while 'playing' in Sound=Space, an 'instrument' appropriate to these children's sensorimotor capabilities. These responses suggested two different levels of musical self-regulation (ability to self-monitoring behaviour

and to recognise oneself as controlling musical events) and, thus, of auditory feedback awareness. Low-level experiences indicated a weak association between spatial location (input) and the sounds produced (output), suggesting that musical events were ‘unintentionally’ triggered by children through the use of a fast locomotion and an ‘automatic’ and repetitive spatial orientation, even when they were specifically invited to find sound-targets in S=S. High-level experiences of musical self-regulation, on the other hand, evoked a stronger auditory-spatial association but was less frequently observed and exhibited by very few participants. These responses revealed a seemingly predictive and self-corrective behaviour which was only performed in goal-driven activities. More specifically, the sound produced (‘played’) appeared to be a consequence of an expected auditory outcome that would, in some cases, inform children’s subsequent actions (auditory feedback loop) in S=S.

These findings offer some evidence to support action-based effects on music perception (Leman & Maes, 2014; Maes et al., 2014) in early childhood. The self-regulatory sensorimotor responses of the 4-year-olds seemed to evoke different embodied listening experiences, potential indicators of varied skills and levels of sensitivity to auditory feedback.

This exploratory study not only provided some insight about children’s self-regulated movement repertoire in a movement-inducing-music situation (‘musical instrument playing’ paradigm), but also a reflection on its methodological approach which would have direct implications in the following study. More specifically, it was decided that in study 2 imitation would be more controlled in order to highlight the uniqueness of each child’s body movements. Furthermore, the stimulus would also be focused on a specific structural feature of music rather than in several, which would facilitate the identification and description of possible correspondences between participants’ actions and the content of the musical stimulus. One key aspect that study 2 (‘music-inducing-movement’ situation) decided to continue emphasising was the use of an engaging and playful research environment for children to make comfortable individual choices of movement to music and enjoy the whole experience.

Chapter 3

Study 2 - Embodied Beat: Research Design

3.1 Introduction

The previous chapter focused on an exploratory study that aimed to investigate children's choices of action in a 'movement-inducing-music' situation. In particular, it intended to identify and classify the body movements of a small group of 4-year-olds when exploring and playing a 'musical instrument' (Sound=Space). The self-regulatory sensorimotor behaviour observed within this interactive musical environment offered some insight about the type of 'motor commands' that were freely used by children and, thus, about their ability to recognise themselves as controlling sound/musical events (musical self-regulation), a basic requirement to play a musical instrument. A varied repertoire of body movements were identified and then classified as expressing either low-level or high-level experiences of musical self-regulation. The first considered actions that seemed to suggest a diminished sensitivity of the 4-year-olds to the auditory effects of their own actions, whereas the second seemed to involve a different quality of attention and the use of a more goal-directed movement behaviour (moving to generate sound/music).

As mentioned earlier, the previous exploratory study considered children's self-regulatory repertoire of actions in a 'movement-inducing-music' situation in which body actions directly affected the musical outcome. Study 2 will now focus on self-regulatory processes but in a 'music-inducing-movement' situation, that is, in which music is expected to influence movement. Moreover, it will specifically address sensorimotor synchronisation to a musical beat as a low-level reflective response to music, characterised by a more 'automatic' and effortless behaviour (Leman, 2008).

However, instead of examining the accuracy of children's synchronisation to the beat often associated in research with prescribed actions (outcome-oriented approach),

this study will focus primarily on children's spontaneous choices of actions exhibited during the moving-along-with-the-beat process (process-oriented approach). By considering the content of children's sensorimotor choices, rather than the accuracy or end result of a synchronised prescribed action, one will assume the possibility of children to self-regulate their own behaviour in a more effective way and according to their own physical constraints.

As follows, this investigation aimed to identify the free and individual body movement choices of 4- and 5-year-olds to strongly rhythmic music with a salient and steady beat presented at different tempi. This overall question gave rise to two further research sub-questions. The first intended to find the similarities and differences between children's movement patterns and the second to identify the adjustments made to that repertoire in response to tempo changes.

It is important to clarify at this point that the movement observed in this study was not 'self-initiated' or 'spontaneously elicited' but emerged following an external invitation. However, choices of repertoire were not prescribed, which consequently made them spontaneous in essence.

The findings of this investigation aimed to provide some insight into the embodied and developmental account of rhythm perception, as well as shedding light on the degrees of individuality of young children's movement patterns in response to a musical beat. Moreover, it was also designed to contribute to a better understanding of self-regulatory sensorimotor behaviour in early childhood, which in practical terms could imply empowering young children in educational settings to carve out their own embodied music learning experiences in a meaningful and fulfilling way.

The following sections of this chapter will now describe in detail the research design and methodology used in the present study, starting by describing participant recruitment and ethical procedures.

3.2 Participants

A total of 47 children (24 male and 23 female) were included in the study and recruited from a Nursery and Primary School in Edinburgh. The 4-year-olds were

selected from the Nursery and the 5-year-olds from two first year Primary classrooms. Both age groups constituted the participants of the present investigation.

3.2.1 Group 1: Four-year-olds

This group involved a sample of 25 healthy children (9 male and 16 female) of 4 years of age (range 48-59 months, mean age 53.4). Four additional participants were observed but excluded due to either technical problems with the video camera (2), the evident absence of any movement during the whole game (1) and an informed decision to withdraw from the study (1). Moreover, and according to the reports of participants' parents, 9 children had experienced some music and dance classes, 8 children had never had music classes, 7 children had never had either music or dance classes and 1 child had never had dance classes.

3.2.2 Group 2: Five-year-olds

A group of 22 healthy children (15 male and 7 female) of 5 years of age (range 61-70 months, mean age 65.9) participated in this study. Three additional participants were observed but excluded for showing no movement at all during most of the activity (1) or for deciding to withdraw from the study (2). Additionally, parents reported that 12 children had never had either music, 4 children had experienced some music and dance classes, 4 children had never had music classes, or dance classes and 2 children had never had dance classes.

3.3 Research Ethics Procedures

Prior to the recruitment process, Enhanced Disclosure Scotland approval was obtained as well as the approval of the Ethics Research Committee from Edinburgh College of Art, University of Edinburgh to conduct the study with young children (see Appendix C).

Written informed consent was then sought from parents/guardians before the commencement of the research, comprising an information leaflet (Appendix D) and the parental consent form (Appendix D). Both documents contained a brief description of the aim of the study and of the musical activity in which their children would participate. Moreover, it also explained how the ethical issues concerning

privacy and confidentiality with regard to the personal details and audiovisual data to be collected from the preschoolers would be handled, as well as a succinct explanation about the plans for dissemination of findings. Parents were also assured that they had the right to withdraw their children from the study at any stage and for any reason and that they could contact the research team if any questions arose or to request a copy of a future publication.

After parental permission was obtained, the 4- and 5-year-olds' voluntary informed consent was then obtained verbally in the presence of the teachers and through the use of an accessible explanation that suited the participants' age and level of understanding. The young children were invited to participate in a game and informed that they could refuse to play it at any time and that their decision would be respected with no negative implications. To facilitate the communication of this particular intention, appropriate signals (verbal and non-verbal) were also agreed between researcher and each child to point out any potential discomfort. Lastly, children were encouraged to ask questions at any stage of the process.

Given the complexity of ethics in research involving young children, it was decided that a more in-depth reflection would be included in Appendix E, which would also provide some more information about the ethical procedures adopted in this study.

3.4 Materials

The setting where children's behaviour was observed was located within the Nursery building. It consisted of a spacious room (approximately 8m x 8m), identified as the 'climbing room', equipped with gymnastic apparatus to support physical activities for the early years' classes. To conduct this study some of that equipment was removed from the setting, while other items remained in place and were used to specifically assist the research set-up.

Children's movements were video recorded by 1 Canon Legria HF R28 9 camcorder (32GB dual flash memory) supported by 1 small lightweight tripod. The musical stimulus, previously chosen from a drum loop pack in Garage Band (Apple software application), was delivered via a Creative Inspire T6160 Speaker System composed

of 1 subwoofer, 2 satellite speakers and a wired remote control (to power on/off the speaker system as well as adjust its volume). This surround system was connected to an ASUS laptop (Eee PC Seashell) on which Ableton Live 8, a software music sequencer and digital audio workstation, was used to stretch and shorten audio samples as well as to randomise the order of a set of musical phrases and to play back those selected phrases to the children. The first audio editing procedure, however, was developed in Audacity (a free open source digital audio editor) with the purpose to create a series of loop-based audio samples with a specific duration and subsequently different combinations of those samples (tempo modulations).

The video camera, laptop and surround sound system were plugged to 1 multi-socket extension (5 meters) and then masking tape was used to cover any loose cable and, consequently, prevent anyone from falling. This same tape was also used to delineate an area of approximately 3m x 3m on the floor at the centre of the room where the activity would take place (Figures 3.1 and 3.2).



Figure 3.1: Research setting (red circles indicating the localisation of the material)



Figure 3.2: Movement delineated area

Following the data collection, the analysis phase additionally required 1 21.5-inch iMac (2.7GHz quad-core Intel Core i5) and the iMovie software, a video editing software application.

3.4.1 Video Setup and Recording Procedures

In the present research, video-recording was chosen as the appropriate technique to collect data and support the subsequent analysis stage. This approach provided (1) a

temporal and sequential record, (2) a fine-grained audio-visual record and (3) a durable, malleable and shareable record of the phenomenon under scrutiny (Jewitt, 2012). The first point refers to the possibility of having repeated viewings of the movement data and also to its temporal manipulation by slowing down or speeding up motion, freeze-frame or use video clips with or without sound. The second aspect focuses on the fact that video permits recording very detailed events within a particular context (e.g. gestures), while the last point addresses the ability of video data to be revisited several times and shared, enabling in this way multiple viewpoints.

By choosing to use video in research one is acknowledging that the participants' conduct will be to some extent influenced by the presence of a camera. However, and according to Heath, Hindmarsh and Luff (2010), reactivity in this type of context is a phenomenon often exaggerated and rather than "assuming an *a priori*, all-pervasive influence of the recording process on the participants, it is worthwhile addressing the problem empirically" (p. 47). As follows, the actual impact of the video camera on participants' behaviour will depend upon the practicalities and contingencies of each particular study. It is also relevant to emphasise that casual glances to the camera do not necessarily imply that those being filmed are permanently worried with the presence of a camera while the data is being collected. The "occasional moments of awareness do not impact on the quality of the data corpus as a whole" (Heath et al., 2010, p. 48), that is, will not undermine normalcy of behaviour or distort the quality of all the video material collected. One particular strategy used in this research to minimise reactivity and to make the camera familiar to the children was allowing them to manipulate it, while turned off, during one of the early visits to the school (prior to data collection), as well as encouraging them to ask any questions about the device.

After deciding that video was be the best tool to gather data, the next step consisted of negotiating its use with all those involved in the study. This necessarily implied discussing ethical concerns, in particular, those related to access to the images, storage, privacy and anonymity as already discussed in section 3.3. Overall, it was

also important to assure all the stakeholders that the use of video would not cause any harm to the children or to the educational setting involved in the research.

Prior to video-recording I decided to develop some preliminary fieldwork that would help me to get to know the school context, select the appropriate setting to investigate the behaviour of interest and to decide “when and how to record, where to position equipment and how to deal with problems that might arise in securing a clear visual image and good quality sound” (Heath et al., 2010, p. 50).

The ‘climbing room’ in the Nursery was the place chosen for the study mainly because of three reasons. Firstly, unlike the other rooms in the school this setting permitted children to move around quite comfortably and freely through space. It was also big enough to allow setting up all the necessary equipment but, most importantly, to capture good quality images. Secondly, given that this room was only used for the physical activities of the early years classes this implied more availability of the space which consequently would facilitate the planning and scheduling of the video-recording sessions. Lastly, the ‘climbing room’ was situated right next door to the 4-year-olds’ classroom, just separated by a 3-metre open room where children usually kept their belongings. This would enable moving participants from one room to the other more easily and in a very short period of time.

During this early stage some photographs were taken from the scene to capture the original layout of the room and thus to help making informed decisions about the necessary equipment and all the set-up practicalities. These images along with a checklist of the material and notes about installation procedures would ensure that the video-recording sessions would be consistently identical. It was also fundamental during this preliminary fieldwork to practice setting up and using all the technology involved proficiently before any data was collected. It took several attempts before being able to record usable data (preliminary tests and pilot studies). This initial work enabled a review of the materials early on in the process and to identify as well as rectify any problems arising.

For practical reasons some of the original climbing and gym apparatus from the room was used as part of the research setup, as it provided a stable structure for the camera, laptop and loudspeakers. Additionally, it also made the whole setup more familiar to the children used to using the apparatus in the room and therefore diluting the presence of the research equipment (see Figure 3.1 where research equipment is circled).

The room layout, more specifically, the precise location of the behaviour of interest within the room, as well as the position of the video camera, loudspeakers and laptop, was chosen not only for the researcher's technical needs (e.g. having the volume remote control located close by), but it also took into account the child's viewpoint of the setup. This meant that even though the equipment needed to be accessible to the researcher it was crucial to minimise its potential negative impact on the young participants and to present it in an aesthetically pleasing manner.

It is fundamental to acknowledge that the video data will be shaped by the choices made by the researcher at this early stage of the study. In particular, the “negotiation access, decisions concerning the choice and positioning of cameras, scale and when to stop collecting video, the place that video is given in data set, and how to manage and sample video data, including preliminary transcription and coding” (Jewitt, 2012, p. 12).

An important decision was made regarding the period during which the video recordings would be collected. It was determined that these data would be gathered at one specific point in time (cross-sectional approach), which implied having one intense period of data collection sessions per age group, preferably during the same week, instead of sparse intervals of video recording. As a result, the children's weekly schedule and the availability of the climbing room had to be taken into account to avoid unnecessary disturbance to the usual activities of the school.

The decisions involved in the choice of a video camera for this study were theoretically informed and shaped by the research aim and questions, the participants

and the behaviour under study, as well as by the physical constraints of the setting, the nature of the research design and by the type of data needed.

A single camera view was chosen to be the most appropriate to record children's actions. Not only was this choice sufficient to capture the necessary details of the behaviour under study but it also minimised the threat of reactivity. According to Jewitt (2012), some researchers argue that "the use of multiple cameras is not advisable as they multiply the data collected, can overcomplicate the interaction by adding multiple perspectives, can fracture sequences of interaction (in a similar way to a mobile camera), and present challenges for analysis" (p. 16).

Other practical decisions were made, namely, the use of a small camera supported by a mini lightweight tripod. The small size of both these devices aimed to reduce the impact of the setup within the room and make it as unobtrusive as possible for the young participants. As previously mentioned, the use of the gym apparatus as part of the set-up would also play down the physical presence of all the equipment (Figure 3.1). Furthermore, a light and small camera and its respective tripod would be easier to carry to the research setting.

To reduce the time of training to a minimum, an easy-to-use camera was chosen. During the preliminary fieldwork the most fundamental functions of the camcorder were explored and tested. One important decision, which at first sight would seem irrelevant, was to turn off the autofocus control to avoid the camera attempting to continuously adjust and re-adjust the focus of the image once the child's movement started. This could seriously compromise the quality of the images. Instead, the researcher orientated the camera on the fixed point of interest and manually focused the image. Another relevant aspect considered was keeping the video camera connected to the power supply during recording, even if the battery was fully charged, just as a precaution.

Throughout the testing sessions the researcher determined the appropriate volume level that would be consistently used in all data collection sessions. It was decided that it had to be loud enough to encourage children's movement but not intense

enough to be heard in the 4-year-olds' classroom. Considering that the data is multi-modal, it was important to capture a good quality image and sound. However, considering that the audio element was secondary for the analysis of the behaviour of interest, it was decided that the sound quality provided by the camcorder would be satisfactory and thus an external microphone would not be necessary.

In order to improve the quality of the video recording it was decided that the blinds of the room would be closed. This aimed to prevent having irregular patterns of shadow and light areas in the image. The visual consistency of the recording would also indirectly benefit the analysis process. Additionally, this would also avoid children being distracted by outside events or blinded by the light. Given that the camera would be orientated in the direction of the windows, having the blinds closed was crucial. This procedure necessarily implied testing in advance the lighting system of the room to determine if its power would be sufficient for the required standards of the recording. Even though the level of brightness was enough, the fact that it was controlled by an automated lighting system implied that long moments of inactivity during children's performance could result in the lights turning off.

A fixed camera was selected as the most appropriate option for the present study. This decision was based on the premise that its stable position could reduce the 'subjectivity' of the recording process, more often associated with a roving and handheld camera. It would also enable the researcher to record the activity under scrutiny without having to anticipate where the events would arise and thus to unintentionally exclude important details. By deliberately avoiding movement, panning or zooming I expected to capture a steady and more holistic view of children's behaviour. Another recognised advantage for the use of a fixed camera in this particular study was the fact it would be less demanding for the young children and allow "the researcher to remain relatively unobtrusive and avoid, as far as possible, participating in the scene or drawing attention to the camera by continually looking through the viewfinder" (Heath et al., 2010, p. 40).

The decision to use a fixed camera necessarily entailed the careful selection of a viewpoint within the setting that would frame the pertinent action. Inevitably, this

decision was related to the question ‘how much space will the children need to comfortably move during the musical activity?’ The answer to this question had necessarily to weigh the type and quality of data needed, the scaling and framing limitations of the video camera as well as the specific nature of the physical setting. Having taken into account all these aspects, it was decided that the behaviour of interest would occur within a specific area of the climbing room and the camera would be positioned accordingly and in a way in which the action could be easily framed and the best quality image captured.

The circumscribed area mentioned was located at the centre of the climbing room. Its perimeter would be clearly marked on the floor through the use of tape (Figure 3.2) and children would be encouraged to move within this space which was considered sufficiently wide for them to move freely and comfortably, after both pilot studies, and at the same time compatible with the camera framing possibilities.

The use of a visible delineated area where movement would take place aimed to avoid the danger of having important events happening in areas of the room where the fixed camera could not fully cover. Moreover, having the whole space of the setting available for the moving activity could potentially have given the children the impression that they had to explore the entire room. This could have been an overwhelming experience for some of the young participants, even more so, considering that their performance would be individually recorded. Such experiences could potentially result in self-restraining actions or, on the other hand, in very fast and uncontrolled movements. Even though one could claim that these extreme reactions may reveal the individual nature of children’s behaviour, it is very likely that they would be signs of distress. Using a great amount of space for movement could also represent the danger of young participants’ running out of energy more quickly, given longer distances would more likely be covered, which could seriously jeopardise the completeness of the activity.

Overall, I was aware that any decision concerning the amount of space provided for movement would affect to some extent and in different ways the behaviour under study. Considering that there are no perfect solutions, the best compromise had to be

sought between the quality of the data needed (phenomenon of interest), the well-being of the young children, the characteristics of the research setting and the limitations/potentials of the video camera. As follows, this study opted for inviting children to move within a delineated space in the room (3 m x 3 m) in order to provide them with a more contained and less overwhelming environment, and at the same time, to enable the image to be easily framed. This decision was also expected to increase the children's concentration on the activity and thus on their responses to the musical challenge.

After determining that the behaviour of interest would take place within a specific circumscribed area of the room, the fixed camera was then able to frame the pertinent action. This option which is typically assumed in more controlled research designs and settings (e.g. laboratories) aimed to ensure that the images obtained were as 'raw' and 'objective' as possible and, consequently, to safeguard the consistency of the video recordings which would benefit the analysis process.

In the present investigation the use of a fixed camera meant that I maintained full control over that device. In other words, the presence of other people in the research setting was avoided. However, this did not necessarily mean that I was preoccupied with the camera. On the contrary, once the camera was turned on my role was to stay as near as possible to the children and encourage their performance while being filmed. It is important to clarify that even though I kept close to the participants, I deliberately avoided being captured by the camera. Overall, all these decisions were taken to minimise the impact of the camera on the children's actions not only to ensure the quality of the data but especially to safeguard their well-being during the video recording process.

Along with this choice it is often expected that the researcher assumes a more distant and less interactive role in relation to the participants. However, considering the age of the young children and the level of familiarity already developed with them prior to video-recording, it was important to avoid dramatic changes in the nature of my relationship with them and maintain normalcy as much as possible. This would not

only ensure the quality of the data but it would also prevent children from being negatively affected by those unexpected changes in my behaviour.

To prevent collecting unnecessary data, which could lead to having an overwhelming amount of video material and slow down the analysis process, it was decided that the video recording would be planned. “There is no universal ‘right amount’ of video data to collect rather the amount of video data required needs to be determined by the research approach, aim and questions of a study and pragmatic questions of time and resource” (Jewitt, 2012, p. 18).

The question of ‘how much video to collect’ would be answered and determined by a very short and pre-structured activity in which each child would be individually invited to participate in. This implied that the behaviour of all participants would be recorded for the same amount of time and following the same structural procedures of the activity. Considering that each child’s performance would be individually captured, I decided that each video clip would correspond to a single performance rather than having one long and continuous sequence of images that would include all participants’ performance. In order to create those individual video clips the researcher had to discretely turn on the camera once the child arrived to the room and turn it off immediately after s/he left.

The use of this procedure had some practical advantages, namely, the fact that it prevented the memory card of the camera reaching its full capacity before the end of each data collection session, as well as enabling me to have short and manageable video records even before any editing operation. However, throughout this process it was important to be very consistent in turning on and off the camera for each child’s session in order to prevent the loss of data simply because I had forgotten to press the record button at the right time.

As previously mentioned, recording individual short video clips of each child’s performance was an effective way to reduce the amount of data and enable a more productive overview during data analysis. However, this was not the only procedure used to make the data more manageable and ensuring its security. Another strategy

was transferring all the video material from the memory card of the camera to an external hard drive immediately after each set of data was collected, and also identifying each clip or file with their respective participant identification code. The following step comprised editing those video records to ensure that only the behaviour of interest, that is, children's movements in the activity with a predefined duration of 1 min and 58 seconds would be included and all unnecessary material erased. Finally, the last procedure before the analysis stage consisted in converting the original AVCHD (Advanced Video Coding High Definition) format of the video record into an MPEG-4, a compressed format compatible with almost all media players/video editors.

In this study video records are seen as an “unproblematic replica of events” (Jewitt, 2012, p. 10) which means that they consist of an information source ready to be analysed (counted or coded) and subsequently transformed into data. As follows,

“reality remains relatively uncontested, [and] the need to ensure the objectivity of the video record is paramount (e.g. using fixed cameras and clear video recording protocols), research and participant roles are clearly delineated...The acknowledgment of the researcher and their use of video technology in the construction of the data are thus restricted to questions of objectivity and quality control, and the identification and removal of moments where process being video recorded appears to ‘rupture’ the participants’ practice as bad data” (Jewitt, 2012, pp. 10-11).

Following this detailed description of the material used in the present study and of the video-recording procedures underlying data collection, the following section will now address the selection process of the musical stimulus.

3.5 Stimulus

In this section I will now provide the rationale supporting the selection process of the stimulus and then describe the specific details of the piece of music chosen. It is important to highlight that this choice was made to support the specific activity in which children would be involved and to invite them to move in an effortless way and, consequently, to elicit spontaneous responses to the structural features of the music.

3.5.1 Rationale

Any study aiming to understand children's embodied choices to music has necessarily to consider a stimulus with the potential to elicit movement. This requirement becomes essential when the very act of moving is an integral part of the instructions or, in other words, when children are specifically invited to move in response to music. Moreover, given that in this particular research a 'move-as-you-wish' paradigm was used rather than a prescriptive one (e.g. tapping to a beat), it became fundamental to find an appropriate movement-inducing stimulus that could easily support children's self-regulatory movement process and thus allow them to make their own individual and creative choices of repertoire.

The predictors of *groove*, or the qualities of music that make one want to move (see chapter 1), became a pre-requisite for the stimulus selection. It was essential to find a piece of music with a clear and salient beat, ideally associated with a high degree of percussiveness. Inherent rhythmic regularity tends to facilitate movement towards an anticipated impact (e.g. Madison et al., 2011), and this was complemented with syncopation in order to introduce variety and some degree of perceived tension as well as maintain the high level of groove (Stupacher et al., 2013).

Another concept that may affect people's willingness to move to music is tempo. Considering that this element will be the only variable manipulated in the present investigation, any choice of a particular tempo had to be properly informed by studies in this area. That said, in the next subsection the selection process of the musical speed for the stimulus will be described and supported, whenever relevant, by references to other research.

3.5.1.1 Musical Tempo

Tempo represents the speed of a given piece expressing how fast or how slow it is. According to McAuley (2010), this concept "is typically associated with the rate of periodic events (beats) that listeners perceive to occur at regular (equal) temporal intervals" (p. 166). In the case of the present investigation, tempo will be modulated and its potential effect observed primarily in terms of children's movement choices. Therefore, any adjustment to their expressive repertoire may potentially reflect the

discrimination of different tempi and thus the physical embodiment of the different spatio-temporal intervals between the beats.

Identifying the optimal pace for the young participants to move to music constituted the first step of this process. It was expected that a ‘comfortable’ tempo would not only increase children’s willingness to move (groove) but also their synchronised responses to the beat. Therefore, the 4- and 5-year-olds’ spontaneous motor tempo (SMT) seemed to be the appropriate timing rate to have as the first reference for the selection of the different musical tempi. However, it is important to acknowledge that the findings on SMT in early childhood (Provasi & Bobin-Bègue, 2003; Drake, Jones & Baruch, 2000) are mostly based on a tapping paradigm which necessarily implies that children’s preferred motor tempo had been assessed through the use of a prescribed gestural movement.

Finger or hand tapping entails a motor skill which requires the control of smaller muscles of the body. Interestingly, even though this action represents a potential challenge for young children given the immaturity of their motor system, tapping has been frequently used in studies with participants as young as 2½ years of age (Provasi & Bobin-Bègue, 2003). Considering that SMT of 4- and 5-year-olds has not yet been measured using the move-as-you-wish procedure, at least to our knowledge, children’s self-paced tapping rate will then become the primary reference for determining the optimal musical tempo of this study’s stimulus. With this backdrop in mind, I will now briefly address some of the key findings on SMT and sensorimotor synchronisation (SMS) regarding preschool children⁵.

As previously mentioned, spontaneous motor activity (often using tapping) is the estimate most commonly used to assess people’s preferred tempo (McAuley, 2010; Repp, 2005; Repp & Su, 2013). Several studies have found that SMT decreases across the life span (Drake et al. 2000; McAuley, Jones, Holub, Johnston, & Miller,

⁵ The beat-per-minute convention will be adopted to indicate the musical tempo but references to the inter-onset interval (IOI), the time interval between successive beat events, will also be made whenever necessary.

2006) which suggests that young children prefer to tap at faster rates than adults. While 600ms (100 bpm) represents adults' SMT value (Fraisse, 1982; McAuley et al., 2006), as well as their preferred perceptual tempo (McAuley, 2010), the optimal motor tempo rate for the 4-year-olds and older children lies somewhere between 400ms (150 bpm) and 500ms (120 bpm) (Drake et al., 2000; McAuley et al., 2006).

Sensorimotor synchronisation (SMS) is another measure that assesses motoric activity but, in this particular case, regarding the "coordination of rhythmic movement with an external rhythm" (Repp & Su, 2013, p. 403). Interestingly, in most SMS and SMT studies, children's motor behaviour tends to be predetermined by the researchers and often constrained to one body part (e.g. finger or hand). Moreover, the young participants are explicitly asked to synchronise their tapping either to a metronome or to an isochronous monotone beat sequence, and less often to pieces of music played in different tempi (Repp, 2005; Repp & Su, 2013). As Eerola et al. (2006) pointed out, "the absence of evidence of synchronisation during early childhood is the problem of acquiring reliable data with very young children" (p. 473). Furthermore, the "typical data collection methods are often motorically too demanding, require too much concentration, or are otherwise unattractive to young children" (p. 473).

SMS studies agree that accuracy of synchronisation in young children improves with age (e.g. Provasi & Bobin-Bègue, 2003). McAuley et al. (2006) reported that 4- and 5-year-olds did not match accurately their taps to the beat but older children were gradually able to do so. Moreover, while 3-year-olds tend to maintain their tapping rate at 2Hz (500ms, 120 bpm) without significant adjustments to the musical tempo, children of 5 years of age and up gradually show more tempo flexibility, in particular towards slower tempi (Van Noorden & De Bruyn, 2009). These latter results were interpreted in the light of the resonance theory of Van Noorden & Moelants (1999), which suggests that young children "have a narrow resonance curve centred near 2 Hz, which enables them to synchronise only at their preferred tempo. The resonance curve broadens with increasing age (...)" (Repp & Su, 2013, p. 404).

Others have corroborated the previous evidence suggesting that children have a narrow zone of accessible tempi or entrainment region than adults (Drake et al., 2000). Additionally, research on coordination of walking and clapping to a metronome have shown that as age increases the variability of SMS decreases (Gestchell, 2007) and that children's adjustments to different tempi also tend to improve as they grow older (Clizbe & Getchell, 2010). In short, young children tend to have a faster SMT than older children and adults, and show a more limited range for synchronisation which gets wider with age and more adaptable, particularly in the slower tempi (Provasi, Anderson & Barbu-Roth, 2014).

Even though tapping is predominantly used to assess children's synchronised responses to a beat, some researchers (Eerola et al., 2006; Moog, 1976; Sims, 1985) have decided to exclude this prescriptive and more restrictive physical approach in favour of a more spontaneous motoric behaviour (move-as-you-wish paradigm). This necessarily implies that young participants are free to make their own movement choices and thus to self-regulate their own embodied musical experience. Furthermore, given that in this approach participants are not explicitly asked to follow the beat, beat-accompanying movements may or may not occur. The absence of this specific instruction consequently highlights the importance of selecting a high-groove piece of music with a strong accented beat. Moreover, unlike most SMS tapping studies that tend to use a metronome or a monotonic isochronous rhythm sequence, investigations supported by the move-as-you-wish paradigm always use movement-inducing pieces of music.

The few SMS studies in early childhood that have used the latter procedure (Eerola et al., 2006; Moog, 1976; Sims, 1985) corroborated some of the previous tapping-based findings. More specifically, they found that children from 3 to 5 years old were often not synchronised to the beat, however, the older children tended to show a more accurate performance than the younger. Furthermore, the young participants also exhibited very little adjustments to tempo changes.

Any study aiming to observe children's spontaneous movement responses to a beat presented at different tempi, has necessarily to consider the level of 'groove' that

those rates represent for the young children. In other words, one should make sure that the musical tempi underlying the stimulus have the potential to elicit comfortable moving-along-to-the-beat responses. The optimal motor rate for children to move to the beat often corresponds to a central tempo ('moderate tempo') from which other tempi are then derived. In Sims' (1985) case, three pieces were chosen each one with a different musical speed. The in-between piece corresponded to the metronomic value of 138 bpm (435ms). Although the author does not justify the reason behind her choice, it is interesting to verify that the value used is not too distant from young children's SMT (Drake et al., 2000; Provasi & Bobin-Bègue, 2003). On the other hand, Eerola et al. (2006) selected one children's song (141 bpm, 425ms) with an original tempo that was deliberately identical to what Provasi & Bobin-Bègue (2003) found to be toddlers' preferred tempo rate (430ms, 140 bpm).

The rates for the 'slow' and 'fast' sections were determined differently by Sims (1985) and Eerola et al. (2006). In the first case, the original tempo of the chosen pieces would determine the exact musical speed that would be used in the moving task. As follows, the metronomic value of 150 bpm (400ms) corresponded to the fastest musical speed whereas 32 bpm (1875ms) would represent the slowest tempo. In the case of Eerola et al.'s (2006) study, another strategy was used, which consisted of modifying the original tempo of the piece of music selected (141 bpm, 425ms). The audio was stretched and shortened in steps of 10% ranging from 340ms (176 bpm) to 510ms (118 bpm) and taking into consideration the "the constraints imposed by the highly limited resonance curve" (p. 473) around the 2-4 year-olds' SMT.

As aforementioned, in the present research young children's SMT (140 bpm) became an important reference for the initial selection of the musical tempi. Not only was this value found in tapping studies (Drake et al. 2000; Provasi & Bobin-Bègue, 2003) but also in Eerola et al.'s (2006) study which used the move-as-you-wish approach. In the latter, 3- and 4-year-olds showed a mean periodicity around 415ms (145 bpm).

Considering the previous evidence, the current study opted to use the metronomic marking of 144 bpm (417ms) as its fastest tempo. However, in both pilot studies this speed rate was found to be too fast and challenging for children to attempt to

synchronise their movements comfortably to the beat. Therefore, it was decided that this value would be replaced by a lower metronomic mark of 132 bpm (455ms), which would then become the upper limit of the tempo range used in the movement task. The fact that 144 bpm was excessively fast to facilitate synchronisation could be an indicator of a developmental difference between children from 2 ½ to 4 years of age (e.g. Eerola et al., 2006; Provasi & Bobin-Bègue, 2003) and children from 4- to 5-years-old.

Considering that the present study aimed to observe children's physical adjustments to tempo changes, primarily in terms of their movement repertoire, it was fundamental to find a selection of tempi that were clearly different. This procedure became even more critical because only one piece of music was to be used as the stimulus. Therefore, by having a very different selection of tempi (i.e. very distinct spatiotemporal intervals between beats), very noticeable changes might be expected to occur in participants' body and spatial patterns.

Although it is acknowledged that children may not be able to synchronise their movements to the beat accurately when tapping outside their 'optimal entrainment region' (Drake et al., 2000), it should be emphasised that SMT of 4-5 years-old children has not been yet measured using the move-as-you-wish paradigm. Therefore, it is pertinent to observe whether or not preschool children were able to discriminate tempi, even if beyond their SMT-tapping region, by pointing out any change in their movement repertoire. This necessarily meant identifying participants' self-regulatory strategies to physically accommodate those different spatio-temporal intervals between the beats.

As previously stated, the tempo rates selected should be experienced by children as clearly different events, however, the sensorimotor phenomenon of groove should never be compromised by that choice. In other words, it was fundamental to maintain children's willingness to move in response to the rhythm-based music throughout the whole task. Taking into consideration that fast musical tempi tend to increase the arousal levels of listeners (Eerola, Friberg, & Bresin, 2013; Zwaag, Westerink, & Broek, 2011) and that children also show a preference for pieces with a fast speed

(Lamont, 2003), the priority became to determine how slow the ‘slower’ sections should be without disturbing the groove effect.

After choosing 132 bpm (455 ms) as the upper limit (‘fast tempo’) of the stimulus’ tempo range, the other musical tempi were then selected and specific rates aimed to deliberately coincide with recognised metronome markings. In a descending order, the next rate selected (100 bpm, 600ms) was slightly slower and often identified as ‘andante’ (at a walking pace). This value corresponded to the original tempo of the music piece but it also represented, according to the *Nelson Textbook of Pediatrics* (Behrman, Kliegman & Jenson, 2003, p. 2262), a value within the normal resting heart rate of children between the age of 3 and 6 years old. Moreover, the rate in question also refers to adults’ SMT obtained through tapping (Fraisse, 1982; McAuley et al., 2006). For practical reasons, the 100 bpm section was designated as ‘moderate tempo’ given that the 132 bpm corresponded to the ‘fast tempo’ section.

A 60 bpm (1.000ms) metronome marking, commonly classified as ‘larghetto’, was then selected for the ‘slow section’. This value would be sufficiently distinct from the ‘andante’ value in order to enable clear changes in children’s behaviour to be observed. The last tempo selected represented the slowest rate of the stimulus (‘very slow’ section) with a metronomic marking of 35 bpm (1714ms), which is commonly referred to as ‘grave’. One should emphasise that both these slower rates were clearly outside children’s motor tempo range, given that they are approximately two times and three times slower than the SMT of 4- and 5-year-old children (120-150 bpm, 500-400ms) (Drake et al., 2000; McAuley et al., 2006).

Lastly, it is important to mention that an extremely slow tempo (20 bpm, 3.000ms) was used in the pilot studies instead of the ‘very slow section’ (35 bpm), with the deliberate intention to disrupt children’s embodied perception of a periodic beat. Given that “the range of tempi over which beats are perceived is limited...if music is performed too slowly, rhythmic organisation tends to fall apart, leaving only series of isolated sounds” (McAuley, 2010, p. 172). This specific section of the task aimed to help compare children’s movement choices in a ‘no beat’ segment (extremely slow tempo) and in ‘beat’ sections (fast, moderate and slow tempi). Furthermore, through

this comparison I expected to evaluate, in relative terms, the effect of the beat in participants' rhythmic motoric patterns.

In short, in order to increase the probability of children spontaneously performing rhythmic motoric responses to the beat and also exhibiting potential adjustments to different musical tempi, it was decided that firstly participants' repertoire of movements would not be prescribed. This necessarily entailed that the young children had to self-regulate their own body actions choices. Secondly, it was also determined that some of the musical tempi selected for the moving activity would fall clearly within preschoolers' motor tempo range (fast and moderate tempi) and others would fall deliberately outside those limits (slow and very slow tempi).

3.5.1.2 Complementary Requirements for Stimulus Selection

Other aspects that could indirectly support participants' groove experience were also considered in the stimulus selection process. One of them was the ecological validity of the piece of music chosen. Studies aiming to observe sensorimotor behaviour of young children seem to have different views about the use of 'real-world' music. In many experiments in which tapping is used to measure children's preferred motor tempo or synchronised behaviour, the stimuli are artificially created and tailored to the aims of the research (e.g. Drake et al., 2000; McAuley et al., 2006; Provasi & Bobin-Bègue, 2003). According to Dowling (1989) these types of experimental stimuli "are usually brief, monophonic, and of uniform rhythm, loudness, and timbre" (p. 247). This author is particularly critical about what he calls the 'skimpiness' of the stimuli and their lack of representativeness, and naturalness (Demorest, 1995; Dowling, 1989; Schmuckler, 2001). Since they differ considerably from real world music, Dowling (1989) defends that the experiments using this type of stimuli "cannot tell us anything about music perception, but merely about some aspects of human information processing" (p. 247). The intention to isolate meaningful musical features necessarily entails that these variables will be disassociated from other integral variables and, consequently, misrepresent the complexity and richness of the music piece as a whole. This also means that the results will not be generalisable, since participants are unlikely to listen to these

stimuli as real world music in their natural context (Demorest, 1995; Dowling, 1989; Schmuckler, 2001).

Studies using a move-as-you-wish approach to understand children's music-accompanying movements tend to avoid artificially constructed stimuli (Metz, 1989; Moog, 1976; Sims, 1985; Gluschankof, 2006; Eerola et al., 2006). Regardless of whether the studies are experimental or observational, real-life pieces of music, often groove-based, are an integral part of their selection. However, this also implies that variables will not be isolated or controlled as in situations where the stimuli are specially created. On the other hand, these stimuli are expected to represent more accurately not only relevant real world attributes of music but also its impact on children's sensorimotor behaviour, the phenomenon under study.

Not only was ecological validity considered in the stimulus selection process but also children's degree of familiarity with the piece. The use of a fairly unknown music stimulus aimed to prevent, as much as possible, the influence of previous individual and shared movement experiences to that particular music repertoire. This procedure consequently implied that the stimulus would then be heard for the first time by the 4- and the 5-year-olds during the movement task and that their choices of movement patterns would be mainly individual and thus not directly influenced by others' suggestions. Interestingly, this principle does not seem to be applied in other similar studies. For instance, in Eerola et al.'s (2006) research the young participants were asked to move to a piece of children's music that they had previously listened to and moved to in their Nursery, probably in the company of their peers and teachers.

In order to promote more spontaneous choices and discourage the direct influence of stylised dance movements, it was also decided that music genres associated with familiar dancing styles (e.g. Hip hop) would be excluded from the stimulus selection. However, this decision did not mean that potential references to those popular dance styles would be dismissed during the observation and analysis of children's movements.

‘Move-as-you-wish’ studies tend to use either different pieces of music as their stimuli (Moog, 1976; Sims, 1985) or just one single piece (Eerola et al., 2006). Despite these distinct procedures, they all use tempo changes to observe whether children adjust their motoric behaviour accordingly. In the first case, each piece corresponds to a different tempo whereas in the second case the same piece is presented at different tempi. In this study it was decided that the last option would provide more control over the tempo variable but without compromising the ecological validity of the stimulus. If the same piece is presented in different tempi, a time-stretching procedure will then be necessary. As follows, the underlying technical operation implies choosing a piece of music (audio) that is sufficiently flexible to be shortened (faster tempi) and stretched (slower tempi) without damaging its sound quality.

Another final prerequisite for the stimulus selection consisted of excluding any lyrics from the music stimulus. The use of a purely instrumental piece aimed to prevent the potential influence of the narrative component in children’s choices of movement (e.g. an ‘elephant’ would suggest a completely different movement quality and body/spatial organisation than an ‘ant’). Interestingly, some similar studies have deliberately included text with movement references to encourage the young participants’ to move (Eerola et al., 2006).

In sum, several different requirements were considered during the stimulus selection process with the purpose to facilitate children’s movement choices (move-as-you-wish paradigm). As follows, the use of a groove-based piece of music was identified as one of the most fundamental prerequisites. It aimed to encourage the young participants to move in a seemingly effortless way and, thus, to facilitate spontaneous and individual decisions regarding their repertoire of actions. Therefore, the music stimulus had to include the most relevant musical predictors of groove, namely, a rhythmic and syncopated pattern with a steady and strong accented beat, reinforced by the use of instrumental percussion, and different musical tempi that would not only facilitate children’s rhythmic responses approximately within their optimal motor tempo (120 bpm-150 bpm) but also challenge them to move at very slow rates that would clearly fall outside their preferred motor tempo range. Other aspects were

also considered to support children’s groove experience, in particular, the ecological validity of the stimulus, the use of an unknown music piece with an unfamiliar genre and style, and finally the exclusion of lyrics.

Having presented the rationale behind the selection of the stimulus, the next section will now specifically focus on the description of the piece of music chosen for this study and on some practical procedures used.

3.5.2 Description

The first stage of the selection process of the stimulus consisted of gathering a series of short music samples with a high level of groove which included the prerequisites previously discussed. Through a process of elimination, three samples were chosen from the drum loops pack of GarageBand, a software application developed by Apple (see Figures 3.3, 3.4 and 3.5). These three samples would then be used in the pilot studies and assigned to different children.

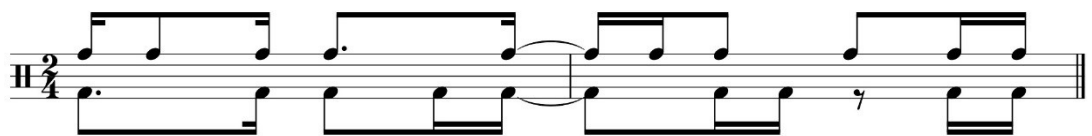


Figure 3.3: Sample 1 - 'Combo Percussion 2' (see Appendix F.1, audio file 1)



Figure 3.4: Sample 2 - 'Motown drummer 11' (see Appendix F.2, audio file 2)



Figure 3.5: Sample 3 - 'Djembe' (see Appendix F.3, audio file 3)

In order to determine which sample constituted the most appropriate music stimulus for the study, it was decided that agreement would be sought among a group of independent judges (please see Appendix G for a description of the aim, method and results of the inter-judge reliability assessment). Considering the clear results obtained, sample 3 became the stimulus of this study.

The drum sample selected (Figure 3.5) consisted of two overlapping syncopated rhythmic patterns in duple meter (2/4), with a strong accented and steady beat. The three measures of the sequence corresponded to 3s and 55cs in the original audio. This short sample would then be repeated continuously to create an ostinato or loop with a maximum duration of 15s. The reason behind this decision was threefold. Firstly, the repeated exposure to the same rhythmic material aimed to increase predictability and thus to encourage children to move towards the anticipated impact of the beat and, eventually, performing synchronised responses. Secondly, a 15s sequence would be sufficiently long for the young participants to explore their repertoire of movements and make their individual choices, but also sufficiently short for them to maintain their level of engagement in response to the same rhythm sequence. Finally, having a loop with 15s necessarily implied that the three measures of the repeated sample would be abruptly interrupted once the time limit had been reached. This sudden effect was believed to be preferable to having to wait for the whole pattern to end or use fade out to minimise the interruption effect. Not only would this decision bring coherence to the ‘freeze-to-silence’ challenge of the game, but it would also potentially increase children’s enthusiasm and their expectations of that unpredictable transition.

Given that the same musical material was presented repeatedly in a loop, it could be argued that a degree of artificiality was being introduced to the process which could compromise, to some extent, the ecological validity of the stimulus. However, if specific musical traditions are considered, such as the West African djembe drumming practice in which the present stimulus is embedded, then the resilient musical repetition becomes truly a ‘real-word’ compositional process (Iyer, 2002; Pressing, 2002). Furthermore, the short duration of the looped sample (15s) is also expected to dilute the potential threat of unnaturalness.

As already mentioned in the rationale (section 3.5.1), tempo was the only variable manipulated in the study. Given the fact that just one music sample was used as the stimulus, I decided that the different tempi would be generated from the original tempo (100 bpm, 600ms) and through a time-stretching/shortening audio procedure (Ableton Live, version 8).

The first step of this process consisted of determining the number of tempi and their corresponding metronomic references. Four different musical rates were chosen and identified as fast (F), moderate (M), slow (S) and very slow (VS). After the initial value of 144 bpm proved to be uncomfortably fast to facilitate synchronised responses in the young children during the pilot studies, the value of 132 bpm was then used to represent the fastest tempo of the whole activity.

Having set the reference of 132 bpm as the upper limit of the tempo range, the other musical speeds were then selected. For the moderate section the original tempo of the sample (100 bpm) was chosen, followed by the metronomic reference of 60 bpm and 35 bpm assigned to the slow and very slow sections respectively. After the time-stretching process each sample, with its specific metronomic marking, was then repeated to create a 15s loop sample through the use of a digital audio editor (Audacity).

It could be claimed that, by having different tempi all played for a maximum length of 15s, children would not be exposed to the rhythmic pattern in each one of those sections the same number of times. For example, in the slow tempo the pattern would be played fewer times than in the fast tempo. Although this point was considered, I decided that the best option would be to assign the same time limit to all the sections. This would not only ensure the structural coherence of the activity, by avoiding an excessively long ‘very slow section’ or an elusive ‘fast section’, but it would also help maintain a similar level of engagement of participants in each section. Moreover, given that young children prefer to listen and tap to a fast tempo (Lamont, 2003; Provasi & Bobin-Bègue, 2003), the invitation to move for a longer period of time to a slow tempo could have potentially reduced their enthusiasm and, ultimately, compromised their willingness to move.

The next step was to create six different combinations of the four tempi, which would then be randomly sequenced and presented to the children during their movement activity. Although the aim was to create a varied sequence of tempi for each one of the combinations, it was decided that the moderate section would always be the first tempo (M1) to be presented in all those segments. This decision was based on the fact that a moderate rate would be neither too slow nor too fast to start the activity and, in this way, children would not feel overwhelmed by having to move to more extreme tempi. The same principle would also be applied to the last tempo of the six combinations, implying that a moderate tempo (M2) would bring a sense of closure to the activity. Finally, the fast (F), slow (S) and very slow (VS) tempi would follow M1 and six possible sequences of those three sections would create six different combinations that different children would move to.

One structural feature that was common among all combinations was a silence interval that alternated with each musical tempo. Four blocks of silence alternated with the five tempi, as shown in Figure 3.6. These short silent sections (5s each) corresponded to the ‘freeze’ block of the activity and constituted one third of the duration of the music sections (15s each). This interval aimed to increase children’s expectation of the challenge of being able to interrupt their movement once the music stopped but it also gave them time to recuperate from the exertion of an ongoing movement.

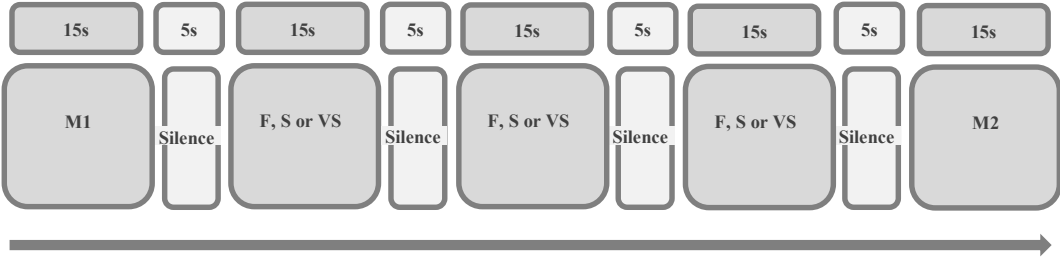


Figure 3.6: Diagram of the structure of the music stimulus (see Appendix F.4 for an audio example of one possible combination: M1-F-S-VS-M2).

An activity with five music blocks of 15s each and four blocks of 5s of silence comprised a total of 1min and 58s. This relatively short duration of the game was considered ideal for children to actively engage in moving to music, to experience the rhythmical content of the stimulus, particularly, the salient and strong accented

beat in four different tempi, and to make their own spontaneous and individual choices of movements throughout the game.

In short, this chapter presented the research design of study 2 in association with a ‘music-inducing-movement’ situation, a distinct context from the one previously explored in study 1 and in which children’s movements were able to influence the sound/music produced. Despite this foundational difference between both studies, there was a clear common purpose of investigating self-regulatory sensorimotor processes in early childhood. Specifically in the case of study 2, the aim was to identify and describe the spontaneous and individual body movement choices of 4- and 5-year-old children in response to a rhythm-based music with a strong accented and salient beat presented at different tempi.

After describing the details of the young participants, this chapter examined the ethical procedures used and reflected upon the specificities of research involving young children. Furthermore, the methodological decisions and practical arrangements regarding the video setup and recording procedures were also described and discussed as determinant aspects of a successful data collection and data analysis (e.g. the setting up of the equipment, children’s familiarity with the camera, the use of a fixed camera, the duration of the video recording).

Finally, this chapter provided a rationale for the choice of the musical stimulus, specifically regarding its potential to induce movements in the young participants. As follows, the concept of *groove* or the music’s ability to make one want to move was considered, particularly in association with some recognised musical predictors of movement (e.g. a clear salient beat, a high degree of percussiveness and syncopation). Moreover, the ecology and familiarity of the stimulus was additionally discussed, and a rationale for the choice of different musical tempi was also provided. In the last section of this chapter, the music sample selected for the study was then described.

Chapter 4 will now outline the type of observational method used in this study, as well as the methodology chosen to support the analysis of the observational data (video recorded movements).

Chapter 4

Embodied Beat: Method & Data Analysis

Following the previous description of the research design of study 2, specifically focused on ethical procedures, on video recording arrangements and on the musical stimulus choice, Chapter 4 will now consider the observational method for data collection and also the data analysis procedures. In terms of the first point, two distinct approaches will be described, more specifically a naturalistic observation and a structured video observation adopted at two different stages of the research. With regard to second point, a rationale for the data analysis will be provided followed by the description of some methodological procedures, in particular of the use of a category system (coding scheme) partially influenced by the Laban Movement Analysis system. But firstly, the following paragraphs will briefly reflect and clarify some basic questions related with the design of the present research.

For this study a ‘semi-controlled descriptive research’ was adopted rather than a wholly flexible or a fixed design. Behind this decision was the plan to adopt procedures in order to control the environment of interest and the phenomenon under study to some extent. Given this active and deliberate attempt to shape the experience of participants in a particular situation, and the intention of producing changes in their behaviour, the present investigation could be seen to fit the criteria of an experimental design (Muijs, 2011). However, this argument loses its strength once some of the procedures adopted are scrutinised. More specifically, the choice of a naturalistic educational setting to observe children’s behaviour necessarily implied the use of a convenience sample instead of a random selection of participants from a known population, which is a highly recommended procedure in pure experiments.

A counterargument could still be made in favour of a quasi-experimental design, given that despite the use of a convenience sample I decided to develop a specific intervention to elicit children's movements and also to manipulate one variable. Moreover, considering that the phenomenon studied was deliberately changed and manipulated, the hypothesis of a non-experimental fixed design which evokes exactly the opposite, would not be defensible (Robson, 2011). Even though a 'quasi-experimental design' thesis seems to be the most appropriate, one has to reject it on the grounds that it would not reflect the descriptive nature of the research question. By aiming to characterise children's behaviour ('what happens'), this study is intentionally excluding the questions of 'how', 'when' and 'why' that behaviour occurred, answers typically obtained through pure experiments and quasi-experiments. In other words, children's movements would be described "without exploring the causal relationships involved in that event" (Given, 2007, p. 250). As follows, instead of having two non-equivalent groups to compare (treatment group and control group) in a naturalistic setting and through the selection of a specific pretest-posttest design, which would enable to measure the degree of change occurring as a result of the treatment applied, a single-group intervention was used and the phenomenon of interest described and the data quantified through descriptive statistics. Considering the overall arguments, it was decided that the present study would be defined as a semi-controlled descriptive design.

As aforementioned, a real-life setting was chosen, more specifically, a Nursery & Primary School that had met all the fundamental requirements: accessibility, geographic proximity and, most importantly, classes with young children within the age range of interest, as well as a spacious room for them to move and thus for data to be easily collected. Furthermore, it is important to emphasise that the choice of this particular naturalistic setting instead of a laboratory not only attended to practicalities regarding participant recruitment and space logistics, but it also provided a familiar and safe environment for the young children which could potentially affect their behaviour in a positive way. Even though an educational setting has been chosen for this descriptive study, in fact children's movement responses could also have been studied in other environments given that the

behaviour in question was non-context dependent. However, using an environment that was familiar to the children would most likely increase ecological validity and children's well-being during data collection.

The degree of control of this study not only attended to the choice of a specific setting and, consequently, to the use of a convenience sample, but also to the use of a pre-designed situation or intervention (musical activity) with one manipulated variable, in which children would be invited to participate. This control was also partially extended to data collection and to the subsequent data analysis which would then describe quantitatively the main features of the behaviour observed.

In sum, even though some experimental procedures were used in this research with the purpose of providing some degree of control to the phenomenon of interest (e.g. the choice of a specific naturalistic setting, the use of a convenience sample, the intervention/manipulation of one variable), my intention to identify and characterise the behaviour instead of explaining 'how, when and why' it occurred reinforced the descriptive design claim. However, and considering the specificities of this study it would be more coherent to define it as a semi-controlled descriptive research design.

4.1 Observation

Observation was the method chosen for this research, which overall implies watching an ongoing behaviour process, event, or situation, recording it in some way and then describing, analysing and interpreting the observational data collected. Directness is recognised as its major advantage, enabling watching what people do and say first-hand without having to ask them about their views, feelings or attitudes. As follows, the observation method seems particularly relevant when studying non-verbal behaviours (e.g. moving to music), even more so when young children are involved. A direct observation in a natural setting may also benefit ecological validity since the behaviour of interest will be studied in a real-life context and not in an artificial and contrived setting.

The main weakness of observational studies is the phenomenon identified as reactivity (the observer effect). It refers to the extent to which the observation of a

behaviour influences the situation observed. Different strategies tend to be used to overcome this problem which could go from total detachment (e.g. the observed are oblivious to the fact they are being observed) to the other end, that is, through the development of great complicity making the observed “so accustomed to the presence of the observer that they carry on as if she was not there” (Robson, 2011, p. 317).

The observation method in this research comprised two distinct but interconnected approaches used at two different stages of the study. Their differences lie on the degree of pre-structure used during the observation, on how the information was recorded and also in terms of the role assumed by the observer in the situation observed (level of participation). The first observational approach consisted of a naturalistic observation, often associated with more flexible, qualitative and unstructured designs. The second approach, on the other hand, was a structured video-based observation usually connected to fixed, quantitative and systematic designs. Both these observational approaches will now be described in more detail below.

4.1.1 Naturalistic Observation

A naturalistic approach was adopted as an exploratory and preliminary stage to the video-based observation that would follow. More specifically, it provided relevant information about the appropriate procedures to use with the specific group of children participating in the research. In essence a naturalistic observation is flexible, unstructured and an effective way of exploring real world phenomena about which little is known (McKechnie, 2008). Consequently, it requires a substantial amount of time, which in the case of this study was spent in one particular location.

This naturalistic observation aimed to collect unstructured data about the educational setting and the young participants. In practical terms it implied getting the children and their teachers familiarised with me and vice versa, knowing the physical space of the setting, acknowledging the school daily routines, identifying the interaction strategies and patterns of communication between children and teachers, as well as listing the objects and props mostly used during their activities. Through this process

I aimed to ensure the success of the following systematic stage of the research, in particular because it would depend greatly on the level of trust developed among all the stakeholders but most importantly because children's wellbeing during the musical intervention would more likely facilitate the spontaneous nature of their movement behaviour.

In this particular data collection process fieldnotes were used to record written descriptive information about the participants (4- and 5-year-olds), the type of interactions developed between the children, and between children/teachers, children/researcher and teachers/researcher, the school activities, events and daily-routines, the setting and objects/props used. Given that during this direct observation phase no notes were taken, in order to avoid disrupting in the flow of events, it was decided that immediately after each observational session the main points would be recorded. Full fieldnotes were then developed within the 24 hours of the data collection while the occurrences were still fresh in my memory. They were written in the first-person using a free-flowing style based on the chronological account of observations which included approximate time references. Even though some impressions and more speculative reflections were separately annotated, the main focus was still the objective description of events (see Appendix H as an illustration).

Participant observation was the qualitative technique used in this field work, which implied the researcher taking on a role in the social situation under observation (Given, 2008). The appropriate degree of participation had to be decided considering the purpose of observational study, the characteristics of the participants, the nature of the setting and the specific features of the observer (e.g. gender, ethnicity). All things considered, I decided that two different roles would be adopted in this study. For the adults directly and indirectly involved in the study (teachers, assistants and parents) the participant-as-observer status would be the most appropriate, however, for the group of children a complete participant role would be preferable and justifiable.

In the first case I assumed an overt role of participant observer. This meant that from the start I made clear to the teachers, assistants and parents that I would be an

observer. This role entailed that observation occurred while I was participating in the activities promoted by the educational institution under investigation. Inevitably, for the success of the observation it was critical to develop a fairly close relationship with the stakeholders and gatekeepers in order to gradually get their trust, as already mentioned. As pointed out by Robson (2011) maintaining “the dual role of observer and participator is not easy, and acceptance will be heavily dependent on the nature of the group and the interaction of particular features of the observer with the group. Your age, class, gender and ethnic background can be important in particular circumstances” (p. 322).

In the case of the young children in the current study a complete participant role was adopted. This particular approach involves acting as natural as possible within the setting of choice and being accepted as a member of the group of interest. By deliberately concealing the observation process from the children I aimed to avoid affecting the participants and allow them to carry on with their habitual activities in the nursery and school, but especially because in doing so I expected to maintain the level of spontaneity and trust when we began the second stage of the study (the structured video-based observation). A complete participant role inevitably raises ethical issues, which were already addressed in section 3.3, but its use was justifiable considering it was adopted to ensure the children’s well-being and to increase the level of engagement during their participation in an activity specifically designed for them. As follows, taking this approach offered more advantages than disadvantages for the children.

Participant observation as a technique involves building a relationship of trust with the individuals that are directly and indirectly involved in the study. This necessarily involves spending a considerable amount of time with the group until one becomes a full member. During this particular stage of the study (naturalistic observation) the amount of time spent in the environment would depend on the level of trust developed between children and the observer. Once children were familiarised with my presence and a good relationship had been built, then it was possible to move to next systematic stage of the observational process.

In sum, a naturalistic observation approach was chosen as the preliminary stage of the data collection because it allowed me to gather information in an informal manner about the setting and participants, but most importantly, it enabled me to establish a trustworthy relationship with the children and teachers (overt observation, adults; covert observation, children).

4.1.1.1 Procedure

Six visits to the Nursery (2 and a half hours each) and 6 visits to the Primary 1 classes (2 and a half hours each) were carried out over a period of almost three months. This followed the explanation of the research aims, procedures, ethical issues and any other relevant aspect of the study to enable and securing agreement to participate from the Head teacher and all the 6 teachers. Moreover, and most importantly, these preliminary visits only took place after parents and their children (participants) have given their informed consent.

In the first visit ‘Ana’ was presented to the children as an ‘assistant’ that would visit them on a regular basis and would help them (e.g. distributing the daily snack) and join their daily activities. After a brief discussion with the teachers, it was decided that this role would be the most appropriate for me given that the children were very much used to welcoming different assistants and trainees in their classrooms.

Considering that one of the main goals of visits was to gradually develop a familiar and trustworthy relationship with the 4- and 5-year-olds, as well as with the teachers, it was fundamental to get involved in the class routines as soon as possible but without being overly intrusive. As follows, during this process I had to be particularly aware of any sign of distress or of acceptance. Interestingly, from the second visit the level of proximity increased considerably. In the case of the younger participants this familiarity was translated in spontaneous invitations to join their activities and games (e.g. ‘duck duck goose’), in drawing offers including portraits of ‘Ana’ usually with a big smiley face and also in free ‘hair treatments’ from promising young hairdressers.

Acceptance was also gained in the 5-year-olds group, however, given that the environment of the P1 classes was noticeably more formal (e.g. children seated at their desks), this implied that different interaction strategies had to be developed. In this process teachers were very helpful and invited the assistant 'Ana' to sit next to the children and join their activities, from puzzle games to writing exercises, from Christmas paintings to other arts & crafts activities. Lastly, there was also increased familiarity with the teachers, expressed in invitations to drink a cup of tea or to join their common room during lunch.

During the visits to each classroom I was able to gather information on some of the communication strategies used by teachers. For example, every morning teachers from both groups gathered the young children in the centre of the room and welcomed them, before informing the class about the daily activities. In this very brief meeting children were also encouraged to ask questions or comment on something that was particularly interesting in their lives. It was also interesting to notice teachers' lively voice and their enthusiastic and confident delivery. At times some props would be adopted in support of this process, for instance, once a bag with some chocolate coins was used to determine randomly which children would be involved in particular task on that particular day.

I also used specific communicational approaches to increase the level of trust with the young children. One simple strategy was to squat down to the children's eye level and engage them in eye-to-eye contact when talking to them. Another was wearing colourful clothes as much as possible to fit in 'visually' with the room setting but most importantly with the group of children.

Understanding children's routines in the nursery and primary school, which entailed identifying what they are accustomed to (classroom setting, time schedule, activities, materials and props, rules, communication and interaction strategies) became an important reference for the next stage. Moreover, they enabled me to tailor some of the procedures of the musical intervention to the needs of the group of participants under investigation. This specific systematic observation stage will now be described in some detail in the following subsection.

4.1.2 Structured Video-based Observation

Systematic observation is a technique that collects data based on pre-specified rules and prearranged procedures (Croll, 2004) that will then enable the description and quantification of the observed behaviour. The current study involved a musical intervention in which children were invited to participate and their behaviour was to be subsequently observed (cross-sectional data). In this data collection stage only information considered relevant to the research purposes, will be regarded.

Unlike the naturalistic observational process in which ‘observation’ and ‘analysis’ are intertwined during the recording process (fieldnotes), in a structured observation the methodological procedures of ‘video-based observation’ (data collection) and the ‘video-based analysis’ will be identified as two different stages, and thus described separately in two different parts of this chapter. For the purposes of the present section only the former will now be addressed.

This systematic observation was based on the video recording of a semi-controlled musical activity involving individual children. The intervention had been designed in advance even though part of its procedures (e.g. invitation to the activity, strategies of interaction and propos used) were only devised after the naturalistic observation stage, given the intention to tailoring them specifically to the group of participants.

The use of video to record children’s behaviour instead of note taking aimed to preserve more effectively the complexity of the raw data and to enable examining it afterwards repeatedly by using slow/fast motion to speed or slow down the images or by simply freezing them when necessary. Considering that the pre-defined categories of behaviour will not be annotated in real-time but only after the collection of the audio-visual data, this observation is in essence indirect.

In a structured observation that necessarily implies a more fixed design, the researcher is usually expected to use a more detached approach in terms of participation. In this particular case, and considering the roles of participant-as-observer and complete participant previously assumed, it was decided that the same approach would be maintained. This would prevent introducing dramatic changes in

the relationship with the children or alter the trust already developed, which could have had a strong impact on the behaviour of interest and at some extent compromise children's wellbeing during that process. Moreover, the reactivity phenomenon at this observational stage was expected to be minimal considering the preliminary field work that had already acclimatised children to my presence and interaction style.

4.1.2.1 Procedure

The feasibility of the procedures supporting this musical intervention was previously verified in two pilot studies conducted in two different countries which are described in detail in Appendix I.

Considering that some of the procedures have already been addressed in the description of both pilot studies (Appendix I), the following paragraphs will now describe the steps that each child went through in the main study from the moment they were selected to participate in the musical activity. That said, this subsection will focus specifically on the information given to the children during the presentation of the activity, on how the order in which the participants would play the activity was determined, the verbal instructions regarding that musical task and also some ancillary strategies of interaction and props adopted during this process.

In the last day of the field work children were informed that they would be invited to participate in a very exciting game. The original name of that traditional game (Musical statues) based on the simple principle 'move-to-music & freeze-to-silence', was deliberately replaced by the name *Ana's Game*. This decision was made after the first pilot study given that some of the children who admitted to know the game said they were supposed to 'run' or 'walk' to the music. As follows, a statement like this revealed that in their past experiences of that game children had been instructed to perform specific body actions. In order to counteracting these expectations, a more neutral name was chosen also aiming to somehow increase the curiosity of the young participants.

When the 4-year-olds and the 5-year-olds were gathered in the centre of their classrooms, early in the morning as usual, I presented *Ana's Game* for the first time, as follows:

Good morning boys and girls! Today I am very happy! Do you know why?...I am going to invite you to play a game....a really fun game, called *Ana's Game*! [I showed them a card with the name of the game and an image with three smiling children (see Figure 4.1)]. Would you like to play it with me...one at a time? [short pause] It is a very easy and exciting game. I will tell you about all the details in a minute but first I would like to find out who will be the first, the second, the third, etc. to play this game. I have put all your names inside this pretty green box, as you can see. [The researcher shows them the interior of the box]...Now, I am going to ask for your teachers' help...They will pick one name at a time from the green box with their eyes closed. The names selected will then be sorted and displayed on this lovely board, so everyone can see them!⁶

Ana's Game



Figure 4.1: Image associated with *Ana's Game* [Untitled illustration of three children dancing].

Retrieved 12, October, 2011 from <http://www.kolrinahstl.org/23728>

Even though both age groups were based in different classrooms in two different buildings, the information about the game was provided in an identical way on two distinct days.

⁶ Considering that in the 5-year-olds class there were some children whose parents did not give consent to participate in the study, an additional explanation had to be included in the instructions immediately before the names of children were randomly chosen from the box. After discussing with the teachers, it was decided that the non-participants would be oblivious to the fact that their names would not be included in the selection box. By saying that “unfortunately, and since time is short, some of you probably will not have the chance to play this game. But do not worry because I have prepared another exciting activity for all of you to play together in a few days time [I was referring to the workshops I ran after data collection with the whole class]. This strategy aimed to minimise as much as possible any disappointment amongst the non-participants.

After this presentation all children were very enthusiastic and immediately raised their hands after being asked if they would like to play the game. They were also very excited to see their names being randomly chosen and then displayed on the board. Moreover, teachers' involvement during this selection process became a key element especially because of their high motivation which seemed to have reinforced the excitement of the young participants.

During this presentation I deliberately used communication strategies normally employed by the teachers and hence familiar to the children. As follows, a very energetic tone of voice was adopted, accompanied by expressive gestures, almost as if a very exciting story was being told. Moreover, all the props adopted (e.g. the game's image, the green box and the board) were carefully chosen in order to provide an aesthetically pleasing experience to the children but also to match, as much as possible, the colourful environment of the 4- and 5-year-olds' classrooms.

After the selection order was completed and children's consent sought, the researcher invited the first child on the list to accompany her to the next room ('climbing room'). During this journey, each participant would be informed that s/he was free to stop playing the activity at any time without any negative consequence. These individual instructions were as follows: "This game is really fun, you will see. I hope you enjoy it but if you don't, please feel free to stop any time and we will return immediately to the classroom. No worries! [The researcher smiles]. You just have to tell me, raise your hand or simply leave the room, alright?"

Once they arrived to the climbing room, I asked the child if s/he would agree for her/his performance to be video recorded with a camera, which was already known to all participants (section 3.3). As soon as the child gave consent, the camera was discretely turned on. I then went straight to the centre of the delineated square area marked on the floor with the child and assumed a squatting position, looking into the child's eyes and with a smile and lively voice explained the rules of the game. During this process the most important words of the instruction were properly emphasised, as follows:

As I already told you, *Ana's Game* is very easy! When you hear the music, you move as you wish and when the music stops you freeze like a statue. OK? [one-second pause] When you hear the music, you move. When the music stops, you... [The researcher pauses and waits for the child to complete the sentence in order to assess her understanding and also to encourage her to interact]...freeze! So let us now assume a statue position before the music starts. Are you ready? [I left the delineated area and sat on the floor, but not too far from the child, while reaching the laptop] 1....2.....and 3! [The researcher presses the play button and one of the six possible combinations of the stimulus is then played].

As aforementioned in previous sections, this presentation aimed to be short (approximately 30s), simple and clear, age-appropriate and presented in a consistent way to every participant.

During the game I deliberately and directly observed the child's performance, smiled with occasional vertical head nodding as a sign of encouragement and to assure the child that s/he was doing well. However, it was fundamental to avoid nodding in synchrony with beat to prevent giving temporal clues to the child. Immediately after the game, I met the child in the centre of the square and said "Well done!". Then I asked in an informal manner "What did you like the most in this game?" and "What were your favourite movements? If the child was unable to articulate it verbally I also invited her/him to move ("Could you please show them to me?").

The previous questions were designed to evaluate participants' awareness of their movement preferences. Nonetheless, and as the pilot work had already suggested, participants' answers were very unclear and unconfident. One could argue that their unsuccessful responses reflected the spontaneous nature of the musical statues game. In other words, when one plays this game their attention is mostly focused on the underlying challenge, that is, being able to move continuously to the music and freeze immediately once the music stops. This necessarily implies that throughout the process the player is not self-aware of his or her spontaneous choices of movements, which in fact was the reason why this particular game was chosen for this study. As follows, it is understandable that most children were unable to answer those questions and thus articulate their preferred movements.

After this very short inquiry, the child would then be accompanied back to the classroom and advised in a playful way to keep this game 'a secret' from their

friends until they all have played it. While leaving the room the camera was turned off. The total duration of this individual session, from the moment the child arrived in the setting (climbing room) until s/he left, was approximately 4 minutes.

4.2 Data Analysis

After collecting and subsequently editing the audio-visual recorded data, the next stage used an appropriate methodology to analyse that material. A systematic procedure was chosen with the aim of describing children's behaviour quantitatively. More specifically, several coding schemes (CS) were developed to record the individual repertoire of movements exhibited by each child. As follows, in the next subsections a rationale will be provided to justify this decision along with a description and operational definition of the categories composing the CS devised.

4.2.1 Rationale: Coding Scheme

A coding scheme, also recognised as a category system, is a well-known form of structured observation (Robson, 2011, p. 329). The use of this systematic procedure in the present study involved quantitising the audio-visual data through descriptive statistics in order to “facilitate pattern recognition or otherwise to extract meaning from qualitative data”, according to Sandelowski, Voils & Knafl (2009, p. 210). Moreover, these authors also hold that adopting a quantitising process in qualitative research allows “analysts to discern and to show regularities or peculiarities in qualitative data they might not otherwise see (...) or to determine that a pattern or idiosyncrasy they thought was there is not” (p. 210). Moreover, others who also defend the adoption of numbers in qualitative research state that the use of quantitative data facilitates identifying and “correctly characterise the *diversity* of actions, perceptions or beliefs in the setting or group studied” (Maxwell, 2010, p. 478). This point is particularly relevant in this research given that individual choices are a central theme. Diversity should not be overlooked in favour of “the assumption that similarities are theoretically more significant than differences” (p. 479). Moreover, the differences “found must be analysed in ways that retain these differences and attempt to understand their significant, rather than imposing uniformity on the basis of unexamined or theoretically based assumptions” (p. 479).

Developing a CS involves the use of predetermined categories for observing the behaviours of interest. The choice of these categories and its respective operational definition must be directly linked with the research question, which in this particular case, aims to identify children's individual repertoire of movements in response to a salient and steady beat presented in five different tempi. In other words, the behavioural categories should provide meaningful information to answer this question.

Given that a CS entails an *a priori* catalogue of behaviours, a period of exploratory pilot work of observation is needed to identify and refine the appropriate categories to be analysed. Therefore, these observational categories should be *focused* (by only reflecting specific aspects of interest to the research question), *objective* (involving a minimum level of inference), *non-context dependent* (the event coded is separate from the contextual setting in which takes place), *explicitly defined* (operationally defined in a precise way), *exhaustive* (at least one of the behaviours must happen, i.e., it covers all possibilities), *mutually exclusive* (events do not overlap, i.e., they cannot occur at the same time) and *easy to record* which nevertheless implies being familiar with the category system (Robson, 2011, p. 335).

As previously mentioned, a CS depends on the research question that one seeks to answer which consequently determines the type of data to be collected and subsequently analysed. In this particular research a set of coding schemes was used to observe behaviour sequences. It was decided that the 'unit' to be coded would depend on an 'event-based' rather than a 'time-based' coding. This means that coding would be elicited by a particular event and not by a specific time interval. The latter implies that the observer records the presence or absence of behaviours within specified short and regular intervals (e.g. 5 seconds), and neither the frequency and duration of behaviours are considered. "If a behaviour occurs once or 10 times during an interval, it receives the same score; if a behaviour starts in one interval and terminates in the successive one, it is scored in both" (Mann, Have, Plunkett & Meisels, 1991, p. 229). Even though time-based coding is widely used, especially given its recognised simplicity and ease of use (e.g. coding just the occurrences and not the onset/offset of the behaviour, a simplified observer training, a high agreement

between coders), it is often criticised by its lack of accuracy (Mann et al., 1991; Robson, 2011). It considers that all behaviours are 'equal' disregarding their temporal differences (frequencies and durations) and when the interval of time chosen is shorter than the shortest codable behaviour, distortion could be introduced into the data. In this way it tends to dismiss "true behavioural patterns, incidence, or prevalence of behaviours... [Consequently, researchers] should consider seriously the problems associated with time sampling and the appropriateness of its use in studies of social behaviour and development" (Mann et al., 1991, p. 239).

Considering these limitations of time-based coding, it was decided that an event-based coding would be chosen for the present study. Within this option one would still be able to assign behaviours either as *events* or *states* (Altman, 1974). While 'event coding' only looks at frequency of behaviour, 'state coding' additionally records duration. As follows, this latter type of coding would not only consider duration (i.e. the time spent in a particular behaviour) but also preserve frequency (i.e. the number of times an event occurred) and the sequence of information (i.e. which occurrence followed which). State coding would necessarily imply recording the onset (start) and the offset (finish) of the coded behaviours and also determine *a priori* whether the codes are mutually exclusive and exhaustive. Again, all these choices should depend upon the type of information needed to answer the research question.

Given that duration of children's movement patterns was the most relevant aspect to be recorded in this study, it was decided that a state coding would be used. Furthermore, events would also be considered mutually exclusive and exhaustive, which means that it would not be possible for one movement pattern to occur at the same time as another (mutual exclusion) and also that all movement categories would cover all eventualities (exhaustiveness). In practical terms, each onset automatically corresponds to the offset of another behavioural state.

Given that in this study the performance of each child was by design divided into five independent sections corresponding to each sample of music (15s each), a new behavioural state was coded every time a new section started. For example, if a

participant decided to perform only one movement pattern during the whole game, this meant that that particular behaviour would be recorded as a new state in each one of the 5 sections. In other words, rather than having only one behaviour recorded throughout the game it was decided that 5 independent records of the same behaviour, each one with the same duration, would be assumed. This type of procedure would be fundamental to determining the differences of repertoire in each tempo/section (duration, frequency and sequence) of the game, within each child's performance and across the group of children.

It is also relevant to clarify that even though the coding process considered the 5 sections independently, each child's performance was always considered as one segment to be recorded from the beginning (1st section) to the end (5th section). That is, the coding process did not consider one specific tempo/section for all children and then repeat the same procedure for the other tempi. Instead, the same category was observed across the different tempi for each child.

Another decision made during this process implied that there would not be a time limit to viewing the videos while coding. The observer would be able to watch the images as many times as necessary and to play them in slow motion.

Even though nowadays there are several video annotation and coding tools available to facilitate the analysis of behavioural data (e.g. The Observer XT, Anvil or VCode & VData), a more manual coding procedure assisted by iMovie was adopted. This particular software application served the purpose of the study, given that it provided the necessary basic options to support the observation, particularly regarding the onset/offset times of the behaviour and the possibility of viewing the video clips at different speeds. Even though this approach was more time-consuming, it provided an opportunity for in-depth analysis and offered, to some extent, a less restrictive observational approach in comparison to using video annotation and coding software. The data arising from the video observation was then transferred to Excel spreadsheets, to enable statistical manipulation and lastly displayed in bar graphs.

In short, in this study the development of a CS implied that the observer (1) would respond to an event and record what type of event it was, (2) would code behavioural states and thus gather information about ‘when’, ‘how often’ but most importantly ‘for how long’ a movement pattern took place, and (3) would ensure that any behaviour would not be recorded at the same time as another and that all categories of movement would exhaust all the coding possibilities.

4.2.2 Coding Scheme 1: Body Actions

The development of this first CS comprised a preparatory stage of analysis which consisted of an exploratory pilot work with a twofold aim. Firstly, it was an unstructured observational platform to analyse the audio-visual data and to gradually extract the meaningful categories to support the following coding stage. Lastly, throughout this process the observer was able to develop and enhance observational and analytical skills.

In this initial stage a written description regarding the performance of each child was used to describe the most relevant information about participants’ choices of movement (see Appendix J for an example). Different strategies and techniques were used throughout this exploratory process. According to Carol-Lynne Moore & Kaoru Yamamoto (2012) it is fundamental to primarily understand the difference between a focal and a subsidiary awareness, that is, the ability to focus on the behaviour of interest as a whole “while remaining subsidiarily aware of [its] details” (p. 151). By understanding this distinction the observer is better able to control the observation process, to clearly focus on what is relevant and thus to use movement analysis more meaningfully.

During the various stages of observation and analysis, the four-phase model of research proposed by Moore & Yamamoto (2012) was adopted. This involved: (1) *relaxation* or “an unfocused state of receptiveness” (p. 152) which implies being calm but yet in an alert state of mind, (2) *attunement*, as if a photographer was gradually adjusting his camera by firstly sensing the general configuration of movement before making informed decisions about the most relevant features, (3) *point of concentration*, gradually focusing one’s attention on a specific component of

movement behaviour, and (4) *recuperation*, having regular breaks to maintain fresh and acute perception.

The outcome of this descriptive account was a catalogue of movement patterns, more specifically, of *body actions* that would constitute the categories of the first CS. The choice of these specific macro units of observation necessarily implied the deliberate use of a high-level categorisation, which aimed to preserve at this stage the ‘wholeness’ of the movement behaviour and, thus, of its richness and complexity, before any attempt to break it into smaller parts.

After this selection the different body actions were operationally defined (see Appendix K) and partially supported by some literature on motor development (Gallahue & Ozmun, 1998; Payne & Isaacs, 1999) and on dance education for young children (Haselbach, 1971). Additionally, in order to ensure that the definition of these categories were objective and clear, two experts on movement analysis were regularly consulted and any necessary adjustments made.

4.2.3 Coding Schemes 2 to 8: Laban Movement Analysis

Following the development of the first CS, which aimed to preserve the entirety of each body action, another set of coding schemes was subsequently devised. As aforementioned, this process involved breaking the initial units of movement (body actions) into individual and smaller ‘parts’. In other words, the analysis gradually moved from a macro to a more micro and detailed analysis.

In order to determine the meaningfulness of those smaller components, a checklist was previously created (see Appendix L). It entailed a series of movement categories which was marked as either present or absent in each child’s performance, and, if present, a brief description would then be added. This checklist enabled to diagnose what specific components of the movement patterns stand out and, therefore, whose presence would be justified in the following coding schemes.

The categories of movement used in this observational schedule consisted of pre-existing categories pertaining to the Laban Movement Analysis (LMA), a conceptual framework originally devised by Rudolph Laban (1879-1958), one of the pioneers of

modern dance in Europe who was a dance artist, choreographer and a theorist (e.g. Laban, 1963; Laban, 1971). LMA is nowadays a widely used system for observing and analysing human movement behaviour that has been continuously refined and extended by some of his most well-known students (e.g. Lisa Ullmann, Irmgard Bartenieff and Warren Lamb).

LMA consists of a multi-layered system generally divided into four categories - Body, Effort, Space and Shape – each one with its respective subcategories. The Body category considers the human body structure and its physical features during the moving process. More specifically, it “describes how the body is organised, [its] specific body parts and actions, and what is emphasised” (Studd & Cox, 2013, p. 133).

The Effort category is often described as the dynamics of the movement and it comprises four basic factors - Flow, Weight, Time and Space - each one defined by a continuum with two extreme poles. The Flow factor refers to how one controls the ongoingness of movement either by releasing it (free flow) or by holding on (bound flow). Weight Effort, on the other hand, relates to the amount of exertion used in the movement, ranging from delicate or decreasing pressure (light weight) to forceful and increasing pressure (strong weight). The Time factor is characterised by one’s inner sense of timing when engaged in an action. In other words, it is not about assessing how fast or slow a movement is but about the attitude of the mover towards time. At one end of the continuum there is the lingering attitude (sustained time) while at the other extreme the sense of urgency (quick time). Finally, Space Effort refers to how the mover actively changes his/her attention to the surroundings either by using a multi-focused approach (indirect space) or a single-focused approach (direct space).

Laban’s Space category defines “where you are, where you are going and how much space is required” (Studd & Cox, 2013, p. 105). More specifically, it identifies the mover’s location in space, where the movement is going (spatial directions or points used) and how large is the mover’s peri-personal space or kinesphere. Finally, the Shape factor concerns the way the body changes its form during the movement

process. Three subcategories are considered and identified as Modes of Shape Change. Shape flow consists of an inner-dialogue or moving to sense the self (e.g. movement adjustments made after being seated for a while in the same position), Directional movements ('me in the world') characterised by spoke-like (e.g. pointing to someone) or arc-like (e.g. playing badminton), and Shaping, the last mode of shape change, which implies the need of the individual's moving forms to mold, manipulate and adapt to the people, objects or environment of the world (e.g. wringing out a towel or hugging someone).

As already mentioned, the LMA-based checklist had the purpose of identifying which of the pre-existing categories would stand out in children's embodied responses to the rhythm-based music. This early observation would enable the development of a clearly focused CS afterwards. Even though this observational schedule was filled in by only one observer, LMA experts were consulted throughout this process and all decisions were appropriately evaluated and discussed. The outcome of this preliminary assessment showed that the most salient LMA categories in children's movements were Body and Space. Consequently, Effort and Shape would be excluded from further observation and from the coding schemes.

It is interesting to mention that, even though Effort is the category often studied in research about music and movement, especially because of its dynamic qualities, its' very subtle presence in participants' responses could be potentially explained in two different ways. First, the use of a specific percussive music stimulus was seemingly neutral with respect to dynamics, even more so, given its repetitive nature. Secondly, the Effort category is recognised by some as still being absent from young children's immature movement behaviour (Amighi, Loman, Lewis & Sossin, 1999). The Shape category (in particular, the modes of shape change) was also not evident in participants' performance, a fact that justified its exclusion from the further analysis.

The following subsections describe in more detail the coding schemes and the subcomponents of each category that were developed.

4.2.3.1 Coding schemes 2 to 4: Body (LMA)

In this study the umbrella concept of Body encompassed three subcategories that are associated with three distinct coding schemes (see Figure 4.2). CS 2 refers to the differentiation between Gestural and Postural movements. The first is defined as a movement confined to a body part (e.g. hand tapping) while the second refers to a movement in which the whole body actively participates (e.g. jumping).

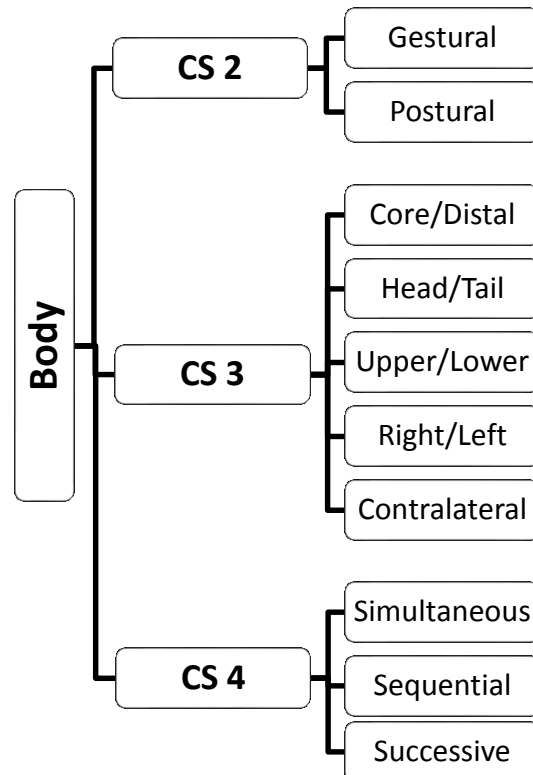


Figure 4.2: Diagram of coding schemes 2-4 (Body)

CS 3 considers the five patterns of developmental progression (Hackney, 2002; Studd & Cox, 2013) which support the organisation or connectivity of the body. According to its increased level of complexity, they will now be described. The Core/Distal pattern entails moving inwards towards the body centre and outwards using the 2 arms, 2 legs and head-tail (e.g. starfish movement). Head/Tail emphasises the connectivity between the two ends of the spine (e.g. hip hop worm movement). Upper/Lower, also known as homologous pattern, differentiates the upper-limbs and

spine from lower-limbs and spine (e.g. children playing leapfrog). The Right/Left or homolateral pattern establishes the distinction between the right and left limbs and, thus, between the two sides of the body which characterises the bilateral symmetry of the human body. Finally, the Contralateral pattern, identified as the most complex, is characterised by a diagonal movement of the upper limb(s) with the opposite lower limb(s). This necessarily implies an oppositional Upper/Lower patterning but also having the right and left sides crossing the midline of the body (e.g. crawling or walking).

The last coding scheme (CS 4) of the Body category refers to the body phrasing which characterises the movement or, more specifically, to its initiation and sequencing in relation to the body parts. In order to understand how the movement is spread through the body, two subcategories were considered. The first (Simultaneous movement) implies the initiation of multiple parts at the same time or, in other words, having the whole body moving at once (e.g. most ballet steps). Unlike this simultaneous initiation, a sequencing entails a time progression (body parts moving in a sequence). This later component can be divided into Successive movement, when the movement develops successively through adjacent body parts (domino effect) and Sequential movement, when movement flows in a sequence but through non-adjacent body parts (e.g. arm-foot-head).

It is also important to note that the category 'none' was added to all these three coding schemes with respect to unexpected interruptions (e.g. tying a shoelace) or occasional moments of stillness during children's performance.

4.2.3.2 Coding schemes 5 to 8: Space (LMA)

The main distinction between these coding schemes concerns general space (CS 5) and personal space (CS 6-8). CS 5 considers the space in which one moves, more specifically, the possibility of moving in place or travelling through space (moving from one place to another). Even though it can be argued that both these subcategories could be easily replaced by the concepts of stationary/axial movements and locomotor movements respectively, which some studies seem to adopt (e.g. Sims, 1985, Rodrigues, 2012), for the present research this procedure represented a

problem given it intended to analyse Body and Space separately. In other words, classifying a movement as locomotor (Gallahue & Ozmun, 1998; Payne & Isaacs, 1999) not only implies that people travel from place to place (Space) but it also entails the use of a specific body action for that purpose, such as walking, running or sliding (Body). This classification becomes ambiguous and unhelpful when one identifies a type of action (Body) that enables locomotion but is actually performed on the spot (Space), that is, without accessing general space. In order to prevent this potential confusion, it was decided that CS 5 would just focus on the spatial elements of the movement, that is, on the distinction between Actions done in place and Travelling actions.

The following coding schemes address the peripersonal space of the mover (*kinesphere*), that is, the space that surrounds the mover's body and within the reaching possibilities of his/her limbs without changing one's place. CS 6 focussed on the spatial directions used by the child, more specifically, the dimensions that supported the movement. Three possibilities were considered which included the Vertical dimension (up-down), Horizontal dimension (left-right) and the Sagittal dimension (forward-backward). A vertical jump, a lateral pelvic sway or a rocking action are clear examples of movements supported by these spatial dimensions. Three other subcategories are also included in this coding scheme as the result of two different dimensions combined (four possible directions). More specifically, Vertical plane (up-right, down-right, up-left, down-left), Horizontal plane (left-forward, right-forward, left-backward, right-backward) and Sagittal plane (forward-up, forward-down, backward-up, backward-down). Three examples that illustrate these three two-dimensional movements are a star jump, a hip movement using a hula hoop and finally a somersault (see Figure 4.3).

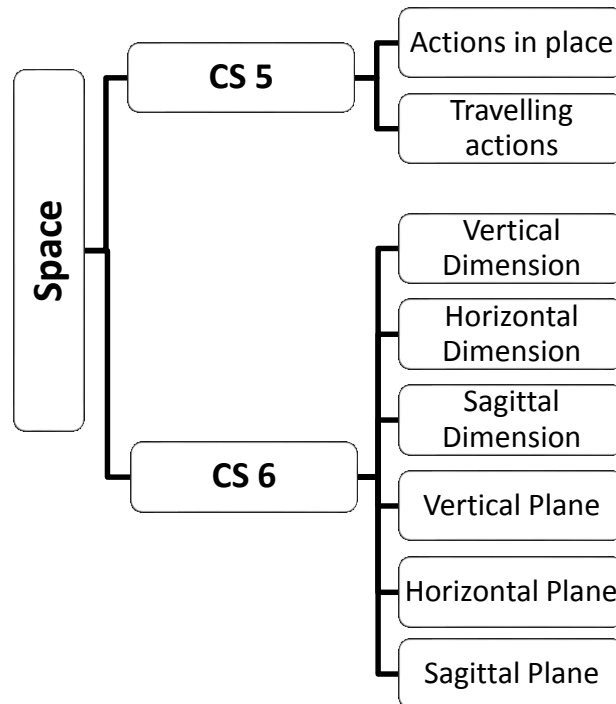


Figure 4.3: Diagram of coding schemes 5-6 (Space)

CS 7 refers to the height level of the kinesphere that each participant could explore while moving. Children’s movements may comprise a high-level (e.g. leaping), medium-level (e.g. actions done at the waist level) or a low-level (e.g. rolling on the floor). Finally, CS 8 considers how large is one’s reach space, that is, the individual peri-personal spatial sphere. The different possibilities entail a Near-reach (movements done near the body midline), Mid-Rreach (movements done at about elbow distance away from the body midline) and Far-reach space (movements done as far as the mover can reach) (see Figure 4.4).

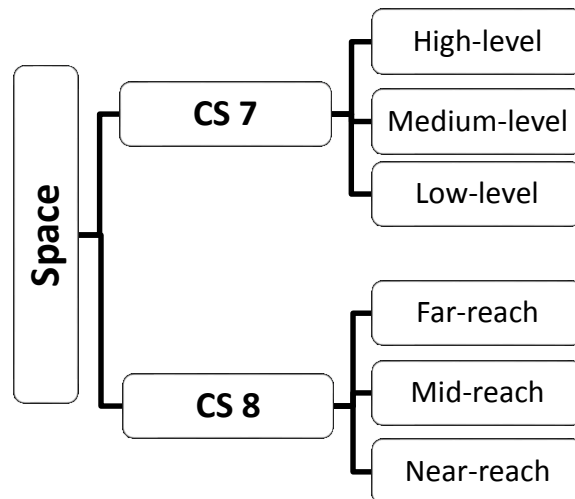


Figure 4.4: Diagram of coding schemes 7-8 (Space)

Once again, the category ‘none’ was included in each one of these four coding schemes with regard to interruptions during children’s performance or to occasional moments of stillness.

To summarise, in this study coding schemes were used as a systematic procedure supporting the analysis of children's embodied responses to music. The choice of an event-based coding entailed that movement events would be mutually exclusive and exhaustive and that they would not be elicited by a time interval. Furthermore, each movement unit was considered as a behavioural *state* which implied that not only frequency but also duration would be annotated. While the first CS aimed to retain the complexity of each movement pattern by using Body actions as macro categories, the following CS adopted LMA pre-existing categories (Body and Space) to help break the movement patterns into smaller components for more detailed analysis.

Overall, this chapter presented two distinct but interconnected observational approaches supporting the data collection process. The first, a preliminary naturalistic approach, aimed to gather information about the children, teachers and educational setting, and most importantly, to get the young participants familiarised

with the researcher (participant observer). This process would ensure that the following procedures, more structured in essence, would attend to the particularities of the naturalistic context, would provide a comfortable environment to encourage children's spontaneous movement choices to music and would also safeguard their well-being at all times.

The second and subsequent observational approach, a systematic video-observation, was characterised by a semi-controlled situation (a musical game) in which each child was individually invited to participate. Participants' video recorded movements in response to the rhythm-based music were then analysed by using a series of coding schemes, in part influenced by the Laban Movement Analysis.

Chapter 5 will now present the results regarding the 4-year-olds' spontaneous choices of movements during this game. It will specifically consider periodicity and synchronisation, the repertoire of body actions and the body and spatial features underlying those movement choices.

Chapter 5

Embodied Beat: Results 1

This chapter is organised around the coding schemes (CS) presented in Chapter 4. It will firstly consider the similarities and differences between the 4-year-olds' repertoire of body actions (CS1) performed in response to the rhythm-based stimulus presented at different tempi. The Body (CS 2-4) and Space (CS 5-8) features supporting those movement patterns will then be described. Throughout the statistical description of these data, any adjustments to tempo changes will be reported when necessary. The chapter starts by considering the assessment of children's motor tempo or speed based on the regularity of their physical accentuations.

5.1 Periodicity and Synchronisation

Understanding sensorimotor synchronisation (SMS) from a process-oriented viewpoint implies focusing primarily on the repertoire of movements performed by the young participants in response to the rhythmic content of the music. In other words, rather than being specifically focused on determining how accurate children are in their synchronised responses the aim was to identify the variety of movement patterns that supported that particular embodied behaviour. However, in order to determine whether and how the 4-year-olds' repertoire was related to the periodic content of the stimulus, it was fundamental to assess beforehand, and in relative terms, the regularity of their physical accented responses to music and the adjustments of those responses to tempo changes. In this way, it was possible to establish a connection between the salient rhythmic features of the stimulus (the steady and accented beat) and participants' behaviour, before describing in more detail the repertoire of movements performed.

The following two subsections will now present the estimates of the intra-observer reliability (Intra-OR) and inter-observer reliability (Inter-OR) tests relative to each child's predominant motor tempo in each of the 5 tempi (methodological procedures of both assessments can be found in Appendix M). The comparison between these estimates and the original tempi helped determine participants' adjustments to tempo changes.

Importantly, 4 participants from the initial sample of 25 were excluded from the reliability assessments and from further analysis because their small-amplitude movements prevented the observation of the physical accentuations necessary for the tapping task. As follows, the impossibility of determining the periodicity and motor tempo of these children meant that any attempt to establish a connection between their repertoire of body actions and the rhythmic content of the stimulus was compromised. Consequently, the following results only consider the data of 21 participants.

In sum, the spontaneous periodicity underlying each 4-year-olds' movements ($N=21$) enabled the identification of their motor tempo, or movement speed, in the different sections of the game, and two reliability assessments were conducted to ensure the consistency of this observational process.

5.1.1 Intra-observer Reliability (Intra-OR)

In terms of the Intra-OR a positive linear correlation (Pearson's r) was found between the responses given by the same observer at two different time points one week apart, regarding each section/tempo of the game. As shown in Table 5.1 (below), the values of $r(19)$ ranged from .73 to .91, $p < .01$ which indicates a very good level of reliability given that Pearson coefficient is higher than .70 (Chen & Krauss, 2004). These values show the strength of the relationship between the responses of the same observer assessed at two different times.

	Fast	Moderate 1	Moderate 2	Slow	Very Slow
Pearson Correlation	.916**	.783**	.862**	.733**	.896**
Sig. (2-tailed)	.001	.001	.001	.001	.001

N = 21

** . Correlation is significant at the 0.01 level (2-tailed).

Table 5.1: Pearson’s correlation coefficient for assessments of the 4-year-olds’ motor tempo in response to 5 different musical tempi (Intra-OR)

5.1.2 Inter-observer Reliability (Inter-OR)

This reliability assessment only considered half of the sample ($n= 11$). The r value obtained for Inter-OR shows a positive linear correlation between the responses of two different observers regarding each section of the game. The annotations of both observers indicated a very strong relationship in the five sections/tempi (r higher than .70). As Table 5.2 below shows, the $r(9)$ value of Fast, Moderate 1 and Moderate 2 and Very Slow tempi ranged from .80 to .75, $p < .01$ whereas $r(9)$ for the Slow tempo was .70, $p < .05$. These data highlight a strong linear relationship between the two observers’ scores when recording the movement speed of children’s periodic movements.

	Fast	Moderate 1	Moderate 2	Slow	Very Slow
Pearson Correlation	.808**	.754**	.782**	.704*	.794**
Sig. (2-tailed)	.003	.007	.004	.016	.004

n = 11

*. Correlation is significant at the 0.05 level (2-tailed).

** . Correlation is significant at the 0.01 level (2-tailed).

Table 5.2: Pearson’s correlation coefficient for assessments of the 4-year-olds’ motor tempo in response to 5 different musical tempi (Inter-OR)

5.1.3 Motor Tempo per Musical Section

Figure 5.1 presents a comparison between the original tempi of the stimulus (beats per minute, bpm) with the mean of the 4-year-olds’ motor tempo obtained from the Intra-OR assessment. These values show that even though there was a slight decrease of children’s speed from the faster tempo (133 bpm) to the slower tempo (122 bpm),

that difference did not seem meaningful given that no dramatic changes were observed between the 5 sections. This indicates that children did not adjust the speed of their periodic movements in response to the different tempi.

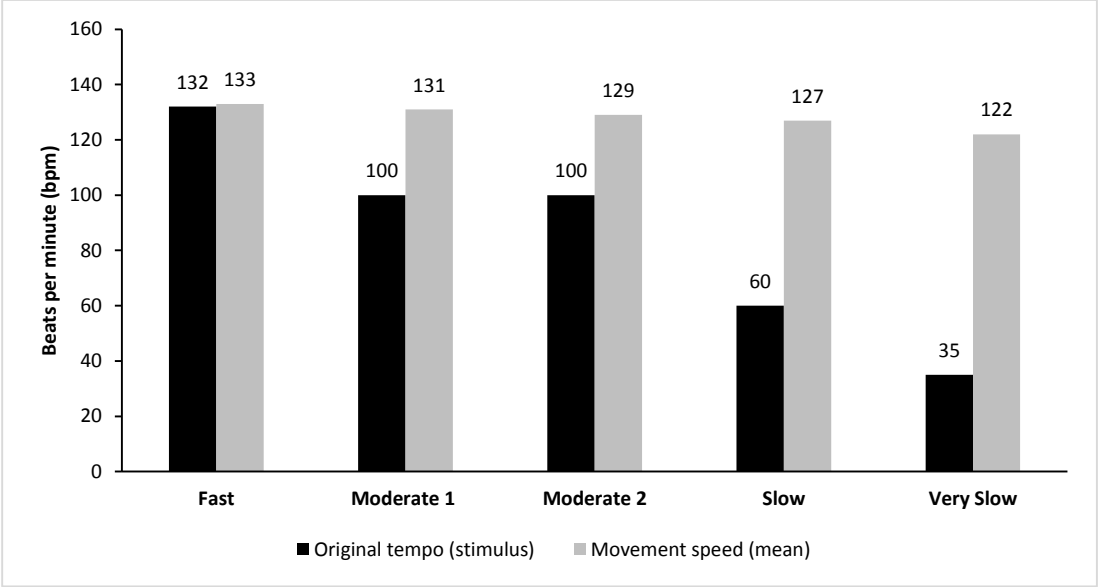


Figure 5.1: Bar chart to show the 5 original stimulus tempi (bpm) and the corresponding mean of the 4-year-olds’ movements

From analysis of the individual speed of each child’s movements it was clear that there was a great deal of variability between participants’ responses to each tempo (see Appendix N), with speed values within the group ranging from 59 bpm to 213 bpm. In the Fast section 47.6% of participants’ moved faster than the original tempo (132 bpm) and their speed ranged from 102 bpm to 194 bpm. In the remaining tempi this variability was also observed, with speeds ranging from 100 bpm to 201 bpm in Moderate 1, the first tempo to be presented in the game and with most children (95.2%) moving faster than the original tempo (100 bpm), and in Moderate 2 with a velocity between 98 bpm and 198 bpm, with 85.7% of the children moving above the original tempo (100 bpm). In the Slow section the speed ranged from 62 bpm to 192 bpm with 100% of the children above the original tempo and in Very Slow from 59 bpm to 213 bpm, also with 100% above of the original tempo (35 bpm). The fact that most children did not match the musical tempi of the stimulus strongly suggests that participants’ movements were not synchronised to the beat.

The previous description showed that each child had indeed reacted and made adjustments in response to changes in tempo, even though within their own specific movement speed range which seemed distinct from the ones used by their peers. Considering the tempo limits of the music stimulus, 35 bpm - 132 bpm one would expect that the children's responses would occur approximately within this range, which covers a '97 bpm interval'. However, taking into account the 4-year-olds' performance, it was found that the mean of all participants' motor tempi just covered a '32 bpm interval', a much more restricted range than the one suggested by the stimulus. Furthermore, the narrower speed range observed within the group of participants implied a '2 bpm interval' (116 bpm - 118 bpm) and the wider speed range covered a '87 bpm interval' (213 bpm - 126 bpm).

This evidence indicated individual differences in terms of children's motor tempo preferences that possibly reveals their maximal pulse salience zone (Fraisse, 1982, Parncutt, 1994), or in other words, the range - from the lowest to the fastest rates - at which the 4-year-olds can discern and most strongly feel the beat (see Appendix O for some examples). The mean periodicity found in the 4-year-olds' performance was 128 bpm and the mean of the upper motor tempo limit was 144 bpm whereas the mean for the lower limit was 113 bpm.

More than half of the 4-year-olds (57.1%) showed a decreasing linear trendline from the faster to the slower tempi, which means that their speed tended to be faster in the fast section, slightly slower in the moderate sections and much slower in the slower sections. However, even though most participants showed this decreasing linear trendline they tended to use different speed rates from each other, and as already mentioned, distinctly different metronomic values from the ones of the original tempi. The other half of the group showed either an increasing trendline (23.8%) (i.e. moving faster in the slower tempi or slower in the faster tempi) or an identical speed (19%) in all the 5 tempi.

In sum, the evidence of a spontaneous periodicity underlying children's movement responses, even though not synchronised to the beat, and the clear speed adjustments in response to tempo changes through their individual motor tempo rates and ranges

help provide an understanding of the 4- year-olds’ repertoire of body actions, which can now be identified as ‘rhythmic patterns of body coordination’.

The next section will now describe children’s repertoire considering the variety of various patterns performed across the group and per child, as well as the predominant body actions exhibited. The presentation of these data considers the overall performance of the 4-year-olds throughout the game and also a more specific description of their behaviour in each of the 5 tempi. Lastly, similarities and differences will be pointed out all through the following section when relevant.

5.2 Repertoire of Body Actions

A great variety of body actions was found across the group of participants throughout the game, more specifically, 11 different movement patterns and 2 additional categories regarding occasional moments of stillness and of unexpected interruptions (e.g. tying shoelaces), as Figure 5.2 shows. Gender differences, however, were rarely observed in children's choices of body actions. As follows, it was decided that this matter would not be pursued any further.

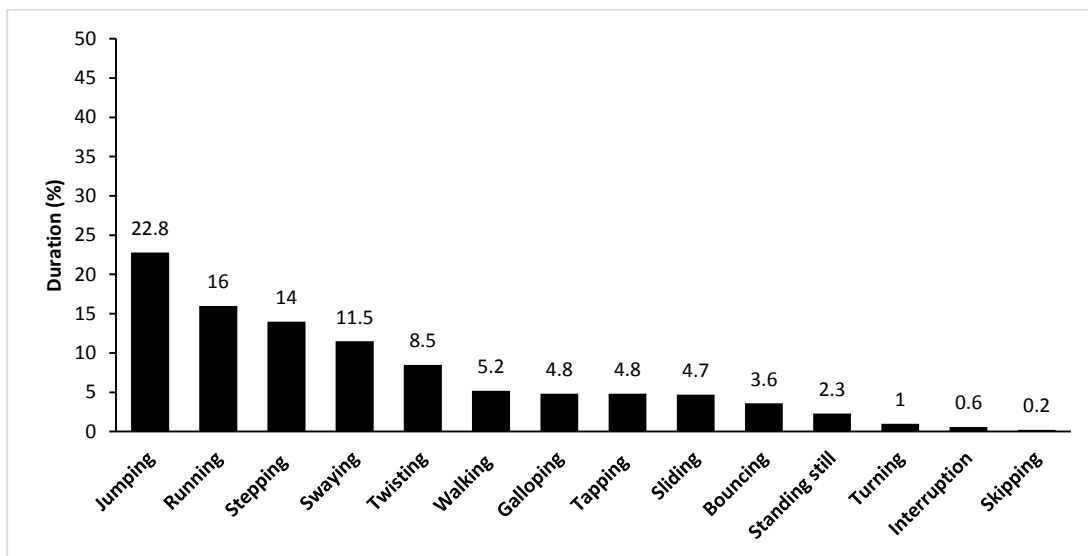


Figure 5.2: Bar chart to show the percentage of time with regard to the main categories of body actions exhibited by the 4-year-olds across all 5 tempi

Jumping, Running, Stepping, Swaying, Twisting and Walking were the six most popular body actions across the group (see illustrative video clips in Appendix P) not

only in terms of their duration but also because they were performed by the largest number of movers (Jumping 42.8%, Stepping 28.5%, Swaying 28.5%, Running 23.8%, Twisting 19% and Walking 14.2%). The predominant role of these specific body actions would be maintained mostly unaltered when changes in tempo occurred. This suggests that the 4-year-olds tended to accommodate the tempo modulations not so much by changing their repertoire but primarily by adjusting their movement speed.

The number of actions exhibited by the 4-year-olds increased significantly to 32 if variations of those main actions are considered (see Appendix Q). For instance, the Jumping category can be divided into a series of other patterns such as, Vertical jump, Star jump, Hop, Split jump, Sideways split jump, Horizontal jump or Twist jump. Given this diversity and in order to preserve the richness of children's movement choices, it was decided that from this point forward the variations of the main actions would now be considered.

Even though the repertoire exhibited across the group of participants was clearly varied, each body action was in fact performed by a small number of children (mean 2.56, mode 1). Vertical jump and Standing still were the two mostly shared actions among children but only 38.1% of the participants actually executed them. Stepping (28.6%), Running/Swaying (23.8%) and Twisting (19%) were the next most popular actions within the group. Fourteen of the 32 body actions identified were executed by only one child each (4.8%). This evidence seems to suggest that the repertoire of each child has an individual character, given that from the total number of body actions observed only few constituted a common repertoire among participants.

Another aspect to be examined is the variety of body actions within each child's performance or, more specifically, the number of different actions used per participant in the moving-along game. Again, despite the large number of actions observed across the group most children tended to have a fairly restricted repertoire (mean 3.9, mode 2). Appendix R shows two examples of children playing the game and using a different number and distinct types of body actions in each of the 5 sections. The sequence of tempi of both the examples reflect the specific tempi

combination that was assigned to these two participants (see also the corresponding video clips in appendix S).

5.2.1 Dominant Actions

All participants showed a clear preference for one particular body action throughout the game, which tended to be different from child to child. This dominant action would be performed by children around 80% of the total duration of the game. Moreover, this preferred action would be in most cases supported and alternated by other transient actions. However, this alternation would not affect the ongoingness of the periodic motion. Lastly, it should also be reported that these preferred movement patterns would be consistently performed throughout the 5 tempi, as the figure below shows.

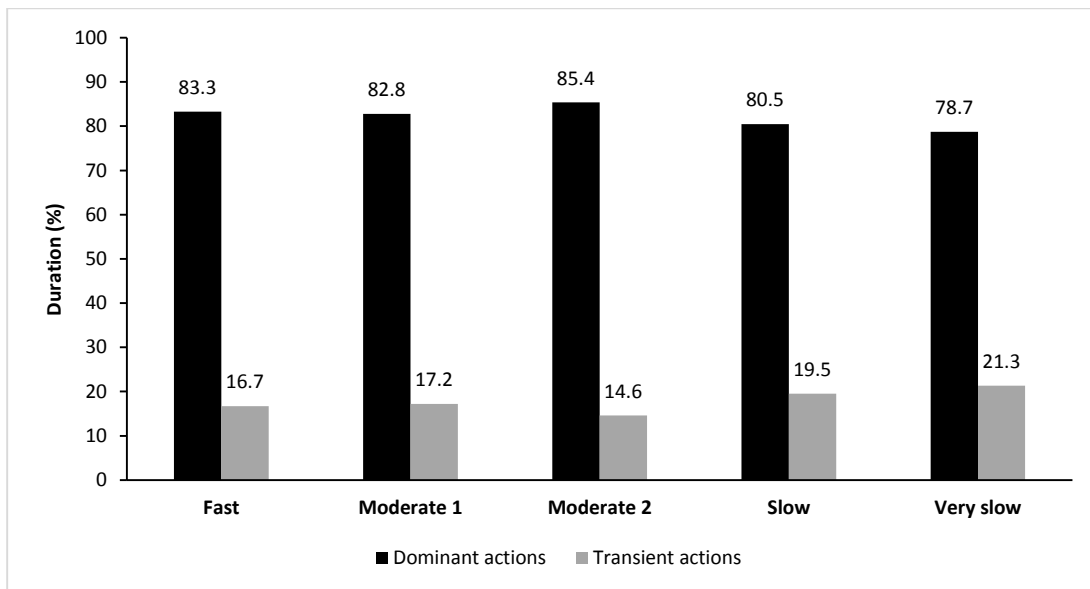


Figure 5.3: Bar chart to show the duration of the dominant and transient actions exhibited by the 4-year-olds per tempo

5.2.1.1 Inter-observer Reliability (Inter-OR)

An Inter-OR was conducted to estimate the degree to which two different observers would give consistent estimates regarding the identification of the dominant action performed by each of 4-year-olds during the game (see the description of the research design and methodology of Inter-OR in Appendix T). The results showed an “almost perfect agreement” between both observers (Landis & Koch, 1977, p. 165),

$k = .83$ (95% CI, .668 to 0.99), $p < .001$. The two observers strongly agreed about the type of dominant action exhibited by each participant and also about its designation.

5.2.1.2 Repertoire

Across the group of participants, 9 different dominant body actions were identified (Figure 5.4). Five of those preferred patterns were executed by different children whereas the remaining 4 would be performed by only one child each. Vertical jump was the dominant action mostly shared by the 4-year-olds (22.7% of the total number of participants), followed by Running, Stepping, Swaying-rocking and Twisting.

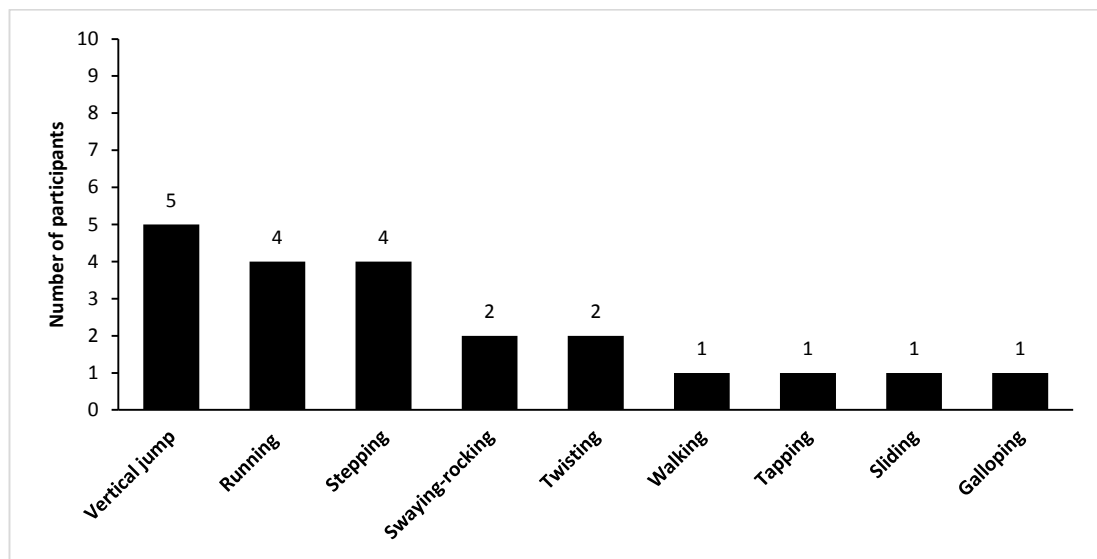


Figure 5.4: Bar chart to show the number of participants per each type of dominant body action

As the graph below shows (Figure 5.5) all children performed their dominant action with a duration of more than 60% of the total amount of time of the game. Moreover, most of the remaining participants used their preferred action in a very persistent way, some of them executing that action more than 90% of the total duration of the musical activity, which suggests that that preferred action would be almost the only action to be performed in every section/tempo.

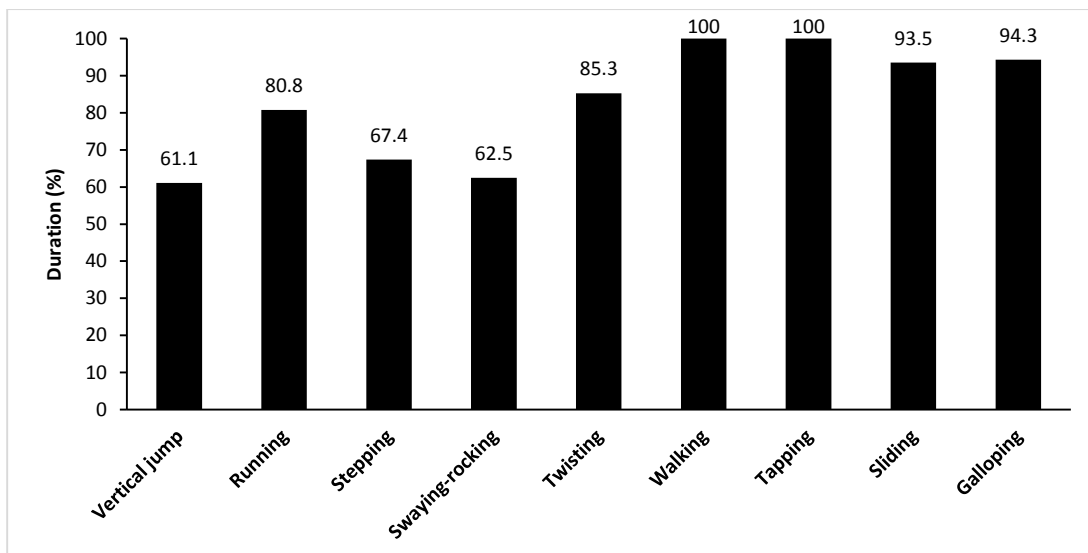


Figure 5.5: Bar chart to show the duration of each type of dominant body action performed by the 4-year-olds across all tempi

5.3 Body Features (LMA)

The following subsections will now describe the body characteristics of the repertoire of body actions identified in children’s performance. It is worth remembering that the body categories considered were derived from the Laban Movement Analysis (LMA) system.

5.3.1 Gestural & Postural Movements

The actions performed by the young participants were mostly postural (Figure 5.6), which indicates that there was a clear preference for whole-body actions. On the other hand, gestural movements were rarely observed and tended to be represented by hand and foot tapping. This tendency was maintained throughout the 5 different tempi.

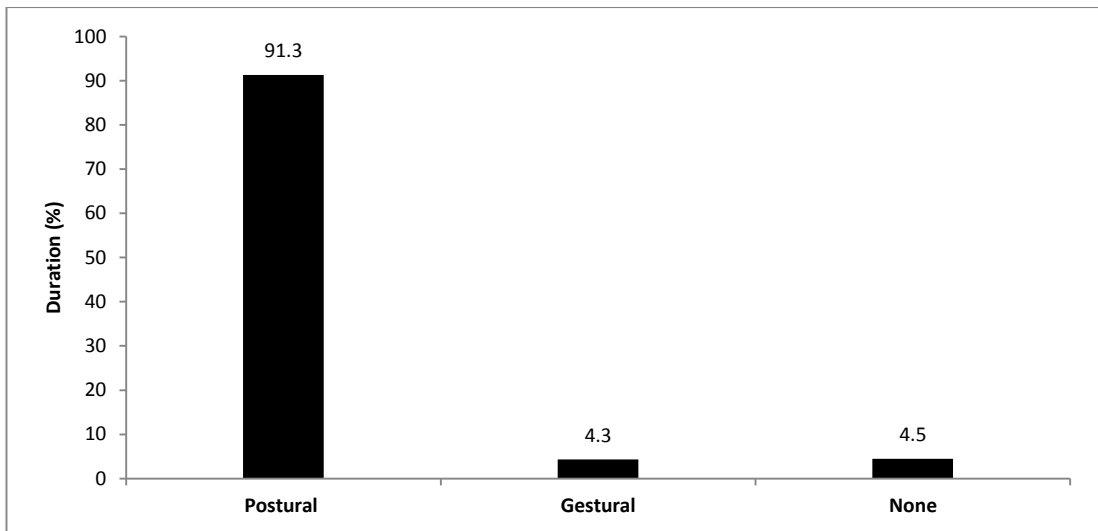


Figure 5.6: Bar chart to show percentage of time spent with regard to postural and gestural movements performed by the 4 year old children across all 5 tempi

5.3.2 Patterns of Body Organisation

As shown in Figure 5.7, the developmental pattern of body organisation that supported most of children’s actions was the Upper/Lower pattern (homologous). This choice was followed by the Right/Left (homolateral) body pattern of body connectivity which structured actions such as Swaying. Core/Distal and Head/Tail patterns were not included in participants’ repertoire. This hierarchy of preferences was maintained in all the different sections of the game.

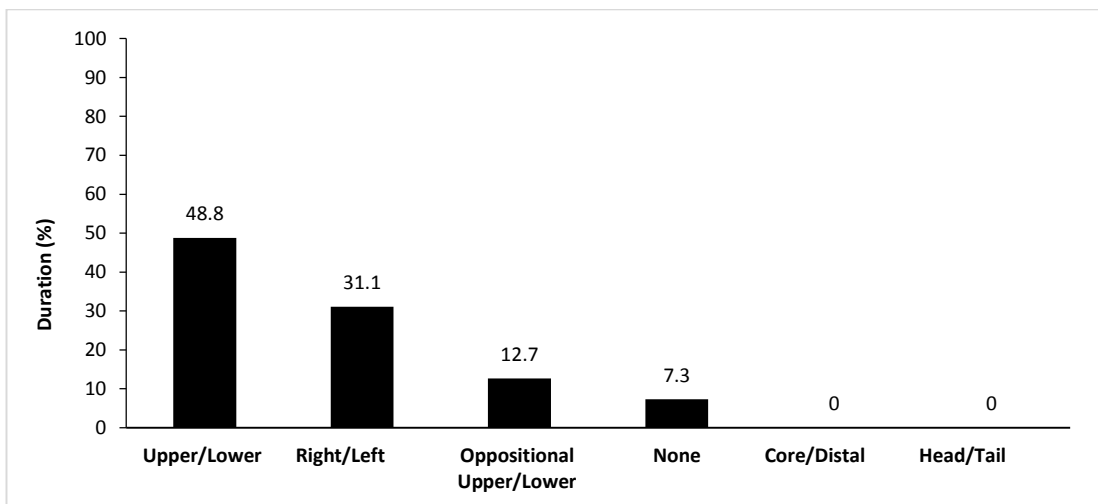


Figure 5.7: Bar chart to show patterns of body organisation exhibited by the 4-year-olds across all 5 tempi

5.3.2.1 Dominant Body Unit (Upper & Lower)

The Lower-body unit (pelvic girdle, legs and feet) was clearly the most active throughout the game, even though in a few cases children's movements emphasised both Upper and Lower units or just the Upper-body (upper spine, arms and hands). These results suggest that for almost all of participants the Lower-body was the unit supporting the periodic motion which implies that the regular accentuations were specially located in the pelvic region, legs or feet. The Upper-body unit seemed to have a more ancillary quality except for the children who used the support of the spine, arms or hands to create an accented pulse.

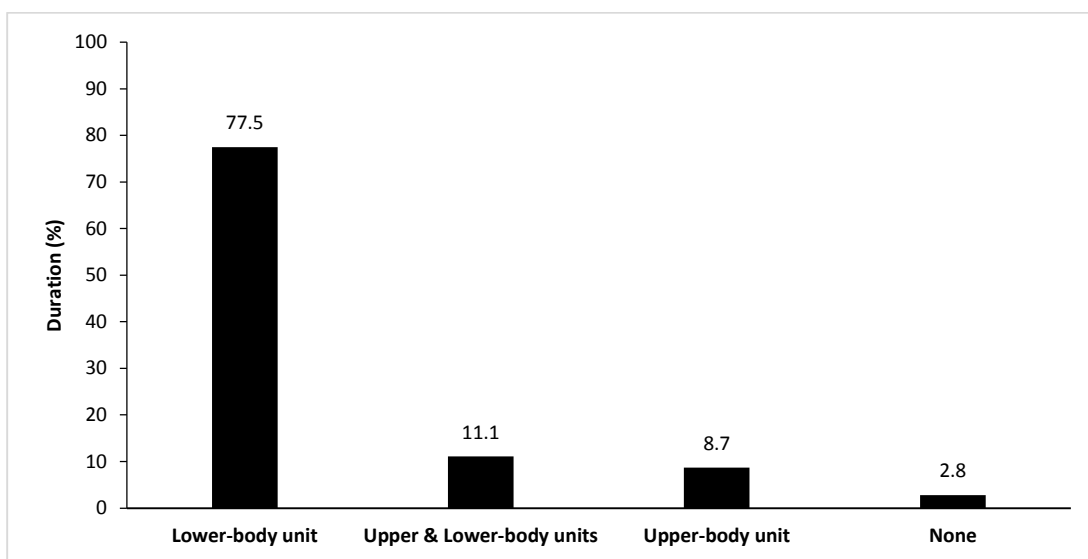


Figure 5.8: Bar chart to show prevalent body unit supporting the 4-year-olds' movements across all 5 tempi

5.3.3 Body Phrasing

The 4-year-olds' movements were clearly simultaneous (Figure 5.9), which means that their active body parts tended to move at once and not progress in a sequence. This could be an indicator of child's sensorimotor stage of development as well as a response to the impact of the percussive beat.

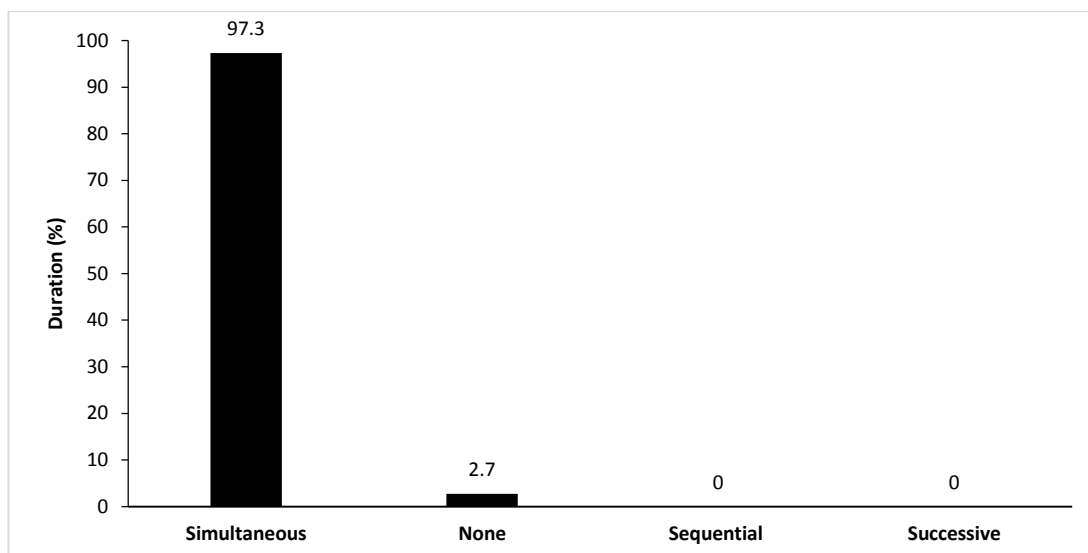


Figure 5.9: Bar chart to show percentage of time spent with regard to the different types of body phrasing executed by the 4-year-olds across all 5 tempi

5.4 Space Features (LMA)

This section will now consider the spatial preferences underlying the 4-year-olds' repertoire of movements. Again, the categories considered were inspired by the Laban Movement Analysis system but now applied to the Space component. The general space categories, or the possibility of travelling through space, will be considered in the next subsection (5.4.1), whereas the peripersonal space, or the space that surrounds the mover's body and within the reaching possibilities of his/her limbs, will be addressed afterwards in the remaining subsections.

5.4.1 Actions in Place & Travelling actions

From the graph below (Figure 5.10) it is clear that most children chose to move in place and that less than a third of participants decided to travel through general space. These spatial options were maintained almost unchanged in each tempo of the game, with the lowest percentage of 'actions in place' observed in Moderate 1 (Figure 5.11).

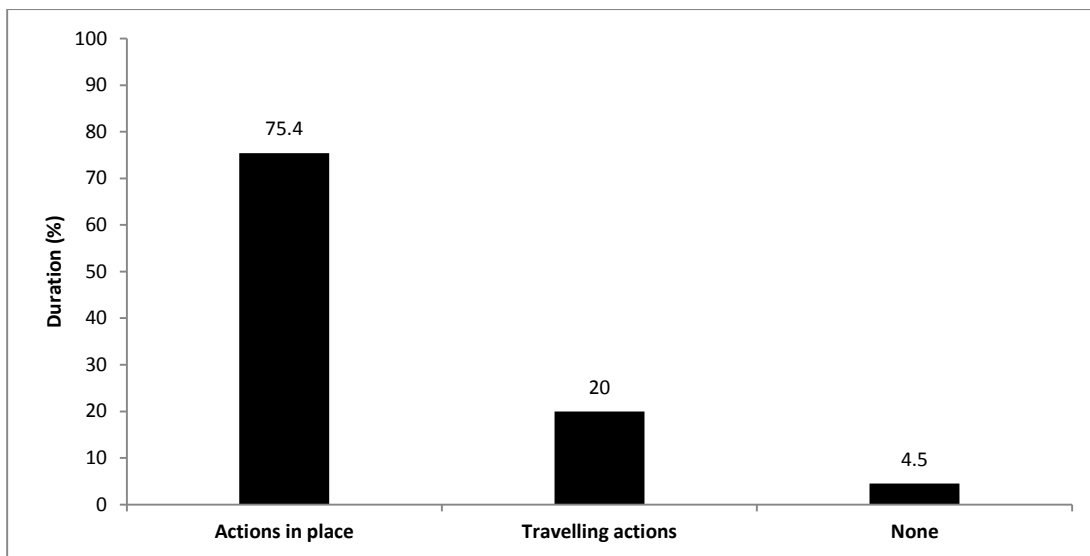


Figure 5.10: Bar chart to show the percentage of time spent with regard to actions in place and travelling actions exhibited by the 4 year old children across all 5 tempi

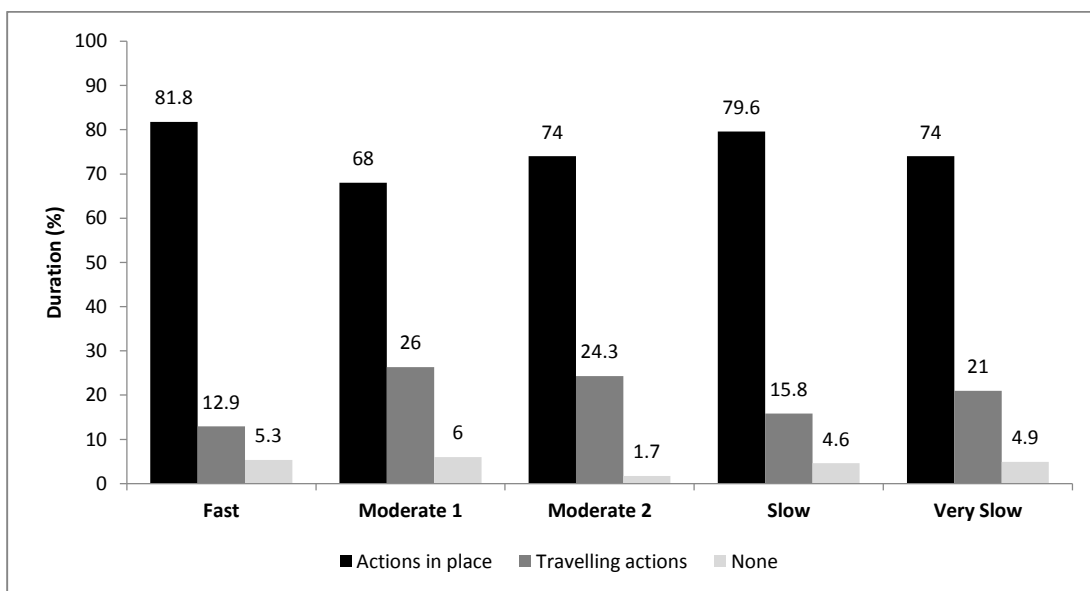


Figure 5.11: Bar chart to show the percentage of time spent with regard to the 4-year-olds' actions done in place and their travelling actions in each of the 5 tempi

5.4.2 Directions (Dimensions & Planes)

Despite the great variety of body actions performed across the game, most children tended to exhibit a clear preference for up-down directions in their movement patterns as shown in the graph below (Figure 5.12). These spatial directions were predominant mainly in one-dimensional movements (vertical dimension) such as

Vertical jumping, but also when combined with other directions (sagittal plane and vertical plane). The directions forward-backward were the next spatial choice of participants, either performed independently (e.g. Swaying-rocking) or in association with other directions (sagittal plane and horizontal plane). The clear predominance of the up-down directions, in particular in the vertical dimension was maintained throughout the different tempi (see Appendix U).

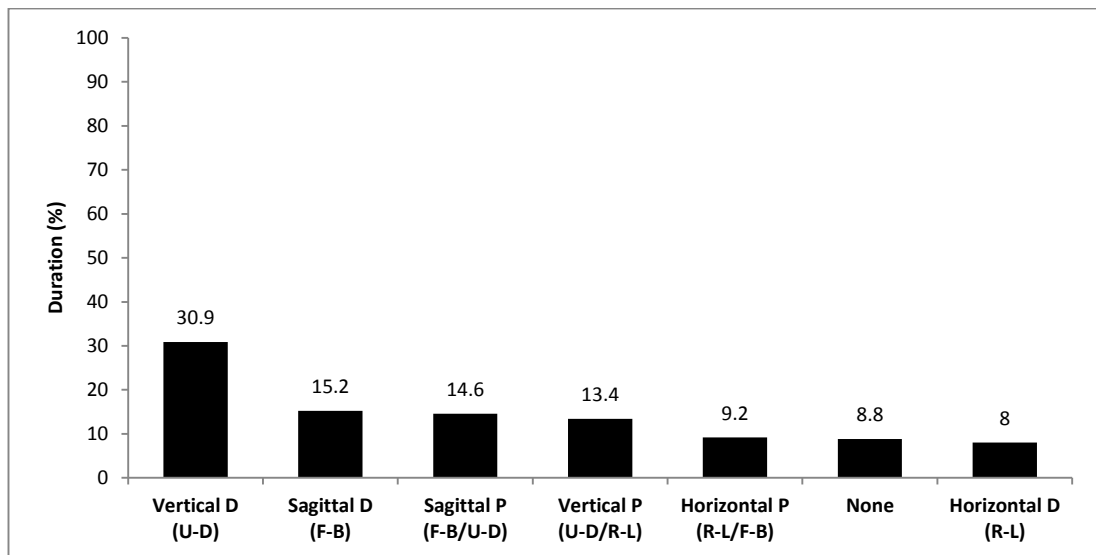


Figure 5.12: Bar chart to show the percentage of time spent with regard to different dimensions and planes of body actions performed by the 4 year old children across all 5 tempi

5.4.3 Height Level

As Figure 5.13 below demonstrates, children's peripersonal space while moving was characterised by only one height level (high), which was dominant in all the different sections of the game. This meant that children did not performed level changes in their performance.

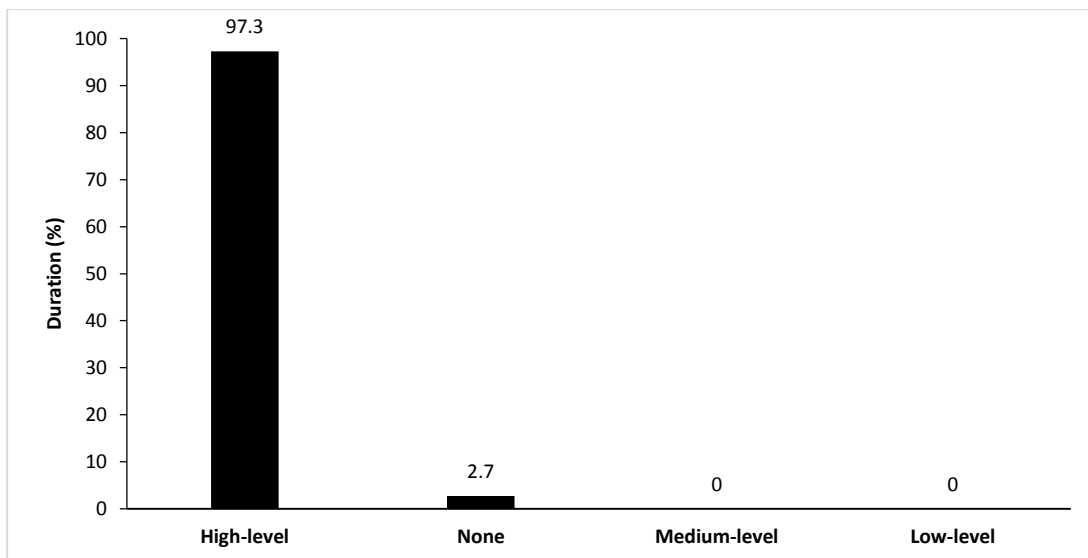


Figure 5.13: Bar chart to show the percentage of time spent with regard to different height levels used by the 4-year-olds across all 5 tempi

5.4.4 Reach Space

Slightly more than half of the movements were performed in the mid-reach space of children's kinesphere, that is, by them extending their upper or lower limbs to about an elbow distance. Actions using near-reach and far-reach space were also observed but at a lower level, as Figure 5.14 shows. These values remained unaltered in all the sections of the game.

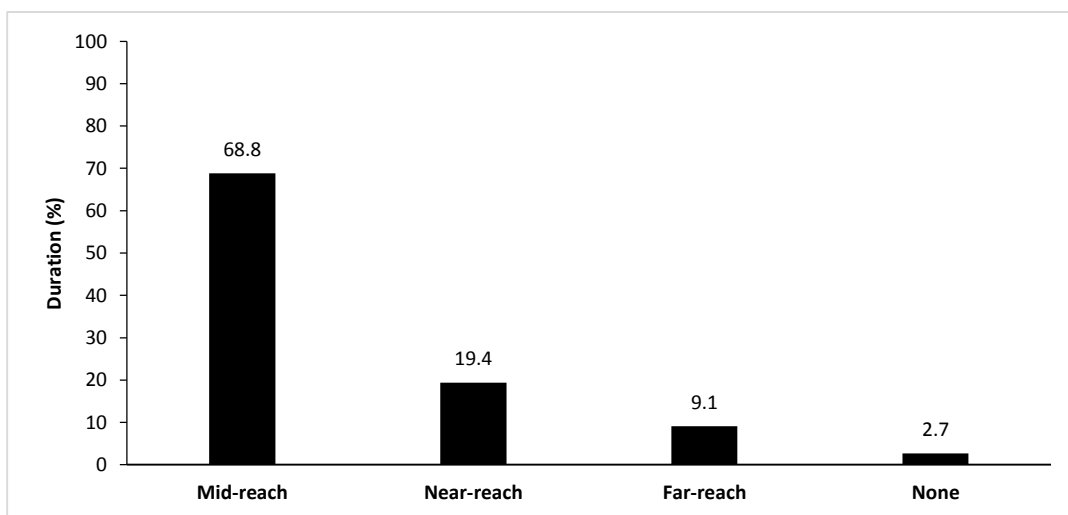


Figure 5.14: Bar chart to show the percentage of time spent with regard to the different reach space movements exhibited by 4-year-olds across all tempi

In short, the main results show that most of the 4-year-olds exhibited clear spontaneous periodic movements, even though not accurately synchronised to the beat. However, each child evidenced flexibility in their motor tempo in response to the different tempi/sections of the game. Moreover, whereas a great variety of body actions was observed across the group of participants, only few movements constituted the sensorimotor repertoire of each 4-year-old. In fact, each child would show a clear preference for one specific action throughout the game, which would be supported by transient actions in some cases.

Great similarities were identified between children in terms of the body and spatial components involved in their actions. With regard to body features, participants showed a preference for whole-body movements, for actions supported by Upper/Lower patterns of body connectivity (specific emphasis to the lower-body unit) and also a preference for simultaneous body phrasing (all body parts moving at once). Considering children's spatial choices, it was found that most children would move in place, exhibit body movements supported by up-down directions, at times combined with other spatial directions, use a high height-level and a mid-reach space (limbs at an elbow distance away from the body's midline).

The next chapter will now describe the results of the 5-year-olds' performance in the game and then discuss in Chapter 7 the most relevant findings of this study regarding both age groups.

Chapter 6

Embodied Beat: Results 2

The previous chapter described the results of the younger group of participants, more specifically their movement choices to a resilient and accented beat presented in different tempi. The present chapter will now consider the performance of the 5-year-old children in the same circumstances. Again, the coding schemes developed for the data analysis will constitute the underlying structure of the following sections, more specifically, they will address the repertoire of body actions exhibited by the 5 year old children (CS1) and the body/spatial components of those movement patterns (CS 2-8). However, before proceeding directly to this description the findings regarding the assessment of children's motor tempo and also of its regularity will be presented.

6.1 Periodicity & Synchronisation

As Chapter 5 already reported, it was fundamental to determine beforehand whether the young participants exhibited spontaneous rhythmic responses to the stimulus, particularly by identifying how synchronised to the beat and how flexibly adjusted to tempo changes those responses were. Nonetheless, it should be emphasised once more that even though this research does not aim to study the accuracy of children's synchronisation, its assessment in relative terms will support and complement the findings concerning children's movement behaviour and their choices.

In the next subsections the estimates of the intra-observer reliability (Intra-OR) and inter-observer reliability (Inter-OR) assessments for each child's predominant movement speed in each of the 5 tempi will be presented and then, based on these estimates, the preferred speed of the 5-year-olds will then be compared with the original tempi in order to identify potential movement adjustments.

6.1.1 Intra-observer Reliability

In terms of the Intra-OR (Pearson's r) there was a positive linear correlation in the responses given by the same observer at two different time points (one week apart) for each section/tempo of the game. As the table below shows, the values of $r(20)$ ranged from .808 to .911, $p < .01$ which indicated a good level of consistency across the observer's ratings over time, in relation to the speed of children's periodic movements in each tempo/section of the game.

	Fast	Moderate 1	Moderate 2	Slow	Very Slow
Pearson Correlation	.867**	.808**	.911**	.853**	.856**
Sig. (2-tailed)	.001	.001	.001	.001	.001
N = 22					

** . Correlation is significant at the 0.01 level (2-tailed).

Table 6.1: Pearson's correlation coefficient for assessments of movement speed of the 5-year-olds in different tempi (Intra-OR)

6.1.2 Inter-observer Reliability

For this reliability assessment only half of the sample ($n= 11$) was used. The r value obtained for Inter-OR indicated a positive linear correlation between the responses of two different observers in each section/tempo of the game. Both observers' annotations showed a strong relationship mainly in 4 of the 5 tempi. As the table below shows, with the exception of Moderate 1 expressing a less strong relationship with a $r(9)= .60$, $p = .05$, the correlations across the remaining tempi ranged from $r(9)= .88$ to $.76$, $p < .01$. These data confirmed a strong relationship between both observers' tapping scores relatively to the speed of children's periodic movements across the different sections of the game.

	Fast	Moderate 1	Moderate 2	Slow	Very Slow
Pearson Correlation	.888**	.602*	.801**	.763**	.823**
Sig. (2-tailed)	.001	.050	.003	.006	.002
n = 11					

*. Correlation is significant at the 0.05 level (2-tailed).

** . Correlation is significant at the 0.01 level (2-tailed).

Table 6.2: Pearson's correlation coefficient for assessments of movement speed of the 5-year-olds in 5 different tempi (Inter-OR)

6.1.3 Motor Tempo per Musical Section

Figure 6.1 below compares the original tempo of each section of the stimulus with the mean of the motor tempo of the 5-year-olds ($N=22$), based on the data retrieved from the Intra-OR assessment (mean of the two observations). These values showed that even though there was a slight decrease of children's movement speed from the fast to the slower tempi, all sections tended to be quite homogeneous suggesting that very few speed adjustments were made throughout the different sections of the game.

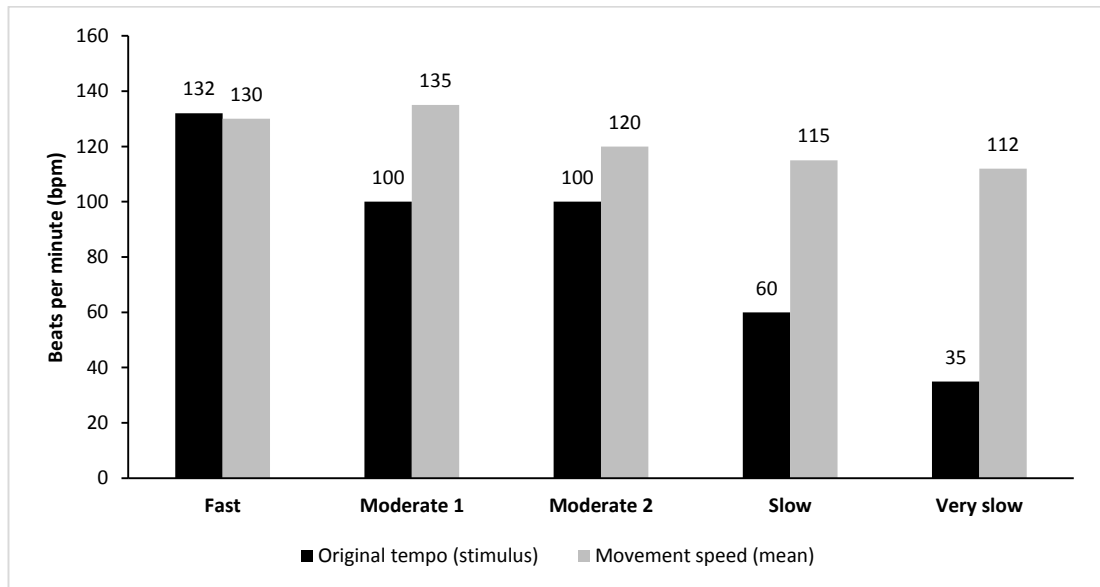


Figure 6.1: Bar chart to show the 5 original stimulus tempi (bpm) and the corresponding mean of the 5-year-olds' movements

However, taking the individual performances into consideration (see Appendix V) this conclusion becomes less precise given there was variability between children's performance in each tempo. In the Fast section, participants' movement speed ranged from 89 bpm to 179 bpm, with only 36% of the children above the original tempo (132 bpm). These differences were also observed in the remaining sections with speeds ranging from 97 bpm to 185 bpm in Moderate 1, the first tempo to be presented to children, with 91% of the children moving faster than the original tempo (100 bpm), and in Moderate 2 with a range speed between 88 bpm and 161 bpm with 73% of the children above the original tempo (100 bpm). In the Slow section the speed ranged from 79 bpm to 152 bpm with 100% of the children above the original

tempo (60 bpm) and finally in Very Slow from 70 bpm to 152 bpm, also with 100% of the participants above of the original tempo (35 bpm).

As the previous data showed, the 5-year-olds tended to respond to tempo modulations by making adjustments to their movement speed, however, these adjustments did not match the original tempi of the stimulus. Moreover, the tempo range of the stimulus 35 bpm - 132 bpm implies a '97 bpm interval' whereas the speed range of participants (mean of all 5-year-olds' speed range) show a limited '34 bpm interval'. The narrower speed range observed within the group of participants just covered a '13 bpm interval', more specifically from 96 bpm to 109 bpm and the wider speed range covered a '84 bpm interval' from 85 bpm to 169 bpm. This seems to suggest the presence of individual differences in the speed/tempo preferences of the 5-year-olds, which could reflect each child's maximal pulse salience. The mean periodicity found in children's performance was 122 bpm and the mean of the upper limit consisted of 141 bpm whereas the mean for the lower limit was 108 bpm.

The differences observed in terms of children's motor tempo range were very clear in the examples presented in Appendix W, which show how four different participants adjusted their speed to the different tempi by using individual rates and ranges. Furthermore, in these examples it is also possible to see that their speed range choices did not correspond to the metronomic values of each original tempo.

Approximately three quarters (77.2%) of the 5-year-olds showed a decreasing linear trendline from the faster to the slower tempi of the game, even though each child's motor tempo range was clearly different from the one used by their peers and, as already mentioned, different from the original tempi. The remaining group of participants decided to maintain either an identical speed rate (18.1%) or, in the case of only one child, an increasing linear trendline (4.6%).

In sum, the evidence provided by this section showed that all 5-year-olds exhibited a spontaneous periodicity underlying their movements. Moreover, they all reacted differently to tempo changes by using individual speed rates and ranges which tended to be above the metronomic values of the original tempi. Despite these

differences there was a decreasing linear trendline in most participants' performance which showed that slower speeds were often related with the slower tempi and faster speeds with faster tempi. Even though synchronisation was not specifically measured, the previous findings strongly suggested that children's movements were not synchronised to the musical beat.

The next sections will now address the results regarding the repertoire of movements that supported the 5-year-olds' regular physical accentuations and also the adjustments made to that repertoire in order to accommodate tempo modulations. Throughout this description similarities and differences between children's choices of body actions will be pointed out.

6.2 Repertoire of Body Actions

The group of participants performed a great variety of body actions, more specifically, 24 different patterns of body coordination throughout the game (see Appendix X). One additional category was added to include the unexpected interruptions that occurred during the game. Gender differences, however, were practically undetected in children's choices of body actions. As follows, it was decided that this matter would not be pursued any further.

As shown in Figure 6.2 below, Bouncing closely followed by Stepping and Jumping, and then by Lateral pelvic sway, Twisting and Running were the most prevalent body actions to be performed during the whole game (see video clips in Appendix Y), not only in terms of duration but also regarding the number of participants who executed them (Stepping 45.5%, Bouncing 31.8%, Jumping 31.8%, Twisting 18.2%, Lateral Pelvic sway 9.1% and Running 9.1%).

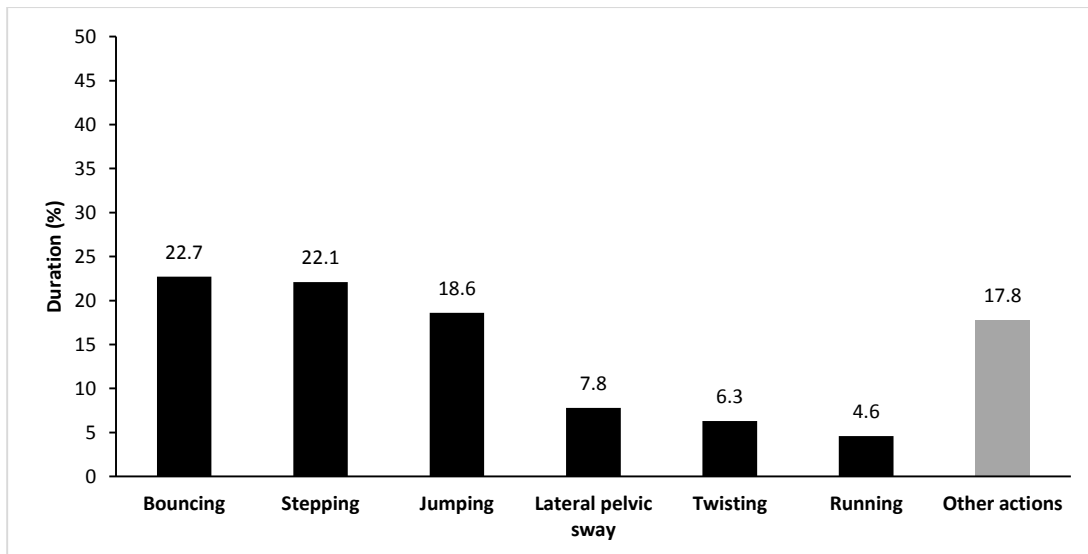


Figure 6.2: Bar chart to show the percentage of time with regard to the 6 most performed body actions exhibited by the 5-year-olds across all 5 tempi

This group of actions would be maintained fairly consistent from section to section, which indicates that even though children tended to adopt different speeds to accommodate the different tempi this repertoire of movements would not suffer dramatic changes throughout the game. As follows, the embodied rhythmic responses of the 5-year-olds to the stimulus seemed to be mostly related with the motor tempo and with the inevitable body and spatial adjustments that that process required, rather than with fundamental changes in the movement preferences of the group of participants.

Even though 24 different body actions constituted a wide variety of patterns performed by children throughout the game, this number increased to 38 when variations of some of these main actions were differentiated (see Appendix Z). As already mentioned in the previous chapter, in order to preserve as much as possible of the complexity of children's movement behaviour it was decided that from this point on the variations of the main body actions would be considered.

Each one of these 38 body actions tended to be performed by only one or very few participants (mean 1.94, mode 1). The most common action was Stepping with

36.4% of the participants using it in their repertoire. Bouncing (32%) and Walking (32%), Vertical Jump (18.2%) and Turning (18.2%) were also evident amongst the children. Twenty-one of the whole number of body actions identified were only performed by one child each (4.5%). These results indicate that the overall performance of the 5-year-olds involved the choice of a specific and individual repertoire.

The previous suggestion can be reinforced by looking at the number of different actions that each child exhibited throughout the game. The wide variety of actions observed across the group was not reflected in the number of actions chosen by each 5-year-old. In other words, the individual repertoire of participants was much more limited (mean 1.66, mode 1). The number of movement patterns executed in each section of the game was also very similar. As an illustration, please see the description of the movement choices of two participants in the 5 tempi (Appendix AA). The first only used one body action type while the second participant performed a series of different movement patterns throughout the game.

6.2.1 Dominant Actions

Most children exhibited a preference for one specific body action while playing the game, and in most cases this action was clearly dominant in their overall performance, that is, it was maintained for a longer period of time (87.2%) in comparison to the other movement patterns more transient in essence (12.8%). Even though there was an alternation between dominant and transient actions, the underlying periodic motion was not interrupted. As shown in Figure 6.3, in most cases children exhibited their preferred action in all the 5 tempi.

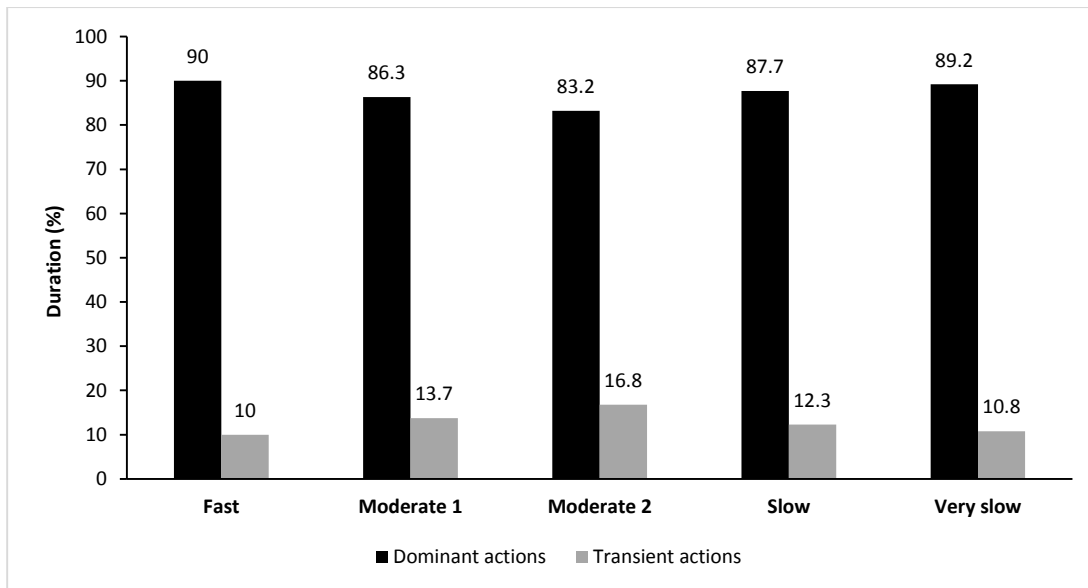


Figure 6.3: Bar chart to show the duration of the dominant and transient actions exhibited by the 5-year-olds per tempo

6.2.1.1 Inter-observer Reliability (Inter-OR)

The purpose of this specific assessment was to estimate the degree of agreement among two observers relative to the identification of the dominant pattern of body coordination exhibited by each child ($N=22$) during the game. The results showed an almost perfect agreement between both observers (Landis & Koch, 1977), $k = .83$ (95% CI, .669 to 1.00), $p < .001$, which implied that the two coders strongly agreed in their identification and designation of the dominant action performed by each 5-year-old child.

6.2.1.2 Repertoire

Figure 6.4 shows that 15 different dominant body actions were observed across the group of participants. Five of those prevalent movement patterns were common to some children while the other 10 were exclusive to one child each. Bouncing was the most shared dominant action by the 5-year-olds (18.1% of the total number of participants), followed by Split jump, Lateral pelvic Sway, Hopping and Stepping-bouncing.

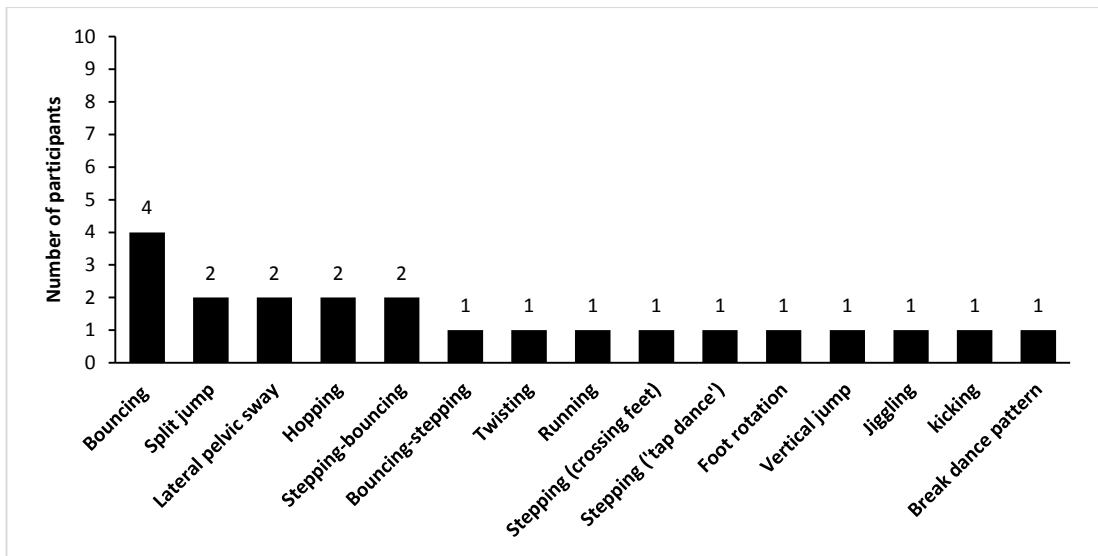


Figure 6.4: Bar chart to show the number of participants per each type of dominant body action

As shown by the graph below less than a quarter of the children exhibited a dominant action with a duration below 50% of the total amount of time of the game. In fact the majority of participants used their preferred action in a very insistent way, with 5 children performing only that action throughout the entire game, that is, across the 5 different tempi.

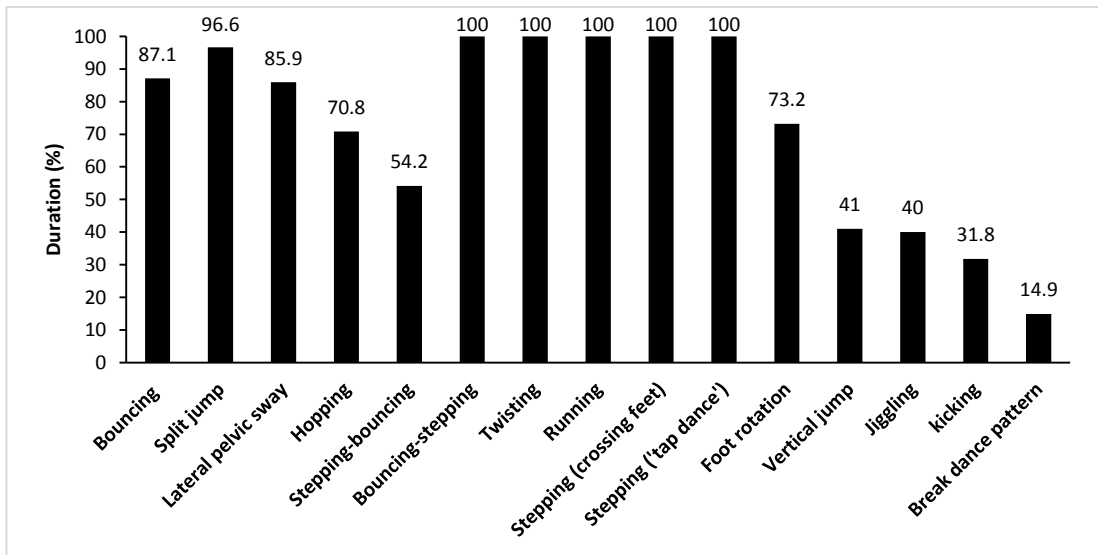


Figure 6.5: Bar chart to show the duration of each type of dominant body action performed by the 5-year-olds across all tempi

6.3 Body: Body Features (LMA)

The next three subsections will now address the constituent body features of the repertoire previously described. As already mentioned, the Body category and respective subcategories were obtained from the Laban Movement Analysis system and included in the coding schemes 2-4.

6.3.1 Gestural & Postural Movements

Most of the body actions chosen by the 5-year-olds were clearly Postural, as shown in Figure 6.6. Less than 5% of the movements exhibited throughout the game were constrained to only one body part, such as, foot tapping and foot rotation. This preference was consistently observed in all the 5 tempi.

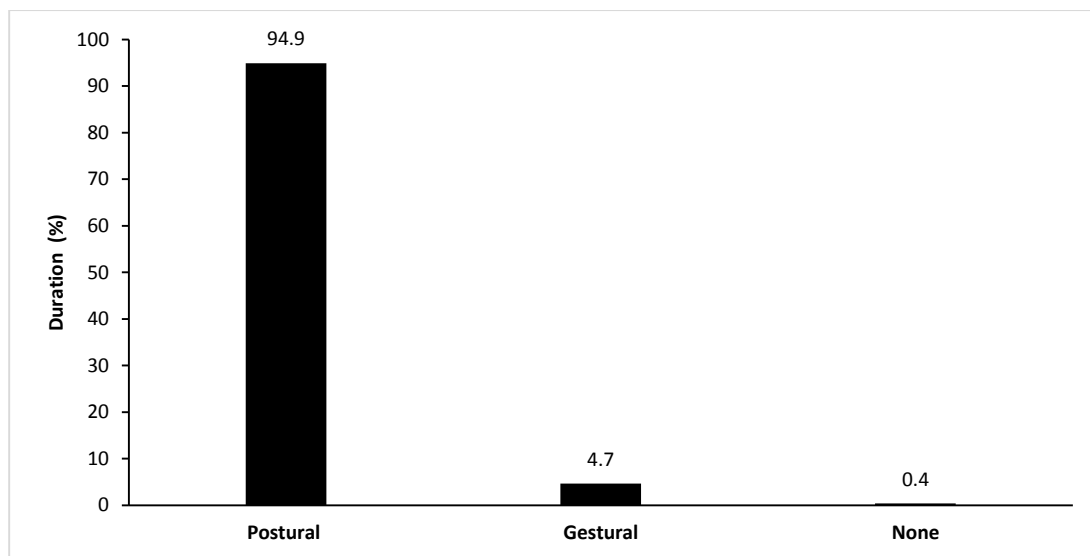


Figure 6.6: Bar chart to show percentage of time spent with regard to postural and gestural movements performed by the 5 year old children across all 5 tempi

6.3.2 Patterns of Body Organisation

In terms of the developmental patterns of body organisation, the Right/Left pattern (homolateral) was the one supporting most of children's movements (e.g. swaying), immediately followed by the Upper/Lower pattern (homologous) as Figure 6.7 illustrates. On the other hand, Core/Distal and Head/Tail patterns were not included in participants' repertoire. This was the case across all the different sections of the game.

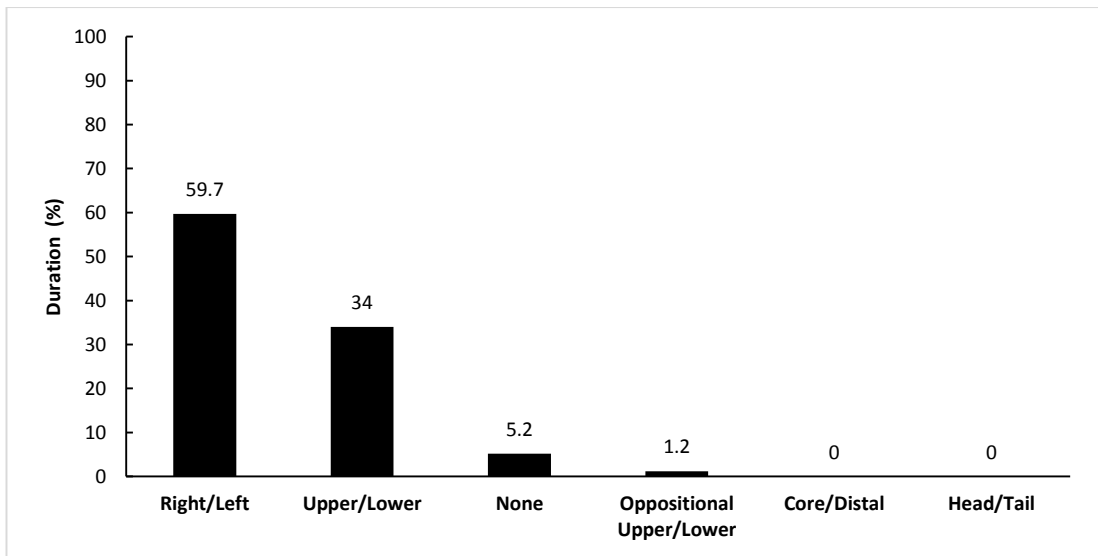


Figure 6.7: Bar chart to show patterns of body organisation exhibited by the 5-year-olds across all 5 tempi

6.3.2.1 Dominant Body Unit (Upper & Lower)

The Lower-body unit (pelvic girdle, legs and feet) was the most active in children's periodic movements. However, in some cases the Upper and Lower units had a similar importance in participants' performance. Accented movements in the Upper-body unit were the exception throughout the game. No meaningful changes were detected across the different tempi.

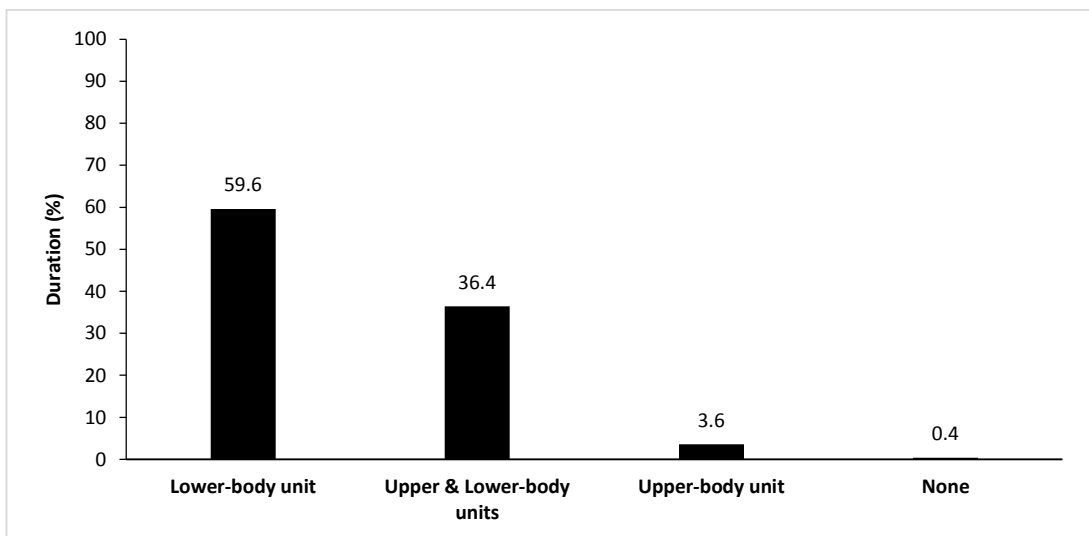


Figure 6.8: Bar chart to show prevalent body unit supporting the 5-year-olds' movements across all 5 tempi

6.3.3 Body Phrasing

The majority of the body actions performed used a simultaneous body phrasing (Figure 6.9), which implies that all body parts moved at once in response to the beat. Only two children showed (on very few occasions) a successive body phrasing, that is, adjacent body parts that moved one after the other. This exceptional situation would occur when spinal movements were involved.

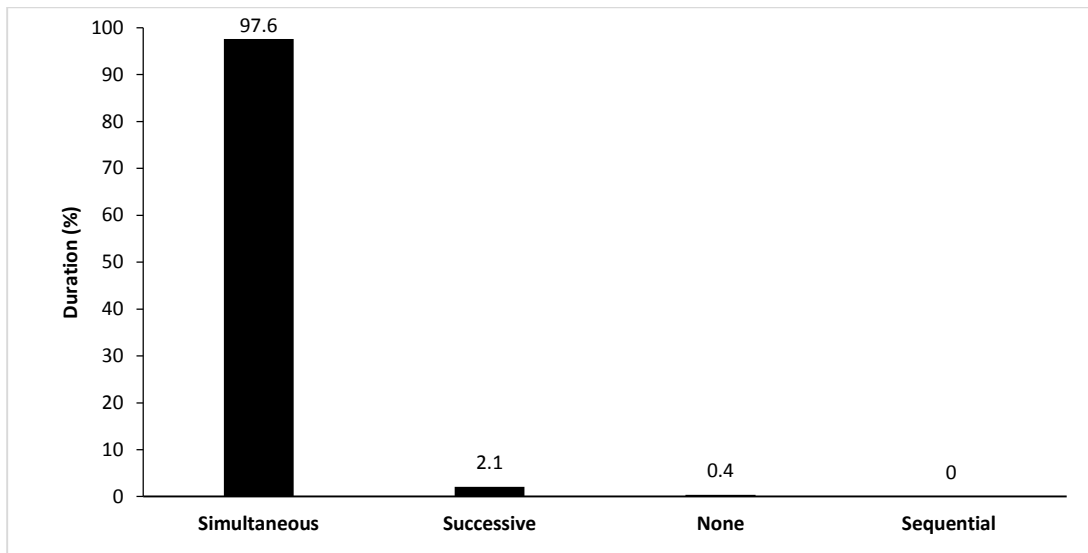


Figure 6.9: Bar chart to show percentage of time spent with regard to the different types of body phrasing executed by the 5-year-olds across all 5 tempi

6.4 Space Features (LMA)

The spatial features underlying the periodic movements performed by the 5-year-olds will now be considered in the following subsections. These findings refer specifically to the coding schemes 5-8 whose categories were LMA-based.

6.4.1 Actions in Place & Travelling Actions

In terms of the use of general space, the results show that most body actions were performed ‘in place’ throughout the game (Figure 6.10). The categories used in this coding scheme focused exclusively on the spatial features of the actions performed and not on their body quality. In other words, a ‘locomotor action’ such as running could be classified as an ‘action done in place’ if the mover decided to run on the spot, or it could be classified as a ‘travelling action’ if the mover decided to travel

from one place to another. The clear preference for actions done in place was observed in all the 5 tempi, as Figure 6.11 illustrates.

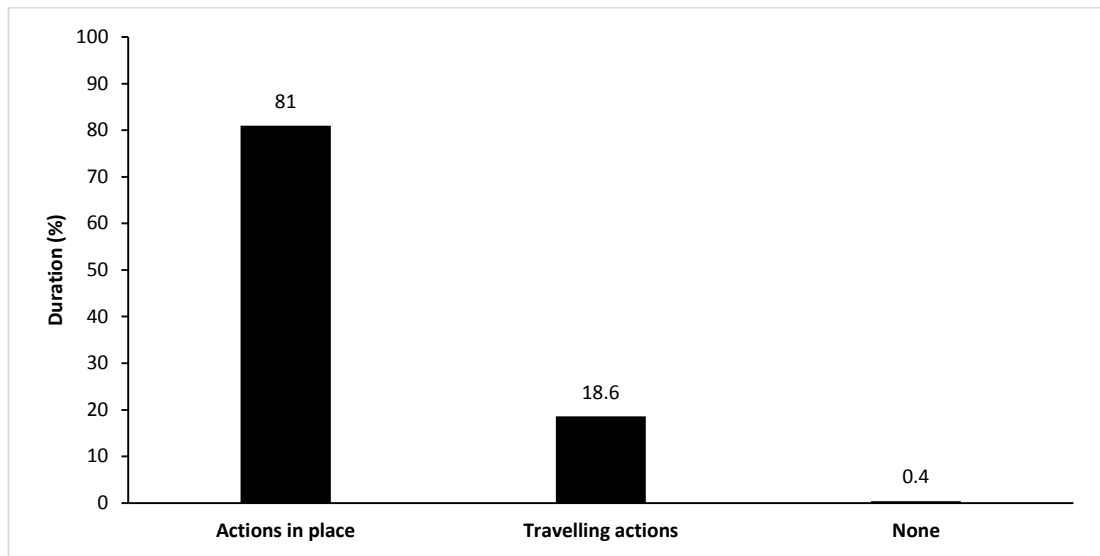


Figure 6.10: Bar chart to show the percentage of time spent with regard to actions in place and travelling actions exhibited by the 5-year-old children across all 5 tempi

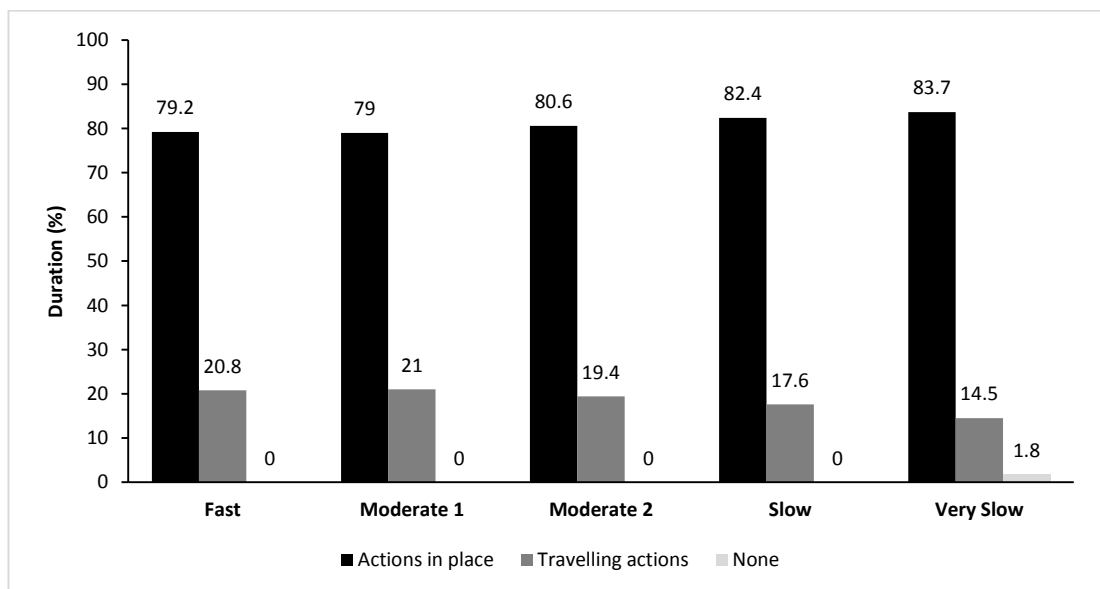


Figure 6.11: Bar chart to show the percentage of time spent with regard to the 5-year-olds' actions done in place and their travelling actions in each of the 5 tempi

6.4.2 Directions (Dimensions & Planes)

In regard to the directionality of children's body actions (peripersonal space), the results show that up-down directions were mostly used in the game to support movements executed in the vertical dimension (e.g. Vertical jump). Moreover, these directions were also used in combination with other directions to form a plane, such as forward/backward (e.g. running) or left/right (e.g. sideways split jump), as Figure 6.12 below indicates. The clear predominance of the up-down directions (Vertical dimension, Sagittal plane and Vertical plane) were maintained without meaningful changes throughout the different tempi (see Appendix AB).

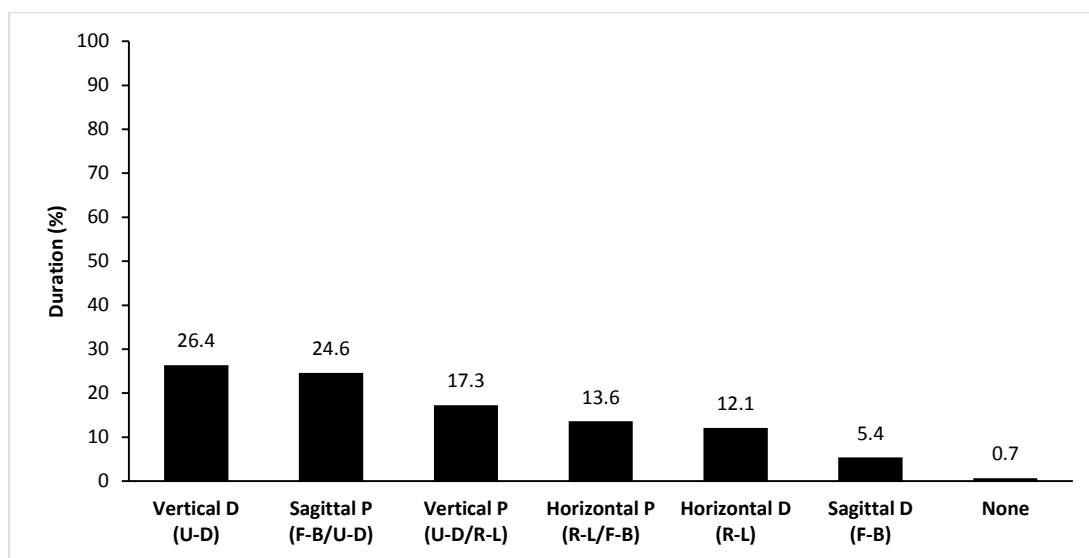


Figure 6.12: Bar chart to show the percentage of time spent with regard to different dimensions and planes of body actions performed by the 4 year old children across all 5 tempi

6.4.3 Height Level

In terms of the peripersonal space from a height level (Figure 6.13), it was found that the majority of children's actions remained at the standing height (high-level) across the 5 sections of the game without level changes being performed. Only one child decided to explore the medium- and low-height levels.

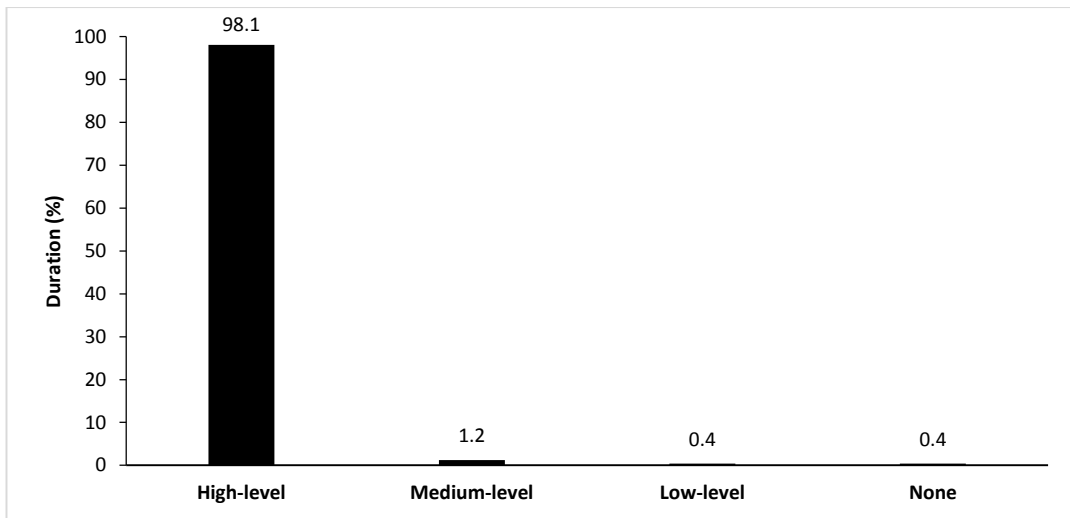


Figure 6.13: Bar chart to show the percentage of time spent with regard to different height levels used by the 5-year-olds across all 5 tempi

6.4.4 Reach Space

Most participants chose to use a mid-reach space in their performance, which means that they accessed their peripersonal space by extending their upper or lower limbs at about an elbow distance. This result was quite close to the reach-space movements that were also performed during the game, as shown in Figure 6.14 below. Movements that accessed the limits of children’s kinesphere were also observed but with a more modest percentage. These percentages were maintained almost the same throughout the 5 tempi of the game.

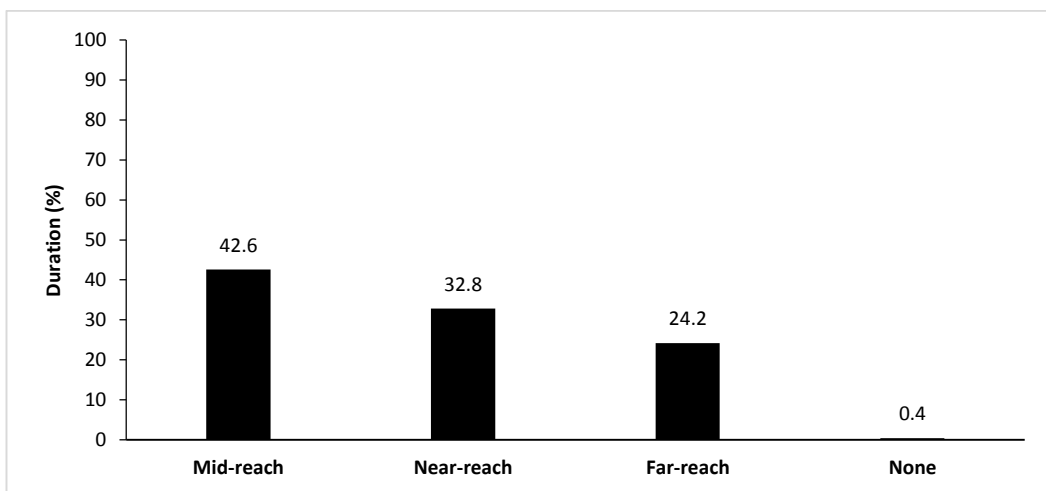


Figure 6.14: Bar chart to show the percentage of time spent with regard to the different reach space movements exhibited by 5-year-olds across all tempi

In sum, the main results showed that the 5-year-olds exhibited a spontaneous periodic motion not synchronised with the musical beat. Despite this fact, children tended to individually adjust their movement speed between the different tempi/sections of the game. Furthermore, it was found that even though there was a great variety of actions exhibited across the group of participants, each child showed a unique and small repertoire of movements and a clear preference for one of them.

Some common body and spatial features characterised the 5-year-olds' embodied responses to the musical beat. With regard to the body it was found that whole-body movements were mostly used, supported by patterns that emphasised predominantly the left and right sides. Moreover, the lower-body was the most active unit in children's movement choices with an evident and gradual integration of the upper-body. A clear preference for movements in which all body parts would move simultaneously was also identified. In terms of space, most children performed actions in place and used up-down directions, at times combined with other spatial directions (e.g. left-right). Finally, the 5-year-olds revealed a clear preference for movements executed with a high-level height and using a mid-reach space in terms of their peripersonal space.

The results regarding both the 4- and 5-year-olds' embodied responses to the musical beat will now be discussed in the following chapter.

Chapter 7

Embodied Beat: Discussion

The previous chapters (Chapters 5 and 6) presented the results regarding the 4- and 5-year-olds embodied responses to a rhythm-based music with a strong accented and regular beat presented at different tempi. The main findings showed that a spontaneous periodic motion consistently supported children's actions throughout the game. Despite the regularity of these physical accentuations, movements were overall not synchronised with the musical tempo of the stimulus. However, the young participants were still responsive to tempo changes by revealing individual speed adjustments. Furthermore, the repertoire observed across the group was diverse even though each child showed a unique set of body actions and a clear preference for one of those actions that would be consistently performed throughout the different tempi/sections of the game.

With regard to the body features, children's movements were characterised by the use of the whole body which was supported by upper-lower patterns (predominantly in the 4-year-olds) and left-right patterns of body connectivity (predominantly in the 5-year-olds). In both age groups the lower body would be the most active unit in children's performance with a gradual integration of the upper body in the case of the older children. Finally, the different body parts tended to move simultaneously rather than in a sequential progression.

In respect to the space features, most body movements were performed 'in place' by the pre-schoolers and used, predominantly, up-down directions. These movements were characterised by a high-level height and a mid-reach (peripersonal) space.

Following this brief summary of the key findings of study 2, the next paragraphs will now discuss them in more detail by addressing periodicity and synchronisation, the

repertoire of body actions and, lastly, the body and spatial components of the movements performed by the 4- and 5-year-olds.

The evidence of a spontaneous and resilient periodicity underlying the 4- and 5-year-olds' movement responses suggests that the temporal structure of the beat, more specifically the biphasic phrase on-the-beat/between-beat, was perceived and embodied by children. As follows, a direct connection between the rhythmic content of the stimulus and participants' actions could then be established. Moreover, the clarity of the periodic motion exhibited by most participants, enabled observers to tap along to children's physical accentuations and infer their dominant motor tempo in each section just by using visual cues as support (audio excluded).

It is also worth reminding that in both pilot studies the 'no beat' section of the game, which consisted of an extreme slow version of the music stimulus, clearly disturbed and interrupted the flow of participants' movements previously established in the 'beat' section(s) of the game. As suggested by McAuley (2010), "if music is performed too slowly, rhythmic organisation tends to fall apart, leaving only a series of isolated sounds" (p. 172), which in the case of this particular study corresponded to very sporadic and irregular physical accents.

According to previous studies this spontaneous embodied perception of the beat can already be observed in newborns (Winkler, Háden, Ladinig, Sziller & Honing, 2009) and young infants (Zentner & Eerola, 2010). In Eerola, Luck & Toiviainen's (2006) study these self-initiated rhythmic responses were also found in children with 2, 3 and 4 years of age when moving freely in response to music, which highly coincides with the results obtained in the present study. This is a significant finding, given that most SMS studies tend to use the tapping paradigm and thus a prescriptive approach to children's synchronisation tasks.

The mean periodicity found across participants was similar for both age groups, with the 5-year-olds exhibiting a slightly slower speed (4-year-olds: 128 bpm; 5-year-olds: 122 bpm). This is in line with Drake, Jones & Baruch (2000) who found that

individuals' spontaneous motor tempo becomes slower with increased age. However, these results are slightly different from the ones presented by Eerola et al. (2006) relatively to the 3- and 4-year-olds's mean periodicity (145 bpm). This fact could be partially explained by the use of different age groups, methodology (music stimulus, data collection procedures) and a distinct data analysis.

Even though synchronisation was not specifically assessed in this study, the periodic rates exhibited by children were clearly different from the metronomic values of the original tempi which strongly indicates that movements were not synchronised to the external beat. This evidence is consistent with sensorimotor synchronisation (SMS) studies in early childhood that have used the tapping paradigm (e.g. McAuley, Jones, Holub, Johnston & Miller, 2006, Provasi & Bobin-Bègue, 2003), but also with studies that adopted the 'move-as-you-wish' procedure (Eerola et al., 2006, Moog, 1976). They all reported that young participants (2 to 5 years of age) are often not synchronised with the musical pulse, however, when they are the movements tend to match the beat just for a very short period of time.

In this study participants have clearly shown a more limited tempo range than the one presented by the stimulus, in particular in the lower region (slower tempi). More specifically, the upper (132 bpm) and lower (35 bpm) limits of the musical tempi were slightly different from the upper (4-year-olds: M=144 bpm; 5-year-olds: M=141 bpm) and lower (4-year-olds: M=113 bpm; 5-year-olds: M=108 bpm) motor speed limits shown by the young movers. However, there was a great similarity between both age groups in terms of the mean of their speed range.

According to literature on motor tempo limits (e.g. McAuley et al., 2006), individuals' capability to move in synchrony with the beat depends on a limited entrainment region which is narrower in young children than in adults. Van Noorden's (2014) recently found that 3- and 4-year-olds are only able to tap to the beat in a narrow range around 2Hz (120 bpm) even though their synchronisation is very inaccurate. On the other hand, children between 4 and 7 years of age gradually expand the range in which they can synchronise, in particular in the slower region, which is in accordance with the findings of the present study.

Even though the mean of children's rates in each tempo suggests that speed flexibility was almost absent (see Figures 5.1 and 6.1), it was clear from an individual point of view that this was not the case. In fact, each young mover tended to show a degree of variation within their own specific motor tempo range. Interestingly, previous studies (Eerola et al., 2006; Moog, 1976) using the 'move-as-you-which' paradigm tend to dismiss these individual differences from their reports.

Despite the great deal of variability found in children's motor tempo rates as well as in their limited speed ranges, the young movers tended to exhibit overall a slower rate in response to a slower tempo and a faster rate to a faster tempo. It is worth reminding that the changes in tempo were abruptly presented to the children during the game, which means that there was no gradual transition (e.g. *accelerando* or *ritardando*) between sections. Moreover, 6 different combinations of tempi had been assigned to different children. Given all these circumstances, one may confidently claim that most 4- and 5-year-olds showed tempo flexibility in response to the music stimulus throughout their performance. The use of a slower speed in the slower sections was slightly more evident in the older age group which could indicate a developmental trait, as already suggested by Drake et al.'s (2000), Eerola et al.'s (2006) and Van Noorden's (2014) findings.

The individual differences between the 4- and 5-year-olds in terms of their motor tempo rates and speed range, as previously discussed, could be partially interpreted through the use of an embodied argument. According to Honing (2013), the research conducted by Todd, Cousins & Lee (2007) and Trainor, Gao, Lei, Lehtovaara & Harris (2009) suggests that "rhythm perception is influenced (or even determined) by our physiology and body metrics from functioning of our vestibular system to leg length and body size" (p. 384). As follows, one could speculate that each child's motor tempo preferences and speed limits could be potentially related with their body specificities and sensorimotor capabilities. Given that moving to the slower tempi (1 accentuation per beat) constituted a challenge for the participants, who tended to move twice as fast or three times faster than the original tempo, one could argue that being in synchrony with the beat (Slow section: 60 bpm; Very slow section: 35 bpm) would possibly require longer limbs and a bigger body size.

Moreover, considering that variations were observed between age groups and also within each age group, it could be suggested that developmental body traits and sensorimotor skills could have somehow influenced their experience of the musical tempi. In other words, each child's synchronised responses to a slow or very slow beat would be intrinsically dependent on how slow they could physically move. However, this is just a possible interpretation given that in this study the effect of individual physical traits (e.g. weight or size) in children's choices of movements was not investigated.

After the connection between the rhythmic content of the stimulus and the temporal structure of children's movements was determined, it became safe to claim that the repertoire of body actions exhibited throughout the game did not represent a random set of movement solutions in response to the game challenge (move-to-music & freeze-to-silence) but an individual choice that was informed and potentially shaped by the salient features of the stimulus (musical beat). As follows, one may then classify those movements as patterns of body coordination.

One surprising finding was the diversity of body actions exhibited across the group of participants, which previous studies have not clearly reported. In the case of Eerola et al.'s (2006) investigation, this variability was probably masked by the deliberate use of very few general categories to classify the type of movements performed. More specifically, children were categorised as hoppers, circlers or swayers. On the other hand, in Moog's (1976) case the reduced number of actions identified could be a consequence of the constraints experienced by most pre-schoolers during the movement task which have been reported by the author.

This repertoire of body actions was characterised by its repetitive nature as well as by an underlying periodicity, which has already been discussed. Jumping, Stepping and Running were the three most popular but also the most common actions between the 4- and the 5-year-olds. Curiously, Jumping was the most performed action during the game, which is in accordance with the fact that 'hoppers' in Eerola et al.'s (2006)

study were the majority. It is also worth highlighting that the most popular body actions identified in the game constituted the repertoire of basic sensorimotor patterns that the 4- and 5-year-olds are already expected to efficiently master (Gallahue & Ozmun, 1998).

Given that this study aimed to preserve the complexity and richness of the patterns of body coordination performed by the young children, some of these patterns fell under a single common category of movement. For instance, instead of categorising a Vertical jump, Star jump or a Sideways split jump simply as 'Jumping', it was decided that the variations would be considered as independent subcategories. This process enabled to emphasise that, each one of these actions represents a clear different and deliberate choice of a movement pattern by children that should be acknowledged.

Despite the great deal of variability across participants, it was surprising to find that each one of the body actions identified were actually performed by one or very few children, which strongly emphasises the individual nature of the repertoire. This argument is also related with the fact that the majority of the children tended to exhibit a very limited number of different body actions throughout the game. Interestingly, the individualised repertoire of each child in response to music as well as their tendency to use very few and exclusive actions in their performance, has only been previously reported by Sims (1985), however without any specific description of the body actions actually performed by the young participants in the study.

Another surprising finding was to verify that the repertoire chosen by each mover would remain in most cases identical in all the sections of the game, strongly suggesting that tempo changes were primarily experienced in terms of speed adjustments. However, even though children's repertoire was maintained unaltered this does not necessarily mean that micro physical adjustments were not made as a result of the increase or decrease of their speed.

Within the limited number of body actions exhibited by each child, there was a clear preference for one of those patterns across the different tempi. This unanticipated

finding indicates the clear choice of a dominant pattern of body coordination, in some cases the only action performed throughout the game, in response to the salient and strongly accented musical beat. It is worth emphasising that this prevalent action would be often supported and alternated by other actions transient by nature, possibly with the purpose of helping the movers to recuperate from the exertion of a repetitive movement task. Interestingly, the transition between these dominant and transient actions would not interrupt the underlying periodic motion.

Even though the choice of a dominant action was a common point between all children, individual preferences were also observed given that each mover tended to select a specific type of body action as their prevalent pattern which would be distinct from those performed by their peers. The few children who shared the same type of dominant action were inclined to jump (vertical jumping, 4-year-olds) and bounce (5-year-olds).

As previously referred, individual differences were observed across participants in terms of their repertoire of movements. However, despite the distinct rhythmic patterns observed, similarities between the movers within each age group were found, which could reflect developmental disparities. More specifically, the 5-year-olds seemed more willing to use 'dance' movements, influenced at times by stylised and conventional genres such as Hip-Hop or Ballet. It is worth reminding that the music stimulus itself did not evoke any well-known dance genre. On the other hand, most 4-year-olds tended to perform crystallised forms of the fundamental motor skills, such as, Jumping, Running or Galloping.

The clear individual and unique choices of children's repertoire to a rhythm-based music, seem to support the embodied thesis of 'body as constraint'. Different physical features and sensorimotor skills, due in part to developmental aspects, may well be determining the spontaneous selection and self-regulation of specific patterns of body coordination. As follows, one particular movement pattern may be more appropriate to one child to experience periodicity than another.

The differences between children in terms of their repertoire of movements were unexpectedly supported by great similarities regarding the Body and Space features underlying those movement choices. From this general evidence, one could immediately speculate that these common preferences may well reflect some universal characteristics of the embodied beat experience.

In terms of the Body features, most children decided to use whole-body movements in their sensorimotor repertoire. Interestingly, the few who opted for gestural movements, such as foot tapping, showed a more inhibited behaviour and seemed more self-aware of the moving task than the other participants. The tendency to use the whole body by the young movers seems to be highly in accordance with Eerola et al.'s (2006) findings and, interestingly, also with Burger, Thompson, Luck, Saarikallio & Toiviainen's (2013) study conducted with adults who were invited to move along with the music. On the other hand, these results differ from Moog's (1976) investigation that reported a stronger presence of gestures in children's performance. However, it is important to highlight that this author reported a great reluctance of most pre-schoolers to move to the music which could explain why many of them exhibited gestural movements.

Even though in this study, as well as in Eerola et al.'s (2006) investigation, postural movements were participants' first choice, it is worth mentioning that SMS research in early childhood is often assessed through tapping tasks (e.g. Provasi & Bobin-Bègue, 2003), which necessarily imply constraining young children's movements to one body part. In other words, even though findings show that children would spontaneously use large body muscles (gross motor skills) to move along with the beat, most SMS experimental studies tend to prescribe gestural movements to young participants, which often require the control of more finer motor skills (e.g. finger tapping). Although this procedure seems to facilitate a more rigorous collection of data, it is "motorically too demanding" (Eerola et al., 2006) and it seems not to represent the embodied musical choices of young children in a synchronisation task nor their individual preferences.

Both age groups showed a clear preference for two patterns of body organisation, more specifically Upper/Lower and Right/Left. However, whereas the 4-year-olds' movements mostly emphasised the connection between the upper and lower units of the body (e.g. Vertical jump), the 5-year-olds tended to highlight the connectivity of the left and right sides (bilaterality). This evidence could indicate a developmental difference between both groups. Another relevant finding showed that independently from the pattern of body organisation, the lower unit of the body was the most active in children's performance. This strongly suggests that the periodic physical accentuations were primarily experienced in the lower spine, legs or feet. However, one should also point out that in the case of the 5-year-olds there was also an increased presence of upper body unit (upper spine, arms and hands) in their physical articulation of the beat. Again, these slightly distinct responses between the younger and older children could indicate developmental disparities. This developmental hypothesis is reinforced by Burger et al.'s (2013) findings which show a "resonating effect" of a strong beat "on the overall body/torso" of adults moving along with the music and the articulation of percussive elements mainly by the "upper extremities of the body (hand, head and shoulder movement)" (p. 7). Moreover, Toivianen & Luck (2010) also found in adults that the one-beat level was embodied by movement of the arms. This may suggest that with increasing age the beat experience in the body is gradually transferred from the lower to the upper body.

As shown in Chapters 5 and 6, most children performed movements in which all body parts moved at once. The preference for a simultaneous body phrasing could be partially explained as a developmental trait given that moving the body in a sequence could represent a more effortful and complex behaviour. Nevertheless, this response could also be related with the structural features of the percussive beat. One could assume that the ongoing "bursts of energy in the musical audio stream" (Leman, 2008, p. 96), associated to a strong accented beat, are more likely to invite the whole body to experience that impact at once rather than in a successive (adjacent body parts) or sequential (non-adjacent body parts) way. Both of these later options would probably occur in response to a short melodic passage with a more clear initiation and sequencing. Moreover, it is also possible that if the slow tempi had been

experienced as such by the young children, the simultaneous phrasing would possibly be replaced by a sequential or successive movement, given that it would be easier to move the body in a sequence rather than moving it at once because of the slow speed.

As already mentioned, each pattern of body coordination was supported by a periodic physical accentuation which evidenced children's articulation of the musical beat, more specifically, of the resilient biphasic phrase on-the-beat/between-beats. The following paragraphs will now discuss the Space features underlying the young movers' movement choices and thus provide additional insights on their embodied beat experience.

The up-down directions were clearly dominant in children's performance and experienced either independently as one-dimensional movements (e.g. Vertical jump) or combined with other spatial directions, devising movements in a sagittal plane (forward-backward & up-down, e.g. running) or in a vertical plane (up-down & right-left, e.g. star jump). This spatial preference would be maintained unaltered throughout the different tempi/sections of the game. Interestingly, the present finding is highly consistent with Eerola et al.'s (2006) results regarding young children (2-4 years of age) but also with Toivianen & Luck's (2010) study with adults, which reinforces the argument of a universal embodied experience of the beat when considering some body and spatial features underlying people's individual and spontaneous repertoire of movements.

Assuming that the 'updownness' supporting most patterns of body coordination observed in this study is a response to the biphasic phrase on-the-beat/between-beats, it is likely that the accentuation experience would correspond to the downward phase of the movement, or more specifically to the end point of that motion, and the transition between accentuations to the rebound and upward phase. However, it is worth reminding that even though this biphasic spatial phrasing reflects the biphasic nature of the musical beat, this does not imply synchronisation. Another point to highlight is the fact that children's preference for movements in the vertical dimension may also be a resonance of the directionality involved in the act of

playing the djembe, the percussive instrument used in the stimulus. In other words, the 4- and 5-year-olds up-down actions could partially represent a decoding process of the direction of the drummers' hand movements, in particular of the extreme end of the downward phase that produces the impact against the base of support (i.e. drum skin).

Interestingly, previous studies suggest that when adults are asked to tap (Carson, Oytam & Riek, 2009) or bounce (Miura, Kudo, Ohtsuki & Kanehisa, 2011) in response to the beat, they tend to spontaneously coordinate their movements in order to coincide the extreme end of the downward phase with the musical beat, which consequently implies the experience of the gravitational force. However, it is suggested that this “ubiquitous tendency to make a downward movement on a musical beat arises not from perception of gravity” or “structural internalisation of its orientation” but “as a result of the economy of action that derives from this exploitation” (Carson et al., 2009, p. 5). The mentioned economy of action entails that by moving downwards the child's action is being assisted by gravity, and thus by the weight of his/her body. Moreover, stability is increased during this accentuation process given that muscle exertion is low as opposed to the phase in which greater force is required to move the body in the opposite direction of the gravitational force (Carson et al., 2009; Miura et al., 2011).

Considering that in this study most actions were performed using the up-down directions, it suggests that the biphasic phrase *on-the-beat/between-beats* coincides with the pattern *giving-in-to-gravity/pushing-against-gravity* and, consequently, with the anatomical actions *flexion/extension* (e.g. jumping and bouncing). As previously mentioned, stability is increased in the downward phase because less muscle strength is required compared to the upward phase, but also due to the fact that by moving downwards the centre of gravity of the body becomes closer to its base of support (Watkins, 2014). In short, children's articulation of the beat (downward movement) may involve a more effortless and stable experience than the between-beats phase (upward movement).

As already emphasised, the updownness of most movement patterns was also experienced in combination with other spatial directions. As follows, some children experienced the biphasic phrase on-the-beat/between-beats not only by giving in and pushing their bodies against gravity but also by transferring their weight laterally (e.g. bouncing-swaying) or sagittally (e.g. running).

If one considers the dominant body actions chosen by the young participants in terms of their underlying directionality, then an important distinction should be made and discussed. The one-dimensional movements that emphasise solely the up-down directions (e.g. bouncing) encompasses a one-cycle biphasic phrase, which means that the embodied beat is repeatedly experienced by both sides of the body simultaneously. On the other hand, dominant patterns of body coordination such as swaying, running or twisting involve a two-cycle biphasic phrase or a bilateral experience of the beat. In other words, this entails that one beat is alternately experienced in each side of the body. Considering the asymmetrical preference of most humans for one side of the body (Porac & Coren, 1981), one could speculate that behind the spontaneous choice of a bilateral pattern there is a proto-experience of metre, which in this particular case would be a duple meter (duple pattern of accents). For instance, for a right-sided child the strong accent would be most likely felt in her dominant side of the body, that is, on the right side.

Another surprising finding in terms of the spatial features underlying the 4- and 5-year-olds' repertoire is the evidence that movements were mostly done in place. Even though this finding should be looked with caution given that children were invited to move within a delineated area in the room, one could still argue that this grounding effect is probably related to the fact that most children experienced the repetitive and strong accented beat in the vertical dimension, which in essence is less likely to invite individuals to travel through space compared to sagittal-based actions. This possible connection between the 'situatedness' of the movement and the steady and salient beat has already been reported by Burger, Thompson, Saarikallio, Luck & Toivianien (2010). In their study with adult participants who had to move along with the music it was found that stimuli "with a clear rhythmic structure in the low frequency range seems to make people move much on the spot, while a less clear

structure in this frequency range rather tends to let people wander around, as if they were “searching for the beat”” (p. 425).

Most children opted by using the mid-reach space of their kinesphere across the different sections. This choice may be potentially explained by the fact that throughout their performance there were no dramatic speed changes that could have elicited a wider exploration of the different zones in their peripersonal space. Given that there was a clear preference for using a short motor tempo range, children’s reach space tended to remain almost the same throughout the game and at an elbow distance away from their body midline.

Finally, the majority of the young participants decided to adopt a high height level while executing their patterns of body coordination without meaningful level changes within and between sections. According to Davies (2003) young children tend to explore the extremes levels (high and low) whereas “the ‘in between’ medium level is used less frequently and with less understanding” by them (p. 21). As follows, one could speculate that given these preferences it is more likely for children to experience the biphasic phrase *down-on-the-beat/up-between-beats* at a high level because it will give them a greater degree of freedom and efficiency compared to movements performed at a low-level height.

To sum up, in this study clear individual and group differences were found in children’s movement choices in response to the musical beat. Interestingly, great similarities were identified in the body and spatial features supporting those patterns of body coordination.

The following points will now resume the most relevant differences and common preferences observed across the 4- and 5-year-old children and thus highlight their embodied experience of a percussive, strongly accented and steady beat. As follows, this study found:

- (1) A periodic motion underlying children's movement choices which was not synchronised to the beat
- (2) Individual adjustments to tempo changes based on each child's motor tempo rates and speed limits, which were not in accordance with the original tempi
- (3) A decreasing linear trendline from the faster to the slower tempi within each child's motor tempo range
- (4) The uniqueness of each child's repertoire, composed by a small number of movements and by a clear preference for one particular body action which was maintained across the different tempi and, in most cases, alternated with other more transient action(s) by nature (periodicity maintained during this transition)
- (5) The use of whole body movements, supported by patterns that emphasised the connection between the upper and lower body units (mostly in 4-year-olds) or between the left and right sides (mostly in 5-year-olds)
- (6) The lower body (lower-spine, legs and feet) as the most active unit in children's movements, with a gradual integration of the upper body (lower-spine, arms and hands) in the case of the 5-year-olds
- (7) All body parts moving at once rather than in a sequential progression
- (8) Most movements performed in place even when actions, clearly designed for locomotion (e.g. running), were used
- (9) A preference for up-down directions, not only in one-dimensional but also in two-dimensional movements (planes) that implied the combination with other spatial directions (forward-backward or right-left)
- (10) Movements performed at a high-level height (position around head height) and the exploration of the mid-reach space of children's peripersonal space (i.e. elbow distance away from the body midline)

Even though this study does not aim to make generalisations from the results, these evidence seems to suggest that the structural features of the music stimulus had an impact on the young children's choices of movement at some extent. Moreover, the choice of a different repertoire of body actions by most participants may possibly

indicate that each young child tended to self-regulate and shape their own embodied experience of the beat according to their body specificities and sensorimotor capabilities. Surprisingly, the underlying body and spatial features of these individual choices of repertoire could very likely reveal a more universal profile of this embodied beat experience, or in other words, a set of common responses to all humans independent from age.

The following chapters (Chapters 8 and 9) will now provide a general discussion and conclusions about the work developed in this thesis.

Chapter 8

General Discussion

This chapter will now discuss the main findings of the two studies conducted in the present thesis. Additionally, an outline of the limitations of this work, implications for practice and possible directions for future research will also be addressed.

The aim of this work was to understand embodied musical experiences in early childhood within the theoretical and empirical framework of Embodied Music Cognition, with a particular focus on the hypothesis of ‘body as constraint’. More specifically, and considering the key concerns that previous research failed to address, this project intended to identify and describe the repertoire of self-regulatory body movements of preschoolers when interacting with music and the similarities/differences of their movement choices. Two observational studies were conducted addressing respectively ‘movement-inducing-music’ (study 1) and ‘music-inducing-movement’ (study 2) situations. Whereas the first focused on musical instrument playing, the second was particularly interested in sensorimotor synchronisation to a musical beat.

The first, an exploratory study (‘experiences of musical self-regulation’), found that the 4-year-old participants exhibited a spontaneous repertoire of varied body movements, or navigational strategies, while exploring the motor commands required to play Sound=Space (S=S), an interactive musical environment responsive to people’s position in space. The sensorimotor actions observed were classified as either low-level or high-level experiences of musical self-regulation, referring to children’s ability to recognise themselves as controlling musical/sound events. Low-level experiences involved a continuous and constant locomotion performed at a fast pace (e.g. running), through the use of circular pathways. Given that these motor commands did not contribute to playing S=S in an effective way (i.e. by developing a

clear association between a desired auditory target and a specific position in space), it was argued that in this specific circumstance children were assuming the role of an ‘active listener’ (moving in response to music) rather than of a ‘player’ of a musical instrument.

High-level experiences of musical self-regulation, on the other hand, were characterised by a discontinuous locomotion exhibited at slower pace, by a readiness to stop travelling through space and by the use of straight spatial pathways. Furthermore, children tended to adjust their position in space, return to a previous location and to repeat a short spatial sequence. These specific navigational strategies, which were performed by a restricted group of participants (2 out of a group of 10), evoked a seemingly predictive and self-corrective behaviour which suggested the children’s recognition of their agency and of their role as ‘players’ (moving to generate music/sound).

Overall, the findings of this exploratory study provided suggestive evidence of potential action effects on children’s music perception. In other words, the repertoire of body movements spontaneously chosen by the 4-year-olds within Sound=Space seemed not only to reflect, but also to define and shape the nature of their listening experience. Furthermore, this study would also influence at some extent the design and the methodological procedures adopted in the following study. In particular, the use of a playful and engaging research environment that would encourage children to comfortably make individual choices of movements to music and in this way self-regulate their own sensorimotor repertoire. Moreover, it was decided that a more controlled and structured situation was needed (e.g. the use of a music stimulus focused on one specific structural feature) to allow establishing clearer correspondences between the movement and the musical content.

The results of the second study (‘embodied beat’) showed that almost all of the 4- and 5-year-old participants exhibited spontaneous periodic movements (regular physical accentuations) in response to a steady and salient musical beat which, however, were not synchronised. This finding seems to be in accordance with previous and similar research in this area (e.g. Eerola et al., 2006; Sims, 1986).

Interestingly, and despite their non-synchronised behaviour, children evidenced individual adjustments in their motor tempo to the different tempi of the stimulus.

Other findings, more related to a process-oriented approach, revealed the uniqueness of each child's repertoire and sensorimotor choices. In particular, the children showed a preference for a small number of movements and for one specific body action that was maintained consistently across the different tempi/sections of the game, and was often supported by other actions more transient in nature. These results strongly support the idea proposed by Thelen & Smith (2006) that the dynamic system tends to be attracted "or 'prefer' only few modes of behaviour" (p. 272).

However, these clear individual differences in terms of the choices of movements were somewhat paradoxically characterised by great similarities regarding body and spatial components, which has not previously been reported. Moreover, this more detailed movement analysis also highlighted some discrete developmental differences between the 4- and 5-year-olds.

With regard to the Body category the results showed children's preferences for whole-body movements, often supported by patterns emphasising the connection between the upper and lower body units (the predominant response in the 4-year-olds), and between the left and right sides (the predominant response in the 5-year-olds). It is important to highlight that gestural movements (e.g. tapping) were almost absent in this study, although they are widely prescribed in studies aiming to assess children's sensorimotor behaviour (e.g. Provasi & Bobin-Bègue, 2003).

The results obtained also showed that the lower-body unit was clearly active in response to the musical beat, with a gradual integration of the upper body in the case of the older children. Furthermore, most of the actions observed tended to use a simultaneous phrasing, that is, all body parts would move at the same time rather than in a sequential progression. This preference seems to provide suggestive evidence of a possible developmental stage, or in other words, that young children

might be less comfortable than adults in executing actions involving the independence of different body parts.

In terms of the Space category, body actions were surprisingly performed in place - even those actions usually identified as 'locomotor', such as running. Another interesting result was children's preference for up-down directions (one-dimensional movements), at times in combination with other spatial directions (two-dimensional movements). Lastly, movements tended to be executed at a high-level height and using a mid-reach space, that is, at an elbow distance from the body midline.

In sum, the beat or more specifically the biphasic phrasing of *on-the-beat* and *between-beats* was embodied by each participant through the use of a unique and small repertoire of patterns of sensorimotor coordination, and by the consistent performance of one of those actions, supported by a resilient periodic accentuation that was not usually synchronised with the stimulus beat. Despite changes in the musical tempo (i.e. increase or decrease of the 'space interval' between beats), adjustments mostly occurred in terms of speed but not in terms of the repertoire of movements spontaneously chosen by children. In other words, the same dominant action was generally maintained from tempo to tempo.

Furthermore, one of the most interesting and unique findings of this study indicated that the constituent body and spatial features of each child's repertoire of actions was very similar across children of both age groups. With this evidence in mind, one might argue that, despite the use a unique set of body movements, most children were able to recognise (decode) what seemed to be similar affordances provided by the acoustic signal of the beat.

In terms of the body, the beat was characterised in general by whole-body movements (e.g. bouncing) with a particular focus on the lower-body unit. Spatially, the beat seemed to be articulated by a resilient 'updownness' (between-beats & on-the-beat), possibly indicating the effect of gravity on the biomechanics of the beat experience. It could perhaps be argued that the influence of the up-down directions and gravity might be related with the fact that actions were mostly done in place.

The findings of this thesis were subject to limitations specific to each of the studies conducted. In study 1 ('experiences of musical self-regulation') three particular limitations were identified. The first related to the Sound=Space system itself, namely, to the fact that the auditory outcome of the children's actions would only include information relative to their spatial position in the room and not information regarding the dynamics of the movement executed. The second limitation was the use of a great diversity of musical topologies, which involved having children exploring and learning the auditory-spatial associations underlying each one of the sound maps and, thus, having less time to know in depth each one of them during the four workshops. Finally, a third limitation was the potential imitative behaviour of the children, given that they would observe each other while waiting for their turn. However, to prevent this possibility, sounds within each topology would be often altered to encourage 'tailored' spatial explorations.

In terms of the second study ('the embodied beat') two limitations were considered. The first concerned the amount of space necessary for children to move comfortably. Even though the final decision was carefully weighted, and supported by both pilot studies, it can still be argued that the use of more or less space would have affected children's actions differently. The second limitation relates to the choice of the musical tempi for the stimulus. Again, all decisions made in the study were clearly supported by literature and by information from the pilot studies. However, restricting the range of the musical tempi used and selecting deliberately more accessible rates to the participants, would probably have affected movement in a different way.

One final point still needs to be mentioned. Considering the relatively small sample size of both studies, and considering the lack of any comparative statistics conducted between groups, caution must be applied when interpreting the findings, as these might not be generalisable to the population of preschool children.

The findings of both studies have a number of important implications for future practice. The first is that self-regulatory sensorimotor processes may constitute valuable information for understanding and developing embodied musical experiences in early childhood. Rather than prescribing the repertoire of actions that children ought to perform when interacting with music, this alternative approach allows children to make their own movement choices and, in this way, shape their own musical experience according to body specificities and sensorimotor capabilities. The use of this particular approach, which allows for individual developmental differences, could not only benefit educational practice but also music research, since experimental contexts currently tend to predominantly use a prescriptive approach.

A natural progression of this work would be to continue investigating the repertoire of self-regulatory movements of young children when interacting with a musical beat, but with the addition of participation from babies and toddlers. This would allow for a rich developmental perspective of the ‘embodied beat’ in infancy, toddlerhood and early childhood. It would also be interesting to observe children’s spontaneous choices of movements when actively engaging with a different set of structural features of music (e.g. an ascending melodic sequence versus a descending melodic sequence; melody versus rhythm; duple meter versus triple meter; different degrees of salience of a beat; *accelerando* versus *ritardando* and so forth).

As suggested by Maes et al. (2014), further investigation of action effects on music perception, based on a forward model (action to perception) will be worthwhile. This type of empirical evidence may help our understanding of how young children’s motor systems and respective actions can modulate their musical perceptual experience.

Finally, in line with Embodied Music Cognition (EMC) and with common coding theory, which assumes a bidirectional flow of information between perception and action, one could propose the hypothesis that *motor development and musical*

development are coupled and thus affect each other reciprocally. This premise could constitute a valuable new line of research within EMC, worthy of future investigation.

Chapter 9

Conclusions

In the present chapter a set of conclusions will now be drawn from this research, with particular emphasis on some key ideas associated with the embodied musical experiences of the 4- and 5-year-olds.

The observational studies conducted in this thesis were both focused on children's association experiences between music and body movement, with the purpose of understanding the effects of action on music perception. Considering this line of thought, it was decided that the principal outcomes of the research would be based on an inverse modeling process (perception → action) that assumes that the listener/mover is able "to render (or decode) perceived patterns of musical expressivity into corresponding body movements" (Maes et al., 2014, p. 2). With this assumption in mind, sensorimotor responses constituted the key to 'access' young children's musical minds and related perceptual mechanisms. Inevitably, observation and analysis of body movement thus became the central element to this music research.

The intention to focus on sensorimotor behaviour from a process-oriented viewpoint rather than from an outcome-oriented approach which is often used in these type of musical studies (e.g. Provasi & Bobin-Bègue, 2003), led to the emphasis on the movement content and processes of self-regulation when interacting with music, as opposed to processes regarding the accuracy (end goal) of the executed movement.

This proposed paradigm necessarily comprised a series of implications, especially regarding the research design. One of the fundamental implications involved defining sensorimotor self-regulation as a 'free and individual choice of body movements' instead of 'an externally prescribed repertoire of actions' (e.g. finger or hand tapping

in sensorimotor synchronisation). Moreover, to facilitate these spontaneous choices of movements in young children there was a need to identify and rely on a short, groove-based stimulus with the potential to elicit effortless movement. This was particularly relevant in the ‘embodied beat’ study given its specific nature (music-inducing-movement).

By encouraging each child to self-regulate their own choices of body movements when engaging with music, variability was assumed as valuable, and not ‘messy’, research data. Interestingly, studies within this field (e.g. Eerola et al., 2006) often tend to dismiss children’s individual preferences for particular actions, and to emphasise common preferences instead. The investment of this research in identifying ‘movement signatures’ (specifically in study 2) constituted one of the original contributions of this thesis.

The intrinsic tension between universal features and specificities of children’s sensorimotor behaviour seems to reflect the tension between the degree of ‘objectivity’ (invariant ‘opportunities to act’ afforded by the acoustic signal) and ‘subjectivity’ (movement signatures based on developmental constraints and unique interactional knowledge with the environment) when analysing the musical content physically articulated by young listeners. Considering this scenario, the present research took a compromised approach by assuming the relevant contribution of both viewpoints in the understanding of embodied musical experiences in early childhood.

One final concluding point, is the fact that by allowing each child to make their own choices of movements to music, one is potentially enabling the young listener/mover to find the most effective solutions and meaningful patterns of sensorimotor coordination for him/her, as defended by the dynamic systems theory (Thelen & Smith, 1994). With this in mind, it becomes fundamental to promote in educational and research contexts self-regulatory processes that will enable each child to shape effectively their movement responses to music and, in this way, to promote positive, embodied experiences in early childhood.

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Appendix A

Musical Topologies

See enclosed CD package for this appendix

Classical Repertoire

In this specific section only 1 very short sample will illustrate the basic audio material used by Rolf Gehlhaar to compose the musical topologies presented below.

A.1 Audio file: Harp

A.2 Audio file: House Music

A.3 Audio file: Marimba

A.4 Audio file: Orchestra

A.5 Audio file: Pan Flute

New Repertoire

Each one of these topologies (below) represents a simulation of a performance in Sound=Space.

A.6 Audio file: Animal Farm

A.7 Audio file: Drum Set

A.8 Audio file: Funky Band

A.9 Audio file: Crazy Bird

Appendix B

Video clips: Sound=Space Workshops

See enclosed DVD package for this appendix

'Free Exploration' Activities

B.1 Individual Navigational Strategies (INS): Low-level Experiences of Musical Self-regulation (example 1)

B.2 INS: Low-level Experiences of Musical Self-regulation (example 2)

B.3 Group Navigational Strategies: Low-level Experiences of Musical Self-regulation

'Guided Discovery' Activities

B.4 INS: Low-level Experiences of Musical Self-regulation

B.5 INS: High-level Experiences of Musical Self-regulation - Slow and Discontinuous Locomotion Rate (walking); Readiness to Stop Locomoting (example 1)

B.6 INS: High-level Experiences of Musical Self-regulation - Slow and Discontinuous Locomotion Rate (walking); Readiness to Stop Locomoting (example 2)

B.7 INS: High-level Experiences of Musical Self-regulation – Jumping in Place
(example 1)

B.8 INS: High-level Experiences of Musical Self-regulation – Jumping in Place
(example 2)

B.9 INS: High-level Experiences of Musical Self-regulation – Straight Spatial
Pathways

B.10 INS: High-level Experiences of Musical Self-regulation – Straight Spatial
Pathways

B.11 INS: High-level Experiences of Musical Self-regulation – Spatial Adjustments;
Returning to a Previous Location

B.12 INS: High-level Experiences of Musical Self-regulation – Repetition of a Short
Spatial Pattern (example 1)

B.13 INS: High-level Experiences of Musical Self-regulation – Repetition of a Short
Spatial Pattern (example 2)

Additional Information

B.14 Sound & Silence

B.15 Collective Playing (Drum Set)

Appendix C

Ethics Research Committee

ECA – University of Edinburgh: Checklist

Research Ethics Checklist: Levels Two and Three

This code applies to all research carried out in the CHSS, whether by staff or students. The checklist should be completed by the Principal Investigator, leader of the research group, or supervisor of the student (s) involved. Those completing the checklist should ensure, wherever possible, that appropriate training and induction in research skills and ethics has been given to researchers involved prior to completion of the checklist, including reading the College’s Code of Research Ethics.

This is particularly important in the case of student research projects.

If the answer to any of the questions below is ‘yes,’ please give details of how this issue is being/will be addressed to ensure that ethical standards are maintained.

1 THE RESEARCHERS	
Your name and position	Ana Paula Ramos da Rocha Almeida PhD student
Proposed title of research	Movement Repertoires of 4 and 5-Year-Old Children in Response to Music
Funding body	Self-funded (until December 2011); Foundation for Science and Technology, Portugal (from January 2012 to January 2013)
Time scale for research	24 months
List of those who will be involved in conducting the research, including names and positions (e.g. ‘PhD student’)	Ana Paula Ramos da Rocha Almeida (PhD student) Dr Katie Overy (Senior Lecturer in Music) Professor Dorothy Miell (Vice Principal and Head of the College of Humanities and Social Science)
2 RISKS TO, AND SAFETY OF, RESEARCHERS	
Those names above need appropriate training to enable them to conduct the proposed research safely and in accordance with the ethical principles set out by the College	No
Researchers are likely to be sent or go to any areas where there safety may be compromised	No
Could researchers have any conflicts of interest?	No

3 RISKS TO, AND SAFETY OF, PARTICIPANTS	
Could the research induce any psychological stress or discomfort?	No
Does the research involve any physically invasive or potentially harmful procedures?	No
Could this research adversely affect participants in any other way?	No
4 DATA PROTECTION	
Will any part of the research involve audio, film or video recording of individuals?	Yes Audio and video recordings.
Will the research require collection of personal information from any persons without their direct consent?	No Permission to participate will be sought from parents as well as from the children who will be involved in the research. Please, find attached the 'Information letter for parents' and 'Parental consent form'.
How will the confidentiality of data, including the identity of participants (whether specifically recruited for the research or not) be ensured?	The children's names and other identifying information will be kept separate from the video and written data collected. Participants will be identified by a number in a database, and no personally identifying information will be kept in the database, apart from age and gender. In order to preserve children's anonymity in conferences, pixel resolution of the videos will be reduced but without jeopardising the viewing of participants' body movements.

<p>Who will be entitled to have access to the raw data?</p>	<p>Myself. My PhD supervisors will have access to raw data, which will not include participants' names or other personal information such as age.</p>
<p>How and where will the data be stored, in what format, and for how long?</p>	<p>The audio and video recordings will be stored in digital format (MPEG files) and the visual and written data will be deleted once there is no further research use for it.</p>
<p>What steps have been taken to ensure that only entitled persons will have access to the data?</p>	<p>The database and video files will only be stored in two external hard disk drives. The only exception to this procedure is when video files, one at a time, are being edited and analysed in <i>The Observer XT</i>. This software will be installed either in my laptop or in one of the computers of the Psychology Department (University of Edinburgh). During video analysis, the internet connection will be turned off.</p> <p>No one can access, read or listen to video data without my personal password. All written informed consent forms, sheets with participants' names and the hard drives will be stored in a locked cabinet in my office at the University of Edinburgh.</p>
<p>How will the data be disposed of?</p>	<p>The raw data will be securely deleted from both hard drives and any printed copies of material will be shredded once there is no further research use for it.</p>
<p>How will the results of the research be used?</p>	<p>The overall results of this study will form a crucial component of the work for my PhD research. Results may be reported and published in scientific journals and conferences.</p> <p>Still images and a selection of video clips (30 seconds) of children's movements, without identifying their names or other personal information, will be included in</p>

	my thesis (DVD) and may be shown at scientific conferences. In these short video clips although pixel resolution is reduced, participants' movements still need to be observable.
What feedback of findings will be given to participants?	When data analysis is complete teachers, children and parents will be informed of the main results of the study via a short report of 2 pages.
Is any information likely to be passed on to external companies or organisations in the course of the research?	No
Will the project involve the transfer of personal data to countries outside the European Economic area?	No
5 RESEARCH DESIGN	
The research involves living human subjects specifically recruited for this research project <i>If 'no' go to section 6</i>	Yes
How many participants will be involved in the study?	Approximately 30-60 participants (depending on the number of children of 4 and 5 years old in the Nursery/Primary School who agree to take part in the research study).
What criteria will be used in deciding on inclusion/exclusion of participants?	Inclusion: Children must be 4 and 5 years old attending a Nursery/Primary school in Edinburgh. Exclusion: none.
How will the sample be recruited?	Several schools have been approached through the help of Dr. Jan McIntyre, Lecturer Developmental Physical Education at Moray House School of Education, University of Edinburgh.
Will the study involve groups or individuals who are in custody or care, such as students at school, self help groups, residents of nursing home?	Yes The study involves the voluntary participation of 4 and 5-year old children at a Nursery and Primary School in Edinburgh. Their parents will be asked to sign an informed consent form, and children will have to affirmatively and verbally agree in participating in the research.

	<p>The researcher will not spend time alone with each child in the Nursery/School premises in the absence of a carer or guardian.</p>
<p>Will there be a control group?</p>	<p>No</p>
<p>What information will be provided to participants prior to their consent? (e.g. information leaflet, briefing session)</p>	<p>Parents of potential young participants will be sent an information letter and a consent form to be signed before the study begins. They will also be given a copy of the written consent to retain for their own use.</p> <p>Parents will be informed that they can ask questions and contact the researcher and her principal supervisor (by phone or by email) at any stage. They will also be informed that they can withdraw data about their child at any stage and for any reason.</p> <p>Children's assent will be renegotiated verbally at each stage of the research, enabling the young participants to withdraw from the study at any time they wish to do so. If possible, the verbal assent will be obtained in the presence of an adult who is known to the children.</p> <p>Children will know that they have the right to refuse to participate and that their decision will be respected and with no negative outcomes. Appropriate signals (verbal or non-verbal) will also be agreed between researcher and each child to point out the participants' will of discontinuing a particular activity if they experience discomfort.</p> <p>Participants will be informed that they can ask questions at any time and at any stage. All verbal explanations will match children's age and level of understanding.</p>

Participants have a right to withdraw from the study at any time. Please tick to confirm that participants will be advised of their rights	<input checked="" type="checkbox"/>
Will it be necessary for participants to take part in the study without their knowledge and consent? (e.g. covert observation of people in non-public places)	No
Where consent is obtained, what steps will be taken to ensure that a written record is maintained?	All informed consent forms will be kept in a locked cabinet in my office at the University of Edinburgh.
In the case of participants whose first language is not English, what arrangements are being made to ensure informed consent?	An accurate translation of the informed consent form, information letter for parents and verbal script will be available in participants' native language if requested.
Will participants receive any financial or other benefit from their participation?	Yes A musical workshop will be provided by the researcher to all participants at the Nursery/Primary School after data collection.
Are any of the participants likely to be particularly vulnerable, such as elderly or disabled people, adults with incapacity, your own students, members of ethnic minorities, or in a professional or client relationship with the researcher?	No It is unlikely but possible that disabled participants and children from ethnic minority groups will be involved in the research. I have obtained Enhanced Disclosure certificate in Scotland, which enables me to work with these groups.
Will any of the participants be under 16 years of age?	Yes Participants will be 4 and 5-year-olds.
Do the researchers named above need to be cleared through the Disclosure/Enhanced Disclosure procedures?	No I have already obtained an Enhanced Disclosure certificate in Scotland for this project.
Will any of the participants be interviewed in situations which will compromise their ability to give informed consent, such as in prison, residential care, or the care of the local authority?	No

6 EXTERNAL PROFESSIONAL BODIES	
Is the research proposal subject to scrutiny by any external body concerned with ethical approval?	No
If so, which body?	-
Date approval sought	-
Outcome, if known <i>or</i>	-
Date outcome expected	-
7 ISSUES ARISING FROM THE PROPOSAL	
<p>In my view, ethical issues have been satisfactorily addressed.</p> <p>Signature Ana Almeida</p> <p>Date 11.12.2011</p>	

Ethical consideration by School

The following section should be completed by the Head of School once the proposal has been considered by the School's research group.

I can confirm that the proposal detailed above has received ethical approval from the School [* subject to approval by the external body named in section 6]

Signature

Date

* Delete as appropriate

Appendix D

Information Leaflet, Parental Consent Form and Certificate of Participation



THE UNIVERSITY *of* EDINBURGH

Research Study in Music Education and Music Psychology

Dear parents,

My name is Ana Almeida and I am a PhD student at the University of Edinburgh. My study aims to understand how 4 and 5 year-olds move and dance spontaneously to music. Given the lack of scientific knowledge in this area, I expect that this research can contribute to the improvement of children's music learning experiences in Nurseries and Primary Schools.

Over the course of January and February of 2012, I would like to:

- Invite each child to **play a game** for 2 minutes.
- **Observe** children's spontaneous movements by making notes and by **audio and video recording** them playing that game.
- Have a short and **informal conversation** with each child, immediately after the game, about their impressions of that specific activity.
- Offer a **musical workshop** in February 2012 to all the young participants of the study as a reward for their collaboration.

All information collected, and any audio or video recordings made, will be kept private and confidential, and will be deleted once there is no further research use for it. Recordings and images will only be shown as part of my thesis, in scientific journals or at academic conferences. In order to preserve children's anonymity, the pixel resolution of the videos and images will be reduced. When the results of the study are reported, the name of the Nursery and Primary School and the names of the children will be changed.

I would be very grateful if you would allow your child to participate in this research by signing the attached consent form. Participation is voluntary and you have the right to withdraw your child from the study at any time. Please note that throughout the study I will also ask the children if they are happy to participate in a game, to have an informal conversation with me and to be audio and video-recorded.

If you have any questions, please feel free to contact me at 0746 668 1206 or A.P.Almeida@sms.ed.ac.uk, or my supervisor, Dr. Katie Overy at 0131 650 8248 or k.overy@ed.ac.uk. You can also contact me if you would like to know the results or receive a copy of any publications arising from the study.

Many thanks in advance!
Ana



The University of Edinburgh is a charitable body, registered in Scotland, with registration number SC005336.



THE UNIVERSITY *of* EDINBURGH

Parental Consent Form

I have been given information about my child's participation in Ana Almeida's research, which is being conducted for her PhD degree at the University of Edinburgh, under the Supervision of Dr. Katie Overy and Professor Dorothy Miell.

I understand that, if I consent to my child's participation, he or she will be invited to:

- **Play a game** for 2 minutes.
- Have a **short and informal conversation** with Ana immediately after the game, about his/her impressions of that specific activity.
- **Be audio and video-recorded** while playing the game and during the informal conversation.
- **Participate in a musical workshop** run by Ana in February 2012, as a reward for his/her collaboration in the study.

I understand that my child's participation in this research is voluntary, and that I can withdraw him or her from it at any time. I have been assured that any information my child provides, and any images and recordings he or she features in, will be kept private and confidential, and will be deleted once there is no further research use for it. Images and recordings will only be shown as part of Ana's thesis, in scientific journals or at academic conferences. I have also been assured that in order to preserve children's anonymity, the pixel resolution of the videos and images will be reduced. I am aware that throughout the study, my child will be asked if he or she is happy to take part in a game, to have an informal conversation with Ana, to be audio and video-recorded and to participate in a musical workshop.

If I have any questions, I know that I can contact Ana Almeida at 0746 668 1206 or A.P.Almeida@sms.ed.ac.uk, or Dr. Katie Overy at 0131 650 8248 or k.overy@ed.ac.uk. I also know that a two-page report will be sent by Ana Almeida with the results of this study. And I was informed that I can contact the researcher if I would like to access any publications arising from the study.

By signing below, I am indicating that I consent for my child to participate in this study.

Child's name

Parent's signature

Date:

Please tick below as appropriate:

My child has never had music
classes.

My child has never had dance
classes.

The University of Edinburgh is a charitable body, registered in Scotland, with registration number SC005336.

Certificate of Participation

Awarded to

For taking part in the study

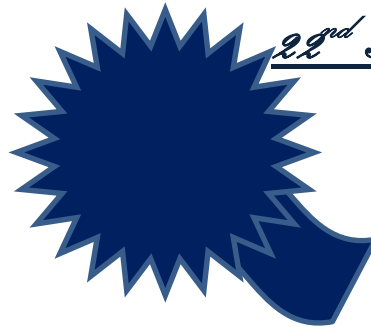
"Spontaneous Movements of Young Children in Response to Music"

Reid School of Music ~ Edinburgh College of Art ~ The University of Edinburgh



29th February 2012

Signature Ana Almeida, PhD Student



Appendix E

Ethics in Child Research

E.1 Introduction

Conducting research that aims to observe and understand 4- and 5-year-olds embodied musical behaviour necessarily entails working directly with young children as participants. The design of the current study inevitably raised a series of ethical issues that were carefully considered at the different stages of the investigation, and which required knowing *a priori* a set of ethical principles regarding the early years. As follows, one will now describe some of those basic principles but only after examining how the term ‘child’ is defined and the different standpoints from which childhood is viewed in social research.

United Nations Convention on the Rights of the Child (UNCRC, 1989), ratified in 1991 by the UK government, defines child as “every human being below the age of 18 years unless under the law applicable to the child, majority is attained earlier” (article 1). It also states that children have the right to freely express their own views in all matters that directly affects them according to their age and maturity (article 12). Both these points became the laying foundations for the present research since its very early stage.

Allison James at the Children and Social Competence Conference, Guildford 1995, argues that the standpoint from which the researcher decides to study children should be carefully considered because of its different ethical implications (Alderson & Morrow, 2004). The methods used, the sample selected for the study, and the interpretation of the findings “are all influenced by the view of children that we [as researchers] take” (Morrow & Richards, 1996, p. 99). The dominant model, influenced by developmental psychology for most the 20th century, has been recently refuted since it “constructs children as *human becomings* rather than fully *human beings*” (Qvortrup, 1994, p.4). Allison James (as cited in Morrow & Richards, 1996) recognises that “the developing child perspective undervalues children’s competencies and when children’s voices are elicited their words may not be taken seriously or even trusted” (p. 99). The developmental view tends to assume children as immature beings lacking knowledge and power.

According to O’Kane (2000) there has been paradigm shifts in childhood research which “involved repositioning children as the subjects, rather than the objects of research” (p. 139) and in some cases inviting children themselves to interpret and shape the research process. Alternative overlapping models to the ‘developing child’ ideal type are now currently in use. Allison James identifies three other ways of ‘seeing’ children in research: the ‘tribal child’, the ‘adult child’ and the ‘social child’ (Morrow & Richards, 1996, p. 99). The tribal child perception recognises that children are competent actors but inhabit an independent world which is conceptually different and separate from that of adults (researchers included). In both the ‘developing child’ and ‘tribal child’ constructions, “children are unable to have the same status as adults” (O’Kane, 2000, p. 139). On the other hand, the ‘adult child’ and ‘social child’ are both socially competent but while in the first children are seen as participants in an adult-centred universe the fourth model, as Allison James states, “understands children to possess different competencies, a conceptual modification which...permits researchers to engage more effectively with the diversity of childhood” (as cited in Morrow & Richards, 1996, p. 100). This theoretical model was the one chosen to approach the 4- and 5-year-olds in the present study.

By accepting to recognise children as agents in their own right and as being able to competently express their everyday worlds, the current research appeared to correspond broadly to the ‘social child’. A set of research strategies and techniques were developed accordingly to enable the young participants to make their own choices at some extent and thus allowing the researcher to understand their natural and free embodied experiences in response to music. When “researchers accept theories of childhood that accept children as real people, more mutually respectful ethical relationships during projects develop” (Alderson & Morrow, 2004, p. 22). Acknowledging and respect each child’s competencies during the research process forms the basis for this newer approach, which consequently implies encouraging children to become active participants. As the philosopher Max Wartofsky (as cited in Qvortrup et al., 1994) states:

“...the child is active in its own right, not simply imitatively, but as...an agent in its own construction and as naturally an agent as any adult, in the sense of agency that concerns the initiation of action by choice” (p. 3)

E.2 Disclosure, Ethics Guidance and Ethical Approval

The first ethical procedure to be sought in studies involving young children is the criminal records background checks, which in this particular research were carried out by Disclosure Scotland under the Protecting Vulnerable Groups Scheme and legislation.

After obtaining Disclosure, information was gathered to clarify any ethical issues and anticipate potential challenges in conducting a project with children. Different existing ethical guidelines supported and outlined the initial planning stage of the research (aims, methodology, analysis and report of findings), more specifically UNCRC (1989), the ethical codes from the British Psychological Society (2009) and the British Sociological Association (2002), the Data Protection Act UK (1998) and Alderson & Morrow's (2004) ten points on ethical research with young children.

Ethics guidance was also sought from senior researchers specifically experienced in conducting studies with young participants. "Research involving children requires particular care (...). Specialist advice and expertise should be sought where relevant" (Statement of Ethical Practice for the British Sociological Association, 2002). Subsequently, and taking into consideration the different guidelines and the expert consultation, an application was submitted to ECA Research Committee of the University of Edinburgh, and Ethical Clearance was obtained. To support the application form other documents were attached, such as a provisional timetable for data collection, an information leaflet and the informed consent form to be given to parents. According to Alderson & Morrow (2004) "RECs [Research Ethics Committee] can help to prevent poor research, safeguard research participants, and be a protective barrier between potential participants and researchers. RECs [also] help to raise awareness and serious concern about ethical standards of research" (p.77).

Although these guidelines and procedures are relevant information to consider during the planning and design stages of a study, it also was important to acknowledge that ethical questions could arise at any point in the research. Morrow & Richards (1996) suggest "that ethical considerations need to be situational and context specific and

above all, ongoing throughout the process of research, from inception to dissemination of the findings” (p. 96).

Child protective regulation is a much debated issue which is permanently trying to balance the impact of adults’ views in a children’s world. There “is a tension between adults regulating children’s lives, on one hand, and giving voice to children’s protective rights, on the other (...). Measures that purport to protect and sustain the rights of children may in turn, work to limit their rights as, in reality, children do not have the same rights as adults” (Danby and Farrell, 2004, p. 37).

In research ethics two main topics are generally at the centre of debates, more specifically, the informed consent and the safeguard of research participants. The first point will now be explained.

E.3 Informed Consent

Consent is the basic and central ethical act of scientific research. In 1947 the Nuremberg Code, the first international guidelines on ethical research to be written, stated that,

“...the voluntary consent of the human subject is absolutely essential. This means that the person involved (...) should have legal capacity to give consent; should be so situated as to be able to exercise free power of choice, without the intervention of any element of force, fraud, deceit, duress, over-reaching, or other ulterior form of constraint or coercion; and should have sufficient knowledge and comprehension of the elements of the subject matter involved, as to enable him to make an understanding and enlightened decision”.

Not only research participants should be “competent to make a rational and mature judgement” but their agreement should also “be voluntary and free from coercion and influence” (Homan, 1991, p. 71). When the consent is informed it means that “all pertinent aspects of what is to occur and what might occur are disclosed to the subject and that subject should be able to comprehend this information” (Homan, 1991, p. 71).

Although social researchers are subject to pressure from people and institutions such as REC’s, to protect the dignity, rights, safety, and well-being of actual or potential

research participants, “no law compels [them] to observe ethics guidelines on consent” (Alderson & Morrow, 2004, p. 98). Respecting consent and refusal not only helps to avoid harm and abuse but also defines the standards of deference for the relationship between all stakeholders of the research (Alderson & Morrow, 2004).

Before consent from participants was sought, several other permissions had to be obtained from the official adult gatekeepers. A written approval from the Head teacher was firstly obtained via email to conduct the research in the Nursery and Primary School premises with the young children and in collaboration with the school staff. It was then followed by a verbal authorisation given by the teachers whose classes would be directly involved in the project. One of the Nursery teachers would become a key element during the data collection stage, offering herself to help the researcher establishing contact with the other teachers and Head teacher, distributing documents to parents, planning the best schedule for the musical activity designed by the researcher to take place during the school daily routines, and identifying the best setting for that event. The success of this research depended greatly on teachers’ collaboration but particularly on the active involvement and interest of this Nursery teacher.

The next step was to ask for consent from parents or people with parental responsibility before the 4- and 5-year-olds were asked to participate in the study.

E.3.1 Research Information Leaflets and Limited Disclosure

The core basic information about the research was set out in simple leaflets to be distributed to parents and teachers. “Using simple leaflets could help to overcome ignorance, resistance and even fear, and encourage more efficient and respectful working relationships between adults and children and young people” (Alderson & Morrow, 2004, p.83).

Nevertheless, and considering that the purpose of the research directly depended on children’s natural behaviour, it was decided that the most relevant points of the study would only be partially and verbally explained to the young participants in a specific moment of the study and by using communicational strategies that would not

compromise their spontaneity. Thus, although children's parents were fully informed beforehand, the aims or methods of the study were not completely disclosed and described to the children. This procedure was acceptable since it involved minimal risk to participants, the potential benefits for them justified the limited disclosure whose precise extent was well defined, and their rights were always taken into consideration.

Spicker (2011) defines covert research as "research which is not disclosed to the subject – where the researcher does not reveal that research is taking place" pointing out as one of the common examples the situation when "a researcher sees and records something when people have not realised that research is going on" (p. 119). The author argues that this type of ethical research is often wrongly mistaken with the concept of deception which "by contrast, occurs where the nature of a researcher's action is misrepresented to the research subject". (...) Researchers who engage in deception mainly say they are doing one thing when they are actually doing another" (Spicker, 2011, p. 119).

The main justification for limiting disclosure to the 4- and 5 –year-olds in both studies was practical and methodological. This decision was not age-related and it would have been made even if adults were participating. Obtaining a formal informed consent from the young participants would have interfered with the naturalistic observation and potentially would lead to significant behavioural changes that could compromise the scientific validity of the research. "Every researcher knows, or should know, that experience of being observed is likely to affect the behaviour of the person who is being observed. (...) Limiting disclosure by the researcher is the obvious way to counter that problem" (Spicker, 2011, p.120). However, it is important to say that children were fully informed in a specific moment of the research that a specific activity would take place and that they would be free join it or not. The information undisclosed to the participants was only the one that could prevent children from exhibiting individual and spontaneous movement choices during data collection stage. "The rules which are applied to covert research necessarily apply to any equivalent situation where people are not aware that research is taking place" (Spicker, 2011, p.131).

Even though researchers must not assume that the leaflet would be read by all those involved (parents and teachers), this informative document should still be written in order to explain them who the researcher is, what intends to do and aims to achieve and why should the research be conducted and how. The leaflet particularly used in this study identified the researcher, the topic and purpose of research and who would benefit from the findings. It also described very clearly what children would be asked to do, the methods to be used, the duration of the activity and the scope of short informal conversation that would take place afterwards, as well as the type of compensation that would be given after the data collection. This document also assured parents that they could withdraw from the study at any time and without any consequence and that their children could do the same when asked to play the game. Information about how the data would be used and disseminated was also given. The contacts of the main researcher and from another member of the research team were additionally provided.

Considering the considerable number of participants in the study and also in order to avoid taking extra time from parents, it was decided that parents would only be informed via the informative leaflet. For any clarification they would be able to contact the researchers directly, by phone or by email.

E.3.2 Parental and Children's Informed Consent

After the research stakeholders have been conveniently informed, they were invited to evaluate if it was worth taking part in the research project and to ask any questions before accenting or refusing consent. "Consent has an impact on all rights. It is about selecting options and personal preferences, negotiating, accepting or rejecting them. Beyond choosing, consent involves deciding and becoming committed to the situation" (Alderson & Morrow, 2004, p. 96). It was fundamental to give an honest and respectful chance to refuse, withdraw, or agree to take part in some or all parts of the research because people may be afraid or too embarrassed to refuse to say no.

In this research parental and children's consent was sought differently not only for methodological reasons, as already mentioned, but also in order to assure the ecological validity the research. It is important to emphasise that the only people who

could give legally valid consent were the children and those with parental responsibility. For this particular research informed consent was obtained both from parents and children. According to Alderson & Morrow (2004) “the capacity or competence to consent involves: having the capacity to make a choice about a particular proposed treatment; knowing the risks, benefits, alternatives; understanding that consent is ‘voluntary and continuing permission’ and that consent can be withdrawn at any time’; each person being informed ‘fully, frankly, and truthfully’ with reasonable care and skill” (p. 102). They also stated that it is “hard to demonstrate competence, and easier to spot incompetence” (2004, p. 104).

Following the clarification on the leaflet about the research aims, methodological procedures and dissemination of the findings, parents or others with parental responsibility (either the mother or father, or one of the guardians) gave their consent by signing a written form, which as previously mentioned described the main points of the study already covered by the initial informative document. A copy of both the leaflet and the signed consent form was then distributed to the parents.

Alderson & Morrow (2004) state that although ethical guidance often uses the expression ‘children’s assent’ these authors argue that consent is preferable. Three reasons are pointed out. First, assent is defined as an agreement by minors who have no legal right to consent, even though the English Gillick ruling (1985) and the Scotland ‘The Age of Legal Capacity Act 1991’ recognises the legal capacity of a person under the age of 16 to consent medical treatment in his or her behalf, without the need for parental permission or knowledge. “Children, therefore, who can make informed, ‘wise’ and *Gillick*-competent decisions are giving consent/refusal rather than assent” (Alderson & Morrow, 2004, p. 97). Secondly, assent may also refer to children’s agreement without being informed of all main issues related to the project and thus only a partially informed decision will be made. And finally, “assent can mean *at least not refusing*” which in some circumstances could disguise a potential refusal of children who are too afraid or confused to say no (Alderson & Morrow, 2004, p. 97). The subjectivity of the term competence is also considered by Morrow & Richards (1996) who argue that its legal definition tends to be mainly focused on the chronological age of the individual. “Children’s competence to consent to

participate in research depends partly on the context and partly on precisely what they are consenting to undertake” (p. 95).

After obtaining parental permission the researcher was now able to ask directly the group of young participants for their consent, which meant that parents’ refusal would override children’s intention to participate. Nevertheless, it was decided that children’s refusal would override parental consent.

Children’s informed agreement was sought verbally in a specific moment of the research process. As previously explained, this information was limited to the description of a specific activity which would be video recorded. The 4 and 5 year-olds would be invited to play that activity and to freely decide if they wanted to participate or not. The scope of the research (aims, methods and dissemination) was intentionally concealed to avoid interferences with children’s spontaneous behaviour while playing the activity. According to the *Code of Ethics and Conduct of the British Psychological Society (2009)* it is fundamental to ensure “that (...) [participants], particularly children and vulnerable adults are given ample opportunity to understand the nature, purpose, and anticipated consequences of (...) research participation, so that they may give informed consent to the extent that their capabilities allow” (p. 12).

The information provided to children, which enabled them to give an informed verbal consent, referred to their participation in a very short musical activity. This event would be firstly described to all participants collectively and then individual permission would be sought. A very clear and accessible language was used in the instructions taking into consideration the age of participants. Children were also informed that the researcher would be happy whether they were willing or not to participate in the event. They were also told that it was possible to change their mind at any time, or in other words, that they could decide to play the activity after an initial ‘no’ or that they could decide to stop playing the game whenever they wished to. The 4- and 5-year-olds could either verbally inform the researcher about that change or they could just raise their hand if preferred.

This information was given in a very informal way and by adopting communicational and familiar strategies often used by children's teachers. The type of interaction used also aimed to prevent each child from thinking that they would participate in a 'serious' task rather than in a playful and engaging one. It was fundamental to find the right balance between asking for their consent and keeping the level of interest and curiosity in relation to the activity that was about to take place. Spending too much time with explanations prior to the event could potentially affect children's enthusiasm and, consequently, the spontaneous quality of their movement choices to music.

Even though most children gave their informed consent, it was fundamental to remain alert for any signs of distress during the activity. The observation of their body language was a fundamental cue to understand if some children would want to stop playing the activity without verbally expressing it either because they felt too embarrassed or fearful to say it. This was one of the strategies used to overcome the disparities in power and status between adult and children.

The direct intervention of the researcher during the activity occurred in two cases. In the first case, one child decided to withdraw from the study once she was reassured several times that she could stop playing the activity at any time and without causing inconvenience to anyone. The avoidance of eye contact, eyes looking down, hollow trunk, and lack of enthusiasm about the activity, were clear warning signs. In the second case, similar signs were found in another child who even though being asked several times if she would like to stop playing, decided to continue but without moving at all. According to Alderson & Morrow (2004), researchers "who respect children's consent and feel accountable to them are more likely to take their views seriously throughout the research (...). Research findings and conclusions (...) may be more accurate when discussed openly with children and young people" (p. 109).

E.4 Participants Recruitment and Inclusionary Criteria

As previously described, parents from the 4- and 5-year-olds were appropriately informed and invited to give permission for their children to participate in the study, more specifically, in a musical task. No exclusionary criteria or methods were used

for selecting participants. This decision would depend firstly on participants' parents and then on children's agreement or refusal to participate in the activity. In the 4-year-olds group all parents consented for their children's to participate in the research and only one child decided to withdraw. Once again, it is important to refer that children's refusal overrode parental consent.

In the class of the 5-year-olds some parents decided not to give their permission, even when the children wanted to participate. In these cases, parents' refusal overrode children's willingness to join the task. Some strategies were then used to ensure that those children would not feel excluded. For example, even though only participants' names were inserted in a 'magic box', all children were told that only some names would be randomly chosen to participate in that specific activity. This would prevent at some extent disappointing the children who were willing to participate in the task but whose parents decided that they should not be involved. Similar strategies had already been used by the teachers during class time and were fairly accepted by the 5-year-olds. All children were also informed by the researcher that those whose names were not randomly selected would soon have another opportunity to play other activities with their peers. This more inclusive task would take place after the data collection stage as a musical workshop. All children (participants and non-participants), as well as their teachers, were invited to participate collectively in this musical session led by the researcher.

E.5 Designing for Children's Well-being

This investigation aimed to promote young participants' benefit during all the stages of the project. One of the initial steps was to try to ensure that enough time was given to the researcher to develop a sound and friendly relationship with participants before collecting data. "Time is also of importance, and research projects need to be designed to allow a relationship to develop between researcher and the researched. Children are not used to being asked their opinions and to relate their experiences to unknown adults, and probably need to have some familiarity with the researcher" (Morrow & Richards, 1996, p. 101). For example, Eerola et al. (2006) who also studied young children's movement behaviour to music reported a high number of

absent responses which could indicate participants' difficulty in establishing trust with the researchers or gaining familiarity with the setting. These authors stated that, of "the 46 children, 18 expressed little or no movement in the laboratory. This was possible due to a number of novel elements (surroundings, new people, etc.) combined with other factors (temperament, time of the day, contextual factors etc.). These 18 children were excluded from further analyses" (p. 474).

One of the first steps to promote children's well-being in research is to acknowledge the power differences between adults and children, and in this way avoid the misuse of this status imbalance and thus respect the young participants' rights and interests. This presupposes questioning "how do researchers' skills in listening, talking and sharing knowledge and decisions with children affect how they work with children as partners and learn from them?" (Alderson & Morrow, 2004, p. 56). In one of Henry Moog's (1976) tests which aimed "to find out more about the types of movements" of the 4, 5 and 6-year-old children to music, the preschoolers were "encouraged to make some sort of response (...)" by following the instructions of the research team, such as "you are allowed to move around" or "would you like to dance to it?" (p. 126). According to Moog (1976), when "this had no effect, [the researchers] gave direct instructions like 'go on, clap' or 'go on, tap on the table' and showed how to do it [themselves]. Only a few children responded to the first invitation to move, and these hesitated to do so; those who did respond to the first command, to move around, were simply being obedient. They had been asked to walk, so they did. There was no natural connection between the music played and the spontaneous movements (...)" (p. 126).

In this current investigation the researcher decided to observe children's behaviour within their familiar school setting and to interact with them in their own terms, but avoiding pretending or 'behaving' like a child. As Morrow & Richards (1996) state, especially in reference to James' 'tribal child' type view of childhood, adult "researchers are surely being misleading if they try to engage with this other world by attempting to suspend their adult status, because they cannot become children again. Attempts to do so can be as misleading and confusing for the children being studied as being deceived in experiments" (p. 97). By informally participating in

their daily activities and to play children's own games when invited, the researcher was able to begin to know the young children, acknowledging their different personalities, their views and feelings and gradually gain their trust.

This familiarity was also naturally developed with the teachers during the visits to the school. Signs of complicity could be seen, for example, when researcher's collaboration was required in small tasks during class time (e.g. serving the snacks or helping children with the tube paints), but most importantly during teachers' breaks (e.g. invitation to have lunch or tea in teachers' room).

During the preparatory stage of the study and before any movement data was collected, a set of sympathetic techniques were developed with the purpose to build trust and deconstruct power differences. For example, the researcher decided to wear colourful clothes during the visits to be in accordance with children's natural tendency to use bright colours and in this way to make her more visually appealing. This was one strategy that aimed to facilitate the researcher's acceptance within the group. The researcher also decided to always talk with the 4- and 5-year-olds at the same eye level, either by squatting down or kneeling. As follows, children would not have to look upwards when speaking to the adult.

In the pilot studies the presence of the teachers in the setting revealed to be too disruptive given that children were constantly seeking for their approval during the moving task. As Thomas & O'Kane (1998) stated, "in school where children are used to having their responses defined as correct or incorrect, efforts need to be made to explain that there are no right or wrong answers (...). The presence of a carer or parent may affect the atmosphere and the outcome of [an observation]" (p. 341). It was then decided that the door of the room would remain ajar for the teachers to look discretely at the children without making their presence noticed. This was one strategy that had the purpose to diminish the status and influence of teachers (adults) over the children. By promoting children's empowerment and agency, the researcher expected that they would feel more comfortable to make their own free and individual movement choices to music, ask the necessary questions or have the confidence to withdraw in case of any discomfort.

By assuming the role of teacher assistant the researcher was in a hierarchical position between teachers and children, which allowed her to be closer to both the adults' and children's worlds. Several signs of acceptance were identified during this preparatory process of informal visits, for example, some children decided to spontaneously draw portraits of the researcher, who was often represented with a big smile, or tried to naturally include her in games that were being led by the Nursery teachers.

The data collection procedure only took place when the researcher was already a familiar presence in the 4- and 5-year-olds classrooms and after a trustworthy environment was built between all those involved in the research. The invitation to play a musical activity and the way the explanation was presented to the children were inspired by the type of language, body language that teachers would normally use in their everyday activities. Other studies have reported the use of this same procedure, such as the research conducted by Thomas & O'Kane (1998) who stated that "some of the participatory techniques of communication that (...) used were derived from tools used by social workers and guardian *ad litem* in working with children" (p. 342).

The element of surprise which was supported by the use of an enthusiastic voice inflection and also by the use of some props, such as a 'magical box' where their names were hidden and from which would be randomly chosen, contributed to elicit children's curiosity and maintain it throughout the activity. During the presentation of the task it was also fundamental to emphasise that they would be involved in a playful and fun activity. "Even younger children understand that participation may be enjoyable, boring, stressful, or hurtful or that it may take them away from something they like to do" (Fisher, 2005, p. 278). By using familiar strategies and by focusing on playfulness the researcher aimed to prevent children from feeling the pressure of having to give a right or a wrong answer.

It was also important to design a musical activity with a very short duration in order to maintain children's level of interest and engagement throughout the whole activity. The intention was to elicit effortless movements in response to the music as opposed to movements performed as an obligation. It was also aimed that the

participation in this specific activity would represent a good experience for all the young participants. As Csikszentmihalyi (1990) states, the balance between inability and mastery is crucial to curiosity and motivation. He defines autotelic activity as an activity that is an end in itself. This optimal experience is carried out by inner goals, which are intrinsically rewarding, and could ultimately generate *flow*, “the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at a great cost for the sheer sake of doing it” (p. 4).

During their individual performance children would be invited to move and their specific location in the room would allow them to clearly see the door at all times. This procedure had the purpose to indirectly reinforce the idea that participants were free to stop moving and leave the room whenever they wished to, given that the way out was clearly accessible. Another important point to highlight is the fact that during the moving activity the researcher was seated on the floor in front of each participant, which allowed her to maintain eye contact at their eye level. Moreover, throughout this process non-verbal positive reinforcement (nodding, smiling and thumbs up) would be constantly given to keep children motivated.

After the activity each child’s performance was verbally praised (e.g. “well done”, “you did really well”, “congratulations”). Even those who decided to suspend their participation were thanked and assured, with a smile, that they have made the right decision given that they were not having fun.

E.6 Rights for Privacy and Confidentiality

The right to privacy, a fundamental ethical issue, was considered at all stages of this research. According to Alderson & Morrow (2004) children’s right to privacy presupposes “avoiding undue intrusion into their personal affairs” (p. 43).

The Data Protection Act 1998, a piece of UK legislation that aims to ensure that personal data are not processed without people’s knowledge and wherever possible with their consent, underpinned the research procedures of the present study. Personal data is defined as any data about an individual or data subject (participant)

which can be used to identify that person. It “includes any expression of opinion about the individual and any indication of the intentions of the data controller [researcher] or any other person in respect of the individual” (section 1.1). The data controller is described as the “person who (either alone or jointly or in common with other persons) determines the purposes for which and the manner in which any personal data are, or are to be, processed” (section 1.1). “Processing” in relation to information or data, means obtaining, recording or holding the information or data or carrying out any operation or set of operations on the information or data (section 1.1).

The Act sets out eight data protection principles which were all considered in the current research. And their key points are,

(1) Personal data should be obtained and processed fairly and lawfully. This means data subjects (children, parents and teachers) should be fully informed about the reasons why they are being asked to provide personal information, who the data controller (researcher) is, for how long the data will be kept and to whom the processed data will be disclosed.

(2) Personal data must be obtained and only used for agreed specified purposes.

(3) Personal data should be adequate, relevant and not excessive to the purpose for which they were obtained.

(4) Personal data should be accurate and kept to date. The data controller (researcher) must ensure that steps will be taken to correct inaccuracies when requested by the data subject (participant).

(5) Personal data must not be held for longer than is required and should be deleted when there is no further use for them. Some data may be retained indefinitely for research purposes, as permitted under the Data Protection Act, subject to the conditions laid down for this type of processing (section 33).

(6) Personal data should be processed in accordance with the rights of data subjects under the Data Protection Act.

(7) Personal data should be safely held electronically and in manual form to prevent unauthorised disclosure of data to any person or organisation other than the data controller and the loss or damage to data that may affect the interests of data subjects.

(8) Personal data should not be transfer outside the European Economic Area unless the country or territory to which the data are to be transferred provides an adequate level of protection for personal data.

Confidentiality is another relevant ethical issue when conducting research with young children. It is children's right to have their identity concealed and some personal details not reported. "Guarantees of confidentiality and anonymity given to research participants must be honoured, unless there are clear and overriding reasons to do otherwise" (Statement of Ethical Practice for the British Sociological Association. (2002, p.5). Children and people with parental responsibility must be allowed to have access to any data held on them. "If any sort of identification is published, then the data are no longer anonymous" (Alderson & Morrow, 2004, p.51).

In the case of the present study, only the research team was permitted to access participants' names and age after a clear and informed justification was given to the parents and teachers.

E.6.1 Ethical Issues in the Use of Video

"It has long been recognised that qualitative research can pose significant challenges to gain access, securing consent and planning projects. Video can exacerbate these difficulties and, unless carefully managed, can undermine the possibility of undertaking the research" (Heath et al., 2010, p.14). In this particular study getting permission from the stakeholders to use video to record young participants' movements in response to music did not represent a difficult challenge. Several reasons could be pointed out for this success, namely the clear and convincing justification for the use of video in this particular research, and the credibility shown by the researcher about the ethical knowledge and concerns about privacy and

confidentiality of participants' visual data. The informative leaflet and the written consent gave the final assurance to the adult stakeholders that at any point of the research and even in cases where permission was granted, children and their parents could refuse images to be recorded or ask for the visual data to be destroyed without any question being asked.

It is interesting to emphasise that video capture is nowadays a very common procedure in people's daily lives, especially because of a more easy access to low-cost digital electronic devices that provide numerous possibilities of audio-visual recording and editing (mobile phones, computers or video cameras), as well as the facilitation of image sharing and dissemination. The everyday immersion in an increasingly dependent audio-visual world has an inevitably impact in research that uses audio-visual data. On one hand, participants may show a more natural behaviour in the presence of a camera, but on the other hand there could be a greater resistance to being filmed because of privacy and confidentiality concerns.

After obtaining the written consent from parents and people with parental responsibilities it was fundamental to promote a trustworthy environment and a friendly communication with the young children in order to overcome unfamiliarity and the natural initial resistance. As Heath et al. (2010) suggests, "before recording takes place, a period of fieldwork is useful to discuss the project with core participants, to clarify any distinctive challenges relevant to the setting, to identify any key concerns and so forth. On these occasions, the fieldwork will give you a much clearer idea of the practicalities of recording in the setting and will also provide an opportunity to learn more about the specific concerns or reservations of the participants. In this way, they will get to know you before they encounter your camera" (p. 16).

Only after confidence was gained, it was possible to conveniently inform participants about the activity that would be recorded and ask for their consent. It "is necessary to explain what you are doing even to the youngest of children in language that they can understand. You need to check that they are willing to be recorded, although with

younger children the extent to which they are truly 'informed' may prove problematic” (Heath et al., 2010, p.21).

To become familiarised with the camera young participants were encouraged to handle and 'play' with that device, which was turned off to ensure that any visual data would be recorded during this exploratory process. It was also important to minimise the impact of the video setup by installing it in a familiar room to the children and especially by using a small-size video camera supported by a small tripod.

In order to prevent collecting information from the children that was not directly related with the purpose of the study, the video recording process was limited approximately to 4 minutes maximum per child. This process would only include the instructions given by the researcher, children's performance and verbal answer to one specific question. No extra visual and personal data was recorded from the participants. To ensure that this plan would be met, the recording button of the video camera would be discretely turned on when children arrived to the room and turned off as soon the activity was finished. Not only this procedure favoured a more sound and ethical data collection but it also promoted data management efficiency. “Rather than collecting data that you will later find to be unusable, it is better to collect a small amount of usable data” (Heath et al., 2010, p. 31).

Personal data from this research is composed by lists containing children's names, their age and the name of their parents or guardians, as well as the reference to their teachers and class. It also includes the informed parental consent, some field notes and a list with the key to codified information. However, “tape recordings, videos and photograph collections [are the data that] raise extra questions about confidentiality” (Alderson & Morrow, 2004, p. 48). Considering that the data from both studies with the 4 and 5 year-olds is mostly visual, specific ethical issues had to be carefully considered.

The first point to be acknowledged concerned the privacy and confidentiality of the visual data containing images from young children moving to music, and how in accordance to the Data Protection Act 1998 this information would be safely held.

Several procedures were used. Once parents and children agreed to participate in this research and images were recorded, the audio-visual data was then edited and anonymised through the use of codes. In the next stage the videos and images were copied to two different external hard drives, and kept in a locked cabinet separate from the notes containing the key to those codes and also from participants' personal details. Moreover, throughout the video editing process as well as during data analysis, the computer used would not be connected to the internet.

It was also decided that during the data collection and data analysis participants' personal information, written and visual, would only be available and seen by the research team (including observers/raters involved in inter-reliability assessments) and in one specific circumstance, by the teachers. Measures were also taken to ensure that unauthorised people would not be able to access the data either in paper records or electronically, and that the data would never be placed on public websites.

Parents consented that their children's images and videos would only be presented in academic and scientific contexts. Furthermore, these visual data would also have a reduced pixel resolution when justified. In no circumstances the data would be broadcast, appear on the web or be used for commercial gain. Published reports would anonymise all references to personal details of participants and of the institution where the study took place. Consent from parents would be sought once again if the images were to be used in a context that was not initially specified in the informed consent.

E.7 Incentives for Research Participation

Before giving their consent parents were fully informed that their children would be compensated for participating in the study. As an appreciation, a musical workshop was designed specifically for all children in the class (participants and non-participants) and it would take place during class time. Although parents and teachers knew about the workshop, children were only informed about this session a few days after participating in the game and 'as a surprise'. It was decided that would be counter intuitive to promise children compensation before their participation in the game because that could have had an impact on their performance. In other

words, participants would be probably more focused on the 'rightfulness' of their movements instead of being internally driven and enjoying the process.

All participants were also offered a participation certificate (please see Appendix D), which revealed to be a very especial occasion for the 4-year-olds. Children were very excited and proud to show their parents the certificate. In the case of the 5-year-olds class the document had to be given discretely in an envelope and without the non-participants noticing it. It was decided since an early stage of the study that participation in this project had to be done voluntarily and thus without financial incentives. The purpose of the task - moving to music - aimed to be motivating enough for children to want to participate and for their parents to support that decision.

As a sign of appreciation teachers were invited to watch a selection of video clips of the 4- and 5-year-olds after data collection and were offered chocolate boxes, as well as a certificate of participation similar to the one given to the children.

E.8 Reporting Back and Saying Goodbye

All stakeholders were assured that they could contact the research team at any time to ask about anything related with the study. A short report with a summary of the findings was also provided to the school (Head teacher), which would then be responsible to inform participants' parents given that the researcher never had access to their contacts.

Several scenarios were considered regarding the best way to say goodbye to the children, with whom the researcher had developed a friendly relationship and which could make the occasion more difficult. It was decided that the ideal moment for goodbyes would take place after the musical workshop, an activity in which all the participants and teachers would be involved. During the session in which teachers watched some video clips of the children, the researcher also had the opportunity to thank them all for their collaboration. In this specific occasion, the Nursery teachers invited the researcher to visit them as well as the children once more. One month

after the data collection, the researcher paid an informal visit to the 4-year-olds class and thanked them again for their collaboration.

The goodbye process ended up with an email to the Head teacher of the Nursery & Primary School, praising the help of all the staff, in particular of the teachers who were directly involved in the research and of all the young participants.

E.9 Dissemination of Findings and its Impact on Children

According to Alderson & Morrow (2004) ethical guidance is mostly focused on each participants' personal cost and benefits during data collection, however “much less is said about ethics of the published reports, either on children in the study or on related groups of children and young people. How might they stand to gain or lose?” (p. 125). By aiming to disseminate the results within a scientific context, one expects that these will reach and be shared among an educational community but also by professionals in other areas (e.g. music psychology, music therapy) interested in early childhood studies. In this way, the results from this research could invite people to reflect about children’s embodied musical experiences and, in the short future to directly affect teachers in their practice and consequently the young children’s learning experiences.

“When projects have lasting effects, children may be influenced in three ways: the policies affect children now: they may affect children in future when they are adults and see the impact on their own children; the effects may last into far future when today’s children are old, long after the researchers have gone. This entitles children to have an even greater share in helping t plan current research and future policies” (Alderson & Morrow 2004, p. 128).

Appendix F

Music Stimulus: Selection Process

See enclosed CD package for this appendix

F.1 Audio file 1: Combo Percussion 2 (sample 1)

F.2 Audio file 2: Motown Drummer 11 (sample 2)

F.3 Audio file 3: Djembe (sample 3)

F.4 Music Stimulus (example of one combination): M1_F_S_VS_M2

Appendix G

Inter-judge Reliability: Selection of a Drum Loop Sample

G.1 Aim

The present assessment aimed to find the degree of agreement among a group of judges regarding the selection of a short music sample, based on the criteria of ‘musical richness’ and inherent ‘groove potential’ for young children. A high level of concordance would ultimately support the final choice of the music stimulus for the present investigation.

G.2 Method

The inter-judge reliability assessment comprised a very brief listening session of a series of music samples by the judges and the report by email of their individual preferences.

G.2.1 Judges

Five musicians with previous teaching experiences in music education for young children were specifically selected for the current assessment.

G.2.2 Materials

This task required that all judges used one sound system of their own choice to play three mp3 audio files of percussive music with an approximate duration of 3s each.

G.2.3 Procedure

An email was sent to the 5 judges containing brief instructions about the listening task and also three audio files. The musicians were specifically asked to listen to three drum loop samples and to choose the one they considered to be the most interesting musically and with the greatest potential to elicit spontaneous body movements in young children.

G.3 Statistical Measure

Considering that a discrete variable on a nominal scale level was assessed by multiple judges, Fleiss’s Kappa an extension of Cohen’s kappa coefficient became the most appropriate measure to estimate the reliability between the 5 musicians, including a correction for chance agreement.

The magnitude guidelines proposed by Landis & Koch's (1977) for Cohen's kappa, and consequently for Fleiss's kappa, will be used as reference. Both authors described the values < 0 as showing no agreement, 0-0.20 as slight, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial and 0.81-1 as an almost perfect agreement.

G.4 Results & Discussion

An almost perfect agreement was found between the musicians, $k = 1.00$ (95% CI, 0.642 to 1.357) which suggested that all the judges strongly agreed that the musical content of sample 3 was not only the most interesting but it also had the greatest potential to encourage effortless movement responses in young children.

From the judges' additional comments, it was also possible to understand that the underlying dynamics and the natural sounding tone of sample selected (i.e. djembes rather than a digital drum set) were two decisive factors for their final choice. However, they pointed out that the sound quality of the djembe loop was inferior to the other two. Finally, one can speculate that the musicians' choice was also influenced at some extent by the fact that sample 3 included one more measure of rhythmic material than samples 1 and 2, and that syncopation was also more clear and salient.

Considering the strong agreement between the 5 musicians, it was decided that the 'Djembe' loop (sample 3) would become the stimulus for the present study, once its sound had been significantly improved by a professional sound designer.

Appendix H

Fieldnotes: 1 Example

H.1 Description of the Second Visit to the Nursery Edinburgh (November 2011)

- **9.00 am** – The 4-year-olds were gathered in a circle (centre of the classroom). I decided to join the group by saying ‘hi’ and by sitting next to them. ‘Lydia’ was reading their names to check who already had arrived to the school and who was still missing.

- **9.10 am** – ‘Lydia’ played a CD and children were invited to sing with her and accompany the music through the use of specific gestures (mimicking). They sang and rehearsed 6 Christmas songs that aimed to be presented in December to their parents. ‘Louise’ gave me the book with the lyrics, but after the first song I decided to sing really quietly without the book and just imitate their gestures. Some children were looking at me and smiling.

Some songs were fast and more energetic, while others were slower and calmer. At some point, after the 4th music, ‘Lydia’ informed the group that she was a little bit disappointed. She told the children that they should be more engaged. They should be able to sing all the lyrics and do the gestures as they did the day before. She also said: **“Today Ana is visiting you and you are not very involved with your singing”**. [**Curiously, I thought they were really engaged in singing. I believe that Lydia felt that I was a visitor and that I should be really impressed by their performance*]. She also said that they were not so enthusiastic about the ‘rocking baby’ song (slow tempo) compared to the ‘?????’ song [**I do not remember the name of the song - fast tempo*]. And one boy immediately responded with a smile: ‘We prefer to sing the faster ones’!

The group sang the last two songs.

- **9.40 am** – ‘Louise’ asked some children to join the reading room and others to play a computer game. The rest of the group was invited to either play with sand, wooden blocks set, glue or plasticine. I decided to join the ‘sand group’. I played with the children and collaborate with them whenever they want me to. At a certain point they asked me my name and they spontaneously told me their own names.

Children from other groups (mainly girls) would approach me at times to show me their special 'socks' or 'shirts'. After I complimented them, they would continue playing in their groups.

- **9.50 am** – I decided to join the plasticine group. Some of the children of the sand group decided to follow me to this new group. I was informed that they already 'baked' some 'sweets, fish and vegetables', so I decided to 'bake potatoes'.
- **9.55 am** – Two girls from the plasticine group said they had a surprise for me and that I should follow them. They showed me the library (one part of the main room). Then, they asked me to read them a story from one particular book. Three other girls then joined this new group. I read that story and immediately they asked me to read another one.
- **10.00 am** – 'Louise' showed an image and a red circle that informed the children that they should clean up the whole room before the Assembly. Every child immediately started to clean the different sections of the room (e.g. sweeping the sand from the floor with a small broom).
- **10.10 am** – The children went to the gym where the Assembly was about to happen.

I met for the first time in person 'Mary', the Head teacher, who was about to lead this Assembly. The main theme today was about 'safety requirements'. Four children with 8 and 9 years old talked about safety procedures to the younger children, who were then encouraged to pose some questions at the end.

- **10.40 am** – The 4-year-olds stayed at the gym afterwards. They were invited by 'Charlotte' to play the 'Duck-duck-goose' game for 10 minutes. I decided to join the circle as I did two hours before. Most of the children did not touch my head ('duck') or chose me to chase them ('goose'). However, there was an exception. One child that had played with me in the 'sand group' touched my head ('duck') spontaneously. 'Charlotte' immediately praised his action and informed the whole group about what had happened. She said that he "included me in the game by touching my head". The next child to play duck-duck-goose decided to include me as well. [***I was really happy!!**].

- **10.50 am** – The children returned to their classroom to eat a snack (carrots, cherry tomatoes, milk) and wait for their parents to pick them up.
- **11.00 am** – ‘Ellen’ asked me if I wanted to meet her before her next commitment at 11.15. **1)** In this meeting I informed ‘Ellen’ that I could only include the morning class, i.e., the **4-year-olds, and the 5-year-olds** (Primary School) in my study. Thus, I would not consider the afternoon group, i.e. the 3-year-olds.

2) I confirmed the **dates of the December and January visits** [*I still need to send ‘Ellen’ an email with these new dates]:

Friday, 2nd Dec (9.00 – 11.15) - VISIT 3

Friday, 9th Dec (9.00 – 11.15) – VISIT 4

Wednesday, 14th Dec (9.00 – 11.15) – VISIT 5

Wednesday, 11th Jan (9.00 – 11.15) – VISIT 6

Thursday, 12th Jan (9.00 – 11.15) – VISIT 7 – DATA COLLECTION

3) List of children’s names [*Send an email to ‘Ellen’ asking her this information – next visit 2nd Dec]

4) I have asked ‘Ellen’ for the **names of all the Nursery teachers and Teacher assistants**:

‘Ellen’ – Nursery Teacher

‘Louise’ – Teacher Assistant (the tallest and youngest)

‘Lydia’ – Teacher Assistant

‘Charlotte’ – Teacher Assistant (blond hair) – She and ‘Ellen’ informed me that she will leave her job next week. ‘Ellen’ still does not know who will be replacing ‘Charlotte’.

5) ‘Ellen’ told me that she talked with ‘Mary’ last week about the possible use of the **dance room** for my study. ‘Mary’ informed her that it will be difficult to use that room. ‘Mary’ said she will give priority to teachers of the school if they need to use it for some activities. ‘Ellen’ was a little bit upset, but then she remembered that she has another room (the ‘climbing room’) at the Nursery. The room has some gymnastics equipment that can be placed in another part of the room. ‘Ellen’ showed me the climbing room and I realised that it had a lot of space for children to move and in fact it was even better

than the dance classroom. [*I need to check how many times I can use the room in January. Send an email to ‘Ellen’]. ‘Ellen’ called me today, after my visit saying that ‘Mary’ said there is no problem for me to use that room and that the other Nursery teachers/assistants also agreed.

6) The dates for the data collection (4-year-olds) can only be confirmed after I know exactly when I can use the ‘climbing room’ during the week in January. What I have talked with ‘Ellen’ was that I could use **Tuesday** and **Thursday** mornings (2 hours) [*I should send an email to ‘Ellen’ confirming this information]. The only date that is confirmed is **Thursday, 12th January (9.00-11.00)**, the first day of data collection. Then, the following dates (to be confirmed) would be **Tuesday, 17th Jan (8.45-9.45 & 10.45-11.15)**; **Thursday, 19th January (9.00-11.00)**; **Tuesday, 24th Jan (8.45-9.45 & 10.45-11.15)**; **Thursday, 26th Jan (9.00-11.00)**; [*I still need to confirm with ‘Ellen’ if this schedule is for the dance room or if it is for the children? If it is for the dance room, maybe I can use 2 hours for the data collection every Tuesday in the climbing room. I was also thinking that I can observe 10 children individually for 2 hours. I would need four days, 2 hours each. Or I can observe 8 children per day. This means I would need 5 days, 2 hours each].

7) I asked ‘Ellen’ what I should do in order to have a **group of 5 year old children** (Primary School – 1st Grade) participating in my study as well. She said she would talk with ‘Mary’ and with ‘Lauren’ (the oldest Primary teacher at the school) to know how I could observe them in their normal activities at school and also how could I observe them individually playing the game (data collection) at the Nursery. I know they will have to come from their classroom (in another building) to the Nursery. ‘Ellen’ already told me that the Nursery does not mind for the Primary children to play the game (data collection) at the climbing room. [*This is fundamental for my study, because I will be able to use the same room, setup and conditions as I did with the 4-year-olds].

8) 'Ellen' called me and said she will meet 'Lauren' on Monday to tell her about my study, and that it would be good for me to meet her next Friday (2nd Dec).

Appendix I

Pilot Studies

I.1 Introduction

Two pilot studies were conducted to evaluate the feasibility of the Embodied Beat investigation and thus to assist the researcher in developing the appropriate protocol. More specifically, this preliminary work would help her to determine and refine some of the most fundamental methodological procedures of the main observational study, particularly, regarding the design of the musical intervention (e.g. stimulus, instructions, equipment, video recording, data management practices).

Given that both pilot studies were planned at different stages of the research process, each one entailed different purposes. However, and despite the fact that they were conducted in two different countries (Portugal and Scotland), their fundamental features would be maintained identical. While Pilot study 1 was mainly focused on evaluating the procedures and technical requirements of the task, Pilot study 2 intended to clarify and make the necessary adjustments to those preliminary logistics but taking into account contextual aspects, that is, the specific setting where the participants from the Embodied Beat study would be recruited. That said, in the following sections the two pilot studies will now be described according to its chronological order.

I.2 Pilot Study 1 (Lisbon)

I.2.1 Participants

This study involved a convenience sample of 21 healthy children (14 male and 7 female) with 3, 4 and 5 years old (4 years and 1 month, SD 0.91). These participants were all recruited from one Nursery in Lisbon (Portugal), more specifically, from three different classrooms which at the time of the data collection had been joined together in only single room with the purpose of preparing Christmas activities. One additional child was observed but excluded given she decided not to participate in the activity.

The Nursery in question was a well-known setting to the researcher where she had previously taught. Given that most teachers and staff were acquainted with the

observer, the permission to carry out a brief study in that institution was easily sought from the Head teacher and Nursery teachers. A written informed consent from children's parents was also obtained few days before the data collection (please see Appendix I.2.3).

I.2.2 Procedure

This pilot work was conducted over a period of two days (approximately 10 hours in total). In the first session the researcher was presented to the class as a teacher who had previously worked in the Nursery and who decided to pay them a visit, and most importantly, to play with them. This preliminary stage aimed to acclimatise the young children and their teachers to the presence of the observer in their classroom but also to give her some time to gradually get involved in their daily activities.

Even though only one day was allocated to this process, the fact that there was already a degree of familiarity with the teachers and the setting, and progressively with the children, facilitated building the necessary trust with all the stakeholders in a very short period of time which would contribute in part to the success of the data collection. However, in the case of an unfamiliar setting it would be crucial to extend the number of visits and give children and their teachers enough quality time for them to get acquainted with the researcher and her presence in the classroom.

During the data collection stage (second day), children were invited to participate in one specific musical task which would be captured on video. The outcomes of this pilot intervention will now be considered in some detail.

The task in question was a well-known game called 'Musical statues'. Its simple structure 'move-to-music and freeze-to-silence', characterising some of the traditional children's games, had already been successfully used by Rodrigues (2012). The choice of this specific activity seemed to serve the purposes of the research given that the players would be mostly focused on the challenge and not so much on the content of their movements. As follows, one would expect that children would be more likely to choose their repertoire of actions spontaneously. However, an unforeseen problem arose when the game was presented to the children. More

specifically, some participants informed the researcher that they already knew that game and that they had to either run or walk to the music. These assumptions about having to perform specific movement patterns were clear warning signs that could seriously compromise the results and thus the feasibility of the study. To overcome this potential roadblock it was decided that in future studies the structure of the game would be maintained but its name had to be replaced by another designation.

The specific selection of this Nursery in Lisbon as the research setting not only attended to the easy attainment of a convenience sample but it also considered the fact that it filled in some of the fundamental requirements of the study. One of those requirements was an empty medium-sized space where children could move freely without bumping into furniture or other objects displayed in the room. Moreover, this place needed to be sufficiently spacious to allow the equipment to be easily set up.

Even though the room available presented great advantages, one negative aspect was the 3-minute walking distance between children's classroom and the place where the data would be collected. Given that this was mainly a one-child-at-a-time travelling process, the total duration of the session increased substantially. Not only that, but also this in-between interval of time tended to introduce some degree of artificiality to the procedure and consequently affect at some extent children's engagement and the spontaneity of their responses in the game. The assistance of some Nursery teachers was essential to accelerate this process and to make it more efficient. Ideally, in the main study the room selected for data collection should be located as near as possible from children's classroom.

At the end of the first day, the equipment was set up and conveniently tested. Two small loudspeakers were located in two opposite sides of the room. The video camera and a medium-sized tripod were positioned at the centre of the room and the laptop that would play the music for the activity would not be too far away from the camera. Children's movements would take place within a clearly visible delineated area in the room. This amount of space (approximately 3 m x 3m) aimed to be reasonable and comfortable enough for children to move in response to the music, that is, not

too small and constraining nor too large and overwhelming. Moreover, it also intended to facilitate the framing process of the image.

The outcome of this equipment testing suggested that it would be beneficial for the Embodied Beat study to use a reasonable spacious room, a small-sized tripod and video camera in order to minimise the impact of the recording process, choose a fairly good surround sound system that could encourage and 'support' children's movements and at the same time provide a good sound quality for the video records. Moreover, the location of the laptop should depend on the position that the research will assumed in the room which, preferably, should be near the delineated area where the activity will take place and where the instructions will be presented. This will ensure a very short travelling distance from where the instructions are presented (delineated area) and the laptop that will initiate the music.

In this pilot study the young children would participate in the game either in groups of three or individually, and the order in which they would play it would be randomly determined. Considering that in the group situation there was a clear tendency for them to imitate each other's movements, it was decided that in the main study children would be invited to perform the task individually and without observing any other participant. Sims (1985) in her study had already opted by having children moving individually to prevent this imitation effect.

In the beginning of the data collection session each child, or group of children, were invited to do a warm-up with the verbal guidance of the researcher. The purpose was to gradually encourage them to move their bodies in order to facilitate their engagement in the following activity, as other similar studies had previously done (Rodrigues, 2012; Sims, 1985). However, one noticed that not only this warm-up increased considerably the time of the whole intervention but it tended to slightly diminish the surprise factor and thus lower children's expectations regarding the game. Moreover, and most importantly, the warm-up with the researcher seemed to have unintentionally influenced children's choices of movement. In other words, the young participants tended to use some of the patterns previously explored and

perform them in response to the music, which clearly suggested of a contamination process.

One final argument against the use of a warm-up session prior to the game, is its threat to the coherence of the gaming principle itself. That is, when children play similar games to the one used in this study they do not prepare themselves physically before the activity, they just start playing the game. The focus is not on the physical exercise but on the playful component as well on the challenge provided by the rules of the game. Considering its disadvantages, this preliminary warm-up was excluded from the main study.

The instructions for the musical activity were individually presented to the children within the delineated movement area marked on the floor. At this stage and even though the game rules were already predetermined, how they would be presented was still an open question. During the pilot work the researcher decided to explore different presentation strategies and through this process the researcher arrived to important conclusions that would inform the following studies.

It was decided that the instructions must be presented consistently, from child to child, which necessarily implies having to memorise them. They should also contain the minimum number of words, be clear and simple and take into account participants' age and level of understanding. Having the right amount of energy in the voice can also contribute for children's engagement. Another important procedure that will increase the impact of the instructions is to avoid engaging children in unnecessary conversations before the game, because that could easily compromise their movement performance. Furthermore, that would encourage them to talk while moving which would not be the ideal scenario.

Another improvement suggested for the instructions, consisted in excluding from its content the information that children should only move within the perimeter of the delineated area. This rule was considered unnecessary given that those who were not informed about that fact assumed that movement had to take place within those

visible limits. This new procedure would reduce considerably the amount of words in the instructions and would make them clearer and simpler.

Another important aspect to consider in the instructions of the main study is the deliberate use of the verb ‘to move’ instead of ‘to dance’ (e.g. “move to music”). Given that the latter tends to be more prescriptive by nature, that is, it tends to suggest the performance of stylised movements to the child rather than free and more idiosyncratic behaviour. As follows, it was decided that the verb ‘to move’ would be used in the final version of the instructions, especially because it would more likely answer the research questions.

One last point that should be taken into account is the fact that in this first pilot study the verbal instructions and overall interaction were given in Portuguese to the children and by a native speaker. Considering that the following studies would be conducted in Scotland then the instructions needed to be presented in English and by a non-native speaker. This would necessarily imply some additional training from the researcher. Not only would she have to memorise the exact wording of the English instructions but also to find the best possible articulation for every word, with the right volume and energy.

For this game different rhythm-based samples were used as music stimuli, as already described in section 3.5. Given that the quality of children’s responses to these different pieces was very similar and considering that only one of those samples would be used in the main study, it was decided that this selection process would be postponed until the second pilot work which would already take place in the research setting of the Embodied Beat study. Moreover, this final decision would also benefit from the opinion of different musicians regarding the musical richness and complexity of each piece, as well as of its groove potential.

During the game the researcher would give the young participants some signs of encouragement. They would be either verbally articulated (e.g. “well done”) or conveyed through simple gestures. However, verbal incitement revealed to be a disadvantage given that it would be captured by the microphone of the video camera

during children's performance. This particular type of intervention also seemed more disruptive than the gestural option. Therefore, it was decided that in the main study, and during the musical game, one would only use smiles, occasional vertical head nods and thumbs up as encouraging signs. Nonetheless, it was fundamental to avoid synchronising those gestures and other ancillary rhythmic body movements to the musical beat so children would not attempt to imitate them.

Even though for most participants the presence of the camera did not seem to affect their behaviour, for some children it became a distracting tool. This self-awareness was translated into recurrent glances to the camera, into questions and pointing gestures. Despite the initial and very brief explanation about the equipment displayed in the room, the researcher realised that other strategies should have been additionally used to minimise the presence of the camera and the reactivity effect. One strategy that would benefit the following studies is allowing children to have time to get acquainted with the video camera before the data collection stage, for instance, by playing with it while turned off and with the guidance of the researcher.

Other decisions were made after this pilot work regarding the location and position of the researcher in the room. Determining a specific leeway area for the observer to be situated would ensure that her presence would not be captured on video during children's performance. Moreover, that precise location would have to enable the researcher to operate efficiently all the equipment and, at the same time, allow her to be near the child who was moving and thus provide her with all necessary support (e.g. eye contact and gestural encouragement). It was also decided that after giving the instructions, the researcher would seat down on the floor in a specific place instead of standing. This would permit to meet the child at her eye level and not look down on her while she was moving.

This pilot study also allowed the researcher to explore and evaluate the timings between each part of the intervention, in particular, between the instructions and the beginning of the musical activity (i.e. the act of pressing the play button on the laptop). It was crucial to find the right timing for this transition to avoid, on one hand, an awkward interval of silence after the energetic presentation of the

instructions and before the music was played and, on the other hand, to avoid rushing too much the process because it could create unnecessary tension and clumsiness. The best solution to this problem was to calmly count ‘1...2....and...3’ after the instructions, using an ascending pitch and increased volume, while moving from the delineated space where the activity would be carried out towards the laptop location. Once the researcher have reached the computer she would then say ‘3’ and immediately press the play button for the music to start and for the musical activity to begin.

The duration of the whole intervention was another aspect explored and then decided. Considering the age range of the participants and the fact that most of them would be invited to move individually while their actions were video recorded, it was crucial to keep this intervention as short as possible. Moreover, given that the duration of the prearranged musical game was already very short (1 min and 58s), all the remaining procedures around that activity had to be efficiently performed to ensure children’s enthusiastic involvement throughout and hence the success of the data collection. A short intervention would consequently mean that children would also be away from their classroom activities just for a few minutes, avoiding major disruptions to their daily routine.

Considering what has been discussed so far, some adjustments had to be made before the second pilot work and main study. More specifically, it was fundamental to exclude the warm-up section, to have clear, short and simple instructions that would be fixed and memorised word by word by the researcher, to minimise the reactivity effect in the observed, to know the sequence and ‘choreography’ of the whole intervention in order to move confidently from one phase to the other, without any hesitation, which would consequently ensure a very short and efficient process. All this would necessarily require additional planning, restructuring and training before any usable data being collected.

In sum, this pilot study confirmed the feasibility of some of the research procedures implemented but it also pointed out some of the most problematic aspects of the design which needed to be changed or simply refined in the second pilot study.

Given that the next pilot work would be conducted in the same setting where the main study would be carried out, it was essential to evaluate once again the procedures that had been successful in the first pilot study, but most importantly, all the adjustments made and the new strategies proposed, some of which attending to contextual specificities.

I.2.3 Parental Consent Form: Pilot Study 1 (Lisbon)



THE UNIVERSITY *of* EDINBURGH

Consentimento informado

Caros Encarregados de Educação,

O meu nome é Ana Paula Almeida, antiga professora de Música da Infantil da Academia de Música de Santa Cecília. Actualmente encontro-me a realizar um doutoramento em Música (Institute for Music in Human and Social Development – Universidade de Edimburgo) cujo principal objectivo é compreender e analisar os movimentos espontâneos de crianças 4 e 5 anos em resposta à música. Com esta investigação espero poder contribuir para o melhoramento das experiências de aprendizagem musical de crianças em idade pré-escolar.

Durante os dias 28 e 29 de Dezembro de 2011 pretendo:

- Convidar cada criança de 4 e 5 anos da Infantil a participar **num jogo** (2 minutos).
- **Observar os movimentos** espontâneos dos pequenos participantes e realizar uma **gravação de vídeo*** durante a sua participação no jogo.
- Ter uma **conversa curta e informal** com cada criança, imediatamente após o jogo.
- Oferecer um **workshop de movimento e música** (30 minutos) no dia 29 de Dezembro a todos os participantes do estudo, como forma de agradecimento pela sua colaboração.

* Toda a informação e imagens recolhidas serão mantidas privadas e confidenciais. Estas serão apagadas no momento em que deixem de ser necessárias para a investigação. As gravações apenas poderão ser mostradas como parte da minha tese de doutoramento, em revistas científicas ou em conferências académicas. A resolução das imagens será também reduzida, de modo a preservar o anonimato das crianças.

Venho assim, pela presente, solicitar o vosso consentimento para a participação do seu filho/filha neste estudo exploratório, que antecederá um estudo maior a ser realizado num infantário em Edimburgo (Escócia). A participação é voluntária, tendo a criança o direito de desistir da actividade a qualquer momento.

Agradeco antecipadamente toda a atenção e colaboração.

Com os melhores cumprimentos,

Ana Paula Almeida
(A.P.Almeida@sms.ed.ac.uk)

AUTORIZAÇÃO

Eu, _____, Encarregado de Educação da criança _____, da classe Infantil da Academia de Música de Santa Cecília AUTORIZO que o meu filho/filha participe no estudo de Ana Paula Almeida no contexto do seu doutoramento, de acordo com as condições que me foram previamente descritas na folha explicativa. Também AUTORIZO que as filmagens a realizar que incluam o meu filho/filha sejam apenas utilizadas na tese de doutoramento da investigadora, em revistas científicas ou em conferências académicas.

(Assinatura do Encarregado de Educação)

I.3 Pilot Study 2 (Edinburgh)

I.3.1 Participants

The young participants of the second pilot study attended a Nursery in Edinburgh, constituting a sample of 8 healthy children (4 male and 4 female) with 4 years old (range 48-54 months, mean age 50.6, SD 2.45) that had been randomly selected from one classroom in that educational institution. In terms of their previous musical and dance formal education, 5 children never had music classes, 2 children never had music or dance classes and 1 child already had music and dance classes.

The deliberate use of a small sample size in this pilot work would ensure that a considerable number of children from this classroom would still be available to participate in the main study. Moreover, it was decided that only the 4-year-olds would be involved in this particular intervention because at this stage of the research an acceptable level of familiarity had already been developed between the researcher and the age group in question compared to the 5-year-olds group.

I.3.2 Procedure

This pilot work was conducted in two rooms in the Nursery, where the main study would also be carried out afterwards. Given that this educational institution was unfamiliar to the researcher it was crucial to have a period of acclimatisation to that physical space but, most importantly, to the young children and the teachers who would intervene, directly or indirectly, in the investigation. That said, considering that the details of this naturalistic and preliminary observation were already described in section 4.1.1, in the next paragraphs only the procedures regarding the musical game, in particular, those that were still unresolved in the first pilot study, will now be addressed.

This practical intervention was carried out during one morning. After all ethical requirements were considered and the informed consent of parents granted, the small group of 4-year-old children was then invited to participate in a musical game. It is important to clarify at this point that the pre-schoolers involved in this pilot work

would not participate in the main study in order to avoid the contamination of the sample.

Following the suggestions of the previous pilot study, a room was chosen near to the 4-year-olds' classroom to facilitate moving children individually from one location to the other. Even though this choice of location represented a clear advantage for this particular age group, the researcher was aware that in the case of the 5-year-olds this would entail having to travel from the Primary school building to the Nursery. In practical terms this would imply that in the main study each child would walk approximately 3 minutes accompanied by the researcher, and under the indirect supervision of school assistants in the premises.

One could argue that it would have been preferable to find another research setting closer to the 5-year-olds' classroom, however, it was fundamental for the research to use the same setting for both age groups. Moreover, the Primary school did not have any available room for the study at the time and, even if it did, it would be more important to bring the older group of participants to the Nursery, which was an already well-known place for most of them, than to bring the younger children to a more unfamiliar building.

Few days before starting the pilot study, the equipment was set up in the climbing room in the Nursery and the necessary tests were performed, as already described in section 3.4. Furthermore, during one of these preliminary visits to the Nursery the researcher informally invited the participants to play and manipulate the video camera while turned off and to ask any questions about that device. Another technical procedure which was context-dependent consisted in testing and determining the appropriate volume level to play the music stimulus that would support and encourage children to move. However, it was fundamental to ensure that the music would not be heard in the 4-year-olds' classroom.

The instructions were now in English and were presented according to a fixed, clear and simple script. The words would be very well-articulated by the researcher who in this particular context was a non-native speaker. Moreover, other decisions were

made to refine the procedures of the preliminary pilot study. The instructions would now be specifically presented within the delineated area of the room and children would be naturally positioned by the researcher at the centre of that circumscribed space, as in Sims' (1985) study. This decision entailed that all children would start the game in a similar position which would bring consistency to the process and at some extent facilitate the video observation and data analysis. While giving the instructions the researcher would establish an eye-level contact with the young participants by squatting down. This procedure aimed to partially deconstruct the powerful position of the adult researcher in relation to the child participant.

Considering that in this intervention different music stimuli were still being used, the ultimate decision about the selection of the most appropriate music stimulus for the Embodied Beat study would rest on a group of judges (musicians), as aforementioned in section 3.5. Each one of the stimuli was composed by different musical tempi with a clear perceivable beat but also by a 'no beat' section. After this second pilot work, and before any usable data was gathered, it was decided that this latter section would be excluded because it introduced an element of disturbance in children's movement responses but, most importantly, it seemed to have affected the engagement of some participants in the activity from that point onwards. However, it was clear that this 'no beat' section elicited responses distinct from the ones exhibited in the 'beat' sections, which may suggest a connection between the regular structure of the beat and children's rhythmic responses.

Another important decision made was that only one observer or data collector would be required to carry out the main study. Given that the researcher was able to efficiently conduct this pilot study by herself, after some preliminary training, it was decided that no assistance would be needed. This would also be beneficial for the children since another adult in the room could potentially increase the pressure over the child who was being individually observed and filmed.

In this specific pilot study one teacher was invited to stay in the back of the room during the musical game. She would be instructed to keep a low-profile and thus a discrete and neutral presence while each child was moving. Moreover, the teacher

would be also asked to avoid interacting with the children through eye contact or gestures. Considering that the reactivity to teacher's presence was evident in most of the participants (e.g. occasional glances to the teacher to look for her approval), it was decided that another solution had to be found that would assure the institution that children's actions were also being monitored by someone other than the investigator. The solution found, which would then be used in the main study, consisted of leaving the door ajar enabling teachers to observe the activity without being seen by the young participants.

In sum, the two main adjustments that had to be made after this pilot work and before the Embodied Beat study concerned the music stimulus and the presence of the teacher in the setting. The first implied the consensual choice by a group of judges (musicians) of one of the three percussive pieces that had been played in the pilot studies. Moreover, this musical stimulus would then replace the 'no beat' section by a 'very slow tempo' section, in which the beat would still be recognisable. In respect to the presence of a teacher in the research setting, it was decided that it would be preferable for her or any other teacher not to be visible to the children during the musical game. As follows, the door would be maintained ajar so teachers could have a peek and observe children's actions.

Appendix J

First Impressions (written description):

1 example

Movement Observation			
Start Date	Study	Participant	End date
18.10.2012	EB	03_G_4_M1_F_VS_S_M2	18.10.2012

First impressions
<p>Moderate 1 The child tries to explore different spatial directions while stepping (forward-backward, left-right, up-down), possibly to find the best solution to physically accentuate the beat. I also get the sense that she is still a little bit inhibited (e.g. she has one finger in her mouth and she explores mainly a near-reach space).</p> <p>Fast The young participant starts this section of the game by stepping to the beat, with her arms still near her body axis. However, suddenly she starts to jump and her arms begin to open (mid- and far-reach space). She is definitely more confident in her movement performance. This particular musical speed seems to have encouraged her to be more adventurous in her choices.</p> <p>Very slow She continues jumping (vertical jump). This particular body action seems to be her preferred way of expressing the steady and strong accented beat.</p> <p>Slow Jumping is still the dominant action in the child's performance. Interestingly, at times she introduces some variations (e.g. turning hop).</p> <p>Moderate 2 Jumping continues to be the prevalent pattern of this participant, alternated by other transient actions.</p> <p>Other impressions:</p> <ul style="list-style-type: none"> - Her movements seem periodic but not synchronised with the musical beat. - Even though I observed some displacement in space during the child's performance, I felt that she wanted to stay mostly in place and not to travel through space. - Interestingly, some body actions that are often identified in literature as locomotor, in this case were not used to access general space ('locomotor actions in place').

Appendix K

Operational Definition: Body Actions

K.1 Introduction

The following body actions constitute the repertoire exhibited by the 4- and 5-year-olds during the musical game. They will now be presented in alphabetic order and organised according to the main categories of body actions (**in bold**). Any variation that falls under each one of those main categories will also be operationally defined (underlined).

It is important to clarify that some of the categories described represent a combination of two different body actions. In these particular cases the dominant pattern will be firstly referred (e.g. Turning jump or Walking-bouncing). Moreover, two specific categories – standing still and interruption - will also be included and defined given that they were performed by some of the children, even though they are not representative of the repertoire of body actions exhibited.

The operational definition of some categories will be based on definitions proposed by Gallahue & Ozmun (1998), Payne & Isaacs (1999) and Haselbach (1971). Lastly, video clips will be included whenever necessary as an illustration of some of the categories defined.

K.2 Body actions

Arms accentuation - Arms moving up and down with an accent being placed at the end of the downward motion.

Break dance pattern - The hands are in contact with the floor and the mover rotates around himself making his feet run around him in a circular pathway.

Bouncing - Bending and straightening of the knees in a repetitive manner.

Bouncing while swaying - Bending and straightening of the knees repeatedly while oscillating the body forward-backward or left-right without the feet ever leaving the floor.

Bouncing-stepping - Bending and straightening the knees repeatedly while moving each foot up and down in succession. The combination or sequence of bouncy steps performed in different directions (e.g. forward, backwards, left and right) will create different movement patterns.

Cartwheel - A circular sideways body movement which starts from a standing position, with arms extended upwards to the sky, and then develops to an inverted position of the body by bringing the hands one at a time to the floor and by allowing the legs to travel sideways over the body until the feet establish contact with the supporting surface one at a time and the mover returns to his upright posture.

Foot rotation - Circular motion of one foot suspended in the air while the other foot supports the weight of the body.

Galloping – Combination “of two fundamental movements, the step and the leap, with the same foot always leading in the direction of the movement. The movement is called a gallop when the person is moving forward or backward (Gallahue & Ozmun, 1998, p. 232).

Hands rotation - Circular motion of both hands clockwise.

Interruption – Unforeseen event that discontinues the ongoingness of the movement (e.g. tying shoelaces).

Jiggling - A quick and light up-down shaking motion.

Jumping - “...when the body is projected into the air by force generated in one or both legs and the body lands on one or both feet (Payne & Isaacs, 1999, p. 266). The “mature vertical jumper prepares by taking a preparatory crouch followed by a vigorous swing of the arms upward in the desired direction of the jump. In addition, he or she rapidly extends the hips, knees, and ankles as the body moves upward. On landing, the ankles, knees, and hips flex to absorb the impact forces” (p. 269).

Hopping - Hopping is a type of jumping (identical to a vertical jump) in which the same foot is used to propel the body upwards during takeoff and also to support the subsequent landing.

Horizontal jump - A jump for distance in which the body is projected both upward and forward using both feet during takeoff and landing.

Jumping for height - The body is projected upwards into the air using a two-foot takeoff and landing subsequently on both feet. This specific jump is about how high the individual is able to elevate off the ground from a standstill, which will imply placing the physical accentuation and spatial intention at the end range of the upward vertical motion.

Jumping-swaying - Lifting the body upwards while moving and transferring weight to one side of the body and repeating the same oscillatory motion in the opposite direction. Moreover, the jumper takes off from one foot and lands on the other one.

Sideways split jump – “After taking off from both feet the legs are opened sideways” (Haselbach, 1971, p. 91). Then, with a new lift the body returns to the initial position with both feet close together before a new sequence begins. This pattern is similar to the star jump but without the movement of the arms.

Sideways split jump & twist jump - During the sideways split jump pattern the torso rotates alternately to one side of the body and to the other.

Split jump - “After taking off from both feet the legs are opened [still in the air] forwards and backwards” (Haselbach, 1971, p. 91). The leg that leads in the first jump (e.g. right leg - forward) will then be replaced by the other leg in the next jump and becomes the leading leg (e.g. left leg - forward). This movement is repeated several times.

Star jump (also known as jumping jack) – Jumping from a standing position with the feet close together and arms at the sides near the body’s midline, to a position in which the legs are open wide sideways and the arms over the head. This pattern is repeatedly performed.

Twist jump - Pelvic twists to the left side and then to the right side of the body while jumping vertically.

Vertical jump - From a standstill position the body is propelled upwards into the air (two-foot takeoff) and then lands on both feet. The only difference between this pattern and a jump for height is the spatial intention of the mover. In this particular case there is no accentuation in the end range of the upward motion, that is, the mover does not intend to reach his maximum height level while jumping.

Kicking - Vigorous and sudden thrust with the foot.

Lateral pelvic sway - Sideways (lateral) motion of the pelvis.

Punching - Sharp punches in the air with the fist.

Running - “Running is sometimes referred to as a natural extension of walking. This form of locomotion is characterised by an alternate support phase and an airborne or flight phase. This flight phase is what most readily distinguishes the walk from the run” (Payne & Isaacs, 1999, p. 259). Moreover, an “experienced runner is capable of using arms in opposition to the legs” (p. 259).

Running sideways - The space is accessed laterally while running. The body is orientated forward but the runner travels in the right or left directions.

Shoulder shrugging - Lifting both shoulders up and down.

Skipping – “The skip consists of a forward step followed by a hop on the same foot (uneven rhythmical pattern). In addition, there is alternation of the leading leg. Unlike gallop and slide, skipping requires both motor tasks (step and hop) to be accomplished on the same foot before the body’s weight is transferred onto the other foot. Obviously, being required to perform dual tasks on a single leg is more difficult than performing a single task per leg as in galloping or sliding (Payne & Isaacs, 1999, p. 279).

Sliding - Galloping in a sideward direction.

Spinal movement – From a standing position a snake-like movement is performed from head to tail bone or vice versa.

Spiralling-jiggling - A series of circles executed while standing on the spot and around the vertical axis of the mover's body, punctuated by quick light shakes.

Standing still - Deliberate stillness.

Stepping - A combination or sequence of successive steps (forward-backward or left-right) that creates a specific movement pattern.

Stepping-stamping - A combination or sequence of successive forcible steps against the base of support (forward-backward or left-right) that creates a specific movement pattern.

Stepping-bouncing - A combination or sequence of successive steps (forward-backward or left-right) performed while bending and straightening the knees repeatedly.

Stepping-twisting - A combination or sequence of successive steps (forward-backward or left-right) performed while rotating the body to one side and to the other around the vertical axis.

Swaying - Oscillatory movement of the whole body side to side or forward-backwards without moving the feet.

Swaying-rocking - Oscillatory movement of the whole body side to side or forward-backwards in which the base (feet) is in motion.

Swinging while swaying-rocking – The arms are suspended and execute a sweeping motion (forward-backwards) while the rest of the body performs a discrete oscillatory movement, side to side or forward-backwards, with its base (feet) also in motion.

Tapping – the act of striking lightly the foot or hand against a stable surface.

Tapping (foot) – Moving the ball of the foot up and down against the base of support and maintaining the heel always in contact with the floor.

Tapping (hand) – Moving one hand against and away from one of the legs.

Turning – From an upright standing position the body (in place) moves in a circular direction wholly or partly around its own vertical axis.

Turning hop - “Take-off and landing use the same foot. The turning develops from a hop with the working leg held straight. This working leg is swung forwards and held there while the supporting leg and the trunk twist round through 180 degrees” (Haselbach, 1971, p. 90).

Turning jump - A “jump that develops from a step that causes the body to turn” (Haselbach, 1971, p. 89).

Turning while jumping - Small circular movement constituted by a sequence of vertical jumps around a stationary point.

Turning while stepping - Small circular movement constituted by a sequence of steps around a stationary point.

Twisting - Repetitive rotational motion to one side and to the other and partially around the vertical axis that runs straight through the body midline (e.g. spinal twist).

Twisting-shoulder wiggle – Small rapid side to side movements of the shoulders while rotating partially the spine to one side and to the other.

Walking - Moving over a surface at a regular pace by advancing the leading feet alternately so there is always one foot in contact with the base of support (bipedal locomotion).

Walking-bouncing - Advancing progressively at a moderate speed with the alternation of the leading feet while slightly bending and straightening the knees.

Appendix L

Observational Schedule/Checklist: LMA Categories

1 example

Observational schedule			
Start Date	Study	Participant	End date
23.11.2012	EB	03_G_4_M1_F_VS_S_M2	23.11.2012

Body Action		
Category	Tempo	Description
Body Actions	M1	<p>Jumping (vertical), from both feet onto both feet, up-down. Duration: 1.8s</p> <p>Twisting, upper-body (torso/spine), to the left and to the right. Duration: 0.8s</p> <p>Hopping, from one foot to the other, up-down. Duration: 0.7s</p> <p>Swaying (pelvis), the sway movement of the hips makes her flex and extend the <i>knees alternately and rhythmically</i>, without lifting the feet. Duration: 4.1s</p> <p>Stepping, <u>SEQUENCE A</u>: one step to the left side, one step to the right side. Duration: 2.1s</p> <p>Jumping (vertical), from both feet onto both feet, up-down. Duration: 0.7s</p> <p>Stepping, <u>SEQUENCE A</u>: one step to the left, one step to the right. Duration: 1.1s</p> <p>Stepping, <u>SEQUENCE B</u>: one foot at a time, forward-centre. Duration: 2.4s</p> <p>Swaying (hips), the sway movement of the hips makes her flex and extend the <i>knees alternately and rhythmically</i>, without lifting the feet. Duration: 1.3s</p>
	F	<p>Stepping (as if walking in place), feet moving alternately. Duration: 4.1s</p> <p>Hopping, up-down. Duration: 0.6s</p> <p>Jumping (vertical – jumping for height), from both feet onto both feet, up-down, arms assist this action. Duration: 5.1s</p>

	<p>Hopping, up-down. Duration: 2.2s</p> <p>Jumping (vertical), alternatively from both feet onto both feet. Duration: 1.5s</p> <p>Sideways split jumping. Duration: 1.5s</p>
VS	<p>Hopping, up-down. Duration: 0.5s</p> <p>Jumping (vertical), from both feet onto both feet, up-down. Duration: 12.3s</p> <p>Jumping (twist jump), from both feet onto both feet, up-down. Duration: 2.2s</p>
S	<p>Jumping (vertical), from both feet onto both feet, up-down. Duration: 8.9s</p> <p>Sideways split jump-twist jump (combined action), from both feet (together) onto both feet (open), up-down. Duration: 0.8s</p> <p>Jumping (twist jump), from both feet onto both feet, up-down. Duration: 2.2s</p> <p>Jumping (vertical), from both feet onto both feet, up-down. Duration: 1.4s</p> <p>Turning hop, preparation, taking off and landing with the left foot, up-down. Duration: 1.7s</p>
M2	<p>Jumping (vertical), from both feet onto both feet, up-down. Duration: 7.2s</p> <p>Hopping, up-down. Duration: 0.4s</p> <p>Walking (sideway cross-over step). Duration: 0.7s</p> <p>Walking, backwards. Duration: 0.5s</p> <p>Jumping (vertical), from both feet onto both feet, up-down. Duration: 0.9s</p> <p>Hopping, up-down. Duration: 1.6s</p> <p>Skipping (focus on jumping for height), up-down / arms rolling forward. Duration: 3.7s</p>

Body LMA (<i>what takes place</i>)		
Postural & Gestural Movements	M1	Postural
	F	Postural
	VS	Postural
	S	Postural
	M2	Postural
Patterns of Body Organisation Core-Distal Head-Tail Upper-Lower Right-Left Cross-Lateral	M1	Upper-Lower; Right-Left
	F	Upper-Lower; Right-Left
	VS	Upper-Lower; Right-Left
	S	Upper-Lower; Right-Left
	M2	Upper-Lower; Right-Left
Most Active Body Unit Arms/upper spine and head & Legs/lower spine and pelvis	M1	Legs/lower spine and pelvis
	F	Legs/lower spine and pelvis
	VS	Legs/lower spine and pelvis
	S	Legs/lower spine and pelvis
	M2	Legs/lower spine and pelvis
Body Phrasing Simultaneous & Sequential or Successive Movement	M1	Simultaneous
	F	Simultaneous
	VS	Simultaneous
	S	Simultaneous
	M2	Simultaneous

Effort LMA <i>(how it takes place)</i>		
Flow		
Free (releasing) <-----> Bound (holding on)	M1	
	F	
	VS	
	S	
	M2	
Weight		
Light (increasing pressure) <-----> Strong (decreasing pressure)	M1	
	F	
	VS	
	S	
	M2	
Time		
Sustained (lingering attitude) <-----> Quick (sense of urgency)	M1	
	F	
	VS	
	S	
	M2	
Space		
Indirect (multi-focused approach) <-----> Quick (single-focused approach)	M1	
	F	
	VS	
	S	
	M2	

Space LMA (where it takes place)		
General Space		
Travelling Actions & Actions in Place	M1	Travelling actions & Actions in place
	F	Travelling actions & Actions in place
	VS	Actions done in place
	S	Actions done in place
	M2	Travelling actions & Actions in place
Pathways Straight, Circular Curved Zigzag	M1	
	F	
	VS	
	S	
	M2	
Peri-personal Space		
Dimensions/Planes Vertical D Horizontal D Sagittal D Vertical P Horizontal P Sagittal P	M1	Vertical D → Horizontal P → Horizontal D → Vertical D → Sagittal D → Horizontal D
	F	Sagittal P → Vertical D → Vertical P → Vertical P
	VS	Vertical D → Vertical P
	S	Vertical D → Vertical P → Vertical D → Vertical P
	M2	Vertical D → Sagittal P
Height Level High Medium Low	M1	High
	F	High
	VS	High
	S	High
	M2	High
Reach Space Far-reach Mid-reach Far-reach	M1	Near-reach
	F	Near-reach → Mid-reach
	VS	Mid-reach
	S	Mid-reach
	M2	Mid-reach

Shape LMA
(the body changing form)

Modes of Shape Change

Shape flow	M1	
	F	
Directional movements (spoke-like or arc-like)	VS	
	S	
Shaping	M2	

Shape qualities (Effort affinities)

Rising/Sinking	M1	
	F	
Advancing/Retreating	VS	
	S	
Spreading/Enclosing	M2	

Appendix M

Intra-observer and Inter-observer Reliability: Assessing Children's Motor Tempo

M.1 Aim

Both Intra-OR and Inter-OR assessments were used to estimate the degree of consistency among observers' responses relatively to the dominant motor tempo of each participant to the different musical tempi of the game. In terms of the first assessment, concordance was sought between the same observer and in the second assessment between two different observers. The decision to use an Inter-Or additionally to the Intra-Or aimed to ensure that reliability would not only be based on the estimates of the relative consistency of judgments within an observer over time but also among two different observers. As follows, validity would then increase.

By using both these reliability assessments one expected to compare more confidently the preferred motor tempo of each child in the different sections to the 5 original tempi of the stimulus. Moreover, it would be possible to estimate in relative terms participants' rhythmic behaviour in response to the beat (periodicity, synchronisation and adjustments to the tempo changes) and use this complementary information to support the description of children's choices of movement patterns.

M.2 Method

Given that the same design was used for Intra-OR and Inter-OR, in the following subsections the specificities of each particular assessment will only be mentioned whenever necessary. The Intra-OR was measured prior to the Inter-OR and it involved one observer (researcher) annotating twice for the whole sample (4-year-olds, $N=21$; 5-year-olds, $N=22$) at two different time points with one week apart. In the case of Inter-OR the two observers (observer 1, the researcher, and observer 2) annotated for a subset of participants that were randomly selected and which constituted half of the sample (4 year-olds, $n=11$; 5 year-olds, $n=11$). This decision was made because asking observer 2, less familiar with the data, to watch the 43 video clips (approximately 1 hour and 8 minutes) would represent a very time-consuming task. More specifically, it would require using a high-level of attention to details for a long period of time and thus the need for recurrent breaks which would then make the whole process less manageable. It is also important to refer that even

though each observer in Inter-OR completed the task independently, they both have used the same setting, material and procedures.

The total duration of each intra-OR sessions lasted approximately 2 hours and 30 minutes while each Inter-OR session was around 1 hour and 30 minutes in total. The Inter-OR assessment, more specifically regarding the session of observer 2, comprised a clarification of 10 minutes followed by a training session (20 minutes) and an observation task which lasted approximately 40 minutes per group of participants (4-year-olds, $n=11$; 5-year-olds, $n=11$). A 30 minute break was also provided between the observations of each age group. In all sessions involving observer 1 (researcher) only the clarification session was comprehensibly omitted.

M.2.1 Observers

Both observers selected for participating in the reliability assessments shared similar expertise. Not only were they experienced musicians but they also had an identical background in movement and dance as well as in teaching music to young children.

M.2.2 Material

One 21.5-inch iMac (2.7GHz quad-core Intel Core i5) and 1 Vaio laptop running Windows 8 (Intel(R) Core (TM) i5-4200U CPU @ 1.60GHz) were used for this particular task. The iMac was chosen to play the videos (MPEG-4 format) in QuickTime Player 7 (for Mac OS X v10.6.3 or later) considering its wide screen size and good resolution. The Vaio laptop, on the other hand, was used to assist the observational procedure by displaying on screen an online metronome (<http://a.bestmetronome.com/>) that would be manipulated mostly through the use of the keyboard spacebar. It is important to refer that the videos were watched directly from an external hard drive in order to avoid copying the files into the computer given the ethical requirements. The results of this observational task would then be recorded on a paper document containing a table with the coded identification of the participants.

M.2.3 Procedure

As previously referred, the Inter-OR assessment was divided into three different stages. However, only the last two were used in the case of observer 1 (researcher) since clarifications about the details of the study were not required.

In the first stage of Inter-OR observer 2 was clarified about the general context of the investigation. She was then informed about the musical statues game that each 4- and 5-year-old children was invited to play individually and that implied a series of alternated events of movement ('move to music') and stillness ('freeze to silence'). It was also explained to observer 2 that children were moving to a rhythm-based music that was presented at a different tempo in each one of the 5 sections. However, the order of those sections/tempi could change from child to child since 6 different combinations were randomly distributed by participants.

Information was then provided regarding the purpose of the observation task itself. Both observers assessing Inter-OR were invited to watch 22 video clips (1 minute and 58 seconds each) of participants playing the game that comprised 5 sections of movement (15 seconds each) intercalated by 4 sections of stillness (5 seconds each). It is worth reminding that in the case of the observer who assessed Intra-OR the number of video clips would be 43.

In the next stage the observers were informed about the main goal of the assessment, which consisted of inferring the metronomic value of the beat that children were moving to. Considering that the audio was turned off, the observers would have to deduce the speed of the musical beat just by watching each participant's accented movements. In practical terms, this process would consist of tapping in response to what seemed to be the predominant pulse underlying children's rhythmic movements. More specifically, this particular finger tapping action had to be maintained as regular as possible as though the tapping itself 'was' actually the beat children were responding to.

The observers were specifically made aware that the aim of the task was not to determine the accuracy of children's synchronisation, which would mean to tap to

every accentuation exhibited by participants, but to infer the musical beat children were listening and moving to, and thus to tap consistently to that regular beat. This implied that even when slight fluctuations occurred in participants' rhythmic movements, the observer would keep tapping to the predominant pulse of the child in the video clip and in this way she would avoid making dramatic adjustments during the task that could compromise the results.

It is relevant to emphasise that observers were also advised to infer and get a general sense of the experienced pulse, not by focusing on a particular body part or joint but by observing the whole body moving. As follows, rather than prescribing beforehand where the beat should be found (e.g. knee joint) it was decided that a more holistic approach would be used to avoid unnecessary constraints to the observation and inference process. These constraints could have potentially compromised the natural development of kinaesthetic empathy fundamental to the task. Moreover, if one body location would have been predetermined for the observation of the embodied beat, it would have implied that the use of other body locations to infer children's physical accentuations would be excluded and thus individual differences could have been disregarded in this way.

The second stage of the Intra-OR and Inter-OR assessments consisted of a training session. After giving the initial verbal instructions, the observers were trained for approximately 20 minutes. They would have to observe one video clip (75 seconds) of one participant from the pilot study and learn how to tap while inferring the musical beat that children were moving to. At the same time they would have to master the practical operations involved in the transition from one tapping segment to the next one. The observers would then be able to repeat this training tapping task as many times as they wished and also to ask all the necessary questions.

During this training session observers were specifically informed that each tapping segment could be immediately repeated if any problem would arise during the process (e.g. loss of focus) or if they thought their performance could be somehow improved. They were also advised that they might find different degrees of difficulty during the task, given that some rhythmic movements would be easier to tap to than

others, and that potential adversities should not affect their motivation. Once participants were confident about the whole process the third stage (observation session) could then begin.

M.2.3.1 Finger-tapping procedure

In the case of the Inter-OR, and for practical reasons, an assistant was invited to play the video clips in the iMac and to annotate the metronomic values obtained from the tapping task in a paper document. The observers would be responsible for operating all the remaining processes regarding the tapping task and the online metronome in the Vaio laptop.

After assuring that the observer was ready, the assistant would play the first section/tempo of the game with the audio turned off. The observer would then tap the keyboard spacebar continuously while watching the video and for as long as the segment lasted (15 seconds). Soon after, the assistant would pause the video and annotate the average of the last 20 taps, which were displayed on the screen in beats per minute (bpm) as Figure M.1 below shows. It should be mentioned that by annotating the average of the last 20 taps (bpm) and not the average of all taps executed during each section/tempo, one would ensure that the initial taps which were likely to be less regular and precise would not be considered. As follows, only the average of the supposedly steadier and confident taps would be recorded. After the first section of the game the observer would had to click on ‘cancel’ and then on ‘tap for custom tempo’ in order to start a new tapping/observation task. This same process would be repeated in the 4 remaining sections of the game and for all participants.

At the end of the observation session observer 2 was offered 1 cinema ticket as a compensation for her participation in the Inter-OR assessment.

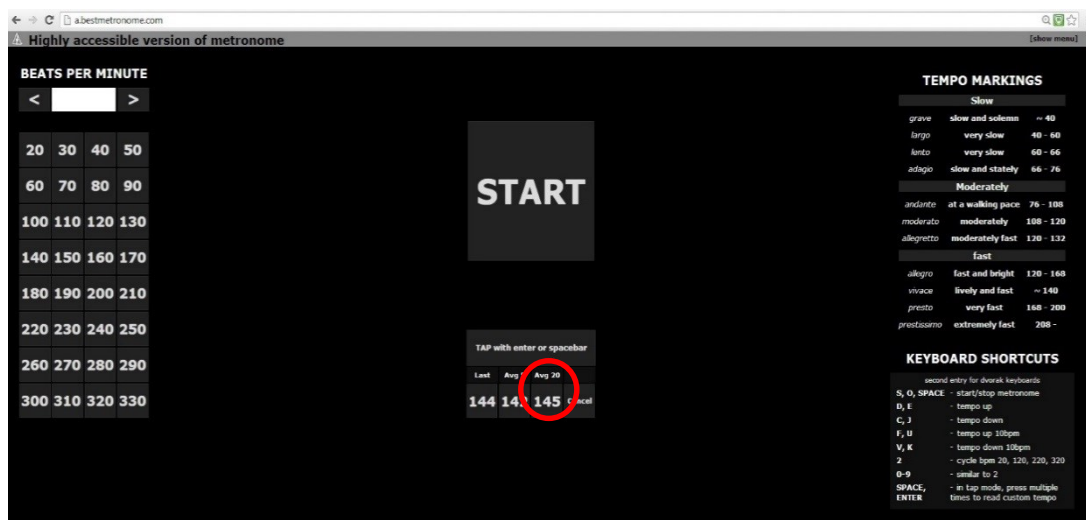


Figure M.1: Display of the online metronome and an example of the outcome of a tapping task (145 bpm, the average of the last 20 taps)

M.3 Statistical measure

Given that ‘speed’ (bpm) is a continuous variable at a ratio-scale level, Pearson’s correlation coefficient (indicated as r) is an appropriate statistics to estimate Intra-OR and Inter-OR among a single pair of observers and for one item at a time. The r will assess the linear relationship between the ratings of two observers and indicate the strength of that relationship (0 to 1 in absolute value). This means that a large magnitude of the coefficient implies a strong linear relationship between the motor tempo assessments of the same observer on two different occasions, with one week apart (Intra-OR), and also between the results obtained from both observers (Inter-OR). Even though Pearson's correlation coefficient “cannot measure agreement as such” it “assumes that a linear function best describes the relationship between 2 series of ratings. (...) In other words, r would indicate perfect agreement only if both raters agree and that their relationship is linear” (Gwet, 2012, p. 250).

All the necessary statistical analyses were performed using SPSS (IBM Corp. Released 2010. IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp.).

Appendix N

4-year-olds' Dominant Motor Tempo in each Musical Section

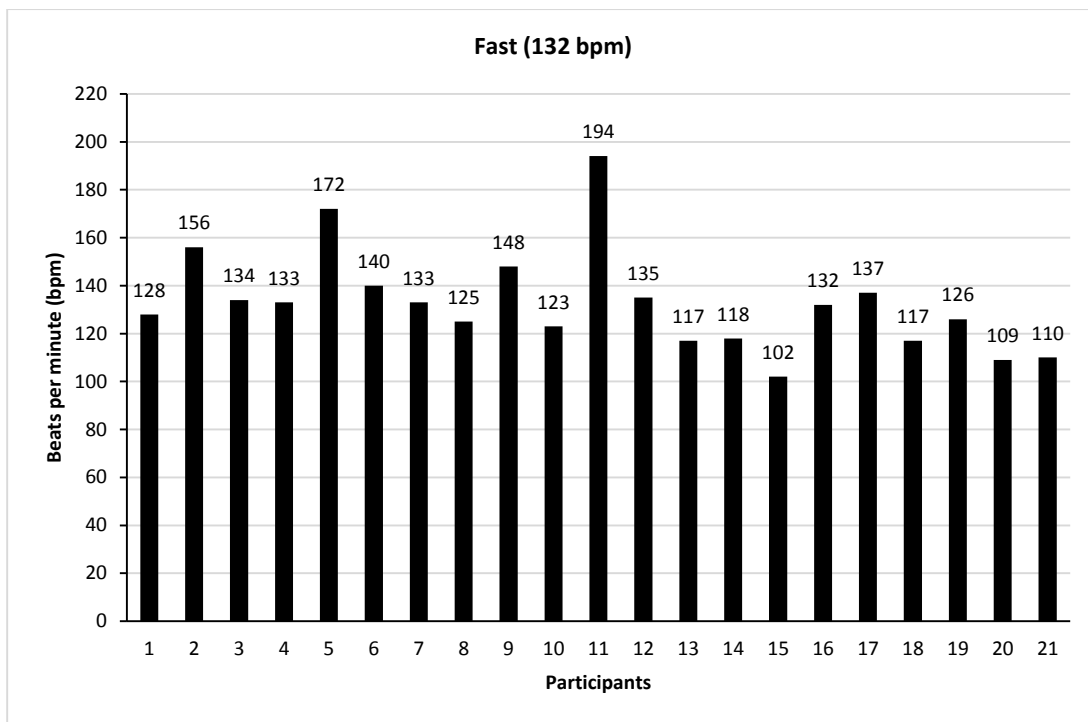


Figure N.1: 4-year-olds' dominant motor tempo responses to the Fast musical section

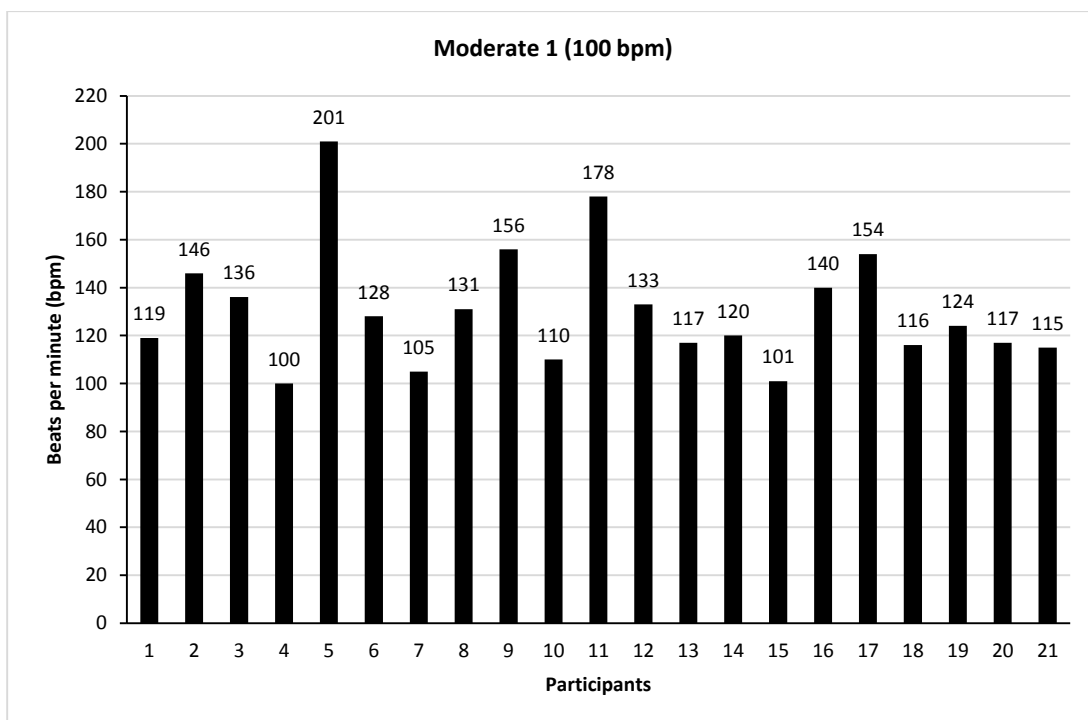


Figure N.2: 4-year-olds' dominant motor tempo responses to the Moderate 1 musical section

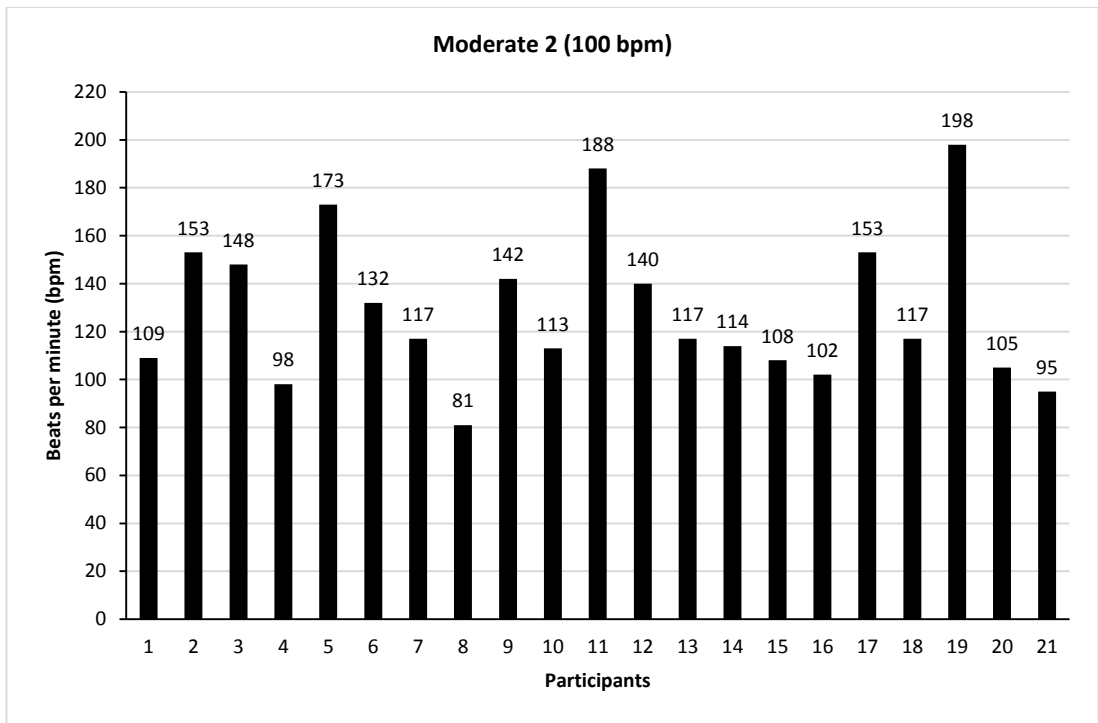


Figure N.3: 4-year-olds' dominant motor tempo responses to the Moderate 2 musical section

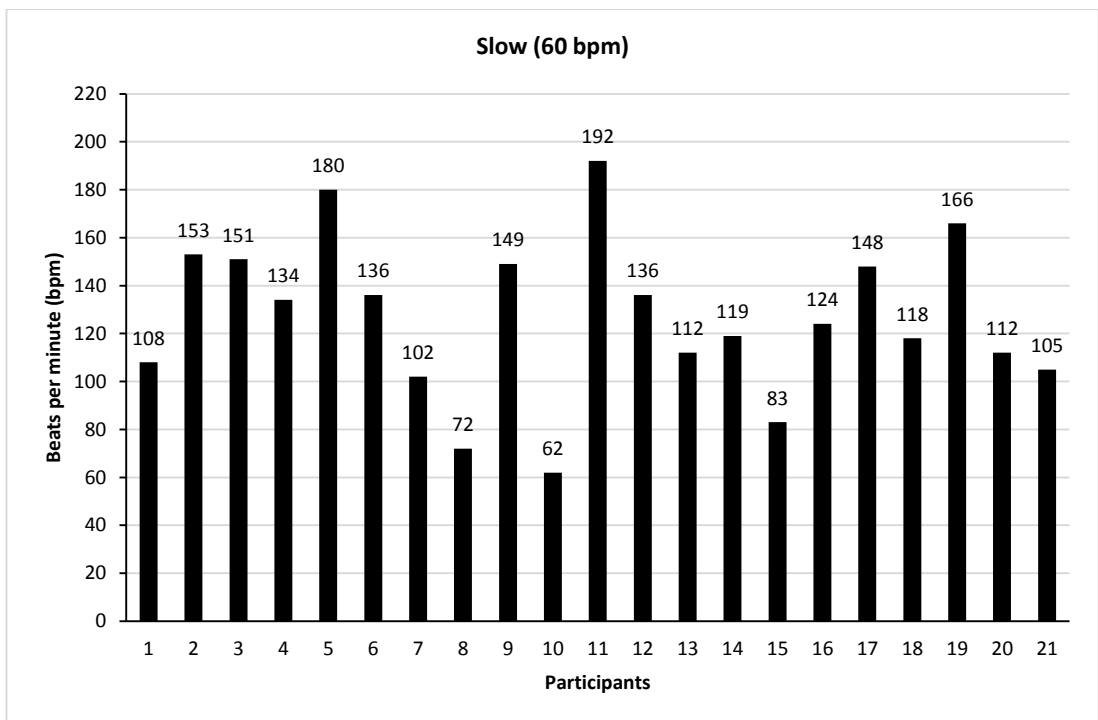


Figure N.4: 4-year-olds' dominant motor tempo responses to the Slow musical section

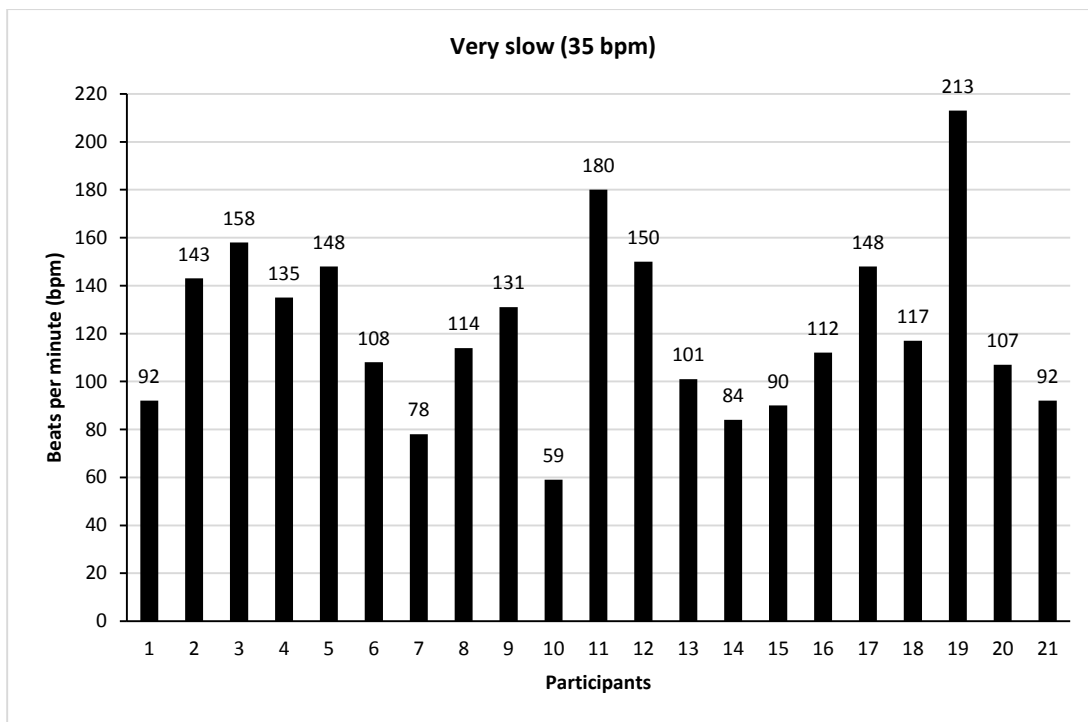


Figure N.5: 4-year-olds' dominant motor tempo responses to the Very slow musical section

Appendix O

Individual Motor Tempi (4-year-olds):

4 examples

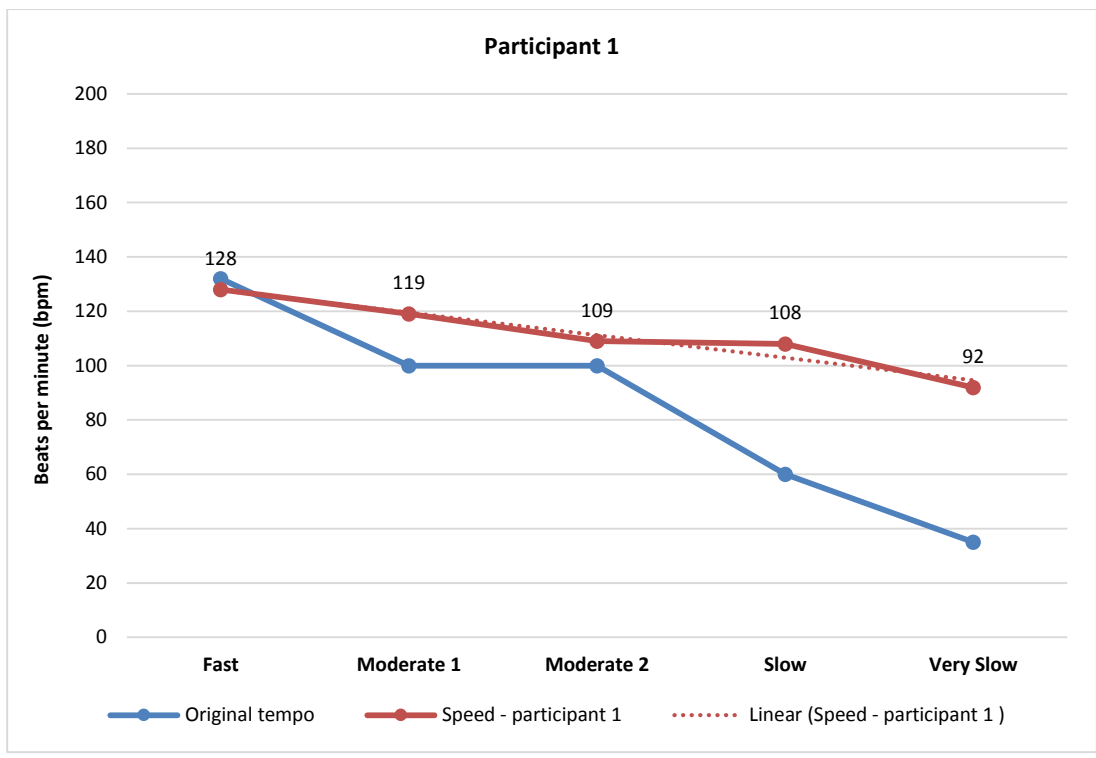


Figure O.1: Motor tempo of participant 1 across the 5 musical sections

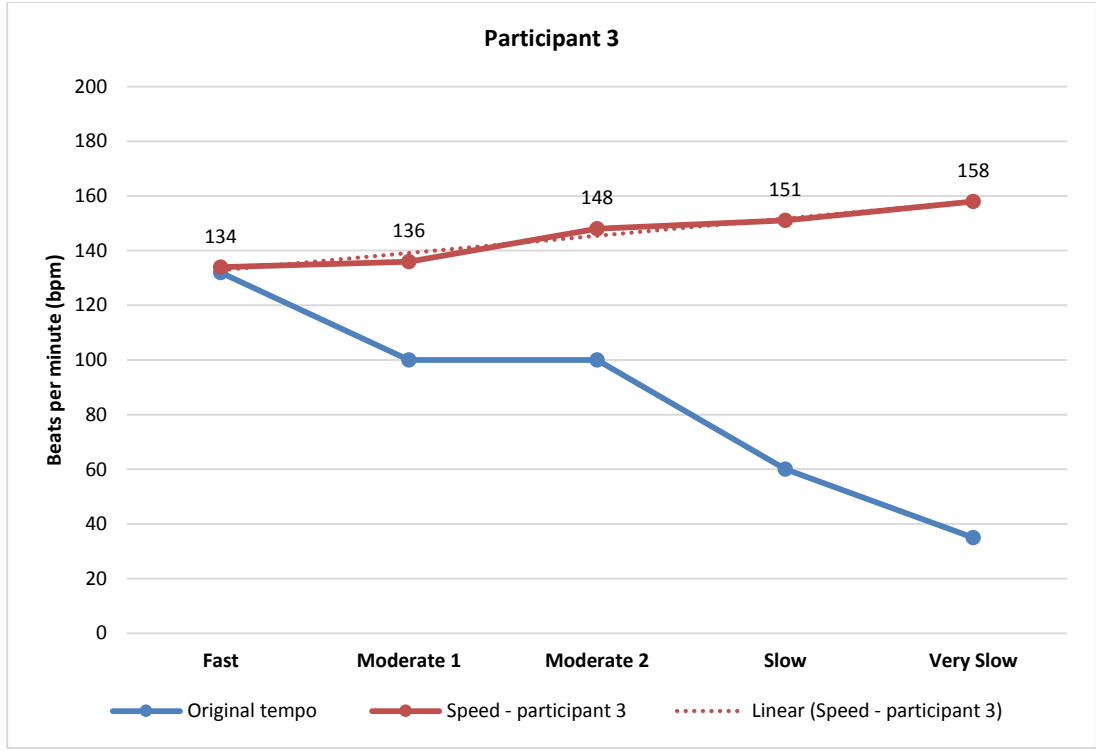


Figure O.2: Motor tempo of participant 3 across the 5 musical sections

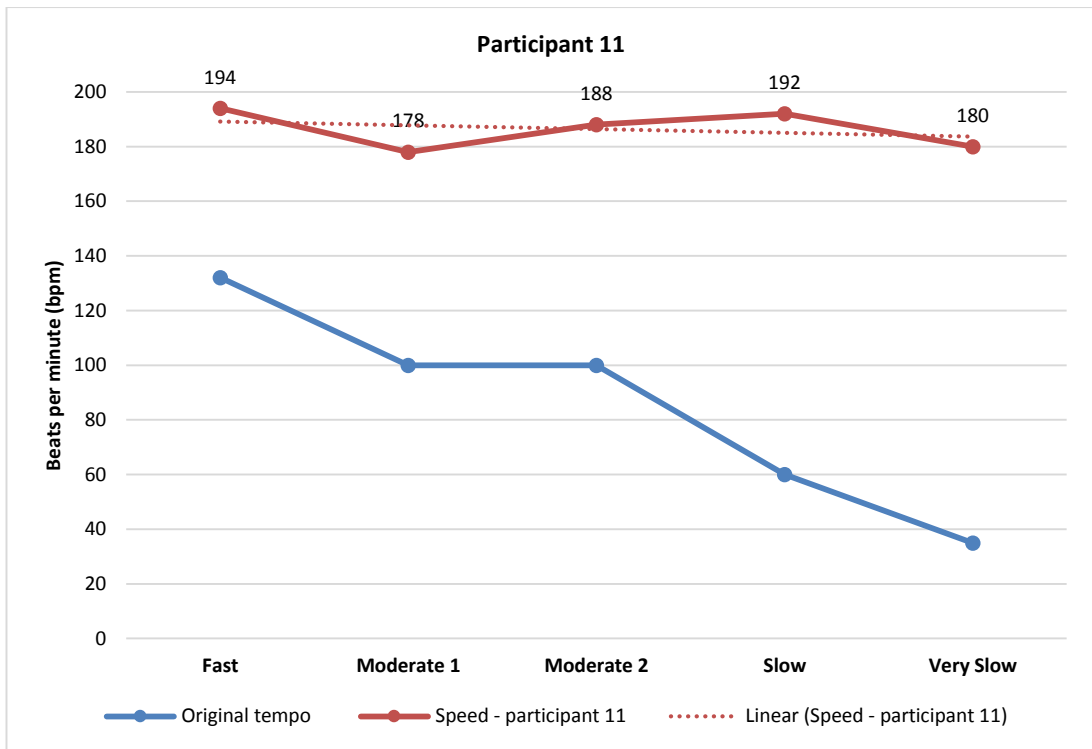


Figure O.3: Motor tempo of participant 11 across the 5 musical sections

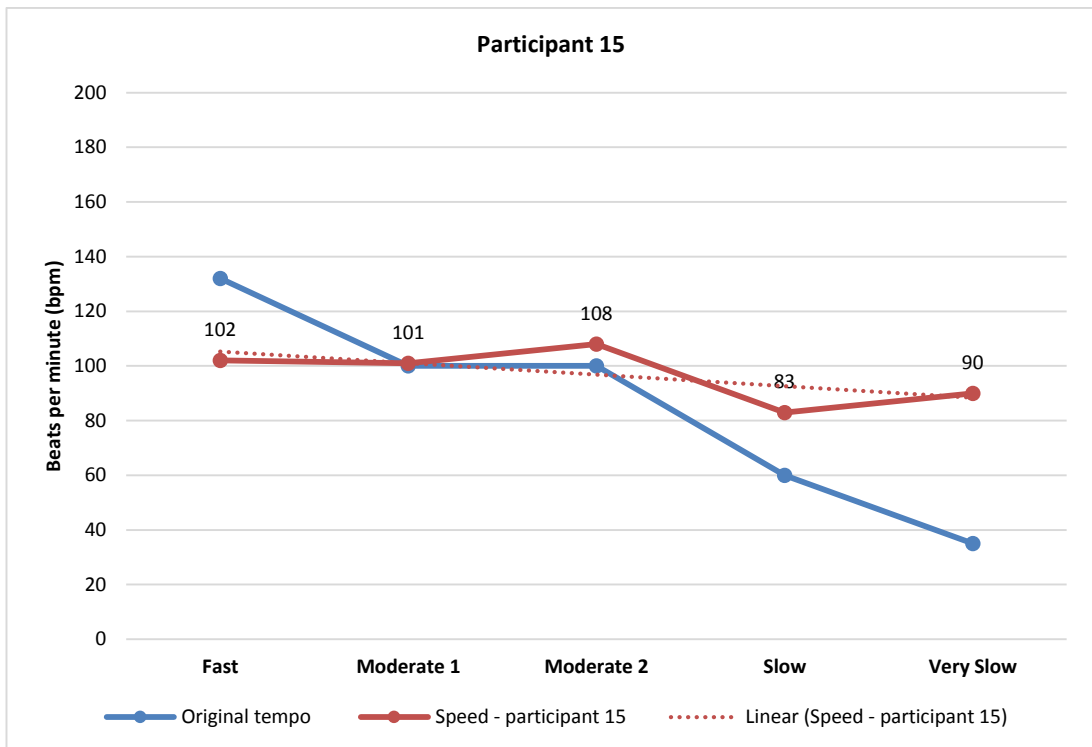


Figure O.4: Motor tempo of participant 15 across the 5 musical sections

Appendix P

Video clips: Body Actions (7 examples)

See enclosed DVD package for this appendix

P.1 Jumping (girl)

P.2 Jumping (boy)

P.3 Running (girl)

P.4 Stepping (girl)

P.5 Swaying (boy)

P.6 Twisting (girl)

P.7 Walking (girl)

Appendix Q

32 Body Actions (variations included):

4-year-olds

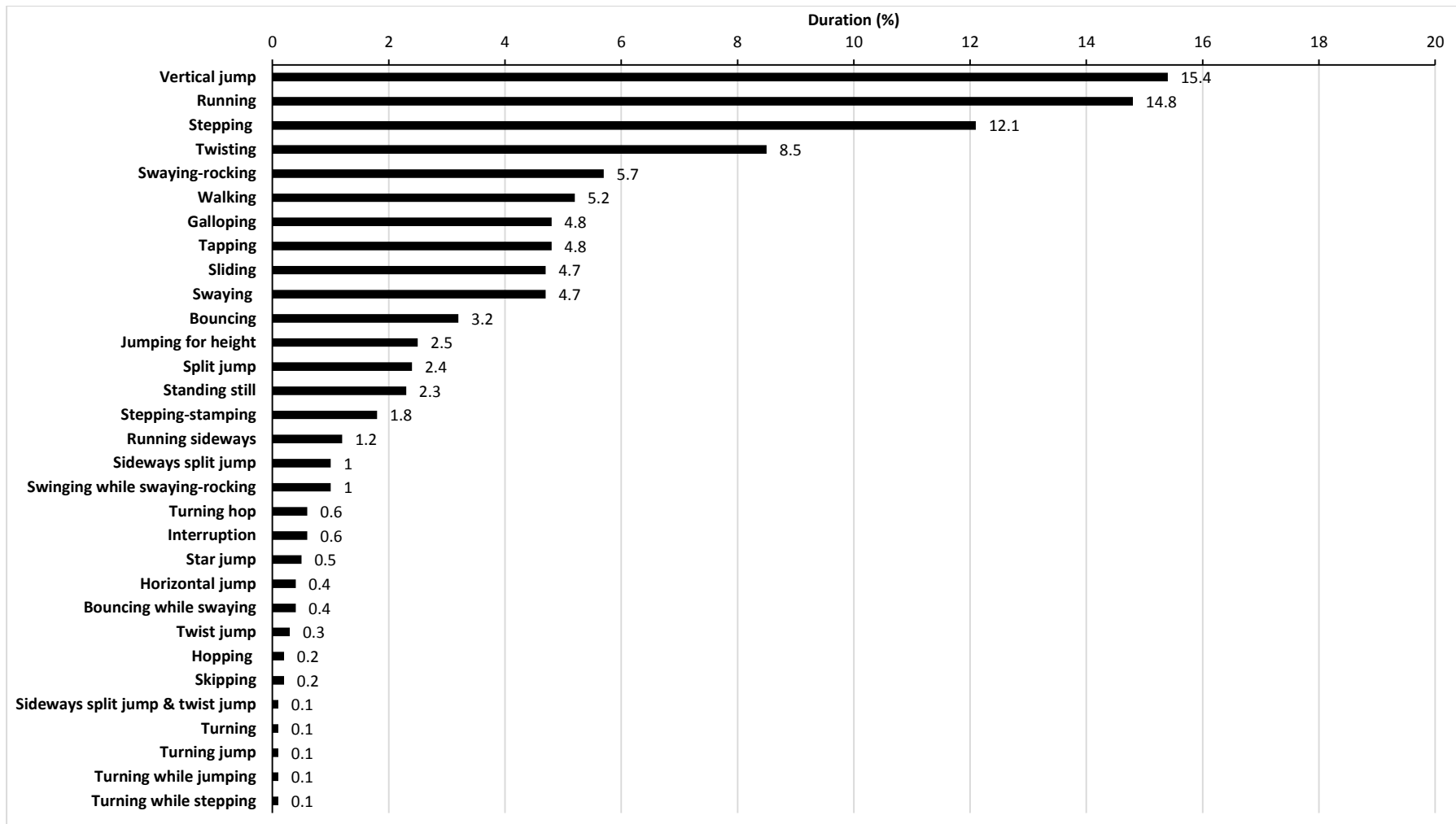


Figure Q.1: Body actions performed by the group of 4-year-olds throughout the game

Appendix R

Sequence of Actions Performed in each Musical Tempo: 2 examples (4-year-olds)

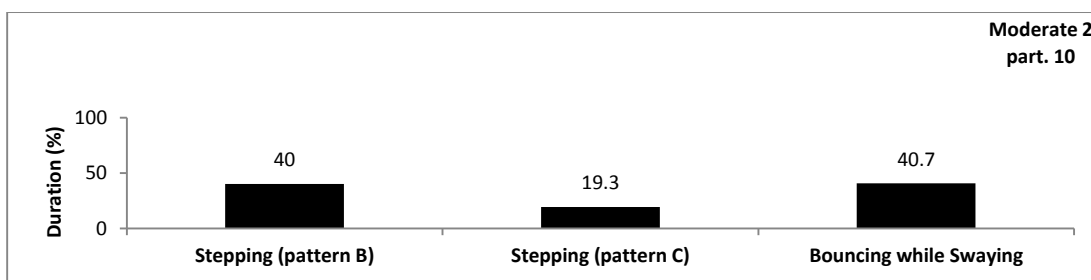
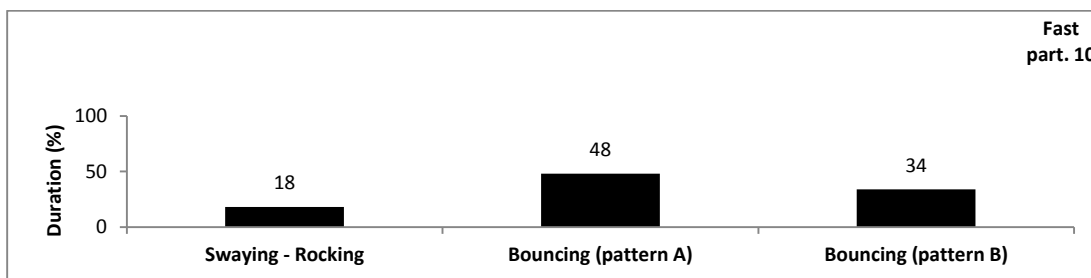
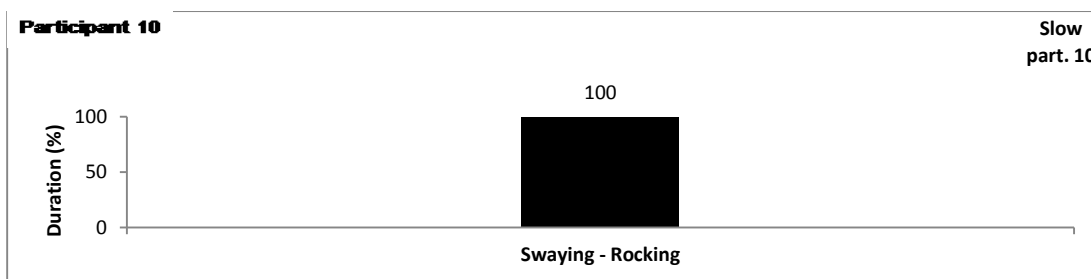
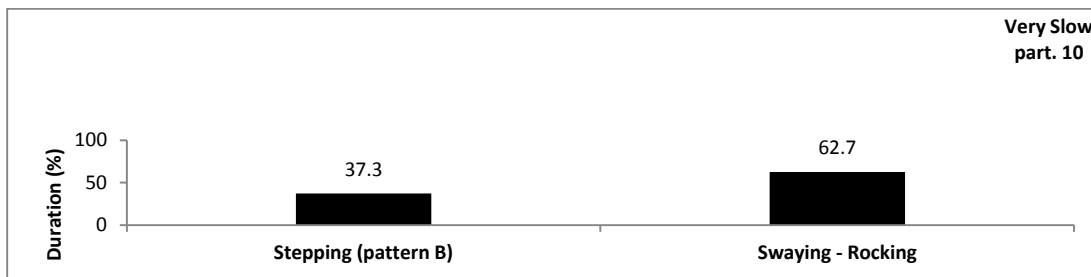
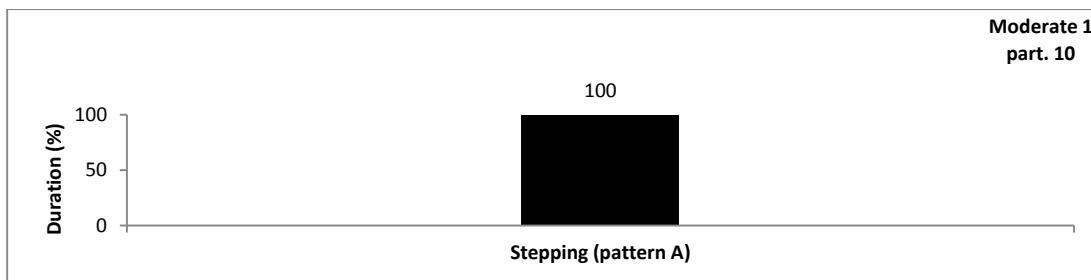


Figure R.1: Sequence of actions performed by participant 10 in each musical tempo

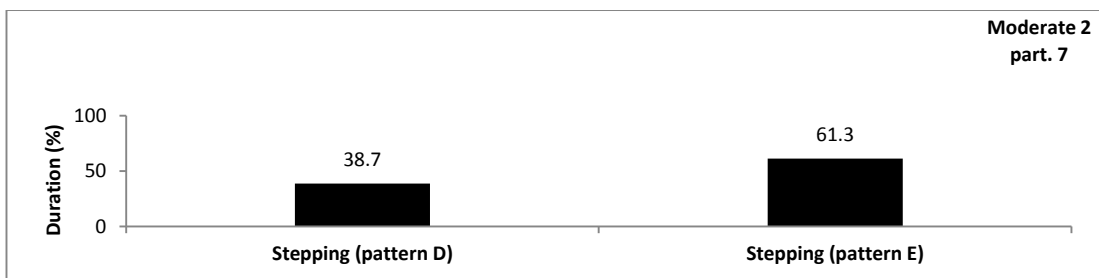
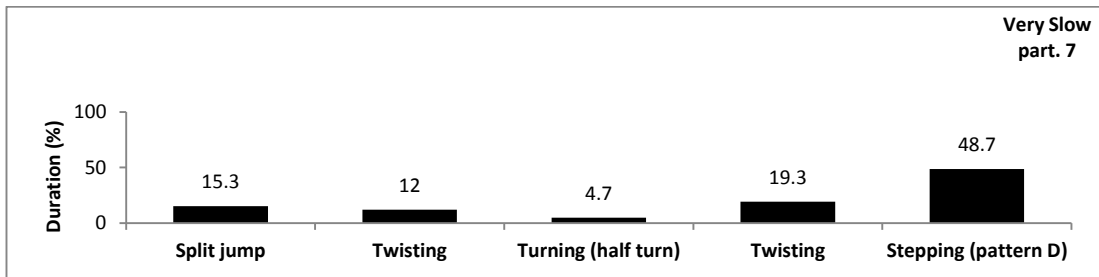
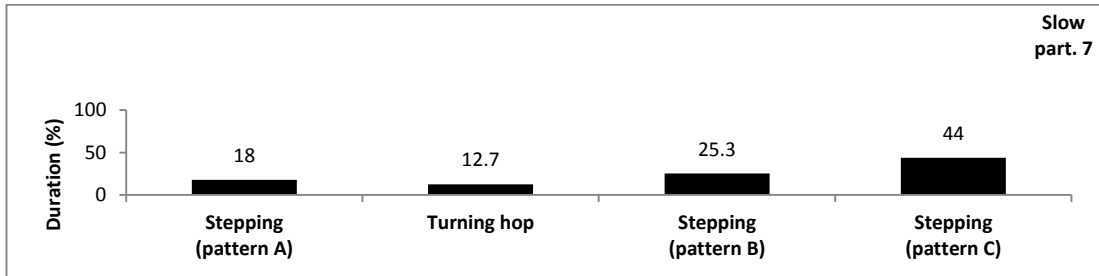
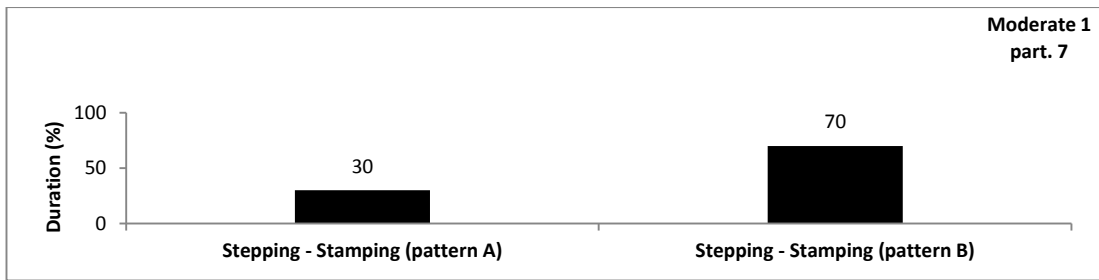


Figure R.2: Sequence of actions performed by participant 7 in each musical tempo

Appendix S

Video clips: Sequence of Actions Performed in each Musical Tempo – 2 examples (4-year-olds)

See enclosed DVD package for this appendix

S.1 Participant 10 (boy)

S.2 Participant 7 (girl)

Appendix T

Inter-observer Reliability: Assessing Children's Dominant Body Actions

T.1 Aim

This specific assessment intended to estimate the degree of agreement between two observers in identifying and naming the dominant body action of each child throughout the musical game. A strong concordance among observers would confidently support the evidence of similarities and differences between children in terms of their movement preferences in response to a regular beat.

T.2 Method

The inter-observer agreement consisted of a session of approximate 2 hours and 50 minutes. It was divided into a clarification session of 10 minutes, a training session of 20 minutes and an observation task which lasted approximately 45 minutes relatively to the 4-year-olds ($N=21$) and 5-year-olds ($N=22$). A 30 minute break was provided between the observation of each age group.

T.2.1 Observers

Both observers selected for this Inter-OR assessment had a good level of expertise in movement observation and movement analysis. Observer 1 was the researcher of this study while observer 2 was a certified movement analyst (CMA) in Laban Movement Studies. Each observer completed the task independently and in different days, but following exactly the same procedures.

T.2.2 Materials

The research setting was a silent office well-equipped with a 21.5-inch iMac (2.7GHz quad-core Intel Core i5). The video clips (MPEG-4 format) were watched in QuickTime Player 7 (for Mac OS X v10.6.3 or later) directly from an external hard drive which would prevent having to copy the video files into that computer which could compromise some ethical commitments. A paper document was provided to the observers with the coded identification of the participants, in order for them to annotate their observations.

T.2.3 Procedures

The Inter-OR assessment was organised into three different parts. The first consisted of a brief clarification session in which a general description of the study was provided, followed by an explanation about the type of musical game children played (music=movement & silence=stillness), its underlying structure (5 sections of movement & 4 sections of stillness) and the instructions given to participants.

The next step consisted in describing the purpose of the observation task. Observer 2 (CMA) was informed that she would watch 43 short video clips (1 minute and 58 seconds each) of young children playing the musical statues game and that this process would imply observing a sequence of movements in response to percussive music (15 seconds each section/tempo) alternated by brief intervals of silence (5 seconds each). It was also explained that each video corresponded to one individual performance. As follows, the observation task consisted of determining the prevalent body action that each child exhibited throughout the musical game, however, without having to measure its duration. Considering that this task was already very time-consuming it was decided that it would be preferable not to determine the duration of each child's actions for this Inter-OR assessment. Instead, the observers would be invited to get a 'general sense' of each child's overall performance and then identify the predominant action. In sum, the agreement would be sought considering (1) the identification of the dominant movement of each participant and (2) the attribution of a specific name to that prevalent pattern.

A training session constituted the second part of the Inter-OR assessment. One video clip from the pilot study (75 seconds) was observed and analysed, and notes written down on a paper document specifically provided for the occasion. Even though music was played during the game, it was decided that the audio would be turned off while watching the video clip in order to increase observers' attention to the visual content. These same procedures would then be applied in the observational stage. During this session questions were greatly encouraged.

Once one was assured that all procedures were clearly understood and operations mastered, then the third part of the session - observational process - could be carried out. At the end of the observation session one meal was offered as compensation.

T.2.4 Statistical Measure

Given that a discrete variable on a nominal scale level was assessed by only two observers, Cohen's kappa coefficient was considered to be the most appropriate statistical measure of concordance to estimate Inter-OR, even more because it includes a correction for chance agreement. Even though it is acknowledged that any of the different magnitude guidelines proposed so far for Cohen's kappa is universally accepted, for this particular study it was decided that kappa statistics would be interpreted according to the ones suggested by Landis & Koch's (1977). These authors characterised values < 0 as expressing no agreement, 0-0.20 as slight, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial and 0.81-1 as an almost perfect agreement.

The statistical analyses were performed using SPSS (IBM Corp. Released 2010. IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp.).

Appendix U

Dimensions and Planes per Tempo: 4-year-olds

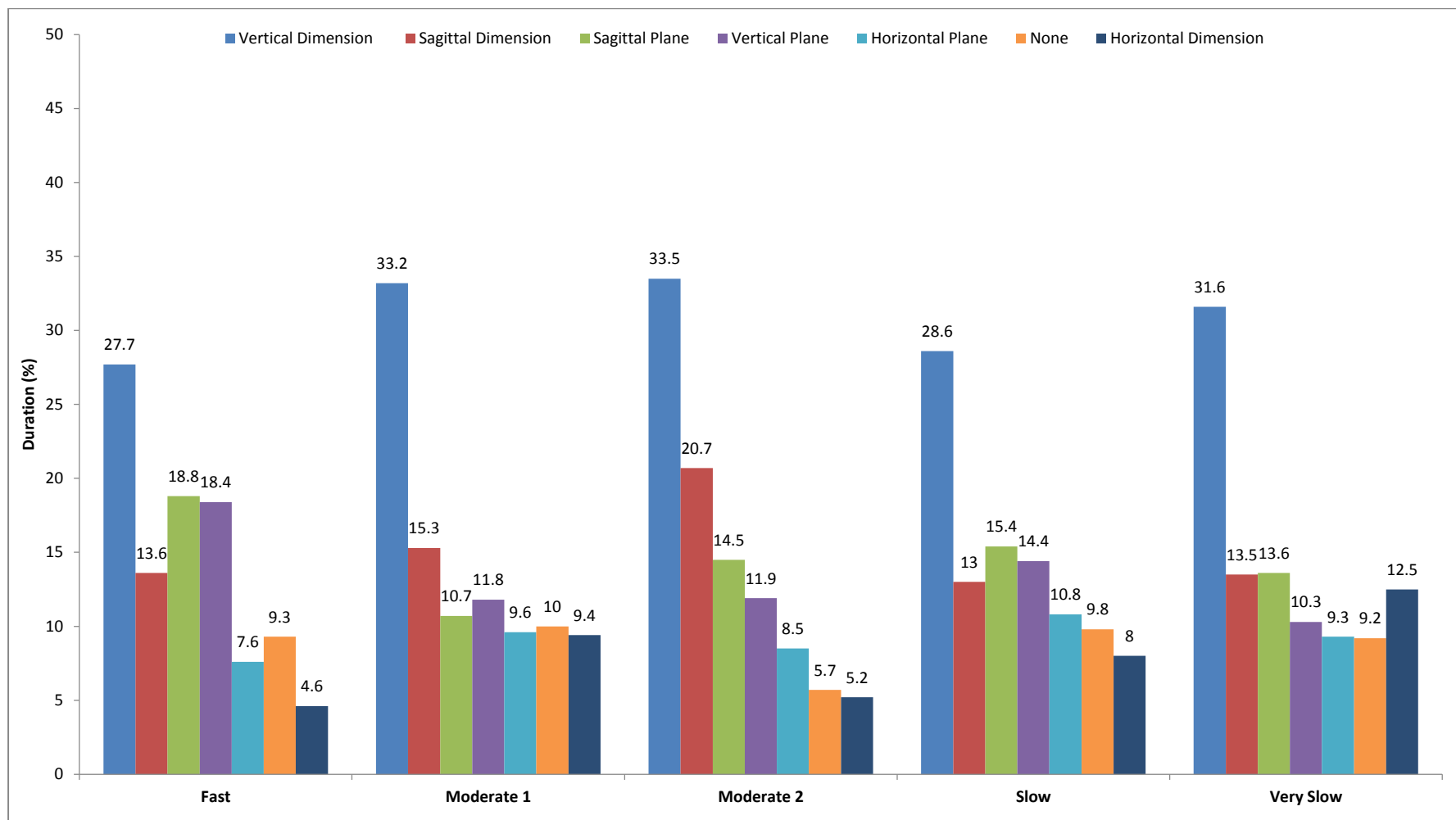


Figure U.1: Dimensions and planes performed in each musical section

Appendix V

5-year-olds' Dominant Motor Tempo in each Musical Section

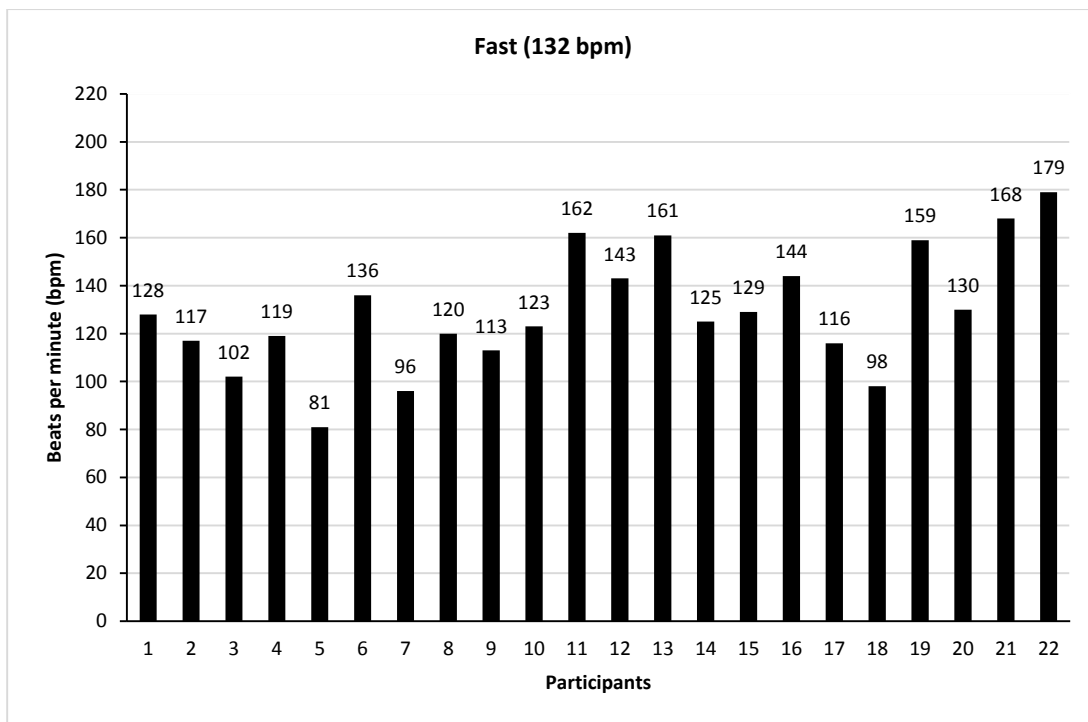


Figure V.1: 5-year-olds' dominant motor tempo responses to the Fast musical section

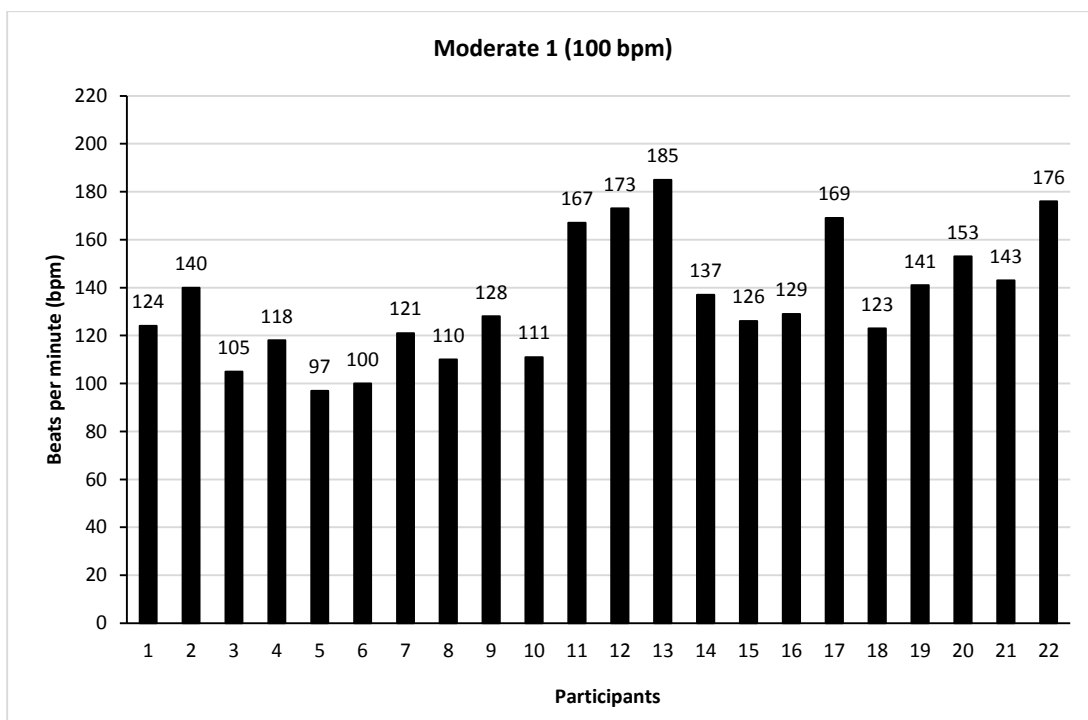


Figure V.2: 5-year-olds' dominant motor tempo responses to the Moderate 1 musical section

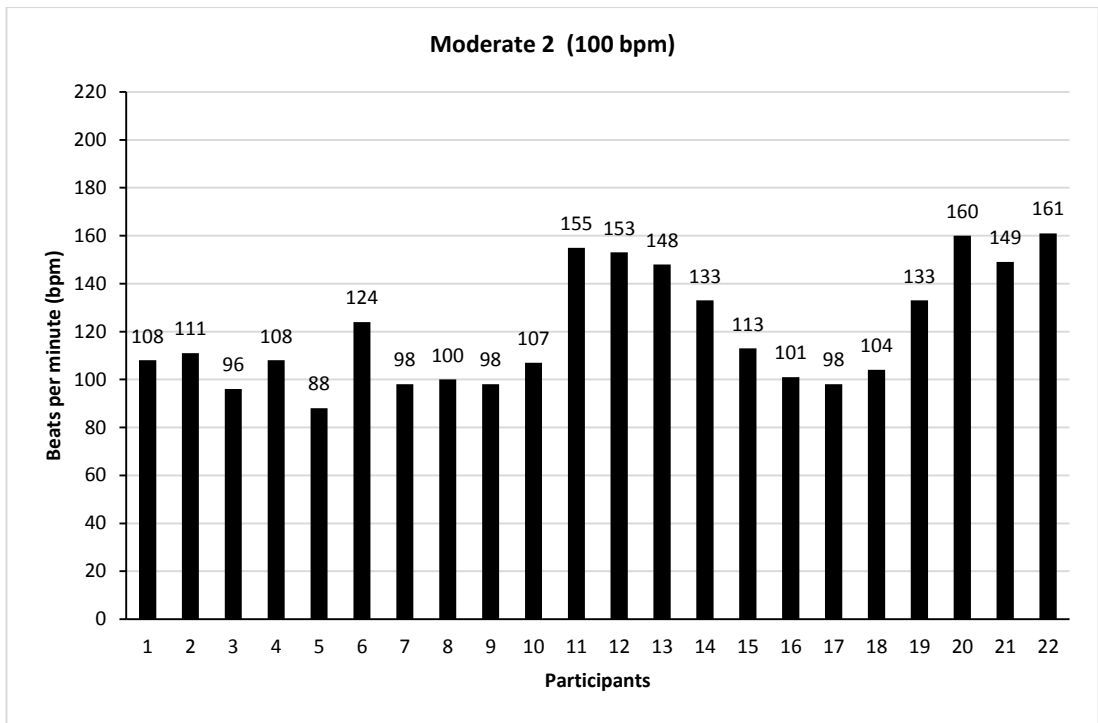


Figure V.3: 5-year-olds' dominant motor tempo responses to the Moderate 2 musical section

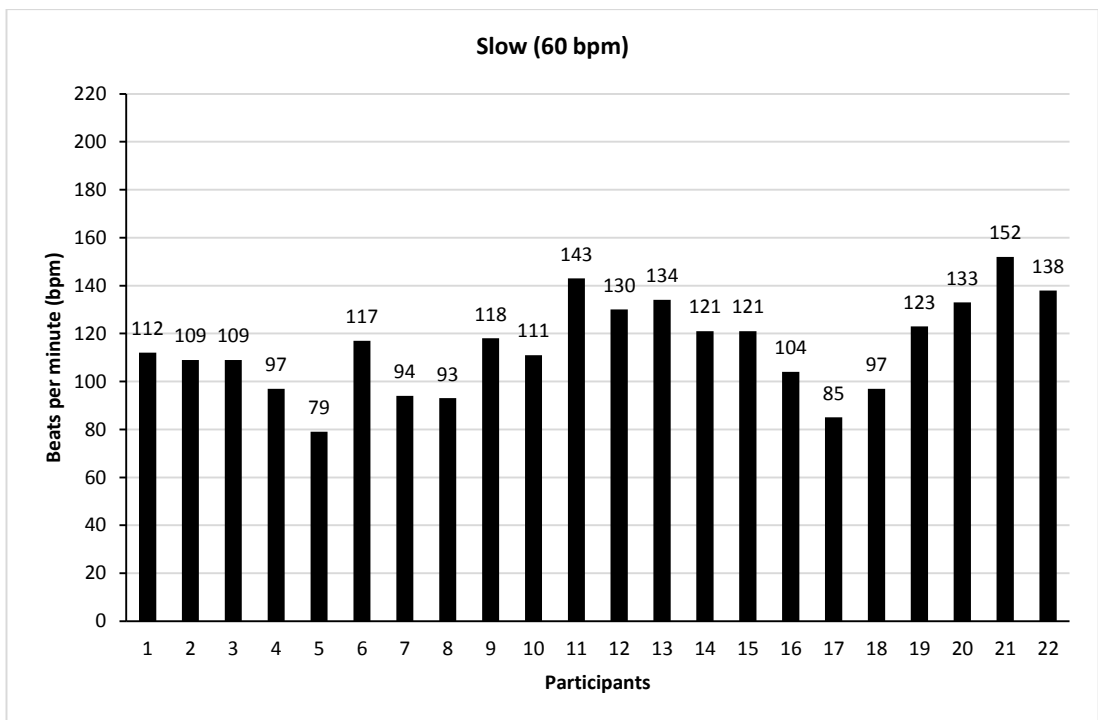


Figure V.4: 5-year-olds' dominant motor tempo responses to the Slow musical section

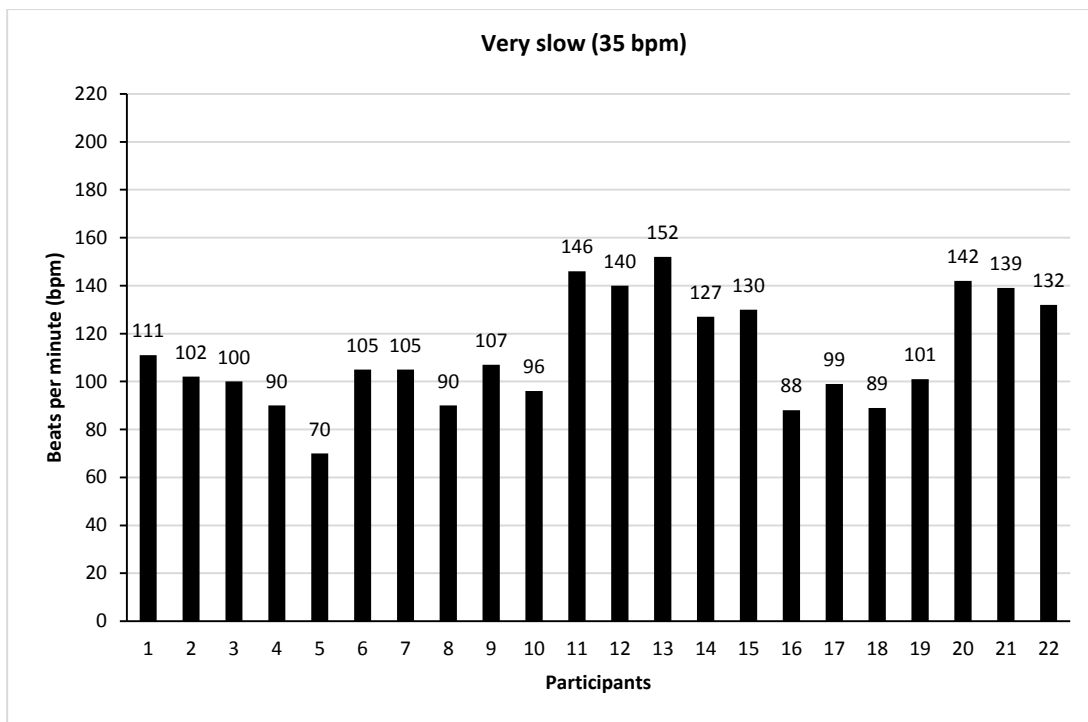


Figure V.5: 5-year-olds' dominant motor tempo responses to the Very slow musical section

Appendix W

Individual Motor Tempi (5-year-olds):

4 examples

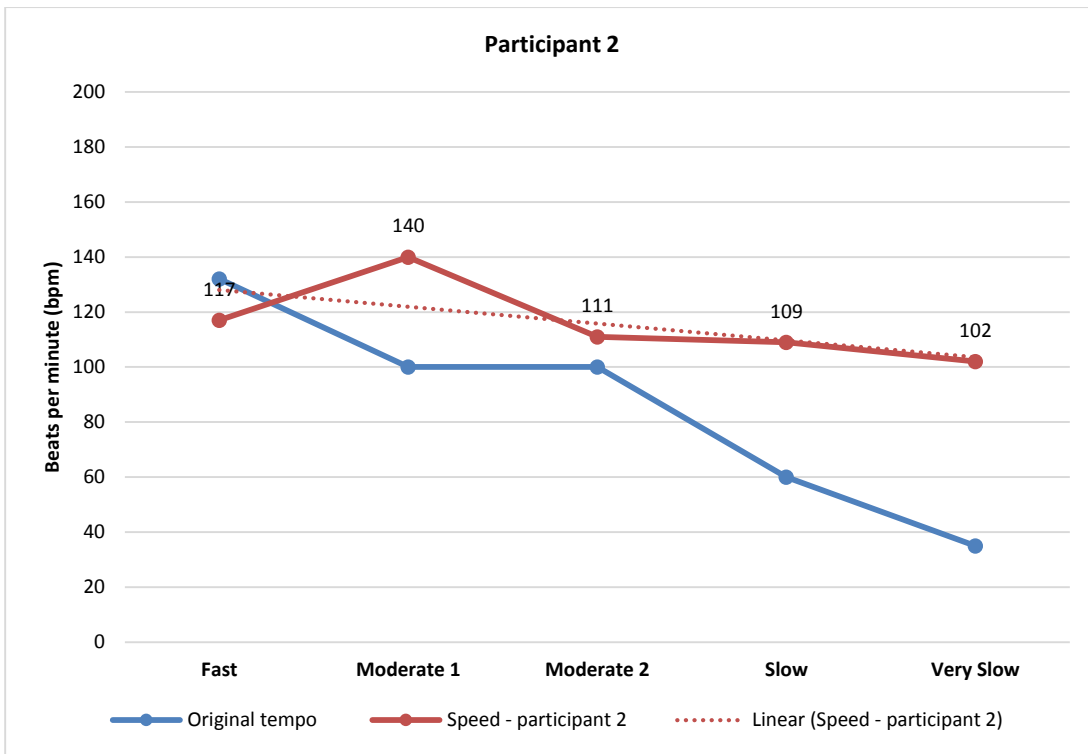


Figure W.1: Motor tempo of participant 2 across the 5 musical sections

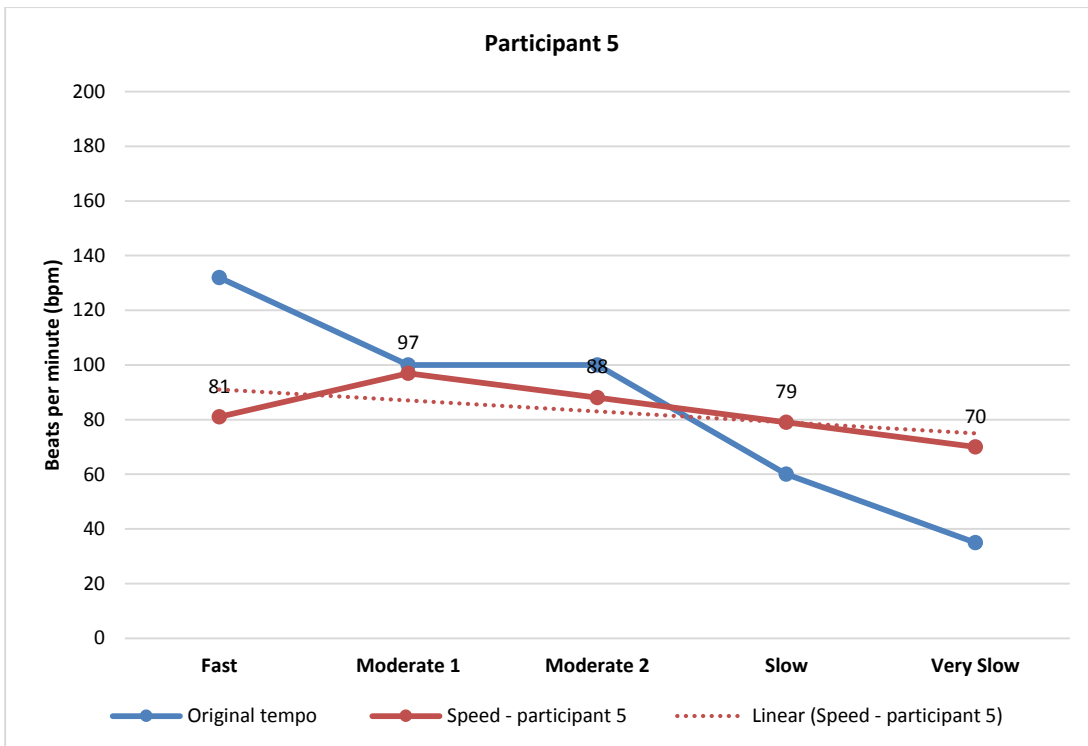


Figure W.2: Motor tempo of participant 5 across the 5 musical sections

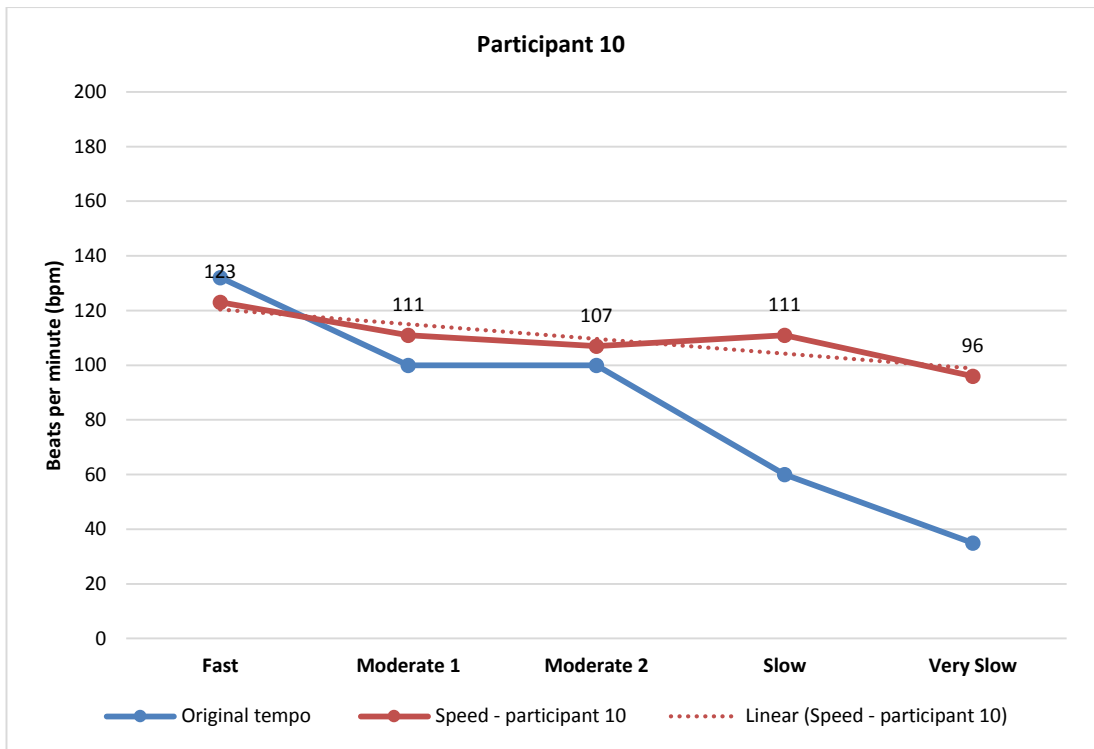


Figure W.3: Motor tempo of participant 10 across the 5 musical sections

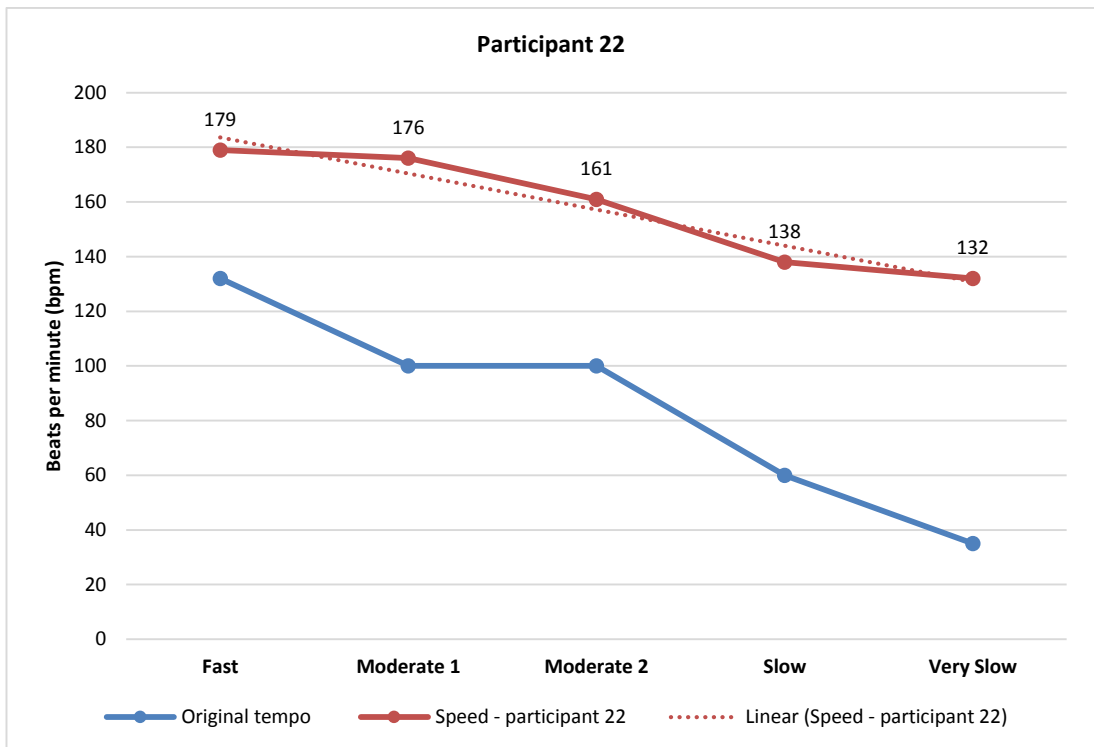


Figure W.4: Motor tempo of participant 22 across the 5 musical sections

Appendix X

24 Main Body Actions: 5-year-olds

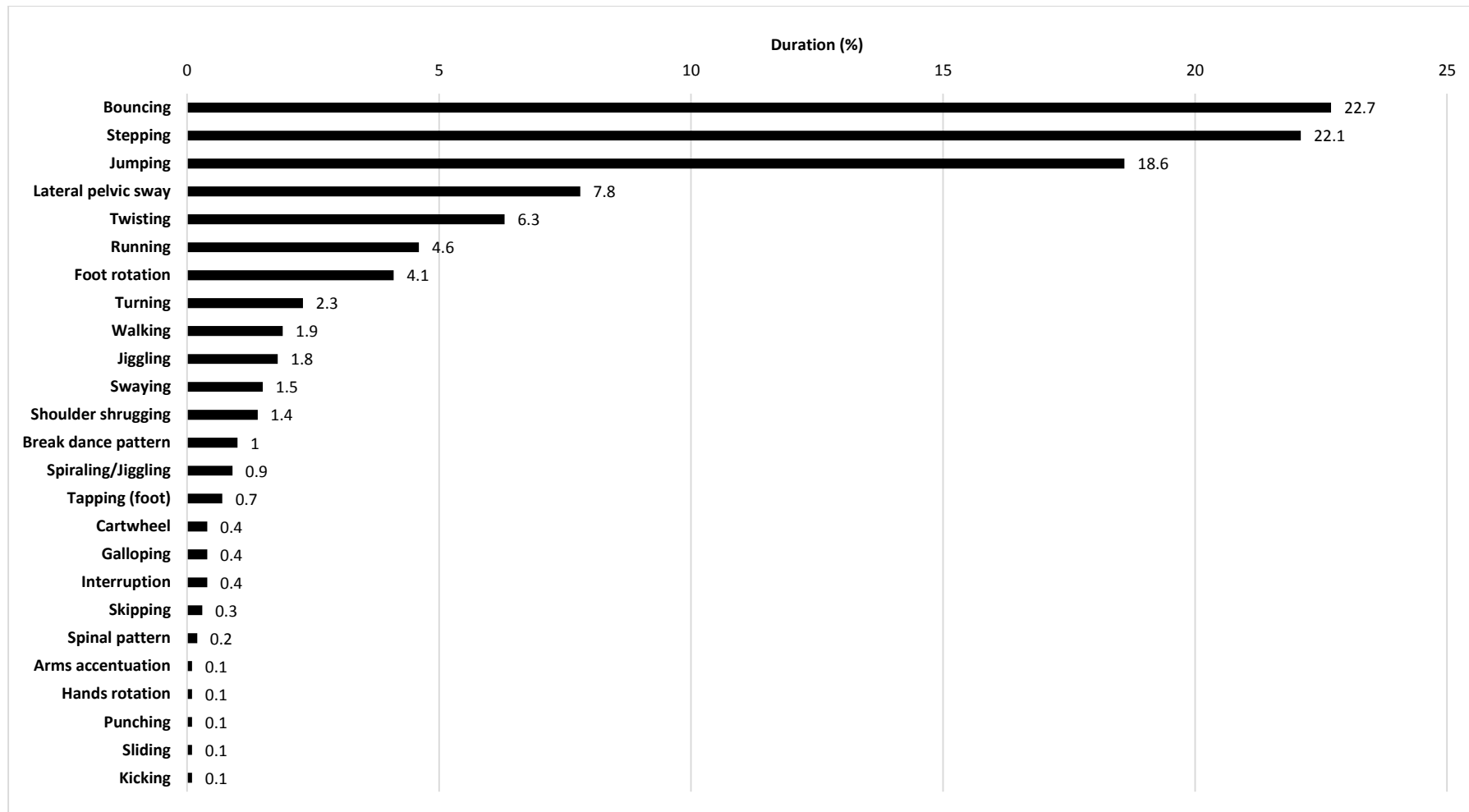


Figure X.1: Main body actions performed by the 5-year-old children throughout the game

Appendix Y

Video clips: Body Actions (7 examples)

See enclosed DVD package for this appendix

Y.1 Bouncing (boy)

Y.2 Bouncing (girl)

Y.3 Stepping (boy)

Y.4 Twisting (girl)

Y.5 Running (boy)

Appendix Z

38 Body Actions (variations included):

5-year-olds

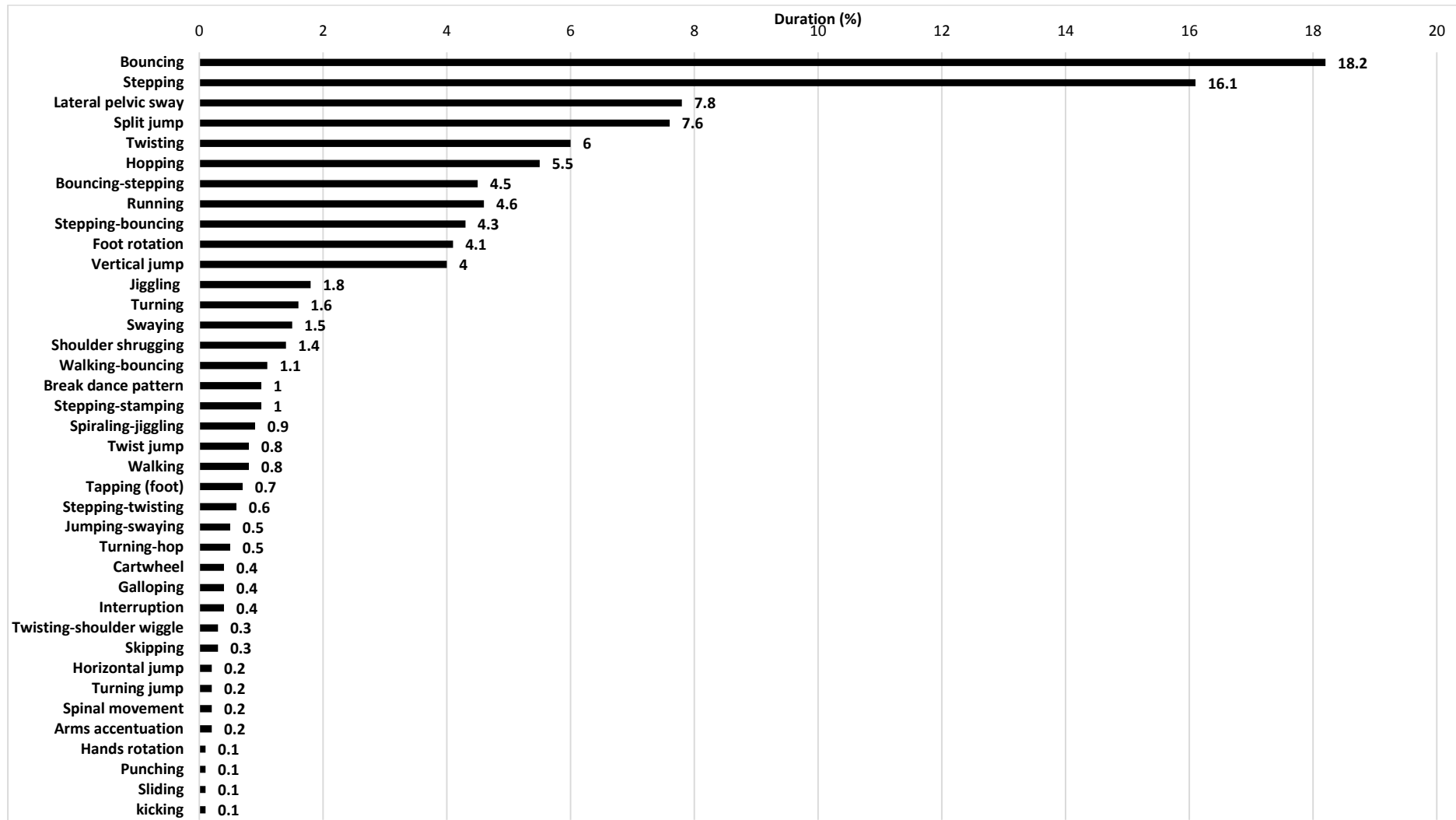


Figure Z.1: Body actions performed by the group of 5-year-olds throughout the game

Appendix AA

Sequence of Actions Performed in each Musical Tempo: 2 examples (5-year-olds)

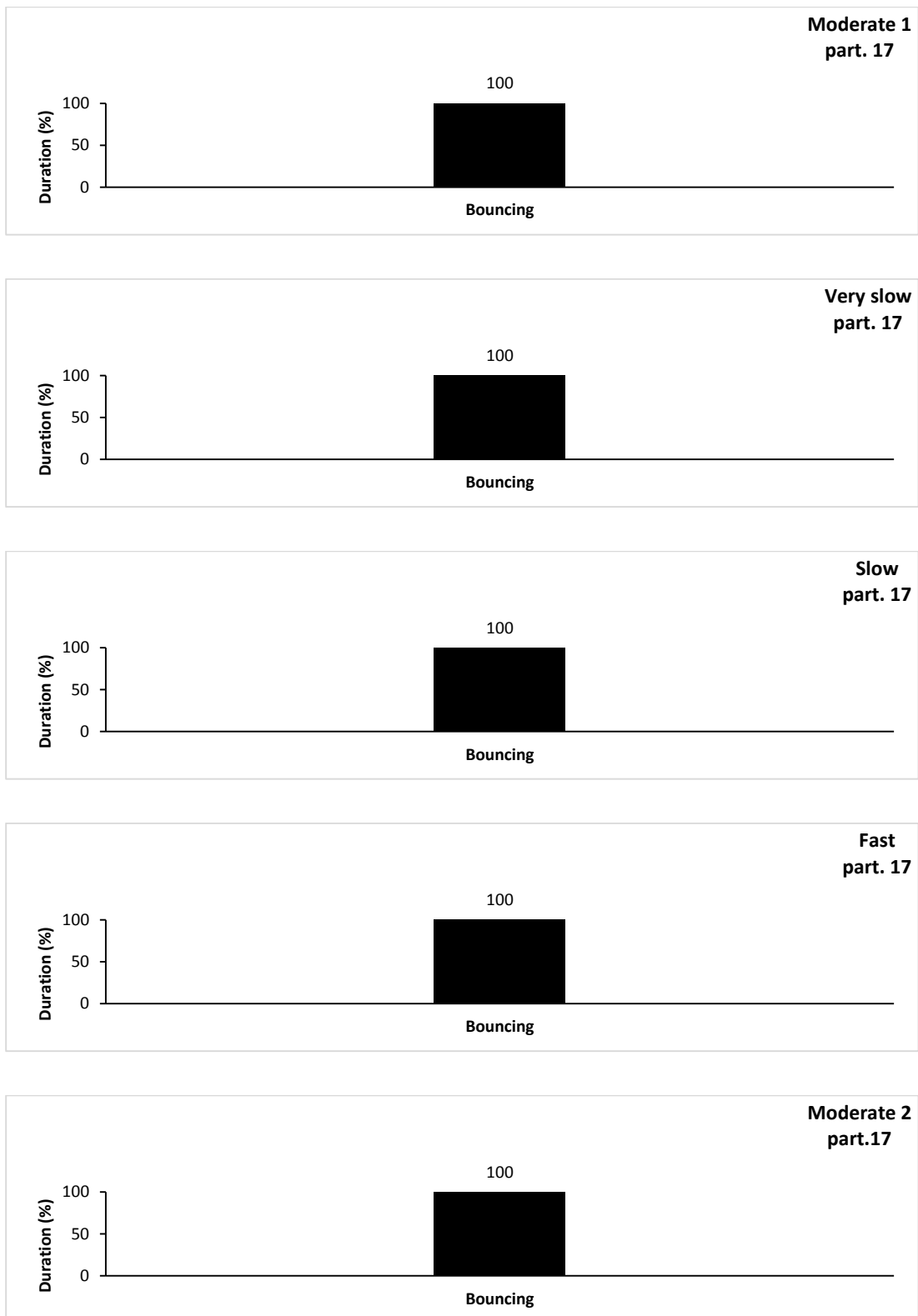


Figure AA.1: Sequence of actions performed by participant 17 in each musical tempo

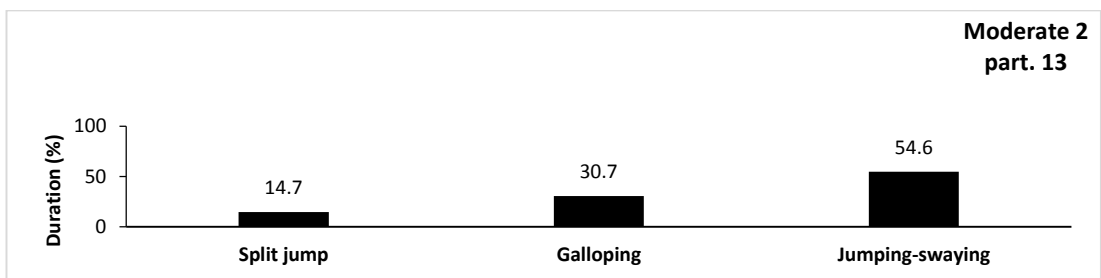
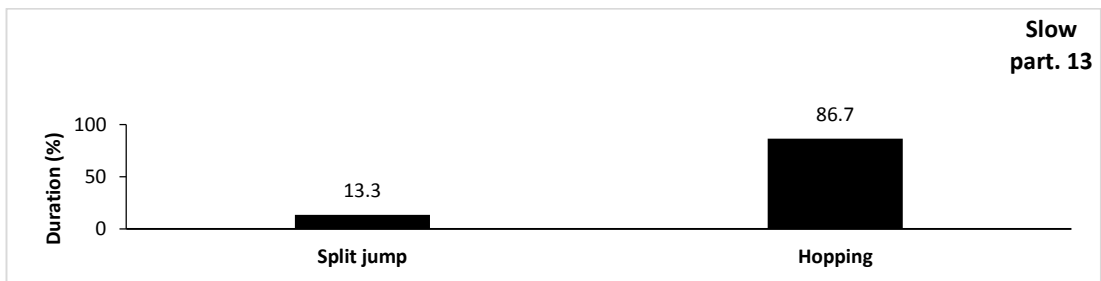
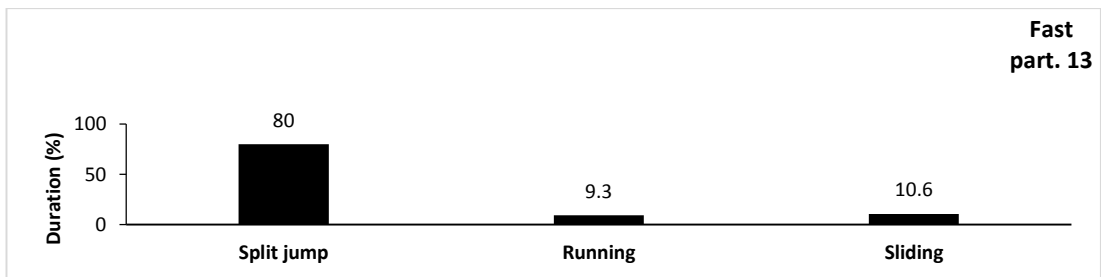
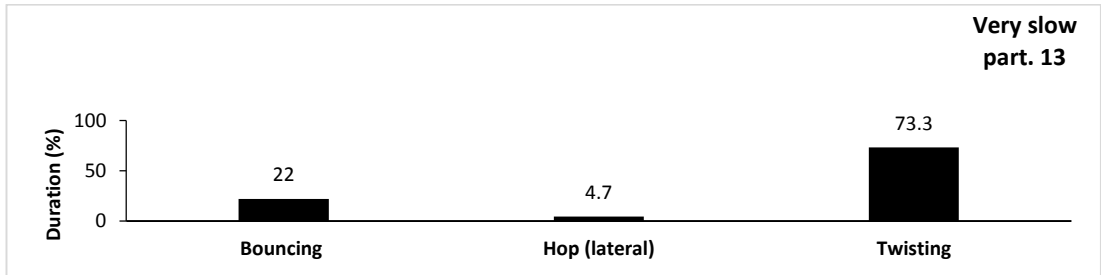
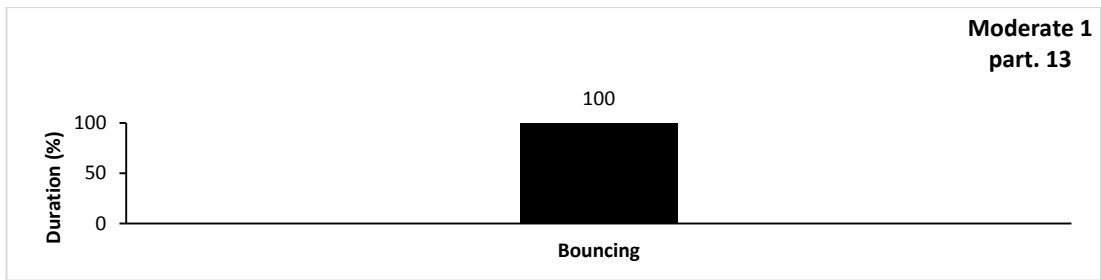


Figure AA.2: Sequence of actions performed by participant 13 in each musical tempo

Appendix AB

Dimensions and Planes per Tempo: 5-year-olds

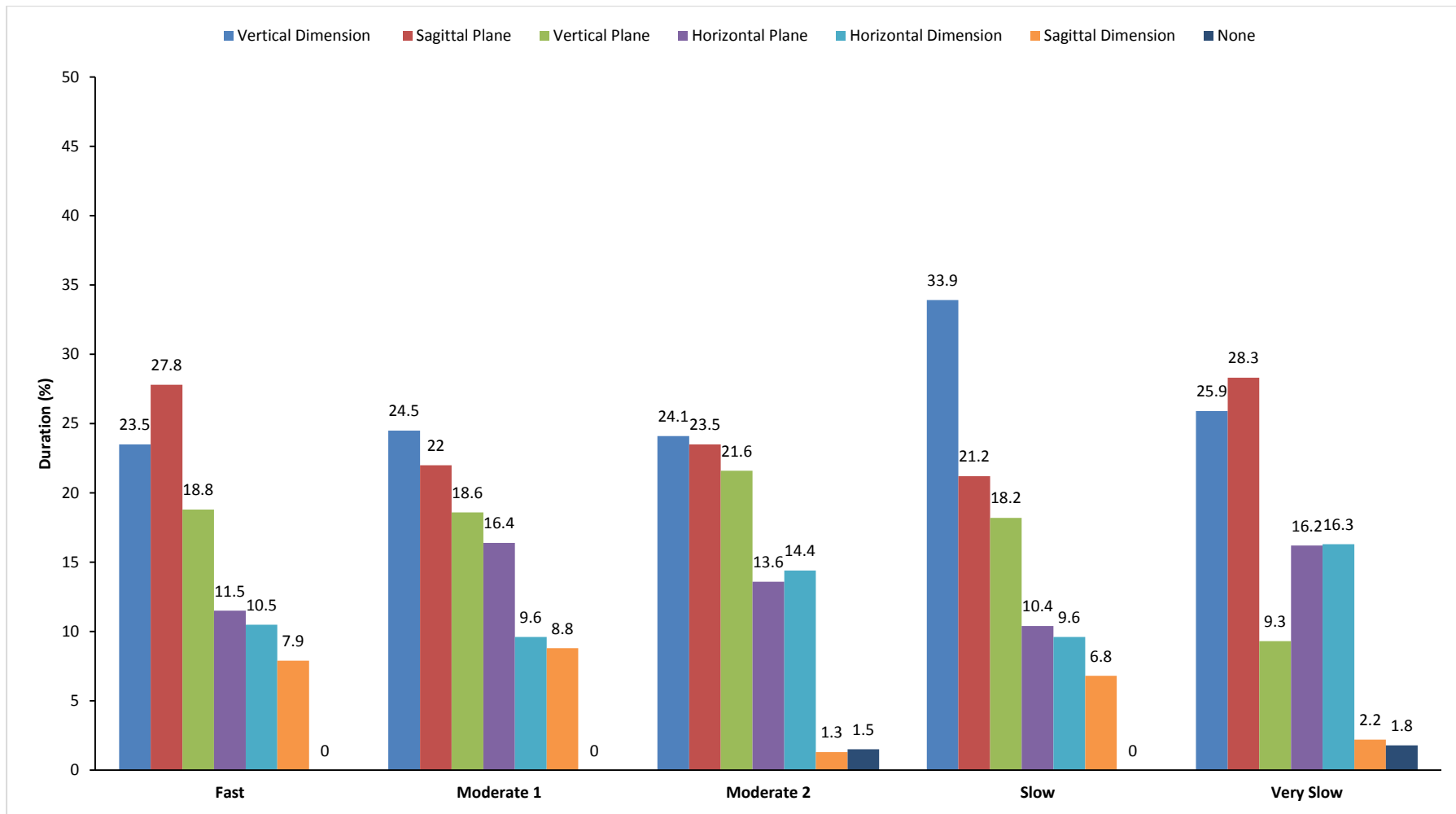


Figure AB.1: Dimensions and planes performed in each musical section

