Landscapes of Affective Interaction: Young Children’s Enactive Engagement with Body Metaphors

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‘I, Minna Orvokki Nygren confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.’
ABSTRACT

Empirical research into embodied meaning making suggests specific sensorimotor experiences can support children’s understanding of abstract science ideas. This view is aligned with enactive and grounded cognition perspectives, both centred in the view that our ability to conceptualise emerges from our experiences of interaction with our environment. While much of this research has focused on understanding action and action processes in individual children or children in pairs, less attention has been paid to affective dimensions of young children’s group interaction, and how this relates to meaning making with body metaphors. Indeed, Gallagher describes how no action exists in a vacuum, but rather revolves around a complex web of affective-pragmatic features comprising a ‘Landscape of Interaction’ (2020, p.42).

This research project addresses gaps in research in understanding young children’s affective engagement from an enactivist cognition perspective. It takes a Design-Based Research approach with an iterative design orientation to examine young children’s interaction with multisensory body-based metaphors through an embodied participation framework. A series of empirical studies with young children, aged 2-7 years, comprising of experiential workshops, build iteratively upon each other. A novel theoretically informed method, Affective Imagination in Motion, is developed involving several purpose-built multisensory body metaphors prompts to enable access to dimensions of young children’s affective engagement.

This research makes theoretical and methodological contributions. It extends the theoretical notion of ‘affect’ from enactive and grounded cognition perspectives through identifying key interactive processes in young children’s engagement with multisensory action metaphors. In addition, the novel method offers a contribution as a way of ‘looking’ at affect within a group situation from affective-pragmatic and social embodiment perspectives. Finally, the research contributes to embodied learning design frameworks offering a guideline for designers wishing to inform their work from enactive cognition perspective.
Keywords: embodied cognition, enactive cognition, grounded cognition, affective engagement, young children’s group interaction, design and embodiment, embodiment effect, joint action, narrative practices, body metaphors
IMPACT STATEMENT

The findings of this thesis provide insights that are of benefit both within and outside academia.

First, the findings contribute to existing work by introducing a novel theoretical approach for studying affective engagement in whole body interaction from an enactive cognition perspective. By studying young children’s interaction through foregrounding action and interaction, this work is beneficial for enactive cognition and learning sciences and human development research communities, and designers who wish to inform their work from an embodiment theory perspective.

Second, the findings propose design implications for existing and future whole body interaction technologies. These implications are beneficial to the fields of movement-based design and human computer interaction, by introducing novel points of iterative design, for example in the area of embodied learning design, or museum exhibition design. Crucially, given that many technologies increasingly cater for whole body movement and group interaction, this thesis provides a perspective to consider some key aspects underpinning young children’s interaction, foregrounding joint action and affective engagement. In this way, it offers a novel direction for the technology industry that’s based on children’s enactive experience.

Third, the benefits of this work may support designers working with whole body interaction for peer groups and families, in areas such as reflective practice, emotional wellbeing, and play.
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To children who play together or dream about playing together.
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Chapter 1 Introduction

This thesis centres around the notion of enactive affective engagement in young children’s interaction whole body interaction (WBI) environments. In the context of this work, by the term whole-body interaction technologies it is meant that these technological systems invite users to use their body movement as the main method of interaction. Recently, designing for such technologies has been explored within the research area of learning sciences to investigate how children engage with whole-body metaphors. Inspired by such work, this thesis investigates young children’s engagement with body-based metaphors and through doing this, develops an iterative multisensory metaphor design. In particular, this work is concerned with the ways in which children interact with body metaphors in groups. In the following, a brief rationale for this research is given.

Rationale and research gap #1: Moving and making meaning together

Whole body interaction environments are becoming increasingly commonplace—found in environments such as museums (e.g., Johnson-Glenberg, 2018; Price and Duffy, 2018; Schaper et al., 2018; Mueller and Isbister, 2014; Antle, 2013; Abrahamson et al., 2012; Malinverni et al., 2012; Price et al., 2009). Increasingly, learning applications have been developed for such environments especially given development in the area of embodied learning. Designed-for activities foregrounding embodied meaning making through affording specific sensorimotor experiences have been shown to afford support in abstract conceptual thinking; engagement, and motivation to learn (e.g., Price et al., 2021; Thomas Jha et al., 2021; Lindgren et al., 2016b). While empirical work is showing benefits, to date little attention has been paid to young children’s interaction and “joint action” (Gallagher, 2020), i.e., how children build meaning together during whole body interaction. Furthermore, with adults, for example, research into embodied technologies has demonstrated support for participatory sense-making from an embodied perspective (e.g., van Dijk, 2018). In particular, that they can afford social situatedness and meaning making. Therefore, this work argues, alongside a
recent call for methodological development in this area (e.g., Madureira Ferreira, 2021), that it is important to study young children's movement-based group interaction.

Rationale and research gap #2: Group pretend play with enactive metaphors

Empirical work in embodied meaning making has demonstrated that movement-based learning environments can afford pretend-play-like experiences for children with abstract concepts (Lindgren et al., 2016b; Gallagher and Lindgren, 2015; Abrahamson et al., 2012; Enyedy et al., 2012). For example, Abrahamson et al., (2012) present several digital interventions for meaning making about science that by incorporating exploration of concepts through movements afford different “being it” experiences for children. A similar experience was reported by Enyedy where children interacted through body movement exploring Newtonian physics concepts of ‘force’ and ‘motion’ (Enyedy et al., 2012). Enyedy described how the pretend play was not only something that came through from children’s experiences, but it was the “imaginary situation” that afforded children with a rich and meaningful experience. Furthermore, in Lindgren’s study with Meteors, children reported moving as meteors (Lindgren et al., 2016b). The notion of the ‘imaginary’ in ‘pretend play’ (e.g., diSessa, 1993; Vygotsky, 1978; Garvey and Berndt, 1975) can foster positive affective and social experiences, that foster creativity and improvisation. Gallagher has written about this more extensively as “narrative practices” (Gallagher, 2020, p. 160). Yet less is understood about how these enactive practices are shaped in social meaning making situations, and how pretend play emerges as a form of affective engagement through action and pretend play. What does this look like from action perspective in young children? Does it relate to notions such as belonging?

Rationale and Research Gap #3: Interaction with mirroring body metaphors

A signifying feature of several whole-body interaction environments that function by a system tracking interactants’ joints movements, are visualisations that “respond” to interactants’ body movements by mimicking these
movements on a display in front of the person interacting with the system (e.g., Inoue and Kitazaki, 2021; Freeman et al., 2020; Lugrin et al., 2016). At present, research in these areas has concentrated in adult interactants’ experience of interacting with such mirroring displays (e.g., Inoue and Kitazaki, 2021; Freeman et al., 2020). Empirical evidence demonstrates that adults’ gain positive experiences of their identity, reporting feelings of “engagement” and “intimacy” (Freeman et al., 2020, p. 4) during interaction with such displays. From a human development perspective, body movement ‘mirroring’ features early on in our lives when an adult affectionately attends to an infant, sharing expressive movements in “joyful dialogic companionship” (Trevathan, 2001, p. 100). A child’s actions are mirrored by attentive adults in a process of ‘attunement’ that supports the development of “secondary intersubjectivity” (Trevathan and Hubley, 1978, see also Braten, 2009; Reddy, 2008; Schaefer et al., 2008; Haft and Slade, 1989; Beebe and Steele, 2013). This process is marked by “cooperative understanding” and “expressions of interest” (Trevathan, 2001, p. 111) where both the adult and the child are attentive to each other’s action in a moment of reciprocity, which results in chains of collaborative action-on-action responses. While the process of ‘attunement’ differs from interaction with a mirroring ‘digital other’ in an AR environment in the sense that the mirroring, responding “other” does not share all of the features as that of a caring parent, the process of mirroring suggests an “embodiment effect” (e.g., Barsalou et al., 2003), or an embodied “simulation” process (e.g., Gallese, 2005; Gallese and Lakoff, 2005), which has been shown to emerge neurophysiologically from the existence of mirror neurons (Rizzolatti et al., 2002). While mirroring seems to hold this relational effect, and foster positive intersubjectivity, and regarding one’s own embodiment in a positive light, at present less is understood about how young children in groups encounter and make meaning of such body metaphors.

For the sake of clarity, the key concepts used throughout this thesis; metaphor, enaction, engagement, and affect are defined as follows:

**Metaphor.** In the context of this thesis, the term ‘metaphor’ is used to describe “a form of conceptual representation” (Glucksberg, 2001, p. 4). Furthermore,
the functions of a metaphor can be defined through the use of two affiliated concepts, the metaphor vehicle, and the metaphor target. An illustrative example is given by Glucksberg (e.g., 2001), with the sentence ‘some lawyers are sharks’ (2001, p. 4). This sentence can be broken up into pieces of the vehicle of the metaphor, which in this case is the word ‘sharks’ and the target of the metaphor, which in the above sentence is the word ‘lawyers’. In addition, the notion of ‘embodied metaphor’ (e.g. Lakoff and Johnson, 1980) is important in this thesis. The aforementioned example uses ‘sharks’ as a metaphorical representation of some lawyers, thus foregrounding a language dimension of a metaphor. But the notion of embodied metaphors, developed by semiotic linguists Lakoff and Johnson (e.g. Lakoff and Johnson, 1980b), seeks to foreground the embodied grounding of metaphors. Lakoff and Johnson describe, for example, the metaphors of in and out (Lakoff and Johnson, 1980a, p. 479) and theorise, within the wider theoretical framework of embodied cognition, that these metaphors emerge from bodily interaction with the world – through having a body we can conceptualise around the notions of in and out that emerge through us having a body in an environment. The notions of ‘metaphor’ and ‘embodied metaphor’ are important for this thesis because it investigates the exploration, design and translation of body-based metaphors from one medium (paper prototype) to physical (moving body) to a digital interactive (multisensory visualisation). Within the context of this work, centred around group whole body interaction, the metaphor vehicle is the children’s ongoing, continuous body-movement in an open-ended multisensory whole body interaction environment. The target, on the other hand, is the changing of pitch and volume, which is represented through a digital mirroring body (a type of ‘avatar’) as an embodied metaphor. Thus, this thesis is focused on the dynamic exploration of metaphors during interaction from a sensorimotor perspective. In this way, the body becomes a way in which to explore dimensions of embodied metaphors in this specific technological space.

Enaction. The term enactment here draws from the distinct scholarship in the wider literature and theorisation of cognition, namely, enactive cognition. Enactive perspective to cognition foregrounds the perceptual and action
dimensions of meaning-making. Enactive cognition (e.g., Thompson and Varela, 2001; Varela et al., 2016) foregrounds the existence of a connection between perception and action and the use of enactive potentialities (e.g., Noë, 2006) within the environment; how the environment is perceived and how it is acted upon. Observing these processes as *enaction* can tell us about the experiences and knowledge that is developed in a situated context. For a person to enact in their environment suggests a process where that person is *enacting sensorimotor knowledge*. This ties to *perception* – to be able to attend to the ‘enactable’ qualities (e.g. ‘enactive potentialities’) of the environment, one must have *experience* of it. In this way, *to move is to make meaning*, and as posited by Renaud Barbaras, the basic process of movement “should be studied in such a way that it can be understood as containing already the germ of the highest level of all: reflexive consciousness as investigated by phenomenology” (Stewart et al., 2014, p. ix). An example of an *enactive process* in this thesis is when children engage in moving their bodies while being aware of their movement causing feedback in the form of a digital body metaphor on a display in front of them. Here, it is important to note that a process of *enacting* is understood to be different to other action-related terms such as ‘action’, ‘actioning upon something’, ‘gesturing’, or ‘motioning’. While the aforementioned terms relate to action, they do not capture the process of *enacting*, which calls for being attentive to perception and reflexive practices. Within the context of this thesis, the term *enaction* is thus defined as a process of *enacting sensorimotor knowledge*, and in particular, how young children engage in such processes within a group setting that is set in a whole body interaction environment.

**Engagement and Affect.** The terms engagement and affect are considered tightly connected in the context of this thesis, and inherently linked to enaction (defined above). The term ‘engagement’ is, within the context of this thesis, defined as an *experience* that is aligned with one’s motivational needs to participate in interaction (Bucher, 2020, p. 6). Specifically, the dimension of engagement that this work is concerned with is the motivational *quality* of engagement, which emerges from theory of self-determination. As Bucher writes, “[I]t’s not just about how much motivation someone has, but also what
fuels it.” (Bucher, 2020, p.11). The classic self-determination theory already embeds notion of affect; people are understood to be motivated to act when an experience aligns with their motivational needs such as autonomy, competence, and relatedness. The term ‘affect’ is, within the context of this thesis, defined as a dimension embedded within the ‘wider whole’ and process of engagement. Specifically, this thesis if concerned with the notion of enacting relatedness, and young children having deeply meaningful experiences, which in turn leads to considerations around, for example, positive intersubjectivity and social bonding. In the context of this work, again from Bucher (2020, p. 243) suggests that “[T]hink about how your design can support positive feelings for your users.” In the context of this study, the motivational quality emerging is considered to be primarily of the nature, or having the deeper quality, of relatedness. In Learning Sciences, this comes under the notion of ‘affective engagement’. In the context of this study, however, ‘enactive affective engagement’ is used to foreground the relational qualities of engagement.

It is against this background that this work focuses on understanding enactive affective engagement groups during interaction with body metaphors in whole body interaction environments. Over the course of the empirical work, a novel method called Affective Imagination in Motion is developed. The method draws from theory of grounded cognition (e.g., Barsalou, 2008), embodied learning design (e.g., Antle et al., 2008) and young children’s science learning from a cultural-historical perspective (e.g., Fleer, 2013). Microinteractional analysis of video data (e.g., Goodwin, 2018; Nemirovsky et al, 2012; Nygren et al, 2022) is used to gain access to young children’s affective engagement from an enactive cognition perspective. In particular, the method gives access to dimensions of children’s enactive processes when interacting with mirroring body metaphors and each other.
1.1 Aims

This research has three core aims:

1) Theoretical Aim: To provide theoretical insights, grounded in empirical data, about young children’s enactive affective engagement with body metaphors.

2) Methodological Aim: To develop methodological approaches to studying young children’s enactive affective engagement with body metaphors.

3) Design Aim: To develop existing embodied learning design guidelines from an enactive affective engagement perspective.

1.2 Research Questions

In relation to the aims described above, this work has one overarching research question, with three deepening sub-questions. The sub-questions relate to the methodological, theoretical and pragmatist aspects of young children’s enactive affective engagement with mirroring body metaphors.

Overarching research question:

*What are the theoretical underpinnings of young children’s enactive affective engagement with body metaphors?*

Three deepening sub-questions:

1. *How can we methodologically study young children’s enactive affective engagement with mirroring body metaphors?*

2. *How does enactive affective engagement help us understand interaction with mirroring body metaphors?*

3. *How can the notion of enactive affective engagement inform the design of whole-body interaction environments incorporating purposely designed enactive metaphors and mirroring body metaphors?*

1.3 Organisation of Thesis

This thesis has two main parts. The first part consists of a Literature Review (Chapter 2), Theoretical Underpinnings (Chapter 3), and Methodology
The Literature Review gives a focused and detailed account of three areas of research literature relevant to this work: (1) embodied meaning making, (2) social embodiment, and (3) affective engagement. The review reveals gaps in researching ‘affect’, which the empirical research conducted as part of this thesis addresses.

The Theoretical Underpinnings chapter discusses the two main theoretical framings for this work: grounded cognition and enactive cognition. Furthermore, three theoretical-analytical approaches will be presented. Together, these frameworks exemplify how knowledge about ‘affective engagement’ is framed within the context of this thesis laying the ground for methodological choices. In particular, the work draws from the enactive cognition concepts of “narrative practices”, “joint action”, and “meaningful action chains” (e.g., Gallagher, 2020), “enactive potentialities” (e.g., Noë, 2006). These form the core to framing young children’s experience and interaction with body metaphors in a group setting.

The Methodology chapter discusses Design-Based Research approach into studying affective engagement from a grounded cognition perspective. It gives a detailed account of how the selected research methodology supports empirical study design to understand affective engagement from an enactive cognition perspective. It demonstrates how participatory, iterative, and comparative elements of design-based research were applied which led to the generation of theoretical underpinnings of young children’s affective engagement with body metaphors. Here, the roles of participants are also discussed and the key ethical questions around studying young children’s embodied experiences and whole-body interaction design from a technology design perspective. The main method, “Affective Imagination in Motion”, is discussed, and how it draws from social embodiment theory, enactive cognition, and human developmental theory, and how it was applied during fieldwork settings during experiential workshops with children. Furthermore, the chapter conveys how analytical frameworks using microinteractional analysis are used to analyse patterns and instances of affective engagement from an enactive cognition perspective. The chapter finishes with a description
of the theoretical contribution of the underpinnings for young children’s affective engagement with body metaphors and three qualities that illustrate this theory in young children: (1) mirroring, (2) belonging, and (3) affective imagination. These findings are extrapolated in the subsequent empirical study Chapters (Chapters 5-8), which through illustrative examples and episodes demonstrate dimensions of this theoretical contribution.

The second part of the thesis consists of the empirical study chapters (Chapters 5-8), the Discussion chapter (Chapter 9), and a chapter for Design guidelines (Chapter 10). The thesis finishes with Conclusions and Future Work (Chapter 11).

Exploratory Study, Chapter 5, studies young children’s enactive participation during interaction with a picture book foregrounding an enactive metaphor, and a digital, movement-based interaction platform that utilises digital visualisations of body metaphors. The study contributed to understanding of affective engagement with enactive metaphors and body metaphors from enactive cognition perspective, especially drawing from notions of “relationality of affordances” (Gallagher, 2020). Chapter 6 studies young children’s sense of embodiment with body metaphors. It found that building a sense of embodiment with the metaphors involved an enactive process of a form of “flickering” between body movement, reflecting on one’s own body movement, and pretend play. Furthermore, this process – when “enacted out” in a group setting - seems to have fostered joint action marked by positive affect, the study suggests.

The empirical study in Chapter 7 is focused on family interaction and the building of positive intersubjectivity moments over time through different types of enactive processes. The findings from this study suggest that there is scope to use body metaphors as a way to support moments of companionship through enaction, which supports a creation of a reflection that makes people turn back towards their peers during interaction.

The study in Chapter 8 focuses on the notion of ‘affective imagination’ and how creativity is realised through young children’s bodies, and the narrative
approaches and frames that they employ in the whole-body interaction environments. This study’s contribution makes theoretical, analytical and design contributions in the form of suggestions, and builds especially on the notion of ‘relationality’ from Chapter 5.

The Discussion (Chapter 9) presents the conceptual, theoretical, methodological and design contributions from this thesis. Four conceptual contributions drawing from the empirical (“enactologuing”, “mirroring self-others”, “reflective bonding”, and “enactive identity playground”) are presented and discussed. Theoretical contributions speak to three core areas of affective engagement and young children’s interaction with body metaphors: mirroring, belonging, and affective imagination. Methodological contributions section presents the novel method developed over the course of this thesis to access dimensions of affective engagement in group enaction, called “Affective Imagination in Motion”, and the microinteractional analytical approach (e.g., Goodwin, 2018; Nemirovsky et al., 2012; Nygren et al., 2022) that presents ways to identify phases of young children’s interaction with body metaphors foregrounding notion of “joint action” (Gallagher, 2020). The design contribution section extends three areas of embodied design: the interrelationship between enactive metaphor design and whole-body interaction, the process of translating from physical to digital in embodied design and sequencing open-ended whole body interaction experiences with mirroring body metaphors for “flickering” (e.g., Fleer, 2013) as an opportunity for young children to explore their sense of embodiment and pretend play through body movement.

The Design Guidelines chapter (Chapter 10) presents ten guidelines developed for group whole body interaction from an enactive cognition perspective over the course of this work, foregrounding experiential factors and affective engagement. The chapter also includes a ten-point design checklist, that draws from the empirical work conducted for this thesis, summarising core values for whole body interaction. The Conclusions and Future Work chapter (Chapter 11) summarises the main contributions from the thesis and identifies areas of future work with children with autism interacting
with body metaphors, body psychotherapy using mirroring body metaphors, and intergenerational interaction in whole body interaction environments.
Chapter 2  Literature Review

In the Introduction chapter (Chapter 1) of this thesis, an enactivist framing of ‘affective engagement’ was presented, adopted from Gallagher’s (2020) notion of action that includes not only the motoric dimension of interaction, but also the emotional, and hedonic aspects. In this Literature Review chapter, a detailed research background linked to these dimensions of affective engagement, and the specific research context of whole body interaction, is given.

This literature review is divided into three distinct, yet interrelated sections: (1) Embodied meaning making, (2) Social embodiment, and (3) Affective engagement. Each section reviews specific dimensions relating to ‘affect’ or ‘engagement’ and identifies the gaps in the literature that the research questions of this research project are targeting. The first section, “Embodied meaning making” first gives an overall introduction to embodiment theory and the importance of embodied experience, focusing on three core areas relevant to this work: Environment and meaning, Enactive metaphors, and Affective imagination. The purpose of this section is to highlight that research gap in understanding young children’s group interaction from an enactive cognition perspective.

The second section, Social embodiment, details empirical research on the theoretical notions of ‘mirroring’, ‘embodiment effect’, ‘shared affect’, and ‘sense of embodiment’. Collectively, these notions speak to the gap in research literature in young children’s interaction in whole body interactive environments incorporating body metaphors forms of ‘mirroring’.

The third section, Affective engagement, brings together literature from learning sciences, affect in ‘action’, and relationships, to explore and present relevant literature in framing collaborative action from an affective perspective specifically, using case studies and other fields to demonstrate how affect has been studied in action, especially from the perspective of affect or relationality.
2.1 Embodied meaning making

At the heart of this thesis is the tenet from embodiment theory that humans make meaning through their sensorimotor experience and that the mind is “inherently embodied” (Lakoff and Johnson, 1999, p. 3). Pioneers of embodied cognition theory, cognitive linguists Lakoff and Johnson (e.g., 1980), posited that sensorimotor interaction with one’s environment forms the core developing conceptualisation and reasoning skills. This theory extended to the notion of ‘embodied metaphors’ (e.g., Lakoff and Johnson, 1980), which explains how we come to develop abstract concepts linguistically drawing from our bodily experiences. Central to this theory is the idea that we perceive the world through image schemas or interactional gestalts ("wholes"), and these are adopted through our sensorimotor capacity to interact with the environment (e.g., Lakoff, 1987, p. xi) to make sense of our experience and allow us to think and conceptualise (Lakoff, 1987, p. xii). Conceptualising meaning emerging from sensorimotor interaction with our environment has a long tradition. Already Dewey (1958), Piaget (e.g., Piaget and Cook, 1952), Vygotsky (1978) and later, for example, Rogoff (1990) and Lave and Wenger (1991), for example, conceptualised the importance of sensorimotor interaction, such as manipulation of objects and gaining sensorimotor experiences as being important to human development.

2.1.1 Environment and meaning

One of the core areas of development in embodiment theory lies between conceptualising the nature and the relationship between the interactant and the environment. Since the early theorisations of embodiment theory, different conceptualisations of the exact nature between the ‘body and its environment’ has been brought forth (e.g., Barsalou, 1999; Wilson, 2002; Gallese and Lakoff, 2005; Rowlands, 2010). One of the core tenets is ‘enactive cognition’ (see Chapter 3). Enactive cognition frames meaning making with the environment stemming from a perception and action continuum. This is related to a phenomenological perspective, the phenomenologists posited that meaning is a body-mediated process foregrounding the importance of experience (e.g., Merleau-Ponty, 2012). In an enactive cognition perspective
(e.g. Noë, 2006), we perceive in our environment qualities that we can enact upon. An element in the environment, an object, can be touched, it can be picked up, or moved, or otherwise manipulated through sensorimotor interaction. In the enactive cognition tradition, which is part of the grounded cognition idea, ‘perception and cognition are action oriented’ (Gallagher, 2020, p. 33). Gallagher (2020, p. 33) describes this from the perspective of the ‘agentive body’ having a structural coupling with the ‘environment’ (Gallagher, 2020). Perhaps most prominent idea of enactivism is that perceiving something is perceiving something as actionable: something appears *grabbable*, or something appears *stretchable*, or something appears *jumpable*. In this way, as Gallagher (2020) notes, the environment becomes a cavalcade of opportunities upon which we can act.

### 2.1.2 Enactive metaphors

Drawing from Lakoff and Johnson’s (e.g. 1980a, 1980b) embodied metaphor theory, enactive metaphors are a development that place action especially on the perceptive and action-ideas during interaction. Recent research on young children’s action experiences from an embodied and enacted cognition perspective has demonstrated how specific social and sensorimotor couplings (processes) that emerged during interaction with an environment designed to foster engagement with scientific topics, resulted in ‘important sensorimotor contingencies’ that children later drew from when communicating about their experiences (Price et al., 2021, p. 42). More specifically, the children recounted and recalled specific interaction experiences through gestures that demonstrated a link between the prescribed activity in the designed environment, and the specific sensorimotor patterns that underpinned conceptualisations of the science topics embedded in that environment. Enactive cognition research calls these types of gestures ‘enactive metaphors’ (e.g., Winner et al., 1979; Gallagher and Lindgren, 2015).

Gallagher and Lindgren talk about enactive metaphor, and their re-enactment as “the exercise of a basic motoric skill, which may be motivated in an intersubjective imitative process” (Gallagher and Lindgren, 2015, p. 397). Using a child’s conceptualisation of a banana as a phone, the authors describe
how “[T]he infant sees the banana as a phone not through a set of mental representations but in the caregiver’s actions, and in picking it up and imitating the caregiver – a clear instance of participatory sense-making. The infant capitalizes on the social affordances offered in such a situation. The affordance is summarized not merely in terms of one object substituting for another but in the dynamic relationship of joint attention and joint action with the caregiver.” (Gallagher and Lindgren, 2015, p. 297).

2.1.3 Affective imagination

What’s particular about young children’s interaction with enactive metaphors is that they can afford particular experiences for what Vygotsky called ‘affective imagination’ (e.g., Fleer, 2013). This notion is linked to ‘socio-dramatic’ or ‘make-believe’, or ‘pretend play’ typically occurs in preschool and primary-school aged children (e.g., Vygotsky, 1978). In embodied learning design, for example, Abrahamson et al., (2014), Lindgren et al., (2016) and Enyedy et al., (2012) have reported young children exploring science concepts such as mathematical rations and Newtonian physics with environments incorporating enactive metaphors as actions fostering children feeling that they “are being it” (Abrahamson et al., 2016). Part of this experience of “being it” may be supported by the environment in which children are exploring with enactive metaphors. For example, an augmented reality platform designed by Lindgren et al. (2016, p. 177), uses a simulation that in a floor projection displays accurate representations of astronomical objects such as asteroids and their movement with dynamic imagery. These objects are acted upon by moving across a floor with a projection of the sky - as predicting the path of an asteroid (Lindgren et al., 2016, p. 177).

2.2 Social embodiment

In social embodiment theory, social stimuli have the capacity to elicit embodied responses. Specific effects can be identified in the ‘whole body sense’. For example, thinking about how we burned our hand on the stove can cause squirming on the spot. Remembering how much fun with had on the swing whilst growing up can bring a lightness to our movement. Grounded cognition explains these ideas as “pattern completion” that carries “across the modality-
specific components of a situated conceptualization" (Barsalou et al., 2003, p. 77). What this means is that when a situated conceptualisation is “entrenched in the memory” then perceiving a part of the conceptualisation has the effect of a “larger pattern” becoming active (Barsalou et al., 2003, p. 77). One of such patterns is “bodily states”, and many of these inferences “may arise automatically” where “strong links between the conceptualization’s modality-specific components” exist (Barsalou et al., 2003, p. 78).

2.2.1 Mirroring

One of the most best-known mechanisms of interaction is known as “mirroring”, referring to responses of motor mirror neurons to seen actions first discovered in monkey premotor area (e.g. Hari et al., 2016). Bodies act as a kind of a metaphor affording affective engagement, through mirror neurons as well. There have been applications of this idea for example in dance-movement psychotherapy as an interactive called the “Mirror Game” that supposedly enables participants to “enter and remain in a state of togetherness” (e.g. Noy et al., 2011). While not discussing ‘togetherness’, the mirror studies in babies are another important study that needs to be looked at here. In dance-movement psychotherapy, this type of interaction is discussed in the context of attachment style. The purpose of this game is to “enhance empathy and emotional understanding of others, and to promote participants’ ability to enter and remain in a state of togetherness” (Schechner in Feniger-Schaal, 2018, p. 2). This quality of interaction has been described in qualitative research as “intervals of “togetherness motion” where the “motion was complex, smooth, and synchronized” (Feniger-Schaal, 2018, p. 2), usually when no leader was assigned to the motion, in addition, movement synchrony and improvisation (e.g., Gueugnon et al., 2016) and group dynamics (Himberg et al., 2018) have been studied in this setting.

2.2.2 Embodiment effect

Related to the notion of ‘mirroring’ is the concept of “embodiment effect” has been known to exist for a long time. It first starts with attunement process. Grounded cognition and social embodiment theory has a unique way of framing embodiment effect. There are also some other conceptualisations of
this, and some bring forth a more “modal” view of the effect. The theoretical stance here is, however, that the overall embodied experience will bring forth the simulation. This draws from writings on social simulation and simulation of meaning (e.g., Barsalou et al., 2003), where conceptual content of social knowledge is constituted by “simulations of perception, action, and introspection” (Barsalou et al., 2003, p. 73). This means that rather than amodal information, which is often used to treat embodiment effect as something separate from embodiment, bodily states constitute the "core conceptual content". This has important implications to qualitative research and understanding affective states when analysing qualitative data. As Barsalou et al. (2003) write: “[K]nowledge is not a redescription of these states in an amodal language but is the ability to partially reenact them” (p. 73). This truly suggest an embodied state where are not only traits and stereotypes, but embodied states are simulations of experiences.

Barsalou et al., (2003) identify three social embodiment effects: in the first two, the “social stimuli produce embodied states. In the third effect, embodied states produce affective responses.” (Barsalou et al., 2003, p. 80). In the last one, it is the direction of the pattern that matters, and makes it more ‘affect’-like. People mimic each other’s embodied states, mimicking others’ postures, communicative manners, and facial expressions. One because that has been foregrounded in neurosciences is the mirror neuron circuit (e.g., Rizzolatti et al., 2002). While there are variety of effects of mimicry, what is relevant for this research project is the notion of ‘social contagion’ – which is explained as “[I]f different people learn similar conceptualizations for the same situation, then when two people share an embodied state, they are likely to activate the same conceptualization, thereby achieving synchrony, coordination, and empathy.” (Barsalou et al., 2003, p. 79). Using yawning as an example, the authors describe how one person’s yawn travels across the two people in the same situation: “[O]nce yawning is induced in both people, it may induce a similar conceptualization, such as that they perceive the situation similarly and coordinate their emotions and activities” (Barsalou et al., 2003, p. 79). However, this is not always the case, and more research is needed to
understand when “complementary states”, such as one’s anger inducing another’s guilt – become present (Barsalou et al., 2003, p. 79).

2.2.3 Shared affect

As discussed in the above, embodied states can induce responses that are affective: “[F]or example, upright posture induces pride and confidence, whereas slumped posture induces shame and uncertainty. Head nods, arm pulls, and the smiling musculature induce positive affect, whereas head shakes, arm pushes, and the frown musculature induce negative affect.” (Barsalou et al., 2003, 79). This means that embodied states induce conceptualisations that include an affective state (Barsalou et al., 2003, p. 80).

We are inherently social beings, wired for connection and meaning making with each other. Since our early days, through the process of ‘attunement’ and ‘mirroring’ with our parents, we learn to develop interactive skills. This is, in part, explained by the discovery of mirror neurons in monkeys, which describes to us the different kinds of actions that make our brains fire as a result. In other words, social embodied meaning making is about considering how, during interaction with others, meaning is co-created in a social situatedness.

There are a number of benefits of such evolutionary adaptation. We can learn to align ourselves more with others, and effects, such as “embodiment effect” has been theorised drawing from empirical research. For example, yawning is a sign of social contagion, as our partner may yawn as a result of seeing us yawn. This is a form of “embodied simulation”, whereby we adopt another’s stance, posture, or action, and in the moment, or shortly afterwards, mimic this embodied experience back to the environment. In this way, there’s also an opportunity for sharing an affective experience – which is one of the hallmarks of building for positive intersubjectivity.

Mirroring’s power has been shown also in interventions for emotional wellbeing such as in the context of body psychotherapy, where different analytical scales have been developed to understand how we meet each other. This is different from other forms of meeting “other bodies in movement”, such as more
traditional cultural forms of interaction such as gestural communication, or other more fun forms of interaction, such as dance classes.

However, while the ‘power’ of mirroring has been explored and is quite clear in the sense of human-to-human interaction, we know less about this effect in young children, and in whole body interaction environments, and what it means to social meaning making.

2.2.4 Sense of embodiment

Young children experience mirrors early on, and at the beginning of this process, they are not certain about their agency over their mirror image. This traditional psychology experiment has been discussed at great length by Merleau-Ponty, and psychologists after him. The main puzzle is, whether a child gains self-referentiality, or not. But eventually, they do come around, and they discover their own agency over their mirror image.

Mirroring experience with body metaphors in environments such as AR or VR has brought about positive experiences of presence, identity, and immersion. Mainly this work has been conducted with adults, and more work is needed to be conducted with children to understand what types of effects they might have. In this way, they seem to be affording experiences around ‘reflection’ on self and play with identity. Explore different ways of being, such as children do, for example in pretend play.

We also do now know, what the mirroring effect is in terms of self-referentiality in young children, and if there are any opportunities for building more social connections when interacting with such environments in groups. Especially given the importance of all kinds of “reflective skills” being important for building experiences with intentionality and reflection. This has also been quoted as an important part of affective engagement.

This has been explored in a variety of different design contexts (meaning tech), but primarily in VR and mostly with adults. More research is needed to understand the emerging social dynamics especially from enactive cognition perspective. Studies in experiencing mirroring digital bodies and non-human
robots have suggested multiple benefits for experiencing the self, potentially highlighting opportunities to connect and spend time with one’s own self that increases self-reflection, feeling of less loneliness, and embodying different objects which suggest pretend play experiences for children.

It has been well established in literature that ‘avatar embodiment’, the way in which for example VR experiences reproduce and substitute a person’s body with a virtual one (e.g., Spanlang et al., 2014) has “strong physico-psychological effects” (Lugrin et al., 2016, p. 309). The factors for such experiences have been well-established (e.g., Spanlang et al., 2014). One of the key questions is body ownership in MR (mixed reality) environments where the researchers investigated especially the use of sound’s effect on the experience of body ownership.

One of the key characteristics of whole-body interaction with displays are various types of visualisations that mimic and mirror the user’s movement. In VR social dynamics, users have reported feeling more engaged and intimate when a VR affordance offers “full body tracking” (Freeman et al., 2020, p. 4), resulting in experiences of presence, embodiment, and attachment. As a result, the authors concluded, “many participants considered experiencing avatars in social VR a more engaging and embodied approach to explore their own identity” (Freeman et al., 2020, p. 5). However, while there has been some research conducted in the VR world around adults’ experiences with avatars, less experience has been reported with children in AR movement-tracking environments, and especially also with groups. So, while the social aspects have been studied, less have been studied where children are actually physically in the same space and using the experiences. In addition, participants in this study also experienced and helped the “explore other undiscovered potentials of themselves” (Freeman et al., 2020, p.6), such as gender identity, confidence for example exploring oneself as a news channel host or becoming good at talk shows – one’s own experience of oneself could thus be seen as transformative.

However, less attention has been paid to the experience of the user moving together with the digital ‘other’, and Freeman et al. (2020) highlight the
importance of understanding other types of tech environments with virtual human or human representations, and the importance to explore social VR users’ self-presentation practices and identity management mechanism, analyse how avatars affect social interaction consequences in social VR, and investigate how experiences of avatars in these spaces can differ from other areas of tech to better understand and improve social interaction dynamics and consequences. While there has been a lot of work conducted into the 3rd person avatar type of worlds, less attention has been paid to mirroring displays and experiences from the user’s perception of the mirroring digital human that is not VR but AR environment. Especially given that mirroring movements are important for social interaction, and that there are many mirror child studies existing, as well as the embodiment effect, there is reason to look at this area further.

Do objects that suggests a body then have different effect? Some things suggest that they do, and they talk about these as ‘embodiment effects’. With young children, mainly in the area of play, certain trajectories have been identified. But these have not been described from enactive cognition perspective, or embodied cognition perspective.

From an enactivist perspective, when young children perceive an object, they act on the “enactive potentialities” (e.g. Gallagher, 2020, p. 33; Noë, 2006) of that object. If they do not know the enactive potentialities, then someone can “scaffold” for them those enactive potentialities by showing or demonstrating these to them from a sensorimotor perspective (Nygren et al. 2022, under review).

From an enactive perspective Gallagher adds that for an action to be “meaningful” (e.g. Gallagher, 2020, p. 14), it is inherently tied to the social context of that action. By jointly acting on an object, meaning can be created. In this sense, it is about collaborative action. He describes objects as “relational” (Gallagher, 2020, p. 10), and through interaction, them becoming ‘meaningful’ to those who use them. Van Dijk (e.g. 2018) has described this at length in design studies from an embodiment perspective, that borrows from participatory sense-making and the notion of social situatedness: it is in the
social context where meaning is created. He describes how meaning cannot be readily ‘prescribed’ to an object, but that it is built during an exchange of meaning in the moment that the participants take part in. Yet very little interaction design with whole body interaction has looked at the notion of affective engagement and social meaning making in young children from an embodiment perspective.

2.3 Affective engagement

Within learning sciences, the notion of ‘affective engagement’ focuses on behavioural engagement and achievement academically (e.g., Bond and Bedenlier, 2019). However, conceptualising affect from an embodiment perspective, however, is not new - already James (1890) who sought to combine thought and feeling describing them as inseparable, developing the concept of ‘thought-feeling’ to “capture the true embodied, affective character of our mental processes” (Johnson, 2017, p. 32). Over the past decades, especially Antonio Damasio (e.g. 1999) has worked in theorising affect from an embodied perspective. In his view, affect can be seen as a continuous body-mind response pattern as humans are assessing their affectedness by their environment. Indeed, while affect and behaviour are sometimes viewed as irrelevant to meaning making and cognition (Barsalou, 2020, p. 6), systems are coupled, and they support goal pursuit and survival. In the more embodied perspective, and what is relevant for this study, is that affect has been studied as ‘affective activity’ (Raudaskoski and Bisgaard, 2018).

However, less attention has been paid to the more nuanced interactions with digital multisensory experiences using body-based metaphors, or the reported relational actions that suggest positive intersubjectivity such as ‘attunement’, ‘movement synchrony’, or ‘entrainment’, or ‘shared affect’. Therefore, there is a need to study affective engagement from the perspective of grounded and enactive cognition. In this research project, affective engagement is defined as young children’s “engaged interactions with motoric, emotional, and hedonic aspects” (Cole and Montero, 2007 in Gallagher, 2020, p. 105). This aspect is seen in this project as aligning closely with embodied participation and Rogoff’s three planes of analyses approaches which promote the study of the
whole body and the social and material contexts in interaction. However, what is specifically looked at here are action-on-action chains, meaningful action chains that support children’s engagement with body-based metaphors.

From an embodied stance, however, other areas of literature in other research arenas have undertaken more embodied views onto relationship building. Such as attunement between child and their mother, and much research has looked at the particular facial expressions, detailed actions, and how people respond to each other’s actions. These studies have demonstrated a detailed, nuanced, almost microinteractional treatment of affective activity that places human relating at its core. Other avenues that have placed much importance to intersubjectivity and action have been, for example, body psychotherapy, and the psychotherapeutic interventions such as mirroring. The mirroring platform suggests certain approaches where interactants ‘meet’ each other and attune to each other’s movement during brief interactive encounters. The meaning of such encounters is to have an embodied experience with another, to relate, and to explore what it is like to move together.

In human development, affect has traditionally been described as “emotional state or feelings” that is contrasted with behaviour, i.e., what a person is doing in a situation, and cognition, i.e., how a person thinks about a situation (Slater and Bremner, 2017, p. 18). What is relevant for this study is that affect is studied through the whole body and its movement. Furthermore, it is studied in a group for a specific reason. In social psychology, affect is related to the need for humans to affiliate with others – that is, “a desire to seek and maintain interpersonal relationships with others” and which is “as fundamental to our psychological wellbeing as food and water are to our physical wellbeing” (Sutton and Douglas, 2020, p. 295).

One of the earliest body-relationships from an affective perspective is the mother-infant attachment process of “attuning” that involves mother cooing for the child, simple dialogues, and an ongoing gaze. This work has lots do with the infant’s self-development. It is an actual relationship that supports the child’s intrapsychic development, and the infant’s “self” is realised in interaction with the mother. A number of papers have been released in this area, and it
has contributed to research in attachment theory, for example. This relates to the notion of “mirror neurons” whereby certain brain areas light up when we see another person, not just our mother, acting out. We are, in this way, interpersonally “relating” or “attuning” to another person, when we are observing their action.

This has been described especially between caregiver and toddlers. For example, in Play Therapy, the notion of ‘creating shared pleasure’ during developmental play often emerges from five core components: “joint attention on objects and events, attunement or matched affect vitality, scaffolding, maintenance of safety via limit setting, and regulation of arousal and feelings” (Schaefer et al., 2008, p. 90). Stuart Brown talks about the seven core properties of play, and the ones relevant for this research project are inherent attraction – by which it is meant that play is fun, making one feel good by providing psychological arousal (Brown and Vaughan, 2010, p. 17). In addition, the author describes diminished consciousness of self which enables is to even create an imaginary self where we “stop worrying about whether we look good or awkward, smart or stupid” (Brown and Vaughan, 2010). This has also been described by Mihaly Csikszentmihalyi as “flow” (e.g. Csikszentmihalyi and Csikszentmihalyi, 1990).

2.4 Conclusion

To study the symbolic value and meaning of these mirror-like modes, this study is concerned with the use of the human body as a mirror, with superimposed external digital visual elements on. Given that attunement is an important part of meaning making in action, and in a mirror mode there are questions of self-referentiality and ‘other’, this study explores sustained engagement with elements that are the body, as well as elements that are superimposed (drawn) on the body as additional objects. The purpose of this is to understand if there are any interactive processes that seem to emerge in relation to a body representation on screen, and how the extra superimposed drawn digital elements complement each other (or not). In sensorimotor terms, it relates to having two types of output: a visualisation of the live video feedback of the children, and then, an additional drawn image of a body on top of that. In
addition, the children are interacting together, so there are questions about bodies and movement at large – how children interact in a group with a mirror like setting, and how do these actions relate to the story that has been devised and the possible metaphorical action. In a group setting, this means having three bodies visible, with additional digital elements on top of the body that mimic the lines that a body would create: a line on top of the limbs, dots on top of the head, the main body is denoted with a rectangular body shape.
Chapter 3 Theoretical Foundations

The underlying theoretical foundation in this research project is the idea that meaning about an experience is an emergent quality, embedded in an active, embodied process. To empirically access and study this process, interaction considering action as it happens in a situation, it is necessary to adopt a theoretical framework that helps conceptualise the physical, digital, and social elements of the environment and their relationship to young children’s experience. Grounded cognition is adopted as a guiding theoretical framing for creating meaning – a framework that essentially brings together a multitude of approaches to conceptualising embodiment. Furthermore, from grounded cognition, a specific approach of ‘enactive cognition’ theory and some specific conceptualisation will be picked out to help understand phenomena in the video data with children. Finally, microinteractional analysis (e.g., Nemirovsky et al., 2012; Goodwin, 2018), as a theoretical-analytical framework, is adopted in this work to identify, analyse, and frame patterns and processes emerging in children’s WBI with abstract science concepts. Together these three theoretical foundations frame and support the research process of accessing and understanding embodied meaning making while focusing on aspects of the interacting the whole body in a group digital setting.

3.1 Enactive cognition

Understanding how young children come to comprehend their surrounding world and its phenomena is at the heart of human development research. The enactive approach to embodied cognition (e.g., Thompson and Varela, 2001; Varela et al., 2016) asserts that cognition “depends upon the kinds of experience that come from having a body with various sensorimotor capacities”, and “these individual sensorimotor capacities are themselves embedded in a more encompassing biological, psychological, and cultural context” (Varela et al., 2016, p. 173). The core of this theory is developed around the concept of embodied action by which it is meant that sensorimotor processes are “fundamentally inseparable in lived cognition” (Varela et al., 2016, p. 173), consisting of two facets: “(1) perception consists in perceptually
guided action and (2) cognitive structures emerge from the recurrent sensorimotor patterns that enable action to be perceptually guided” (ibid.). In this work, we draw on two key notions within the enactive cognition paradigm: Noë’s (2006) “experiential blindness” as it relates to young children’s sensorimotor skill development and science learning, and Gallagher’s (2020) “joint action” as it relates to the social aspects of meaningful action.

3.1.1 Enactive potentialities

In their pioneering work in establishing the theory of enactive cognition, O’Regan and Noë, (2001) assert how our awareness and focus on any given element within our environment brings rise to ‘sensorimotor contingencies’ (aka sensorimotor dependencies, Noë, 2006, p. 6), which the authors view as the cornerstone for thought and action. Sensorimotor contingencies are a type of enactive knowledge, that depending on where we focus in the environment, and how much background experience we have, ranges from a mere scanning-type of our environment perceptually, while others require more mastery. All humans with visual perception, for example, can see a teacup on a garden bench, but “exercising the mastery of the relevant sensorimotor contingencies” (O'Regan and Noë, 2001, p. 944) requires using this knowledge to think or plan. For example, thinking about how hot the tea is and we don’t want to drink it yet, or thinking about bringing tea to a friend.

Noë’s enactive approach places the process of perceiving as acting at the core of developing sensorimotor skill or knowledge (2006, p. 9). This approach conceptualizes knowledge as an enactive process, where it is through the perceiver’s skillful activity that they acquire content from experience in their environment (2006, p. 3). From an enactivist perspective, these skills develop through us having experiences, which are necessary for us to understand our environment. Drawing from case studies in neurology and patients with vision difficulty, Noë argues that just perceiving, such as seeing color, is not the same as understanding; mere sensations of color “don’t add up to experiences with representational content” (2006, p. 5). To truly ‘see’ something “the perceiver must possess and make use of sensorimotor knowledge” (2006, p. 10). Thus, he argues for the enactive approach: to understand what one is seeing, one
needs to have the skills to attend to the ‘enactive potentialities’ of the environment. Only through this type of ‘seeing as acting’ can one come to acquire sensorimotor skill or knowledge. For sensorimotor skill to develop, “sensation is smoothly integrated with capacities for thought, and for movement” (2006, p. 6).

Noë (2006) also discusses how we naturally focus our attention on objects of interest, for example a fly flies towards our eye, and we blink, or a motorcycle turns from around the corner at a fast speed causing us to cross the road quicker. It is here he develops the notion of “experiential blindness” (ibid., p. 3) to denote the difference between just perceiving (such as only seeing) and having an experience. To be able to skillfully act in our environment, we need to perceive actively; or in other words, understand (the) enactive potentialities within our environment. At the core of the enactive approach to cognition is the idea that a skill is acquired through active perception; “we modulate our sensations with movement in a way that is responsive to thought and situation” (Noë, 2006, p. 6). For example, we are jogging and swerve to move away from a tree branch that’s appeared in front of our path.

If having an experience is crucial to put these experiences, or sensorimotor knowledge, into use (Noë, 2006, p. 10), then what does this mean for human development? In other words, how can young children have genuine perceptual experiences where they can exercise sensorimotor skill and knowledge? How might adults be best positioned to support this? In this paper, we take an enactive approach to explore the concept of experiential blindness to demonstrate how the relationship between perceiving and understanding plays out, or how forms of experiential blindness manifest themselves and transform, in children’s science exploration with an adult.“

### 3.1.2 Joint action

Some conceptualization of the individual in action (as is the focus in the above section on Noë’s treatment of enaction) is necessary for conducting analysis of interaction (Gallagher, 2020, p. 42). However, in the social enactive approach an analysis of an individual’s action needs to be situated in what Gallagher (2020, p. 42) describes as “the landscape of interaction” (borrowing
from Bruner’s concept of “landscape of action”, 1986). Indeed, the social approach to enaction highlights how “social dimensions are built into action from the very start” (Gallagher, 2020, p. 42). By this, it is meant that our actions do not emerge in a vacuum, as “[W]e don’t act or learn to act first, and only then enter into interactions” (Gallagher, 2020, p. 42).

At the heart of the social enactive approach is the notion of ‘interaction’ and “joint action” (Gallagher, 2020, p. 113). Within this approach, interaction is defined as “a mutually co-regulated coupling between at least two autonomous agents, where (a) the co-regulation and the coupling mutually affect each other and constitute a self-sustaining organization in the domain of relational dynamics, and (b) the autonomy of the agents involved is not destroyed, although its scope may be augmented or reduced” (De Jaegher, Di Paolo and Gallagher, 2010 as cited in Gallagher 2020, p. 99). Thus, this social enactive conceptualization of interaction emphasizes how action becomes shaped by those who participate in an interaction situation, and how each interactant individually takes part. Interactions include joint actions, “mutually generated intentional actions and responses that lead to a buildup of meaningful action chains” (Gallagher 2020, p. 13).

The meaning emerging from social engagement through action is embedded in the pragmatic nature of action and the task at hand (Gallagher, 2020, p. 107). Interactants’ bodies ‘coordinate intercorporeally’ in the environment through joint attention (Gallagher, 2020, p. 109), which changes depending on the context in which we are acting. For those working next to each other on a factory line, for example, many co-ordinations are pre-defined as practices; moving hands in specific patterns, holding a magnifying glass to check the quality of woven textiles. On the other hand, children who have just run outdoors to roll snowballs together, may not yet have a specified any well-established intention for their action – the goal and intention for continued snowball rolling is continuously shaped by the interactants, and the meaning of action is built during this interaction.

Meaningful shared action refers to the idea that the social setting “allows us to share what is valuable and why it is valuable” (Nemirovsky et al., 2012, p. 293),
and provides different emergent configurations that narrow and refine the field of perception. It also links to Noë’s enactive potentialities in the way that environmental affordances can be social, and “other people afford a variety of interactions” (Gallagher, 2020, p. 10). Given the intergenerational context of interaction in our study, this social enactive approach is a critical component of analysis.

Alongside Noë’s and Gallagher’s philosophical accounts of enactive cognition, the tradition of multimodal analysis offers a theoretical framing of in-situ interaction that addresses the qualia of the interaction involving detailed analysis of how ideas are expressed and constituted by sensorimotor activity (Nemirovsky et al., 2012) and how this is inherently shaped by activities that are suitable and nondeterministic in that specific environment, bringing a phenomenological perspective of meaning making to vocabulary, highlighting the modalities of the body and the environment. To address the ways in which the active human body, in interaction with others, through the use of gesture, manipulation of objects and movement supports scientific meaning making (e.g. Hall and Nemirovsky, 2012) we need to go beyond mere procedural knowledge highlighting “specific modalities of experience for understanding and using concepts”, “the constitutive role of acting bodies” in meaning making about science, and “possibilities for extending the body (and modalities of experience) associated with making and using representational tools” (Hall and Nemirovsky, 2012, p. 5). Given this, we take a multimodal microinteractional approach to analysis in this paper.”

3.1.3 Narrative practices

Gallagher speaks about narrative dimension of enactive interaction, and how through processes of intersubjectivity, young children become capable of understanding “things and people in emerging narrative structures” (Gallagher, 2020, p. 160). Discussing Jerome Bruner’s work, he quotes: “Narrative structure is even inherent in the praxis of social interaction before it achieves linguistic expression” (Bruner, 1990 in Gallagher, 2020, p. 160). Gallagher describes that although we can learn to form linguistic narratives, “the contours of our own narratives are shaped by the structures of the actions and events
themselves. Primarily we narrate our actions and the actions of others. ...Actions take time to unfold; they have a beginning, they develop, they accomplish a goal, and they conclude.” This is the basis of forming social meaning, where intentional movements present “distal goals and social meaning” (Delafield-Butt and Trevarthen, 2015). Quoting the Delafield-Butt and Trevarthen (2015), Gallagher writes how narratives reflect “the innate sensorimotor intelligences of a hypermobile human body” (2015, p. 1).

Gallagher, (2020, p. 161) describes the structure of action as “dynamic and affective” and not static. He also writes how it is in the “focused intensity, expressive movements, heart-rate, respiratory-rate, affective responses” and how these reflect the “vitality dynamics” (Gallagher, 2020, p. 161). He points out that the meaningful action emerges as “embedded in intersubjective interactions” (Gallagher, 2020, p. 161), “and only in such contexts can we speak of an emergence of meaning – a meaning that emerges in the interaction itself.” (Gallagher, 2020, p. 161). He gives an example of a baby reaching for an object in Vygotsky’s (1986) analysis, where a caregiver’s presence gives meaning expressive movement for pointing when there is an interpreter present: “Meaning emerges from movement, a movement that forms instrumental action with a goal, and perceived as such in the intersubjective context, becomes a request for help.” (Gallagher, 2020, p. 161).

He also talks about performative vocalisations where a child’s imitation of narrating of his mother’s “zoom” sounds when they are playing takes over and he imitates his mother (Gallagher, 2020, p. 162). In other words, narrative plays an important role in “reflecting the structure of action as it represents the action. In this sense, narrative structure derives from action structure.” (Gallagher, 2020, p. 162).

Furthermore, a child’s “first attempts at narrating typically” (Gallagher, 2020: 161) “occur in action, in episodes of symbolic play by groups of peers, accompanied by – rather than solely through – language. Play is an important developmental source of narrative” (Nelson, 2003 in Gallagher, 2020, p. 161).
3.2 Microinteractional analysis

Microinteractional approach enables studying children’s experience through attending to meaning in the body’s perceptual and motor activity (i.e., facial expression, gestures, and talk). As Nemirovsky writes, the goal is “with some degree of certainty” to understand aspects of the “realm of possibilities” as young children encounter body-based metaphors (Nemirovsky et al., 2012, p. 294). Microinteractional analysis was selected as it enables the “moment-by-moment bodily and situated activity of subjects engaged in certain events and interactions” (Nemirovsky et al., 2012, p. 294). The bodily modalities of body posture, re-enactment, manipulation of objects, pointing, gesture, facial expression, talk, and gaze, are examples that can be analysed in such video analysis (e.g., Goodwin, 2003; Streeck and Mehus, 2005).

The growing interest in embodied learning, and the role that gesture and bodily action plays in learning and conceptual development (e.g., Nemirovsky et al., 2011), has highlighted the importance of analytical approaches such as microinteractional analysis as a suitable analytical approach (Nemirovsky et al., 2011). In addition, such multimodal approach in microinteractional analysis is useful for studying young children’s interaction given that young children’s verbal capacity is not as fully developed as older children (e.g., Thomas Jha et al., 2021). This view is also aligned with Bakhtin (1981) on the contextual, situated, spread over time, bodily and irreducible to a set of modalities. Microinteractional analysis in the context of this research project allows tracing bodily activities action-by-action over short periods of times, such as within milliseconds, and the bodily modalities and their interconnections including talk, gaze, gesture, facial expression, tone of voice and posture. As Nemirovsky writes: “Given that someone’s horizon is constantly changing as part of his or her flow of consciousness, momentary expressions of surprise, satisfaction, wonder, frustration, appreciation, disapproval, and so on, are the pivots of our interpretive work.” (Nemirovsky et al., 2012, p. 294).

As Nemirovsky et al. write, “no description can be absolute” (Nemirovsky et al., 2012, p. 293), yet in can demonstrate an opportunity to learn about the quality of interaction.
In his writing, Goodwin (2018) talks about how action is organised in an embodied participation framework. In his example with girls who are doing hopscotch, he describes how “[T]he most crucial property relevant to the organization of action displayed through what happens here is reflexive awareness.” (Goodwin, 2018, p. 186). The presence of the mirroring whole body metaphors affords a support for this type of awareness to be built, adopted, and maintained, and there is a type of an allowing or surrendering to this social space, letting it influence one’s own action and attune one’s action accordingly. There is a continuous awareness of one’s coparticipants position and movement, and a type of reflexive awareness and resulting adjustment of one’s own movement in relation to another’s body.
Chapter 4  Methodology

4.1  Introduction

This Chapter presents the qualitative research approach taken in this research project. The aim of this Chapter is to present the methodological choices taken during this research project, and in a detailed way express these in order to be transparent about the research process in the hopes of increasing the transferability and generalisability and reproducibility. The methodological choices were guided by the main research question: What are the theoretical underpinnings of young children’s affective engagement with enactive metaphors and mirroring “body metaphors”?

In his famous essay “What is it like to be a bat?”, Nagel (1974) enquires how to access and arrive at an understanding about a bat’s lived experience when one is human, not a bat, raising issues in phenomenological inquiry and demonstrating how our knowledge about someone’s experience can be very limited. Similar constraints exist in the area of understanding young children’s experience from the perspective of a human adult academic researcher – what can be done? This research project is interested in young children’s, aged 2-7 years of age, experience with body-based metaphors.

Taking a Design-Based Research approach, this research project aims to identify bodily patterns that demonstrate aspects of young children’s affective engagement that emerge in interaction with their peers (and caretakers) during a series of experiential workshops that evolve around activities foregrounding body-based metaphors. These activities foreground body-based metaphors through (1) illustrated images of the body in action (a purpose-built fictional children’s picture book) for prompting enactive dialogue, (2) both carefully selected and purpose-built playful objects that prompt exploration of metaphorical action (children’s toys, both carefully selected and purpose-built), and (3) a sensorial digital platform (movement-visual-sonic) that prompts exploration of and through body movement.
These emerging patterns of affective engagement contribute to understanding of some of the bodily ways in which young children may participate in embodied ideation (for embodied learning environment design), and more widely, reveals some aspects of human development from a grounded cognition perspective when it comes to body-based metaphors.

A grounded cognition perspective embracing a pragmatist philosophy forms the base for this project’s overall Design-Based Research design. Within this wider framework, the chosen iterative design process enables a gradual and comparative development revealing a variety of dimensions to young children’s bodily affective engagement. This constant comparative analysis, which inherits much from a grounded theory, utilises data collected throughout the iterative cycles of modifications of the activity and material prompts, study design protocol and participant group dimensions which in turn reveal new aspects of the phenomenon in question: young children’s affective engagement with body-based metaphors.

The methods for qualitative data collection used across the twenty-three workshops conducted as part of this research project are discussed, and as well as a constant comparative analysis of workshop data and prototype iterations. The chapter concludes with research trustworthiness and considerations about research quality and ethical dimensions of researching embodiment with young children.

4.2 Epistemological Underpinnings: A grounded-pragmatist approach

This research project bases body and the world as central constituents in knowledge creation and conceptualisation (e.g. Barsalou, 2008; Wilson, 2002; Shapiro, 2010). In an epistemological framing that embraces a pragmatist and post-cognitivist approach, where sensorimotor interaction, perception, and introspection are viewed as a basis for cognition through situated action (Heras-Escribano, 2021, p. 337). This epistemological framing is based on the idea that many abstract concepts are grounded in the body, spatial systems and situated actions (e.g., Alibali and Nathan, 2012; Lakoff and Nuñez, 2000; Moyer and Landauer, 1967).
4.3 Design-Based Research Methodology

This qualitative research project is informed by design-based research methodology. Design-based research (DBR) uses an iterative approach conducted in real contexts (Wang and Hannafin, 2005). In education, the purpose of DBR is to “inquire more broadly into the nature of learning in a complex system and to refine generative or predictive theories of learning” (The Design-Based Research Collective, 2003, p. 7). Its core process consists of a dialogue across three areas: theory, practice, and design outcomes (The Design-Based Research Collective, 2003). Successful innovation is a joint product of the theoretical understanding and development of an intervention for an actual context (Anderson and Shattuck, 2012; McKenney and Reeves, 2013). Rather than aiming to develop perfected artefacts or intervention (as in Research-Based Design, see McKenney and Reeves, 2019), in DBR a model is the desired outcome.

In a DBR process, formative evaluation is conducted at each iterative stage. This allows for understanding what aspects of the intervention contribute or hinder the improvement of the design. A theoretical approach generates complex interventions that may improve the design throughout the empirical study and contribute to the underlying theory. Design-Based Research Collective identifies four core values crucial to maintaining rigour throughout the process (2003, p. 7):

- Documenting the process enables researcher to understand why outcomes occurred (especially given that the designer-researcher acquires the “dual intellectual roles of advocate and critic”).
- Being able to limit the number of design decisions as “emergent phenomena regularly lead to new lines of inquiry informed by current theories or models of the phenomena.”
- A context-aware approach that is maintained through all iterations (in some cases, a fundamental rethinking of data may lead to novel interpretations that may benefit the outcome positively).
• Maintaining a productive partnership with the stakeholders (developing research that meets the goals of innovations that are valuable locally and globally, especially for the field of research in question).

Against the epistemological foundation, the methodological approaches chosen for this study support observing affective dimensions of young children’s embodied meaning making. At the core are methods that open a window into children’s selective attention, carrying over of ideas from one task to another, and establishing concepts in their own terms. Together, they may support a model that supports aggregation – meaning representations and guides for interactions with a category that supports conceptual development from a re-enactment perspective.

4.3.1 Iterative design methods

The iterative design methods in this thesis included an iterative approach to translating ideas from a physical prototype into a digital prototype, and then developing the digital prototype iteratively through different modal changes according to how children had interacted on previous occasions. Iterative design methods are committed to participation and in order to answer research problems within the domain of design.

This work makes use of the iterative design model (e.g., Collins, 2004) alongside design thinking (e.g. Carroll et al., 2010) as research methods. In the context of this study, the “Compleat Design Cycle” (Middleton et al. in Kelly et al., 2008) was used as a guide through the iterative stages. The iterative design process will be conducted as a participatory design (e.g., Schön, 1983; Simonsen and Robertson, 2013; Khaled & Vasalou, 2014; Benton et al., 2014) effort, where children are included as informants (e.g., Scaife et al., 1997, p. 350). The researcher will develop the digital technology iterations in close collaboration with associated professional game developers through “reflective practice” (Schön, 1983): the design informs the team members, and each iteration contributes to reframing the design challenge. In the following, details of the Compleat Design Cycle are described, followed by a description of the participatory design approach as well as the co-design methods. Finally, multimodality as an analytical tool in the context of this work will be explained.
4.3.2 Iterative Design process

The purpose of doing iterations in the context of this study is to ask research questions about affective engagement during a participatory design project. The main aim has not been to produce a fully functioning museum exhibition installation, but rather to explore this unexplored territory of affective engagement and embodied learning through taking an iterative design approach. Thus, not all of the facets of the cycle below are fully realised during the course of this project. In fact, the definitive test had to be cancelled in a museum environment because of the pandemic. However, other areas were explored, with an emphasis on understanding the different dimensions of affective engagement in embodied learning in a rigorous and comprehensive manner.

The iterative design-based research process used in the context of this work was guided by Middleton et al.’s (in Kelly et al., 2008, p. 32) Compleat Design Cycle model, which is an iterative methodological approach for design intervention studies built upon seven phases. This cycle is important, as it starts from what the researchers call “Grounded models” meaning a fundamental epistemological position, which in the context of this study is grounded cognition and embodiment theory. Subsequent Phases Development of artefact (2), Feasibility (3) and Prototyping and trials (4) incorporated in this research project as they cover and capture the initial iterative “basic science” steps taken before conducting field studies which this project does not encompass. There were two reasons for not following the iterative cycle fully from Phases 1 through till the final phases as field studies. First being the prototype was not developed for the purpose of a “public trial” in a museum or another learning environment. Rather, the purpose was to study initial steps of a design process, attending to young children’s experiences and observing and understanding details of such interaction to make decisions about subsequent iterations. Secondly, this Chapter will at a later stage describe the Comparative steps taken with the data analysis, which was a ground-breaking point for this study that changed the direction of this study. While this research project was first following this iterative design cycle, with the end goals of “field tests” in horizon, there was a shift in focus as
patterns and understanding of children’s experiences increased for the researcher the research subsequently took a different turn, attending more closely to children’s experiences, and the interrelationships between physical and digital materials foregrounding the body used alongside each other.

Phase 1. Grounded Models

Phase 2. Development of Artefact

Phase 3. Feasibility Study

Phase 4. Prototyping and Trials

Phase 5. Field Study

Phase 6. Definitive Test

Phase 7. Dissemination and Impact

At the end – iterative design approach was used to evaluate the different designs, and how they affected or shaped young children’s affective engagement with the enactive metaphors and the “body metaphors”. Embodied participation ensured that there was no emphasis on the media that was being designed, but the children’s experience with the media was the core of the study.
Figure 4-1 The Compleat Design Cycle (Middleton et al. in Kelly et al., 2008, p. 32) used widely as a methodological approach for design intervention studies. This research project followed the cycle through Phases 1 and 4 iteratively, with a simultaneous process of data collection, prototype iteration and comparative analysis (more on this in the Comparative Approach section further in this Chapter).

4.4 Comparative Approach leads enquiry into Affective Engagement from an enactive cognition perspective

Not only is this research project iterative, but it also embraces a comparative approach to each iteration of the prototype and children’s interaction with it. A sequence of data collection sessions was always followed by a prototype iteration. As the project moved along, each of these cycles were analysed with each other. Thus, data was constantly compared during this process. This is just to show that the main aim of this iterative approach was not to get to a final prototype or educational design product. Rather, it was through different iterations of the study design and the prototype to arrive at some conclusions around affective engagement and embodied learning that designers in different informal learning environment design projects could potentially find useful when informing their practice from an embodiment theory perspective.
Iterative design process in itself suggests a comparative approach to data, which supports an iterative design idea, or iterations around design thinking and making. This is an idea that also is supported in grounded theory research, where you bring together research codes and categories and constantly compare them with each other.

This comparative approach in the context of this study is inspired and influenced by the Constructivist Grounded Theory approach (e.g., Charmaz, 2006). While grounded theory approach is oftentimes used with ethnographic methods and text analysis (data collected through interviews), some parts of the data analysis process are useful when considering design-based research methods and especially iterative methods where data collection is always related to questions emerging from the previous data collection and artefact development phase. Perhaps what is different in the context of this research project is that because the iterations’ purpose is not to produce a fully functioning problem-solving item, and rather to develop theories and methods in embodied learning and design, taking a comparative approach to data analysis and the design iterations, helps to produce rich descriptions of phenomena relating to affective engagement from several different situations, prototypes, and children in different contexts.

4.5 Qualitative Research Design

This section gives an overview of the research design for the project. After the overview, participant criteria and sampling strategies used are described. Data collection methods are critically reviewed and their suitability to the project presented. Finally, the constant comparative method for data analysis is detailed along with considerations for ensuring research quality.

Each activity, the picture book reading and interacting with movement-based digital platform, were analysed for affective engagement. Affective engagement was studied especially from the relational perspective – how enaction, such as gesture or body action, communicates meaning about metaphorical action (especially in the picture book activity) in a dialogic situation. In the movement-based interactive platform, relationality was studied
especially in relation to children encountering the “body metaphors” in the movement-based interactive, and how different interactive processes thus demonstrated ‘affective engagement’ as affective activity that proposes relationality through movement. *Theoretical triangulation* was applied to have multiple theoretical perspectives inform data analysis, as well as *analyst triangulation*, and researcher’s reflective commentary.

The overall design of the research project adopted a qualitative design-based iterative research approach to studying young children’s enactive affective engagement with enactive metaphors and “body metaphors”. In terms of design-based research, it borrowed specific methodological strategies such as experiential workshops with purpose-built material props as enactive prompts, with the view of iterating the digital prop to enable access to different dimensions of affective engagement.

### 4.5.1 Background for choosing a science concept and metaphorical action

Choosing the metaphorical action consisted of several steps:

(a) Literature review on children’s science learning to understand what areas of science children find particularly challenging.

(b) Choose a science concept

(c) Develop an action prompt for exploring different dimensions of the science concept through the body (this will be elaborated upon in Chapter 5 – Materials)

The studies presented in empirical chapters (Chapter 5, 6, 7 and 8) include detailed descriptions of methodological choices taken to help scrutinise research. Each chapter drew from a variety of methodological choices, triangulation supported identifying forms of affective engagement.

### 4.6 Participants criteria and sampling

This research utilised convenience sampling. Children aged 2-7 years were invited to take part in the study and recruited via their schools, nurseries, after-school clubs, and museums to take part in a 1-hour workshop in groups of
three (aged 2-4 and 6). This age range is selected to understand differences in meaning making processes and body-based movements, and to better contextualise the work within a museum environment that is characterised by offering experiences for children across different ages (Price et al., 2016, p. 581). Furthermore, within this age group, a number of studies on encounters and experiences with mirror and identity have been conducted, yet less research has focused on young children’s experience with mirroring body-based metaphors in a third-person AR environment. Given that these experiences are becoming more accessible and commonplace in environments such as science museums, as well as young children’s willingness to often explore environments through movement and play, this age group was chosen in this study. It is important to understand young children’s experiences with such technologies, in order to better understand how these technologies may affect young children’s development, and how designers may harness in their work from such understanding from an embodied cognition perspective.

As Garvey and Berndt (1975, p. 2) write, young children’s play activity takes place in social settings where they usually “interact with only one or two peers at a time”. While the group size increases as children get older, it seems plausible to examine enactive pretending with metaphors in a group setting (Garvey and Berndt, 1975, p. 2).

The participants were sampled on a random basis, where the researcher asked for the teacher to select groups of children from each class within the pool of children who had given consent to participate in the research. Children participated in the workshops on a single occasion. Because the research project was interested in young children’s experience on one occasion, and not in repeated observations with the same children, the sampling issues were scarce.
Table 4-1. Participants.

<table>
<thead>
<tr>
<th>Empirical Study</th>
<th>Workshop no.</th>
<th>Participant groups (names pseudonymised) and children’s age (in brackets)</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 5, workshops at a nursery</td>
<td>Workshop 1</td>
<td>Klara (4), Justin (4), Eva (4)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 2</td>
<td>Lisa (4), Ollie (2), Andy (4)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 3</td>
<td>Sadie (2), Amy (4), Jerry (3)</td>
<td>3</td>
</tr>
<tr>
<td>Chapter 6, workshops at a primary school</td>
<td>Workshop 1</td>
<td>Pyari (6), Ramiya (6), Aziya (6)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 2</td>
<td>Alin (6), Anna (6), Akram (6)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 3</td>
<td>Ovais (6), Gun (6), Jony (5)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 4</td>
<td>Sebastian (6), Shihana (6), Alvin (6)</td>
<td>3</td>
</tr>
<tr>
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<td></td>
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<td>Roger (5), Kristin (parent)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Workshop 3</td>
<td>Jacob (6), Lesley (2), Sandra (parent)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 4</td>
<td>Michael (6), Ellie (parent)</td>
<td>2</td>
</tr>
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<tr>
<td></td>
<td>Workshop 6</td>
<td>Timothy (6), Elias (4), Jonny (2), Libby (parent)</td>
<td>4</td>
</tr>
<tr>
<td>Chapter 8, workshops at a primary school</td>
<td>Workshop 1</td>
<td>Georgia (7), Devan (7), Lucas (6)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 2</td>
<td>Abaan (6), Aurora (6), Lewis (6)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 3</td>
<td>Amani (6), Rai (6), Ava (6)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 4</td>
<td>Amelia (6), Alana (6), Mia (6)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Workshop 5</td>
<td>Jos (6), Lucia (6)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Total children</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total adults</td>
<td>44</td>
</tr>
</tbody>
</table>

4.6.1 Materials

In this research project, the following materials were used:

(1) Purpose-designed Game design 1
(2) Purpose-designed Game design 2
(3) Purposed-designed Picture book 1 (paper prototype)
(4) Purpose-designed Picture book 2 (paper prototype)
(5) Slinky
(6) Purpose-designed Jumping platforms (paper prototype)
(7) Animal gloves
(9) Purpose-designed Cards representing sound waves

The analysis of young children’s affective engagement with enactive metaphors was limited to studying the game design 1, picture book 1, slinky and digital multisensory movement-based interactive and its iterations. Information about Game design 2, Picture book 2 and the jumping platforms can be accessed in the Appendix.

4.6.2 Choosing a science concept

The design of the digital prototype was iterated across three empirical studies in this thesis (Chapters 6-8). The first empirical study (Chapter 5) had the function of demonstrating the possibilities for multisensory development. The following iterations were made:

- Chapter 6: Stickman coloured green with lines instead of dots. Black background added (instead of live video feed). Sound added (continuous sine tone). Sound wave visualisation added (red wriggly line in between the stickman character’s hands). The sound could be changed across the frequency between 100 and 1000 Hz.
- Chapter 7: Stickman and sound wave visualisation displayed and presented first. After some interaction, the sine tone added.
- Chapter 8: Stickman displayed and presented first – lines thinner. Sound displayed second. Third, the sound wave visualisations presented, where all three interactants would have their own visualisation of the sound wave. The sound could be changed across the frequencies 80-400Hz, 200-600Hz, and 600-1000Hz.

Details about the iterations and the rationale for these changes are given in each chapter Materials section.
### 4.6.3 Use of Different Materials across the research project

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Physical Objects</th>
<th>Digital Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Workshop 1 / nursery</strong></td>
<td>Picture Book with stories</td>
<td>Posenet platform</td>
</tr>
<tr>
<td></td>
<td>Toys with sound</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brainstorming with post-it notes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toys with sound</td>
<td></td>
</tr>
<tr>
<td><strong>Workshop 5 / school</strong></td>
<td>Picture Book with stories</td>
<td>Posenet platform with sound, so iteration version 0.2 – add picture here</td>
</tr>
<tr>
<td></td>
<td>Toys with sound</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brainstorming with post-it notes</td>
<td></td>
</tr>
<tr>
<td><strong>Workshop 8 / after school club</strong></td>
<td>n/a, or should I mention matching the picture?</td>
<td>Posenet platform with sound, so iteration version 0.3 – add picture here</td>
</tr>
<tr>
<td><strong>Workshop 8 / school</strong></td>
<td>Picture Book with stories</td>
<td>Posenet platform with sound, so iteration version 0.4 – add picture here</td>
</tr>
<tr>
<td></td>
<td>Picture Book with stories</td>
<td></td>
</tr>
</tbody>
</table>

### 4.6.4 Activities

Explore audio-visual feedback in relation to movement and meaning making in a group setting: 1) purpose-designed illustrated storytelling session about a fictional character exploring sound with their body movements, 2) purpose-designed play with physical toys related to the story’s activities and sound concepts, and 3) interaction with purpose-built motion-based mixed reality environment with audio-visual elements on display.
### Table 4-2 Table for workshops activities.

<table>
<thead>
<tr>
<th>Workshop</th>
<th>Activity 1</th>
<th>Activity 2</th>
<th>Activity 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop 1 /</td>
<td>Picture book reading</td>
<td>Exploring and play with sound and toys</td>
<td>Posenet platform</td>
</tr>
<tr>
<td>nursery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 4 /</td>
<td>Picture book reading</td>
<td>Exploring and play with sound and toys</td>
<td>Posenet platform with sound, so iteration version 0.2 – add picture here</td>
</tr>
<tr>
<td>school</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 6 /</td>
<td>n/a, or should I mention</td>
<td>n/a</td>
<td>Posenet platform with sound, so iteration version 0.3 – add picture here</td>
</tr>
<tr>
<td>after school</td>
<td>matching the picture?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>club</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 7 /</td>
<td>Picture book reading</td>
<td>Exploring and play with sound and toys</td>
<td>Posenet platform with sound, so iteration version 0.4 – add picture here</td>
</tr>
<tr>
<td>school</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 4.7 Qualitative Thematic Analysis Approach

This research project adopted a qualitative thematic analysis approach, a well-known and “foundational method for qualitative analysis” (Braun and Clarke, 2008, p. 78). The purpose of this approach was to approach analysing affective engagement through qualitatively ‘thematise meanings’ (Braun and Clarke, 2008, p. 78). As Braun and Clarke describe, thematic qualitative analysis process was used as the main tool of analysis, and not as a “specific method” (Braun and Clarke, 2008, p. 78). Taking a design orientation to grounded theory meant that my analytical approach shaped the conceptual content and the direction of the research project throughout. The analysis that was emergent from this process led to adopting multiple methods of data collection and I pursued the inquiry conducting fieldwork at several different sites. “Seek data, describe observed events, answer fundamental questions about what is happening, then develop theoretical categories to understand it.” (Charmaz, 2006, p. 25)
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Research Questions</th>
<th>Analytical approaches</th>
<th>Themes</th>
</tr>
</thead>
</table>
| Chapter 5 | 1. How do children enact on purpose-built physical and digital body-based metaphors in a group setting?  
2. What does this tell us about affective engagement? | Microinteractional analytical lense to study young children's enactive practices with body metaphors | 'belonging'  
'embodiment effect'  
'being it' |
| Chapter 6 | 1. How does enactment enable children to build a relationship with body metaphor?  
2. What does this tell us about affective engagement? | Microinteractional analytical lense to study young children's enactive practices around agency and joint action with body metaphors | 'relationality'  
'attumenent'  
'imaginary self' |
| Chapter 7 | 1. What enactive processes foster companionship during family interaction with mirroring body metaphors?  
2. What does this tell us about affective engagement? | Microinteractional analytical lense to study family interaction and enactive practices with body metaphors | 'togetherness' |
| Chapter 8 | 1. What forms of enactive processes do young children engage in with enactive metaphors in a whole-body interaction | Microinteractional approach to analysing affect as a process of interaction. Analysis of affect drew from enactive | Narrative frames for action  
Movement improvisation  
Body memories |
environment with “body metaphors”?

2. What does this tell us about affective engagement?

cognition, play theory, and social embodiment theory.

4.7.1 Video Analysis

Each empirical study included several rounds of analysis of affective engagement in interaction:

**Chapter 5**

The purpose of this analysis was to understand, from an enactive cognition perspective, ways in which children enact whilst encountering body metaphors in a group situation. The analysis consisted of four rounds of analysis for the picture book reading data, and five rounds of analysis for young children’s interaction with body metaphors.

**Chapter 6**

The purpose of this analysis was to understand the notion of ‘relationality’ in young children’s interaction with body metaphors, specifically as an *enactive process*. Three rounds of analysis focused first on young children’s investigation of the body metaphors through movement, and specifically noting down moments of children’s gaining a “sense of embodiment” with the body metaphor, i.e., discovering their own agency over/with the body metaphor. This could be in the form of “self-referentiality”, such as saying whilst moving and gazing at the body metaphor that “that’s me”. It could also involve another process that isn’t as related to the notion of the “self”, but rather an “other”, which would involve less body movement with body metaphor, and be verbally described by the children as the body metaphor bring “it”, or another entity, separated from the self. Furthermore, the subsequent layers and rounds of analysis suggested that children ‘build’ relationality with mirroring body metaphors over time, and this process can have the effect of “joint action”,
resulting in a shared “sense of embodiment” with body metaphors, and marked by positive affect.

Chapter 7

This study focused interaction analysis on the notion of ‘joint action” and “kinaesthetic intersubjectivity”, that emerged during family interaction with body metaphors. The analysis suggested that family interaction with body metaphors fosters moments of positive affect, which manifests as a bodily and positive attentiveness directed towards other interactants in the family, marked by forms of “kinaesthetic intersubjectivity”, such as action-on-action responses, synchronised movement, or the use of touch. In this way, it contributes to the enactive cognition notion of “joint action” (Gallagher, 2020), by demonstrating acting together with body metaphors.

Chapter 8

Qualitative video analysis of young children’s interaction focused on understanding episodes of shared affect in group situation whilst interacting with “body metaphors”. The analysis was based on forms of ‘joint action’, ‘meaningful action chains’ and ‘narrative practices’ (Gallagher, 2020) of shared affect drew from social embodiment theory (esp. the notion of ‘entrainment), play theory (esp. ‘pretend play’ and ‘symbolic play’) and ‘bodily effort’ as markers of shared affect. The types of movement were marked by moments of bodily improvisation with enactive metaphor that made them into meaningful action chains, sharing narrative arcs with others, and utilising shared body memories during improvisation.

4.8 Ethics

Ethical approval was granted by the UCL IoE Ethics Committee.

4.8.1.1 Data collection

This research projected collected qualitative data about young children’s affective engagement with enactive metaphors. The main data collected was video recordings of interaction during the workshops. In addition, two design-oriented workshops, conducted with museum practitioners, were also video
recorded. In addition, fields notes were written by the researcher after each workshop. Data was collected by video and audio recording during observation and workshop sessions, fieldnotes and informal interviews.
Table 4-4. Data collection timeline and iterations of the technology.

<table>
<thead>
<tr>
<th></th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aug</td>
<td>Sep</td>
</tr>
<tr>
<td>Workshop 1 / nursery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 2 / museum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 4 / school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 5 / school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 6 / museum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 8 / after school club</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop 8 / school</td>
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</tbody>
</table>

4.8.2 Video recording

Multiple cameras were set up in the nursery/school/museum to capture facial expressions, physical movements, and social interactions as well as interaction with the projected screen, during which automatic data capture will be utilised. The researcher transcribed these recordings into field notes (including dialogue).

4.9 Organisation of data

Forty-seven video files were collected onto a folder that sat inside an encrypted hard drive. Folders for each study’s video files were created and video clips, field notes and sketches were collated in an excel document.
4.10 Ethical Considerations

Each methodological approach is a choice and carries with it ethical concerns which are crucial for researchers to identify and remain mindful of. No research is without value, and it is well known that all knowledge has both the potential to harm as well as benefit (e.g. Reinharz and Davidman, 1992). In the context of this research project, and more specifically touching on the focus of this work on embodiment research with young children that on emerging digital technologies, learning and design, two broad facets of ethics are discussed in the following sections: (1) research purpose, and (2) technology and children.

4.10.1 Research Purpose

This research project focuses on embodied issues around young children’s meaning making with abstract concepts in environments that utilise emerging new technologies. The purpose of the research is to understand young children’s enactive affective engagement with body metaphors in whole body interaction environments. The aim of this research is in this way to produce embodied knowledge and move research toward praxis (e.g. Maxwell, 2009). Research has the potential to support equality agenda through critiquing existing power relations; focusing on understanding experiences of groups whose voices may be frequently marginalized, committing to present diverse standpoints within established fields of research, framing research as practice with a potential to foster social justice; foregrounding intersectionality, and encouraging participatory research participation where appropriate (e.g. Kingston, 2020).

4.10.2 Technology and Children

Young children of today have been exposed to digital technologies for the entirety of their lives (e.g. OECD, 2006), with youngest children with a general first experience with digital technologies before the age of two (Chaudron et al., 2018). Considering the role of digital technologies in embodied learning design with young children brings with it a considerable number of ethical concerns ranging from children’s digital engagement to protection, inclusion and fostering digital skills. The notion of ‘participatory ethics’ allows space for
“complexity of our being, including inescapable impermanence, precludes absolutes, such as moral imperatives” and recalls “creativity inherent in our awareness of complexity and celebration of pattern.” (Bai and Banack, 2006).

Tracking technologies pose other ethical considerations. Those that provide feedback about one’s bodies may have an influence on the behaviour of children and the issues around data security and privacy (Manches et al., 2015). There is also an increasing worry about well-being more generally with children and technologies and technology-use. This stems from a worry about the increasing amount of digital technology in children’s lives displaces more beneficial activities, however this notion is controversial and widely criticised (e.g., Kardefelt-Winther, 2017; Gottschalk, 2019).

4.11 Conclusion

This thesis takes a design-based research approach to explore young children’s affective engagement with body metaphors. Design-based research paired with an iterative and comparative approach supports prototype development, and access to dimensions of affective engagement with purpose-designed and selected prompts. Comparative analysis embedded into each iteration and data collection event supports deepening of understanding of different dimensions of young children’s enactive processes and affective engagement with body metaphors.

The following four chapters present the empirical studies taken as part of this thesis. Chapter 5 details an exploratory study approach to methodological exploration and the dimensions of affective engagement it gives access to within enactive cognition framing. Chapter 6 builds on the notion of ‘perception of self’ in the mirroring body metaphor, presenting a study on young children’s interaction with digital body metaphors and their exploration of their building of a ‘sense of embodiment’ as they explore body metaphors through their movement, and joint action. Chapter 7 builds especially around the notion of ‘relationality’ with body metaphors as discussed in Exploratory Study and extends the notion of ‘joint action’ from both previous studies with a specific focus on the relationship between positive intersubjectivity and reflection on
action. The final empirical study presented in Chapter 8 demonstrates that young children’s interaction with body metaphors is marked by improvisations around movement themes, which builds on the notion of ‘improvisation’ and ‘joint action’ as forms of ‘affective imagination’, thus building on the findings from the Exploratory study.
Chapter 5 Exploratory Study: Affective engagement in young children’s enaction with body metaphors

5.1 Introduction

While children’s affective engagement with enactive metaphors in gesture and movement-based interactive environments has received some attention in recent years (see Chapter 1), less is understood about affect during young children’s group enaction on multisensory and fictionally framed body-based metaphors. Given the importance of social interaction and affective engagement to children’s development (e.g. Appleton, 2012; Finn and Zimmer, 2012) as well as the increasing amount of movement-based interaction interfaces that utilise game-like contexts and simulations with narrative content (e.g. Melcer and Isbister, 2016; Abrahamson et al., 2012), there is a need to understand the notion of ‘affect in interaction’ when designing digital multisensory scenarios for young children’s whole-body interaction with enactive metaphors. This study takes an enactive cognition approach to understand the motoric, emotional, and hedonic dimensions in young children’s interaction with purpose-built and prototypical body-based metaphors (Gallagher, 2020, p. 151). To access these dimensions of affect, a method informed by social embodiment theory (e.g., Barsalou et al., 2003), is developed. This exploratory study is guided by the following questions:

(1) How do children enact on purpose-built physical and digital body-based metaphors in a group setting?

(2) What does this tell us about affective engagement?

This study makes three distinct yet interrelated contributions:

(1) Unpacks the notion of ‘affect’ from an enactive cognition perspective by elaborating on young children’s enactive strategies with body-based metaphors as forms of ‘narrative practices’ and ‘joint action’ (Gallagher, 2020). Enactive framing of interactive patterns highlights the relational
dimensions of affect in action. First, in the dialogic situation of a picture book reading, children express through enaction what different layers of meaning they are making of the action representations set in a fictional context with the picture book. Second, with the movement-based interactive platform, enactive framing also helps conceptualise the collaborative actions that children employ.

(2) Children’s interaction with body-based metaphors indicates a form of ‘embodiment effect’ (e.g., Barsalou, 2008) where an artefact displaying an abstract body pose or a moving body plays a substantial role in young children’s physical and enactive participation during interaction.

(3) The study suggests that methodological prompts with body postures and moving bodies provide an iterative-affective approach for exploring enactive metaphors may be useful in designing with body-based metaphors for movement-based interactive environments.

5.2 Methodology

5.2.1 Research Design

This study took place in a side room in a nursery based in the south of England, where children took part in an exploratory workshop with the researcher in groups. During these workshops, the children were invited to take part in two picture-book reading sessions and to play with tangible toys relating to the picture-book stories and affiliated enactive metaphors. They were also invited to interact freely with a movement-based digital technology. The analysis focuses on young children’s interaction with one of the picture books, called Changing Sound, children playing with the toy affiliated with this story (Slinky), and their interaction with the movement-based technology.

5.2.2 Participants

Participants’ parents were approached via the nursery staff prior to the researcher’s visit and recruited on a voluntary basis. Participants’ parents were given an information sheet and consent form (see Appendix), and the researcher talked through the process with the support from an age-appropriate information sheet (see Appendix) to gain their assent to take part.
Nine children within the target age range (2-7 years) participated in the study (M=3.4 years, SD=0.83). Each group consisted of three children between the ages 2-4 years accompanied by a nursery staff member. Ethical approval was obtained from UCL IOE Ethics committee, ref no. Z6364106/2018/03/147 (see Appendix). All participants were informed that they could withdraw at any time. Names in this study are pseudonymised to maintain confidentiality.

5.2.3 Materials

The data in this study extracted from an experiential workshop designed for exploring ‘affect’ in young children’s group interaction with body-based metaphors. The design and selection of the body-based metaphors is informed by ‘embodiment effect’, a theoretical notion from social embodiment (e.g., Barsalou et al., 2003; 2008; Niedenthal et al., 2005). Empirical research demonstrates that experiencing artefacts depicting human characters elicits action similar to ‘embodiment effect’, a view that is confirmed by other social cognition theories such as ‘mirror neurons’ (e.g., Rizzolatti et al., 2002; Gallese, 2005, for more information see Literature review). Thus, in this study, human body representation of action was incorporated to the study as prompts for eliciting action and studying notions of ‘affect’.

Furthermore, this study was informed by literature relating to children that find it challenging to differentiate between pitch and volume (e.g., Houle and Barnett, 2008; Hendrix and Eick, 2014) and embodied metaphors (e.g., Antle, 2008). To experience sound changing through one’s own body movement, Antle’s (2008) work maps sound physically to sounding objects that can be altered via movement. Moreover, making representations enactive from a narrative and role play perspective has been the goal of recent embodied learning designs (e.g., Abrahamson et al., 2016) in order to create experiences with objects that are story-like and fictional. This aspect of the fiction has been shown to increase affective engagement. Children have been shown to enact stories with characters, thus ‘being it’ (Fleer, 2013) – an affective quality described in empirical embodied learning literature (e.g., Enyedy, 2012). In this study, the picture-book representation extends these works by embedding a visualisation of an embodied metaphor into a familiar format of a picture book.
The picture book is then used to study ‘enactive potentialities’ of body representations at the early stages of a multisensorial enactive metaphor development in order to understand how children experience the action metaphor and the multisensorial dimensions of it.

Three material prompts were designed and selected in order to gain access to data around young children’s participation with enactive metaphors:

1. A purpose-designed picture book with a fictional story depicting an illustrated human character actioning on a hand-held stretchable object modelled on a sine wave.
2. A metallic slinky, sensorially augmented during interaction by researcher using their voice.
3. A movement-based digital interaction platform with live-video feedback of interactants and a superimposed whole-body visualisation of a stickman superimposed on the live-video feedback.

As the children participated in the picture-book reading, they responded to the actions and complexifying metaphor in the moment through enactions of their own, making connections between the action of changing the width between the hands, the sound visualisation, and the function of the object. The picture book was held by the researcher-facilitator on her lap during the picture-book reading, and she turned on to the next page after the story had been explored.

Theoretically framing and preparing the material prompts for the study design involved four steps:

1. Choosing an enactive metaphor that may ground abstract concepts.
2. Designing a fictional story that features the selected enactive metaphor.
3. Selecting a tangible prompt with which to act on the enactive metaphor with sensorial augmentation.
4. Selecting a movement-based interaction platform for group interaction to explore possible future implementation of the selected enactive metaphor.
The following sections explain these steps and provides the rationale and theoretical underpinning the specific prompts within the context of this study.

(1) **Choosing an enactive metaphor that may ground abstract concepts.**

As discussed in the Literature review chapter, body-based metaphors have been implemented in different types of simulations to enable children to access and explore action with enactive metaphors. In this research project, the selected enactive metaphor was to change pitch and volume – concepts that children often confuse with each other (see Methodology chapter for detail), and the metaphorical action was designed around this science concept. As exemplified by the embodiment theory, bodies can express several metaphors (e.g., Lakoff and Johnson, 1980b), such as *inside* and *outside*, or *big* and *small*. Some of these ideas are static such as poses (see Figure 5-1), while others are dynamic and are shaped through ongoing movement which can be called “enactive metaphors” (e.g., Lindgren and Gallagher, 2015, p. 391). In the figure below, the ‘large’ and ‘small’ gestures are mapped onto a ‘sliding’ body gesture that involves motion of the body, in this case, the arms.

![Figure 5-1 The body can convey multiple metaphors in still poses. For example, illustration of the child holding her arms wide open (L) and arms of the girl close to each other (R) may underpin many abstract ideas, including but not exclusively, ‘large’ or ‘small’, respectively.](image)
Figure 5-2 The illustrations above convey dynamic movements. In the image on the left, the child changes position of arms from closer to wide open (L), and on the right, the opposite movement is displayed, where arms are brought back next to each other in front of the upper body (R). These motions can convey a number of abstract metaphors, for example, the moving arms may convey a sliding scale from ‘large’ to ‘small’, such as ‘getting larger’ or ‘getting smaller’, adding elements of time and change in the metaphor.
Figure 5-3 Series of illustrations demonstrate abstract science ideas about pitch (frequency) mapped or ‘translated’ onto the body action metaphors applied in this study.
Designing a fictional story that features the selected enactive metaphor.

The metaphorical action prompt was developed further to incorporate a fictional story around the enactive metaphor to ease access to the science idea – drawing from the work by Fleer (2013). A narrative framing has been shown to support ‘enaction’ of science ideas (e.g., Fleer, 2013). It supports both ‘pretend’ and ‘symbolic play’; for example, a narrative framing of the Three Bears classic children’s story can support children's play in relation to ideas around heating and cooling (Fleer, 2013). Furthermore, picture books with characters have been shown to promote enaction (e.g., Heller, 2019) with young children, which is in-line with embodiment theory and empirical research demonstrating this effect.

A fictional story represented in a picture book format called ‘Changing Sound’ (Figure 5-4) features a sequenced narrative that displays objects that can be worn (paws) (Figure 5-4). It represents an illustrated human character (Figure 5-5) in a fictional world who in the picture book’s narrative changes sound pitch by moving arms dynamically horizontally wider apart and back together again (Figure 5-6) – acting on the enactive metaphor. In the manner of a sine wave, the sound is depicted as a yellow wave object that changes its shape according to how wide apart the wearer’s hands are (Figure 5-6). The picture book is embedded inside of an illustration pad sized 30cm x 42.5 cm.

The picture book’s pages follow a simple sequenced narrative: (1) they show the objects that can be worn (Figure 5-4); (2) show a child wearing the objects on his hands (Figure 5-5); (3) show how a child’s objects create a wriggly line (Figure 5-6); (4) show how the child can use the objects in the environment functionally (Figure 5-7); (5) show how, after the child has used the objects, the story has a reward at the end (Figure 5-8).
Figure 5-4 Picture book page 1. Depicting animal paws that are hanging off the wall.

Figure 5-5 Picture book page 2. Depicting an illustrated character who is wearing the paws.
Figure 5-6 Picture book page 3. Depicting an illustrated character who is creating a sound with his paws. The sound is visualised as a yellow wavy object that appears in between the wearer’s hands when they are wearing the paws. The shape of the wave changes according to the changing width of the hands. In the manner of a sine tone wave, the wavelength becomes narrower when the hands are closer together, thus depicting a higher pitch. When hands are wider apart, the wavelength becomes wider, thus depicting a lower-pitched sound. In addition to the sound object, other paws and a tail are hanging down from the ceiling of the picture. Each paw and tail have a small wave on them. In the story, the character needs to find the matching wave by changing the width between his hands.
Figure 5-7 Picture book page 4. This page depicts the character matching one of the waves on the paws, that creates a connecting yellow line between the character’s paws and the paw with the matching wave. A star depicts the matching line.

Figure 5-8 Picture book page 5. Depicting a cat descending from the ceiling after the waves have been matched. The four stars depict the character having won.
(2) Selecting a tangible prompt with which to act on the enactive metaphor with sensorial augmentation.

As a further action prompt to the enactive metaphor, a physical parallel toy, a slinky was selected. This object allowed physical action that resembles that of the enactive metaphor, as well as giving some tangible feedback with a material that changes when stretched. This prototypical approach with tangible objects and sensorial augmentation of object and the action in relation to embodied metaphors has been explored with children and sound (e.g., Antle, 2008) and as props for bodystorming to explore different sensorial feedback within movement-based exercises (Vidal et al., 2018).

![Figure 5-9 Slinky lengths mapped onto frequencies. Illustration (a) depicts girl holding hands close together keeping slinky at a short length, which is mapped onto a ‘high pitch’, analogous to a sine wave representation of sound. Illustration (b) depicts a long slinky length where the child’s hands are further apart representing a lower pitch, analogous to sine wave representation.](image-url)
Figure 5-10 Metal Slinky. A physical object that can be held by a child at each end, affording a stretching action that reflects the changing width of the picture book’s yellow wave-object (representing changing sound).

(3) Selecting a movement-based interaction platform for group interaction to explore possible future implementation of the selected enactive metaphor.

The movement-based interactive platform is a digital interactive technology based on movement detection that tracks human’s joints in movement during interaction and generates feedback as a human visualisation on the screen with live video in the background. The platform was made available on a Mac 15” laptop computer and placed on a low table about 55 cm in height. The computer was opened, and the children were invited to respond to the researcher’s question: “What do you see?”. The children interacted with the platform simultaneously in a group until their engagement with the object ceased.
Figure 5-11 Illustrated image depicting PoseNet system. Children can see their live video feedback on the screen in front of them. Superimposed on the live video feedback appears a turquoise body figure that is ‘drawn’ in real time over the live video feedback and the human bodies the system detects.

5.2.4 Procedure

Each group of children participated separately in interaction sessions with the picture book, toy (slinky), and the movement-based platform. At the beginning of the interaction, the picture book was opened so that the page faced the children, while the researcher-facilitator held it in her hand. During the interaction, the children were asked to explore what they thought was going on in the picture-book page. They were also asked if they could see what differences there were between objects, and with the slinky, if they could make a very loud sound or a quiet sound by changing the width of the slinky in their hands. The parents and the nursery staff were informed that the researcher was interested in how these objects supported interaction with science-themed objects. During the interaction, the researcher’s primary role was to provide
narrative support and to answer any questions directed to her. The children interacted with the objects for approximately twenty minutes, typically the researcher brought the interaction to a close when they sensed the group’s engagement had ceased. Two of the interaction sessions were recorded using one static video camera, positioned to record all participants taking part in the interaction. In one of the sessions only notes were taken, and illustrations made after the session, due to non-consent for videorecording from one participant.

5.2.5 Analytical process

This study adopted a qualitative microinteractional approach to thematic video analysis (e.g., Goodwin, 2018; Nemirovsky et al., 2012; Nygren et al., 2022) (see Methodology chapter) to study ‘affective engagement’ in young children’s interaction with body-based metaphors from an enactive cognition perspective. The analytical process consisted of multiple viewings of the data. In this way, the approach to the analysis followed a method of progressive refinement of hypotheses (Engle et al., 2007) where prior to data collection, a general theory driven question about affect and young children’s enactive practices with body-based metaphors was formed (see Introduction chapter). Two principal theoretical perspectives from enactive cognition guided the analysis of ‘affective engagement’ in this study: (1) “narrative practices” (Gallagher, 2020, p. 160), and (2) “joint action” (Gallagher, 2020, p. 113). These theoretical perspectives opened a window into looking at bodily affect from a meaningful action perspective that takes into consideration not only the motoric, but also the emotional and the hedonic components of action (see Introduction). These two perspectives afforded an enactive perspective for analysing qualities of ‘affective engagement’ during young children’s re-enactments of illustrated picture book actions, and children’s socially situated action (e.g., van Dijk 2018) with digital body-based metaphors. Furthermore, each of these perspectives was furthermore complimented especially the theoretical-analytical notions of ‘pretend play’ (e.g., Garvey and Berndt, 1975; Hutt, 1981; Fleer, 2013; Vygotsky, 1966; 1978), ‘mirroring’ (e.g., Niedenthal et al., 2005), ‘attunement’ (e.g., Röhricht et al., 2014; Haft and Slade, 1989), and ‘embodiment effect’ (e.g., Barsalou et al., 2003).
The iterative qualitative multimodal analysis began with the researcher watching the two videos twice over and making notes about instances about young children’s enactive interaction during interaction with body metaphors. From the interaction videos, episodes that illustrate ‘relational’ affective activity with body-based metaphors were selected. From the videos, shorter interaction ‘clips’ that represented these qualities were selected (Derry et al., 2010). In addition, thick descriptions (e.g., Geertz, 1973; Goldman-Segall, 1998) of ‘affective engagement’ in action were written to describe the phenomenon under focus. In the following, the approach to analysis will be described in detail.

(1) Video analysis of children’s enaction during the picture book activity

During the first round of viewing, the videos were watched twice over to gain an understanding of young children’s participation through enaction during the interaction. Episodes of enaction were marked down, including a child leaning towards the picture book, pointing at the picture book’s page, vocalisations including shrieks of joy and laughter relating to the picture book reading, or re-enactments that drew from the content displayed in the book. In addition, play with slinky that involved participating in exploring changing sound via enacting on the slinky or the sound itself via vocalisations were noted down. During the second round of viewing, specifically re-enactments that conveyed a dimension about the multisensory metaphor embedded in the picture book action were noted down. During the third round of viewing the selected clips conveying re-enactments of the multisensory metaphor were analysed specifically for the quality of the re-enactment. The qualities were analysed drawing from theoretical literature on qualities of pretend play and mirroring, to capture interaction episodes such as metaphorical action evoking a narrative frame suggested by the picture book, re-enactment revealing how children experienced different aspects of the multisensory metaphor idea through enactment, or physical details about affective engagement in enaction such willingness to re-enact, vivacity and positive affect, attention to detail of metaphorical meaning, playfulness in re-enactment. During the fourth round of viewing, specific clips, which demonstrated a range of different qualities of
affect – in terms of motoric, emotional, and hedonic, were selected to demonstrate what aspects of multisensory metaphors children participated with and how, to demonstrate the relational quality of the enactive metaphor in the dialogic situation. Thick descriptions of the interaction were produced as part of this round of viewing and are presented below in the Findings section.

(2) Children’s enactive processes with digital stickman characters

During the first viewing of the video depicting movement-based platform interaction, enaction was studied from a group interaction perspective. Especially how children displayed actions collaboratively, such as acting on an object simultaneously, or acting in a similar manner as affective enactive processes. During the second round of viewing, the interaction was analysed first for patterns of action where the children were enacting on the ‘digital other’ from the whole-body perspective. The videos were then analysed for the children ‘moving together’ where they were enacting on the whole-body metaphors together through mimicry, re-enactment, movement synchrony or entrainment. These were then analysed from the perspective of the body symbolising or with pretending elements with the body metaphors as in play. Finally, the movement-based interaction videos were also analysed for instances of how children made reflections of each other and their own body movements, thus using the whole body-interaction environment for providing feedback about their own performance; for example, through pointing at each other during interaction, saying something about one’s appearance, or giggling about someone’s face.

5.3 Findings

The findings present processes of young children’s enaction with body-based metaphors. They are divided into two themes. The first theme, Young children re-enact multisensory enactive metaphors, presents four episodes in which children re-enact dimensions of the enactive metaphor action and its meaning. The second theme, Young children enact on digital whole body metaphors, presents three episodes that demonstrate children collaboratively enacting
and making meaning about the movement-based interaction platform and the digital stickmen characters.

5.3.1 Young children re-enact multisensory enactive metaphors

The first theme presents four different affective and enactive strategies children adopted when participating in the dialogue about the picture book’s metaphorical action. The purpose of these findings is to demonstrate different ways in which children expressed themselves in a bodily way drawing from the picture book’s story and fictional elements adopting narrative frames for their enaction that goes beyond simple or pure re-enactment but that conveys affective content in their expression and demonstrates how affective content can be understood from a variety of different ways of expressing oneself. This, in turn, conveys affective meaning that children are drawing from their experience in encountering the artefacts. Theoretically, these findings speak to different forms ‘narrative practices’ (Gallagher, 2020) that children adopted when expressing themselves during the dialogue with the researcher and each other.

Episode 1. Lisa re-enacts body-based metaphor depicted by the character in the picture book

This episode describes how Lisa, 4 years, participates in the dialogue about the picture book by dynamically enacting the illustrated character’s pose presented on the picture book’s page (Figure 5-5) as a response to the researcher’s prompt. Lisa participates in the dialogue with a re-enactment of the character’s pose by bringing her hands up in the air swiftly, mimicking the body action displayed in the picture book by the illustrated character. As she raises her hands, another participant, Andy, who has been attending to the picture book with his gaze, turns towards Lisa to look at her enaction, which becomes the focal point in the group. This episode speaks to a form of “narrative practice” (Gallagher, 2020) in enactive cognition, where the action includes an affective quality and intentionality that draws from communication of pretending.
Researcher: “You could wear paws like that. Big paws like that.” (Pointing at the picture book.)
Lisa: (Gazing at the picture book, lifts her arms up in the air, opening her palms wide and facing outwards in front of her face.)
Andy: (On the right turns his head to gaze at the Lisa.)

Figure 5-12 Lisa’s (2nd from left) re-enacts picture book character’s pose.
Lisa’s re-enactment communicates a quality of “pretending” (e.g., Garvey and Berdnt, 1975, p. 6) through the body. Affectively, it conveys an affiliation with the story of the picture book and the action depicted by the illustrated human character in a picture book. The re-enactment is characterised by qualities of playfulness and a role-like, quality of expression already reported in children’s multimodal dialogues about fictional stories (e.g., Heller, 2019).

Lisa is responding to the picture book’s illustrated character and their position, as well as the researcher describing how the children could be wearing similar paws, through her own action. This can be seen as a ‘testing’ of the action that is depicted, and to experience how it would be like to wear such paws. In this way, she is, in this small moment, eliciting an idea about *wearing the paws* in her hands. She is *imagining* or *pretend playing* that she *is* the character in the moment. The girl participates in the moment through her action, which
demonstrates she is attentive, and interested and motivated to ‘act’ the action out through her own body, thus evoking the character from the illustrated picture book. In this way, she is initiating the metaphorical action that is depicted in the book, but which has not yet been ‘explained’ by the researcher in detail, for example, what the purpose of the gloves or the hands are.

**Episode 2. Andy re-enacts body-based metaphor representation with metaphorical verbal interpretation**

This episode demonstrates how Andy, 4 years, participates in the dialogue about the meaning of the visualisations of the sound objects by dynamically enacting their size difference by changing the width in between his hands. By enacting the illustrated visualisation of the sound with his hands he alludes to “different sizes” of the visualisations verbally, Andy evokes a metaphorical causal connection between the idea that changing one’s hands’ width apart changes visualisations of the sound (Figure 5-6).

*Andy:* “Let me have a little think.” (Touching his right temple with his right index finger.).“Maybe they’re different sizes.” (Enacting changing visualisations with his hands dynamically.)

**Figure 5-13** Andy “let me have a little think” (Image 1) and then re-enacts the picture book’s action and reflects with his speech on the metaphorical action and its function (Images 2-4).

Andy’s enactment conveys appropriation of a *functional dimension* of the metaphorical action. By changing the width between his hands, he makes...
meaning about a connection between the sound visualisation object’s shape, and his hands’ width apart. In this way, he identifies another quality of the metaphorical ‘action affordance’, and this demonstrates how the metaphorical layer in the abstract and imaginary realm is accessible. It is a kind of a deeper meaning that Andy has explored, a connectedness between an imaginary object changing shape when hands are moved in specific ways, the affectivity is a kind of a deeper intimate meaning connected to the abstract idea. The affective quality is in the way that Andy is intentionally making connection between the action and its meaning as he participates in the dialogue, expressing it to the researcher and sharing his interpretation through his re-enactment.

Episode 3. Klara expresses willingness to re-enact a sensorial augmentation of the body-based metaphor

This episode demonstrates how Klara participates in the dialogue and interaction about exploring a connection between changing sound and enacting on the physical slinky toy by changing its width – a metaphorical quality that is explored in the picture book. The researcher is voicing a changing pitch of a sound to demonstrate the idea. Klara responds affectively through voicing her enjoyment (“I like that”) and continues engagement with the researcher and her action through opening her mouth that conveys intentionality to participate in enaction through voice, without any voice coming out.

Researcher: (Making a low pitch to high pitch sound while holding the slinky and changing its width).
Klara: “I like that.” (Turning towards Andy and touching his arm gently).
Klara: (Opens mouth and gazes at researcher intently when researcher widens the slinky and continues making a lower sound pitch.)
Figure 5-14. Klara “I like it” (Image 1) and conveys willingness to participate in connecting the sound with the action (Images 2 and 3).

Voicing out is part of “narrative practices” (Gallagher, 2020), however, here, it is evident that while Klara has the willingness to participate, she either cannot or chooses not to make sounds in the situation. Regardless, her intention that is present through her depicting positive affect through touching her friend’s hand and saying how she likes it, and then opening her mouth open wide to mimic the sound even without making any sound herself. She is conveying her willingness to participate, and intention to participate through re-enacting the sound dimension of the augmented metaphorical action. In this way, she is responding to the prompt of connecting the action with a changing sound, finding this connection enjoyable and “worthy of participating” and attention.

Episode 4. Klara leads collaborative re-enactment of metaphorical action with slinky

This episode presents Klara’s re-enactment of the metaphorical action whilst changing the width of the slinky collaboratively with others, whilst also with her gaze attending to the changing sound produced by the researcher and opening her mouth again as if to re-enact also the voice part (although no voice came out). This episode demonstrates Klara’s re-enactment on the sensory connectedness of the metaphorical action in relation to its relevance in changing the size of the object that is represented in the picture book and demonstrates willingness to connect the sound to the object through attending to the researcher’s voice and testing different lengths of the slinky.
Klara holds the slinky in her hands, and gives the other end to her friend, and the nursery staff participates in holding the other end of the slinky. Researcher vocalises an increasingly low sound as the slinky becomes wider and wider. Gazing at the researcher with her mouth wide open, Klara holds the other end of the slinky up in the air, moving it further away bit by bit thus making it longer.

Figure 5-15 Klara explores changing the width of the slinky whilst gazing at the researcher.

In the episode, Klara leads the exploration of the slinky’s width, taking it to an extreme with the help from others, as well as extending the slinky even a bit longer with the arm that is holding the other end of the slinky up in the air. It demonstrates the capacity of lo-fi objects affording exploration of play, so not only the metaphorical action per se (as in Antle, 2008). While in embodied sketching there is usually exploration of different actions, this finding contributes to embodied sketching by showing how the children can explore
and communicate narrative practices that convey ideas around exploratory play with the metaphorical action, and the sensorial connectedness between the action and the sound.

The above narrative practices episodes convey that children’s enactment is not only showing the pragmatic aspect of the action, the ‘how’ an action may be done through the body, such as through a ‘re-enactment’ and thus noting accessibility, but also nuances of affective aspects of enaction within a social encounter. These affective aspects, which cannot be separated from the pragmatic context (Gallagher, 2020, p. 104) of the picture book reading convey aspects of enactment that give rise to how the child experiences the action metaphor and the meaning that they are gathering from the experience. In this way, it extends the notion of action as an ‘action affordance’ within a “landscape of action” (Gallagher, 2020, p. 11) within the context of young children’s embodied participation and body-based metaphors by attending to what ‘enactable qualities’ they are recreating in their expression.

### 5.3.2 Young children enact on digital whole-body metaphors

This theme presents different forms that children jointly enacted on the body metaphors displayed on a display in front of the children. Four different forms of enaction were identified with “body metaphors”: (1) Young children’s synchronised body movements with whole-body metaphors, (2) Thematic improvisatory play with “body metaphors”, (3) Enacting on the whole-body metaphor, and (4) Re-enacting previous metaphorical action. These interaction patterns speak to forms of “joint action” (Gallagher, 2020, p. 113), that open up a way to analyse the social dimensions of group interaction in the context of interacting with whole-body metaphors and a digital environment.

**Interaction Episode 1: Young children’s synchronised body movements with whole-body metaphors**

This episode presents group of young children’s synchronised movement pattern which they spontaneously engage in upon encountering the “body metaphors” on the display during the initial part of the interaction. The purpose of this episode is to demonstrate how the children share a positive affective
experience that is reminiscent of a dance by moving side by side from side to side. In this way, it speaks to a form of “joint action” (Gallagher, 2020, p. 113), where there is a co-regulation and coupling of a movement pattern that also demonstrates not only relational qualities of the group with each other, but also with the “body metaphors” displayed in front of the children.

Klara (4) laughs out loud and grabs Justin’s upper arm with her left hand. Whilst holding his upper arm with her hand Klara continues swaying motion from side to side, widely smiling, gazing at the display. She is smiling and they all begin to swing on their chairs. Researcher asks: “What happens when you move?” And Eva responds: “They move!” Eva sways from side to side, then gazes at her friends smiling and then laughing. They all look at the screen and smile. Justin shrugs shoulders excitedly and Klara bursts into laughter swinging her body from side to side still holding Justin’s arm then letting go and resting it on his leg. Eva begins to laugh and move from side to side.

Figure 5-16 Group of young children interact with the “body metaphors” displayed on the display in front of them for the first time. By moving synchronously from side to side, whilst gazing at the screen, smiling. Klara is grabbing Justin’ hand.
While here we aren’t talking about the ‘process of alignment’ – because there aren’t two entities but one and a technology, there is regardless a process whereby the other is not ‘fully known’ and it reminds of an encounter with another, through exploratory movements through the body, as a movement that reflects on one’s own movement and onto the other’s movement. When the child says “They move” she is making sense of the experience as if the characters are another and it takes a while before agency is figured out later through more intentional motions that seek to assert functionality and agency. Attunement has to do with unconscious coordination or alignment of “movements, gestures and speech acts” (Gallagher, 2020, p. 103). There is something inherently engaging with a mirror, and there is a similar thing at play here, yet there is a human figure that is being painted onto the screen at the same time.

Understanding the meaning of such interaction is, in Gallagher’s view, both pragmatic and affective (Gallagher, 2020, p. 104), whereby they create intentionality to engage with each other and participating in actions together. The purpose of this example is to demonstrate how the notion of ‘attunement’ of one’s own action with the environment is part of an exploratory exploration with a new material environment -a movement-based technology platform that affords double layered imagery of the interactants, and an added layer of a body representation visualisation. In this way, it speaks to Gallagher’s notion of ‘attunement’ within the theory of enactivism, as well as attunement within the use of a human figure to elicit sustained interaction and movement exploration with a tool, especially in relation to the body-based metaphor that has been explored in the above sections – the hands opening horizontally. Attunement is not as much about synchronising movements, as it is about being attuned, and letting oneself be influenced by other person’s action as it lends itself to, in the case of these children’s, (action-themed) play.

The second example speaks to the notion of young children’s attunement from an enactive cognition perspective. The notion of ‘attunement’ is described as “mutual alignment” of the dynamic interactions of participants’ movement (Gallagher, 2020, p. 103; Trevarthen, 1998; Trevarthen, 2005). It has been
described as one of the earliest sensorimotor interactive processes that occur between a mother and their child that has been described as affecting the relationship and child’s development. Here, an action that the child is doing with the technology is reminiscent of such a process of ‘attunement’ through motion. Here, it relates to finding the function and agency over the workings of the technology. The affective angle or dimension comes from the process of looking at oneself in the mirror and moving, thus showing interest and willingness to engage with another – a similar process to when a mother and their child synchronise their movements to attune to each other.

Interaction Episode 2. Thematic improvisatory play with “body metaphors”

In the third illustrative example, the children in a group re-create, through enaction, versions of an emergent action with the digital dots present on the screen. The function of this example is to demonstrate how children’s body action, with the digital body representation and each other, gives rise to a series of new symbolic meanings to the digital body representation, that emerge during embodied participation in free exploration and enactive play. It demonstrates action as it emerges and evolves around experiencing an artefact, and how it sustains engagement where children are making meaning about their experience through re-creating action improvisations around the symbolic value they have given to the objects. In this way, it speaks to the theoretical notion of an enactive account of play (Di Paolo et al., 2014), where meanings of the body representation, and the enactions with/on it, gain novel meanings through play as they are enacted upon by different children.

The group of children begin by participating in sense-making about the turquoise dots appearing on the screen as part of the stickman visualisation. In the group’s ongoing playful exploration, the dots gain different symbolic meanings starting with Lisa’s exploration of the dots she has seen on the screen. In Lisa’s participation, her enaction with the dots conveys her experiencing them as objects she would like to reach on her “real” human body face by reaching out to them with her hands (Figure 5-17), but which are not ‘reachable’. Nor are the dots ‘catchable’ for Lisa, although during her enactive play she attempts to catch them with a series of grabbing motions with her
hands in front of her eyes, and reaching outwards from her body towards the screen.

Lisa: “Shall reach the dots.” (Touching her right eye with her right index finger, constantly moving the finger back and forth across the eye whilst gazing at the screen). “Can’t reach the dots. Can’t reach the dots! (Opening her arms open wide in the air above her head, then bringing them back down again.) “I can’t catch the dots!” (Bringing both of her hands above her face, hiding her eyes behind her fists, which she is holding tight in fists. Lisa then tries to reach out towards the screen to grab the dots).

Figure 5-17 Lisa is trying to “reach the dots” of the turquoise stickman representation on the screen by touching her own eyes.

In an ensuing action chain, where the first action type influences the subsequent enactive interaction by other participants, Andy continued from Lisa’s invention of the dots as symbols that are grabbable by enactive actions that were an attempt to catch the dots off the sleeves of his arms. In this way, Andy continues Lisa’s adoption of the symbolic meaning of the dots. In his
play, he imagines he can get a dot with his hands, thus extending the imaginary play objects enactable qualities and adding to the imagination.

Andy: Got one! Haa!" (Reaching outwards towards the screen, doing a grabbing motion, then bringin his fist onto his chest whilst doing a little jump. Lisa continues exploring ways to catch the dots with her hands next to Andy.)

Figure 5-18 Lisa pretends to be able to grab the dots (image on the right). Andy becomes interested in touching the dots on his body, trying to grab them.

Lisa gets closer to the screen continuing grabbing motions in the air. She then brings her face closer to the screen and pretends to lick the dots off the screen, making other participants laugh. Similarly, Ollie comes from behind Andy closer to the screen. Ollie reaches his arm out and picks the dot up in the air, then throwing it in his mouth (Figure 5-20).
Lisa: (Licks the dots off the screen. Turns towards the nursery staff standing at the back.

Everyone: (Laughter)

Ollie: (Grabbing some dots in the air close to the screen with his hands). “Uhm!” (Throws the dots he has grabbed into his mouth).

Figure 5-19. Lisa pretends to lick the dots off the screen.
This episode demonstrates how children are, through action, collaborating in examining the reality and the function of the technology through play. This is common practice for young children. Here, the children are exploring the possibilities for enaction – they are enacting on the enactive potentialities of the environment in a pretend way to understand what they can do and what they cannot do, as to explore their corporeal powers in the environment (Husserl in Sheets-Johnstone, 2013, p. 49). When considering body representation as a metaphor, the children are referring to their own bodies when they are interacting with the dots, and they are aware of the other children’s exploration as it becomes their own in the improvised actions that they are doing during play, their personal playful enactions to understand how the system works. Here, in the exploration of the functionality of the technological system, the “kinaesthetic pleasure turns into make-believe” (Di Paolo et al., 2014, p. 76). The children are through social exploration of a real situation through pretend play, and the improvisations around these playful actions each follow similar pretend play context. From an engagement perspective, there is a “meaningful action chain” (Gallagher, 2020, p. 112)
where children are exploring and playing at the same time, simultaneously joining in an action when they are attending to the body representations moving in front of them. Through play, the children are practicing social coordination marked by “experientially guided bodily action” (Di Paolo, 2014, p. 78).

As Gallagher (2020, p. 104) writes, “[T]hese processes result in the creation of meaning that goes beyond what each individual can bring to the process.” How the metaphor becomes or doesn’t become focal to interaction and the children’s own action practice. In this process, they are reflecting on their own, or each other’s action, which is revealed through attending to another’s, or one’s own actions for example through gaze or body posture, enacting permutations of each other’s actions or moving from play to reflective attention.

*Episode 3. Enacting on the whole-body metaphor and the notion of ‘following’*

In the second episode the children became interested in the theme of ‘following’. This was a new way of trying out actions with the purpose of understanding whether they would follow or not. In the first example, Andy is examining ‘following’ with a very slow movement of his finger, while Lisa is jumping up and down asking: “Why can it not see my pants?” Ollie (turns around in front of the screen on the dot) (Figure 5-21).
Figure 5-21. Ollie turns around on the spot quickly to gaze the display again to see if the body metaphors have followed him.
Andy tests the “following” function of the body metaphors by running towards the back of the room and climbing behind a chair to “hide” from the system.

Andy: “Oh, yes!” (Moving behind the chair).

Figure 5-22. Andy moves behind the chair.

Lisa engages in a dialogue about the notion of “following” with the body metaphor, almost as if the body metaphor was an “another”, such as a playmate. She questions the body metaphor following her movements, and engages in a playful question “game” where she is jumping whilst gazing at the display. Meanwhile, Andy has positioned himself behind the chair, and is peeking at the display through a small hole that’s on the back of the chair.
Lisa: “Hey! Why you following me?” (She is moving her finger in an accusatory way towards the screen, jumping).
Lisa: “Hey! Why you following me?” (Turns around.)
Researcher: “Hey, stop following.” (Laughter).
Lisa: “Hey! Why you following me?” (Turns around.) (Andy looks at the display through the whole at the back of the chair).
Everyone: (Laughter).

Figure 5-23. Lisa is asking the body metaphor “Hey, why are you following me?”. Andy (R) is hiding behind the chair, peeking at the display through a hole at the back.


5.4 Discussion

Three theoretical proposals emerge from this exploratory study. Each proposal focuses on the quality of young children's mirroring actions with body-based metaphors.

*Theoretical proposal #1: Mirroring body metaphors foster a form of “embodiment effect”*
The first theoretical proposal suggests that young children’s enactive ‘action responses’ upon encountering body metaphors can be conceptualised as forms of ‘embodiment effect’ (e.g., Barsalou, 2003). Furthermore, this study argues, that these effects are shaped by their ‘social situatedness’ (e.g., van Dijk, 2018) bringing qualitative variety to children’s adoption and configuration of mirroring actions during moments of interaction.

Theoretical proposal #2: Interaction with body metaphors as ‘belonging’

The second theoretical proposal points to children’s interaction with body metaphors being conceptualised as different forms of ‘enactive belonging’. In this way, it expands on the notion of ‘belonging’ as a form of ‘affective engagement’ (e.g., Bond and Bedenlier, 2019, p. 12), which traditionally has been conceptualised as relating to children’s positive affect experienced in their learning environment. By framing children’s actions from an enactive cognition (Gallagher, 2020) perspective, each action constitutes of motoric, emotional, and hedonic qualities. In this way, the study suggests that children’s participation through enactive practices as a form of “affective engagement”.

Theoretical proposal #3: Enaction with body metaphors supports bodily group improvisation

The third proposal this study relates to action-upon-action chains, which children seemed to have engaged in especially when iterating each others’ actions during play with the digital body metaphors. This ongoing iterative enactive process with peers suggested that there is a particular type of “flow” to the interaction (e.g., Csikszentmihalyi and Csikszentmihalyi, 1990) that foregrounds forms of pretend play. ‘Encountering’ this particular type of artefact (e.g. Ackermann, 2004) utilising body metaphors seem to foster engagement that has qualities of playing with “another”, such as a play-mate. In addition, the quality of improvised movement and thematic actions suggest quality of dance, or perhaps improvising on a theme such as musicians in a jazz band. Further research is needed to understand more about the thematic quality of engagement with body metaphors, and this “positive intersubjectivity” it seems to afford through a particular form of movement-
pretend play. Given that “joint improvised action” (e.g., Noy et al., 2011) has not been studied in young children due to lack of experimental paradigms, body metaphors may be an avenue to access such notions.

*Theoretical proposal #4: Dimensions of affective engagement in action can be accessed via body representations in design*

The fourth proposal this study makes is that it is that an iterative design process, and method utilising body metaphor representations can give access to notions of affective engagement with young children’s interaction. With lo-fi prototypes, such as picture books or movement-based interactives utilising a visualisation of a human body, it is possible to access enactive processes, such as re-enactment or joint action. In terms of designing with body metaphors, such early stage of investigating movement and action can give researchers and designers access to dimensions of affect in action before implementing or applying them into a digital design. In this way, it extends the existing approaches to embodied design (e.g., Antle et al., 2008; Márquez Segura et al., 2016). For example, the embodied quality of “being it” (e.g., Lindgren et al., 2016), such as becoming a meteor during interaction, which has been described as an important experiential dimension when children interactive with enactive metaphors, can be studied already with a picture book. In this way, it is possible to access children’s meaning making with and about body metaphors, including the contextual and relational qualities of action when building for whole body interaction settings. Given the importance of understanding young children’s group interaction from an embodied cognition perspective (Madureira Ferreira, 2021), this may be a fruitful approach in approaching group meaning making and interaction. It also indicates the ‘translatability’ of an enactive metaphor into a digital domain. This may be an important aspect given implications in terms of supporting simulating enactive practices with metaphors, and in terms of affective engagement given the relational quality and the enactive expression of this serving as a gateway to a kind of ‘belonging’.
5.5 Limitations to this study

This study also demonstrated the limits of the activities foregrounding the body. Namely, the children during the picture book reading were sitting down. Furthermore, the picture book pages only depicted one illustrated character doing an action. This may have shaped interaction differently during the picture book reading if there were more characters present. This may have hindered children’s exploration of whole-body interactions and using their bodies more fully. Questions from researcher could’ve also prompted more through the use of action words, potentially. One child, who has two years old, was held by the nursery staff during the picture book reading and did not participate through their body apart from playing with the slinky and during open-ended play with the motion-based digital platform, where their participation was more vivacious, sustained and exploratory through the body.

5.6 Conclusion

This study developed a novel method to access affective dimension of movement-based interaction with enactive metaphors. It demonstrated that body metaphors simulate enaction and meaning making about enactive metaphors, making a case for building them into digital multisensory designs. The study also proposes a two-way embodiment effect with digital metaphors, which may be socially interesting. Furthermore, it poses questions about designing with enactive metaphors, which are revisited during iterations of the enactive metaphors in the digital domain in the subsequent empirical chapters in this thesis. It also poses that it is important to understand more about this “mirroring” activity or its quality, especially around the two different types of mirroring, or embodiment effects. Young children’s interaction with body metaphors during the digital interaction revealed a continuous embodiment effect that was social in nature. The method revealed ‘affect’ as children’s narrative practices they utilised when they were engaged with picture book prompts for enacting with enactive metaphors. Furthermore, it also revealed forms of joint action during the movement-based interaction platform. Another dimension of ‘affect’ was the form of ‘embodiment effect’ that arose from children encountering a moving body-metaphor. The findings from this
exploratory study suggest a need for more research into the ‘relational’ dimensions of interaction with body-based metaphors, especially in supporting young children’s engagement, meaning making, and positive social interaction with body-movement.
Chapter 6    Young children build relationality with body metaphors

6.1 Introduction

This study builds on Exploratory Study (Chapter 5) by examining notions of relationality and joint action. The aspect of 'relationality' of objects (e.g., Gallagher, 2020, p. 10) is important especially given the rise of body-based interfaces that utilise movement and whole-body representations (e.g., England, 2011). While in developmental studies children's exploration with objects has been explored through play (e.g., Hutt, 1981), an enactive approach can demonstrate how children effectively 'build relationships' with objects. Environments utilising human or avatar figures have been shown to afford interactive processes that foreground relationality in the sense that they afford a sense of embodiment through reflecting on the virtual body in front of oneself (e.g., Inoue and Kitazaki, 2021). For example, augmented reality environments with mirroring technologies have been described as eliciting “a sense of virtual body ownership” (e.g., Lugrin et al., 2016) which may support, for example, patients with self-image disorders (Lugrin et al., 2016, p. 309). In a VR environment Freeman et al. (2020) describe the “intimate connection between one’s physical body and one’s avatar” (Freeman et al., 2020, p. 5). These studies categorically build on long-standing empirical research in human development and psychology around children's engagement with mirror displays on self-referentiality and self-recognition (e.g., Brandl, 2018). In addition, relationship building between mother and child is noted in the developmental process of ‘attunement’ (e.g., Schaefer et al., 2008), and used as an important movement psychotherapeutic intervention through ‘mirror games’ (e.g., Feniger-Schaal et al., 2021). Against this background this study investigates the process of enacting relationality with “body metaphors”. While some developmental theorists have described mirror tasks only as ‘sensorimotor capacity to match visual and kinaesthetic stimuli’ (e.g., Brandl, 2018, p. 279), less has been written about relationship building and affective engagement with the digital other.
Two research questions guide this study to explore children’s enactive strategies for attuning with body metaphors.

3. How does enactment enable children to build a relationship with body metaphor?
4. What does this tell us about affective engagement?

6.2 Methodology

6.2.1 Research Design

This is a workshop-based study to explore how young children negotiate meanings with cultural artefacts to support building with and for movement-based interaction and enactive metaphors in a group setting.

6.2.2 Participants

Participants’ parents were approached via the school staff prior to the researcher’s visit and recruited on a voluntary basis. Participants’ parents were given an information sheet and a consent form (see Appendix), and the researcher talked through the process with the support from an age-appropriate information sheet (see Appendix) to gain their assent to take part. Twelve children within the target age range of the research (2-7 years) participated in the study across four groups, consisting of twelve individual children (M=5.5 years, SD=0.52). A single group consisted of three children. An older age group was employed in this study to identify any differences or new discoveries in whole body interaction in groups of children. All participants were informed that they could withdraw at any time. Names in this study are pseudonymised for maintaining privacy.

6.2.3 Materials

Two material prompts were provided to invite children’s participation in enacting their ideas:

(1) a purposely designed picture book with visualisations of sound representations and body-based metaphors in a fictional narrative (Chapter 5)

(2) the movement-based digital interaction platform.
For this study the digital motion-based multisensory interface was modified (Figure 6-1) to include sounds and visualisations against a black background. These iterations were based on findings from the Exploratory study which suggested that children were very engaged with their own face and facial expressions, sometimes to the point of frustration. Furthermore, evidence from the embodied participation with the picture book demonstrated that a 'linking' between metaphorical action and the idea of arms having magical gloves that could change sound seemed engaging for the children. This posed questions about a possible discovery and engagement process with a virtual tool to change sound through multisensory iterations, and this supported evidence for building something new with this tool where manipulation of objects is present.

The interface had three modes:

(1) the children could see the interface with a human figure,
(2) they could hear a sound,
(3) they could see themselves behind the stickman figure.
Figure 6-1 Upper row: Illustrations showing the mapping of a human body position on the left, ‘arms wide’, and on the right, ‘arms narrow’. Row below: Illustrations demonstrating mapping of a human body position and resulting visual feedback developed as part of this study including a green whole-body representation and a red wavy ‘object’ that changes shape according to hands’ movement (see Chapter 4 for detailed description about the relationship between hands’ movement and the red line object’ in the context of an enactive metaphor).
Figure X. Illustrated image depicting two of the iterations (a and b) children interacted with, and which were analysed as part of this study. In image a, the illustrations of the movement-based interaction platform screen depict two-part sensorial feedback produced when the system is interacted by three interactants simultaneously: (1) three adjacent visual body representations (in green) and a wavy line (red). Both types of sensorial feedback change in correspondence with interactants' body movements dynamically in real-time (see 5.2.3 for more details). Image b depicts an added sensorial feedback of an audible sine tone which is mapped onto the movement between two hands of each interactant. In the image, each interactant holds a similar position, and their sine tone corresponds to the width between their hands.

Collectively, the purpose of these materials is to understand young children’s participation with whole body representations with iterations of augmented sensorial qualities that are introduced in steps during the interaction. These iterations draw from data analysis in the Exploratory study, and further help understand how multisensory technologies and enactive metaphors support affective engagement.

6.2.4 Procedure

Each group of children participated separately in their own interaction session with the picture book, and the three movement-based platform sensorial iterations. The focus of this study are the first two movement-based sensorial iterations. The procedure with the picture book followed the same protocol as described in Exploratory study (link to Exploratory Study Procedure with
The parents and the school staff were informed that the researcher was interested in how these objects supported interaction with science-themed objects. During the interaction, the researcher’s primary role was to provide support and to answer any questions directed to her. Children interacted with the objects for approximately forty minutes, typically the researcher brought the interaction to a close when they sensed the group’s engagement had dropped. Four interaction sessions were recorded using two static video cameras, positioned to record all participants taking part in the interaction. In addition, field notes were taken by the researcher both during and after the session.

6.2.5 Analytical Process

In the previous chapter, Chapter 5, children’s interaction with body metaphors suggested forms of relational ‘attunement’ with body metaphors. In this study, the process of attunement with body metaphors was studied in a more detailed way especially from the perspective of ‘building relationality’ enactively. Furthermore, this study also focused on understanding how this process of building relationality shaped children’s subsequent ‘joint action’ with the body metaphors. As noted in Chapter 5, the interactive processes of assigning a “self” or “another” to the body metaphor or discovering the connection between one’s own movement and that of the body metaphor during enaction, were foregrounded in young children’s interaction. Discovering one’s own agency has been described in literature on interaction with mirroring bodies as “sense of embodiment” (e.g., Inoue and Kitazaki, 2021, p. 1004). In this study, a microinteractional analytical approach was adopted to study the process of assigning a “self” or the “other” to the body metaphor from an enactive perspective.

In this analysis, episodes of children enacting forms of self-referentiality, and joint action (see Chapter 5) were coded. The coding system was focused on themes around body movements and verbal accounts of children assigning self-referentiality to the digital body metaphor during their exploration of the functions of the body metaphors. What is meant by relationality in the context of this study is a quality of interaction with body metaphors that involves
dimensions of self-referentiality, i.e., child assigning a “self” to the digital other. The “self” could be, for example, that the child describes verbally the ‘digital other’ as “me” or “I” (as in Chapter 5), or they could assign it the role of “another” such as “it” or “them”, or they could assign an imaginary “role” to it, such as a “monster”, and “alien”, or a “baby”. These types of verbal cues conveyed a dimension of relationality that had to do with different ideas about “the self”, and the children built relationality with the body metaphors through their whole-body movements. Another dimension of building relationality with the body metaphor was how these processes shaped subsequent joint action with the system, i.e., other children would join in, as a cue from the child as almost an ‘enactive self-referentiality cue’ that invited others participate.

In the first round of analysis all of the videos were viewed through twice, making notes about moments of interaction where children were enacting self-referentiality with the body metaphor, which could, or could not, be accompanied by children’s verbal assertions relating to “self” or “another”.

During the second round of analysis, only clips where children were assigning “self” or “another” to the body metaphors was analysed with more detail. The theoretical lense of “relationality of affordances” (Gallagher, 2020, p. 10) was adopted during this analytical stage.

In the third round of analysis the focus was on how the process of enacting self-referentiality shaped children’s participation and joint action. The theoretical frame of “joint action” was adopted and read whilst analysing these parts of the video clips.

6.3 Findings

Using three illustrative examples, these findings convey, from an enactive cognition perspective, how digital body metaphors afford specific forms of ‘relationality’ and ‘joint action’ during young children’s interaction. In this way, they build upon two core theoretical notions discussed in Chapter 5. The purpose of these examples is to demonstrate different forms in which this system, the mirroring ‘body metaphors’, afford specific forms of relationality and joint action in young children’s interaction that expose new dimensions of
relationality and joint action and their interconnectedness during the flow of interaction. The purpose of these episodes is two-fold: (1) to demonstrate a relational quality in children’s interaction with the digital metaphors especially their experiences of their own self in relation to the metaphors, and (2) the purpose is also to demonstrate the effect that the sense of self with the system, which is here discussed as sense of agency or embodiment, and the confirmation about that through movement for the others, has in supporting subsequent joint action in relation to the body metaphors. In this way, these findings speak to forms of relationality of affordances (Gallagher, 2020, p. 10) in a two-directional way: they demonstrate the children identifying with the digital other as part of self foregrounds a kind of “I-can” agency (Husserl, 1980), and this discovery has the power to foster forms of “joint action” (Gallagher, 2020, p. 112).

6.3.1 Illustrative example 1. Young children identify mirroring body metaphors as “selves” fostering joint action and shared affect

This illustrative example draws from an interaction between three classmates, Aziya (6 yrs.), Ramiya (6 yrs.) and Pyari (6 yrs.), and the researcher. The purpose of this example is to demonstrate an enactive process that reveals children building a form of ‘relational closeness’ whilst enacting on the body metaphor. The analysis focuses on the interaction between Aziya and Ramiya to convey dimensions of this process, which is split into three chronological episodes. The first episode demonstrates Aziya and Ramiya simultaneously building relationality through exploring the function of the body metaphors using different enactive strategies. The second episode demonstrates Aziya’s relationality with the body metaphor is further shaped through her exploring new whole body interaction strategies. In the third episode Aziya affirms she is experiencing the digital other as “other self” through using “me” while speaking about it. In this way, she gains an “sense of embodiment” (Inoue and Kitazaki, 2021, p. 1004) with the digital metaphor which she reveals publicly through her words. In doing so, Ramiya also joins Aziya in joint whole-body interaction with the body metaphors. In this way, this example speaks to forms of “relationality” and “joint action” (Gallagher, 2020, p. 112), identified as central themes for interaction with body metaphors in Chapter 5.
Interaction episode 1. Aziya and Ramiya enact with digital metaphors to produce relationality with them

Upon launching the system, the three participants are standing in front of the display, and the researcher asks the participants what they can see on it. Smiling whilst gazing the display attentively, Aziya engages in a ‘walking motion’, moving first away from the display towards the back of the room and then returning back again, repeating the action multiple times. Simultaneously, Ramiya remains close to the display, gazing it and standing in front of it without moving she makes a verbal interpretation about her experience. In this way, Aziya, and Ramiya simultaneously ‘build relationality’ through exploring the function of the body metaphors using different enactive strategies.

Participants stand in front of the display next to each other, gazing at it attentively.
Researcher: “What can you see, first of all?”
Aziya starting in front of the screen, begins to take small steps backwards towards the back of the room whilst gazing at the display increasing the distance between herself and the display. She then walks back towards the display again. She repeats this motion several times.
Ramiya: “Magic… magic mirrors?” (Standing close to the front the screen, turning her upper body inquisitively towards the researcher briefly, and then back towards the screen again.)

Figure 6-2 Aziya repeats a moving back and forth movement with the display. Ramiya stands still in front of the mirror.
Aziya’s repetitive motion conveys an enactive process where she is exploring the relationship between the body metaphor and her own motion. The walking motion brings a quality of dancing with a partner, who is mirroring or responding to one’s own movements. In this way, Aziya’s enaction suggests that the digital metaphor gains a form of an ‘other’ that invites interaction and enaction that is relational and to some extent, human-like, comparable, perhaps to dance classes with partners, or interaction during mirroring games in body psychotherapy. In this episode, Aziya’s enactive practices with the body metaphor draw out the relational qualities of interaction with body metaphor, that emerge from the fact that the system has a body shape, and the movements remind that of interacting with a human such as engaging in a dance. The repetitive movement conveying positive affect with her experience with the body metaphor and movement suggests a kind of “peculiar affective consciousness of the self” (Zocchi et al., 2018, p. 147) in relationship to body metaphor, that is embedded in discovery of agency over the body metaphor. Gallagher (2020, p. 45), discusses how action intentionality emerges only after connection of one’s agency has been established.

Ramiya’s interaction also has a relational quality, where the relationality is more attuned with assigning a symbolic value to the metaphor. In her interpretation, body metaphors are “magic mirrors”, a well-known children’s play where one is looking at another person, trying to reduce distance from them without making the other person aware of it. In contrast to Aziya’s whole-body exploration through movement, Ramiya’s interaction with the body metaphors is marked by remaining nearly motionless, and not engaging with the system through exploring with body movements. In this way, she is not accessing all enactive potentialities of the whole-body metaphor.

**Interaction episode 2. Aziya asserts her self-referentiality to the body metaphor**

Aziya continues exploring the metaphor through whole body movement, continuing the ‘dance like’ motion of increasing and decreasing distance from the body metaphor. Ramiya turns around facing Aziya and swiftly moves in front of Aziya, pushing her body telling her firmly ‘not to follow it’. At this moment, Aziya jumps from one leg to the other, dynamically moving her upper
body from one side to the other and peeks at the body metaphor from behind Ramiya. She is laughing. While Aziya continues enacting to explore potentialities of interaction with the body metaphor, Ramiya’s idea is that the body metaphors are the ones that are moving, and that they should not be following what they are doing but remain still. In this way, both are continuing to enact from their own relational perspectives they’ve established with the body metaphors.

Ramiya: “Don’t follow it!” (Stopping in front of Aziya, pushing her body trying to cease her from interacting with the body metaphors through movement).

Aziya: “I’m going everywhere!” (Gazing at the screen, from behind Ramiya, moving out from behind her)

In this episode, Aziya continues her exploration laughing and using new whole-body movements as Ramiya tries to stop her from “following” the body metaphors. Here, Ramiya continues treating it as ‘the other’, or in her words, as “it”, and the relational quality doesn’t incorporate engagement with body metaphors through movement. These enactive processes suggest Ramiya’s enactive framework for interacting with the body metaphors remains as the symbolic idea of a “mirror”, which keeps her from engaging with the body metaphors through her own movement. In contrast, Aziya’s engaging further
and more deeply with the body metaphors using new movements. She is assigning the value of her “self” on the digital other, as she describes her experience as she “going everywhere”. In this way, she is building relationality through discovering agency, or a sense of embodiment with the digital other. The increasing of the intensity and enriched whole-body movements suggests that this is an enjoyable experience for Aziya, as her body relaxes, and she seems to be enjoying moving whilst being mirrored by the “digital other”. Hutt (1981, p. 277) describes how a boy who discovered the function of a toy object became increasingly more relaxed as he discovered aspects of the toy, almost relaxing into a “playful motion”. So here it seems that Aziya has moved from exploration stage with the body metaphor to a more relational stage of interaction, and this is paired with her interpretation, or assigning her “other self” value to the body metaphor.

*Interaction episode 3. Aziya and Ramiya’s joint action with body metaphors*

After Aziya discovered an embodied sense with the body metaphor, she begun to dance with energetic jumping motions, swinging her arms in the air, and laughing out loud. She uses her whole body energetically, jumping from side to side, waving her hands, laughing, and enjoying herself. Ramiya has stopped pushing Aziya, and she turns to look at the display. She then begins to smile and similarly to Aziya, begins to jump and dance. In this way, Aziya’s original assigning of agency to the self seems to have increased Ramiya’s interest in the body metaphors to now engage with “it” through her movement. The ensuing moment, where the pair engage in “joint action” is filled with light cheery vocalisations accompanying their jumping motions that remind that of a fun dance. Their shared laughter and energetic dance-like movements incorporate the whole of their bodies whilst gazing at the body metaphors on the display.
Aziya and Ramiya: “Hee, hee!” (Dancing).

Figure 6-4 Both Ramiya and Aziya dancing, laughing, and gazing at the screen.

This illustrative example draws on the whole-body metaphor object’s property as ‘relational’ (Gallagher, 2020, p. 10). It is through the social interactive processes that new meaning comes about with the experience. Not only in the sense that some of the meaning is negotiated ‘relationally’, but also, a body as a metaphor is ‘relational’. It is engaging to see oneself move and gain a sense of agency, but also, just to observe a body moving or even not moving. From an enactivist perspective, this illustrative example between Aziya and Ramiya demonstrates that there are fewer enactive potentialities to explore when agency is not established. With body metaphors being the affordance, the discovery of agency seems to also foster notions around self-referentiality (“me”), or other-referentiality (“it”) during interaction. However, if self-referentiality is not established, this illustrative example suggests that less enactive exploration present. She is, on the other hand, aware that there is a ‘something’, so she is treating it as an ‘it’, or the ‘other’. So, she does not just treat it as a mirror, otherwise she would engage in a movement game.
6.3.2 Illustrative example 2: Alvin and Shinana. Identifying self with body metaphors fosters joint action

This illustrative example presents interaction between three classmates Alvin (6 yrs.), Shinana (6 yrs.) and Sebastian (6 yrs.) first becoming scared of the body metaphors displayed on the display, with Alvin shouting “Aliens!” whilst looking at the screen. Immediately afterwards, all three children run away from the screen. The purpose of this example is to demonstrate another way in which children discovered their agency over the body metaphors, and similarly to the first example, how one person’s discovery of their agency, followed by joyful exploration, led to the interaction with the designed-for enactive metaphor action. In this way, it speaks to the notion of a form of relationality with the object that draws from a process of discovering agency and self referentiality with the digital other. The joy of the discovery becomes a moment of “shared affect” and “joint action” when Shinana joins in Alvin’s enaction on the metaphor whilst gazing at the screen. It also demonstrates how the discovery of self in this example can foreground the metaphorical action, with the sound being played or delayed in this way.

Interaction Episode 1. Children enact disconnection from interaction with body metaphors

Children were moving in front of the display for a while, interacting with the body metaphor, and the researcher turned the sound on. Once the sound iteration was turned on, the group stopped moving in front of the display, looked puzzled with their mouths and eyes wide open, then one by one ran away excitedly and nervously, as if scared.
Everyone: (Shrieking. Running away laughing one by one very fast from the front of the display to right hand side of the display.)

![Diagram of children running away from a display]

**Figure 6-5** Once the sound is introduced, everyone, including Shinana (pictured) run away from the screen laughing.

This moment marked a disconnection from having interacted with the body metaphor continuously prior to the sound being turned on. The sound, a new iteration, marked a new moment in the interaction that disrupted the flow of interaction with the body metaphors by introducing a new element, a sine wave tone. The children, in this way, distanced themselves from connecting with the body metaphors, here acting out as if the experience changed from something playful to something scary or unknown. In this way, while the connection with the body metaphors had been established prior to children running away, a new element, the sound, shifted the interaction which conveyed other dimensions of the relationality: the possibility for disconnection and its creation, which in this case seemed to suggest a form of pretend play, or an imagination about something that they had explored, yet was now unknown. The whole experience, though, appeared playful throughout as the children were laughing when they ran away.
Interaction episode 2. Alvin establishes agency over metaphor

The children begin to make interpretations about their experience with the body metaphors and the sound whilst off screen. Then they begin to carefully emerge back to be in front of the screen, holding their shoulders up towards their ears, grinning and making excited sounds. They are tightly each holding in their hands long cardboard tubes that they found from the side table in the classroom, as “play swords” to defend themselves the monsters, or aliens. Soon others follow.

Alvin (off screen): “There’s a monster. They’re aliens!” (He emerges back very slowly, holding a cardboard tube in his hand). All: Eeeh-eeh-eeh-he-he-hee! (Excited and nervous shrieking mixed with some laughter, low volume).

![Image](image.png)

Figure 6-6 Alvin approaches the screen holding a found cardboard tube object.

In this episode, Alvin makes an interpretation of the body metaphors by giving them roles, signifying a moment of role play or giving the body metaphors a symbol ‘monsters” and “aliens”. He is approaching them from further away, as if approaching a play mate who is such a monster, and his enactive stance conveys excitement and nervousness, and a willingness to re-engage playfully with the body metaphor. In this way, Alvin is creating meaning about his
experience by going back to the display to discover novel aspects of the body metaphor.

Interaction episode 3. Alvin and Shinana’s joint action with enactive metaphor

As Alvin approaches the display, he gets a chance to be in front of it on his own. At this moment, he brings his hands up in the air, and moves them away from each other. The sound changes. He then shouts out loud how he identifies himself in the screen, as he continues to repeat the metaphorical action. It is at this moment that Shinana runs into the space in front of the display and joins Alvin in enacting on the metaphor.

*Alvin:* “Wait, that’s us! That’s me! It’s me, it’s me I’m an alien!” (Holding his arm in a fist and shouting it out).
*Shinana:* “On the computer, they’re doing the same thing as us!” (Gazing at screen engaging in metaphorical action.)

![Figure 6-7 Shihan(R) and Alvin(L) engaging in metaphorical action with the virtual object.](image)

Here, Alvin and Shinana engage in a form of joint action, which was sparked by Alvin’s discovery of his own self in the system – he self-identified the body metaphor as himself, and his agency over it. In this way, Alvin is enacting what phenomenologists call a “sense of mineness” (e.g., Gallagher, 2020, p. 43), or what has also been called, a “sense of embodiment” (e.g., Inoue and Kitazaki,
The feedback the body metaphors afford, and which Alvin has come to note as he has been with the system first on his own, foregrounds for him that the action he is seeing as being mirrored is indeed his. This novel discovery seems to have attained “affective value” (Berlyne, 1960, p. 73) in the sense that it seems to afford a positive affective experience. The positive affective value is reinforced by Shinana, how joins Alvin in re-engaging with the body metaphors. The excited shouting of this discovery, and his enaction, fostered Shinana to join in the action, where she makes the same interpretation. While Hutt states that “the premature appearance of symbolic play” has its dangers as “we should not expect learning necessarily to occur during such activity” (Hutt, 1981, p. 279). However, this view is in contrast with Fleer’s (e.g., 2013) account of using a story framework for action where the action is part of the experience of learning – and in enaction we are acquiring knowledge if we have the ‘right kind of’ experience (e.g., Noë, 2006).

6.3.3 Illustrative example 3. Identifying self in the system fosters joint action

Two episodes in this example draw from group interaction between three classmates Ovais (6 yrs.), Jony (5 yrs.) and Guni (6 yrs.). The purpose of this episode is to demonstrate a different type of process of attunement, that is related to children exploring the functionality and responsiveness of the body metaphor to their own body movement and interaction in the environment. It seemed that these children were less concerned about “how they were” in relation to the body metaphor, or “who/what the body metaphor is”. Rather, their interaction was marked by an interest in the enactive potentialities of the body representation through having fun with movement, and at times, finding the limits through exploring exaggerated and somewhat competitive movements. This play seemed to be framed around “what this object can do”, which in play theory comes after an exploratory play phase and is more concerned with the playful opportunities an object affords. The exploration takes place through movement variability that involves patterns of mimicry of each other’s movement, an increasing complexity of movement patterns explored when clearly identifying oneself moving with the body metaphor and finding limits of movement whilst doing extreme movements such as jumping.
in a performative way (Feniger-Schaal et al., 2018). The purpose of this example is to demonstrate how children, through movement-based exploration of the body metaphor artefact build a relationship and attune with the body metaphor. It speaks to the theoretical notion of ‘relationality’ of objects (Gallagher), and especially “shared affect”. Affective engagement as a kind of “positive performativity attunement” of movement in attuning with the body.

Interaction episode 1. Ovais’ enaction on body metaphor through competitive play

In the first episode, Ovais announces he needs to take space and pushes other boys away from in front of the display. He then bends his knees, whilst standing in front of the display, and jumps as high as he can using all of his body force, lifting his arms up in the air. Other boys are standing to the side of Ovais watching the display as he does his jump. Ovais lands on the ground with a smash, splashing his hands on the ground with open palms.

Ovais: “I’m going to do something!” (Shouting excitedly, pushes the other boys away from the screen, runs to the side then through the middle of the room and in front of the screen jumps high up in the air and smashes himself on the floor.)

Figure 6-8 Ovais jumps in front of the display. Jony (L) and Guni watch on.
Ovais is in this episode creating and taking space to conduct a movement in front of the display that is his own devising. He wants to be in front of the display on his own and wants to try the effect that his movement has on the system. During his jump, he is not looking at the display. This action has an element of performance in it. In contrast to the above two examples, here Ovais has already established his agency over the digital other but wants to explore the limits of the technology’s capacity to repeat or mimic his actions. In this way, he is engaging in exploratory play that engages the whole body, using a very much an “I-can” attitude (Husserl, 1980, pp. 116-112). This example demonstrates the maximum movement that a body can do in terms of height, so Ovais is aware of his whole body affecting the display and the body metaphor. He wishes to “find its limits”, as to its enactive potentialities, through a whole-body movement that none of the group members have tried before. It becomes a performative moment, everyone’s attention is focused on the display, except Ovais’ who is concentrated in executing his jump in front of the display. With great force, he jumps high up on the spot. He is exerting his body to the maximum which is evident in the amount of force he puts into the movement.

*Interaction episode 2. Jony assigns a new “role” for Ovais*

Once Ovais has landed his jump on the ground, Jony points at the screen shouting how Ovais is “a baby” on the display and laughs, leaning towards the screen from further away.

> **Jony**: “You’re a baby” (shouting excitedly, pointing at the screen).
> **Guni** gazing at the screen, standing still, laughing.
> **Ovais** gazes up at the researcher, then quickly runs away from in front of the display to the side ceases from interaction for a while.
The effect of this, for Ovais, was different from the above examples where exploring agency fostered other children joining in. Here, the assigning of a role is made by Jony, who makes an interpretation about what he is seeing on the display. Ovais moves swiftly away from the position, as if slightly defeated by this assertion of him being a “baby”. Perhaps there is something humorous about this example, as it demonstrates that regardless of whether we, in our bodies, may feel this “I can” force, such as described in the above, and which is evident in the forceful and powerful way that Ovais uses his body to jump high up, to then be assigned the “role” of a “baby” demonstrates another quality of interaction with body metaphors, and that the playful movements, and the ways in which the body metaphors respond to these movements, may rather than affirm a relational closeness with the body metaphor, to actually produce momentary relational distancing with the effect of a child momentarily interrupting their participation. It is as if, in this example, Ovais rejects or doesn’t agree with Jony’s assertion, it is in conflict with the action that he has just produced. In this way, it doesn’t align with his idea of the “sense of embodiment” (Inoue and Kitazaki, 2021, p. 1004) in this environment.
6.4 Discussion

This study makes three contributions. First, it extends the enactive notion of ‘relationality of affordances’ (Gallagher, 2020, p. 10) discussing the process of a child identifying themselves in the digital other as another “self” through movement (e.g., Freeman et al., 2020). In this way, this study argues, this process speaks to the process of ‘attunement’ between a parent and a child, the earliest form of mirroring action and positive intersubjectivity (see Chapter 2), as the ongoing action-upon-action has a quality of ‘responding’ to the other. The second contribution is connected to the first: it extends the notion of “joint action” (Gallagher, 2020, p. 106) emerging as a peer response to self-identification. In this way, it merges into a shared “sense of embodiment” (e.g., Inoue and Kitazaki, 2021, p. 1004) with body metaphors, that is marked by shared positive affect. In this discussion, the notion of ‘relationality of affordances’ and ‘joint action’ are discussed separately. At the end of the discussion, the two are brought together. The discussion section concludes with the third contribution, which elaborates on designing with body metaphors.

Extending the enactive notion of ‘relationality of affordances’

There were three key ideas or processes that emerged from the data, and these form key discussion points.

1. Interaction with body metaphors affords experiences for children that are ‘relational’ in nature. In Action and Interaction (2020), Gallagher writes about relationality of affordances, and how it is the interpersonal realm that is an important for different dimensions of the objects to be realised. While Gallagher is elaborating on the meaning that can arise from such interaction, with objects that resemble human bodies can afford another form of ‘relationality’ of affordances. The findings from this study suggest that children enactively “built” relationships with the mirroring body metaphors, thus expanding on findings from Chapter 5. This relationship building was evident in the data in the ways that children assigned different “selves” and “others” verbally, and how they gazed and invited the body metaphors into their movement play almost as if as “playmates”. This foregrounds the “personhood”
of the digital other. By this it is meant that, in the case of mirroring body metaphors, a quality of being with “another” is foregrounded, as well as is interacting with a (novel) object.

2. Developmental psychologist Corinne Hutt (1981) describes how it is during playful exploration that young children can discover novel dimensions of affordances, such as their function. This study argues that the body metaphors are a particular form of ‘object’ that foreground relationality. While the notion of mirroring bodies affording relationship-like experiences of, for example, “intimacy”, or “engagement”, young children’s exploration of such objects is interesting, because it inherently involves a notion of spontaneous ‘pretend play’ and exploring ‘sense of embodiment’ with the body metaphors. In this way, this study argues that for young children, mirroring body metaphors afford particular forms of relationality and interacting with them incorporates a kind of “relationship building” through movement that bear similarities to movement-based expressive movements, such as an experience of a “joyful dialogic companionship” (Trevarthen, 2001, p. 100). Perhaps this is similar to children interacting with, for example, dolls, yet here, the continuous reflective movement-based feedback affords a kind of intimate connection that is heightened by the continuous gaze, and the seeking to continue engaging in a playful motion with the body metaphors as if in a dance. Framing these interactions from the perspective of “relationality” foregrounds a suggestion that there is more to interaction with body metaphors than figuring out the object’s function during play (e.g., Hutt, 1981) and the cause-and-effect relationship between one’s own movement, and the movement of the digital other, and that identity is a core part of interacting with body metaphors. This suggests a kind of intimacy through movement with the digital other, which comes about when there’s a real discovery of the “matching” of the movements between the interactant and the digital other.

3. The various movements that children do – the back-and-forth walking like the child in the first example, followed by dancing, and then the thinking that one is an alien, then oneself, then identifying oneself as an alien through movement – is like a mirroring process, but one where there are also “new”
identities being created all the time through creative ideation with the system and the metaphor. What is foregrounded in children’s interaction is: “who is this” and “what can they do?”. In this way, rather than it being a toy or an object, it becomes almost a play mate. From an enactive cognition perspective, it speaks to children enacting on the relational qualities of the object (Gallagher, 2020, p. 10) as much as they are discovering the function of any toy. These are, in the case of the body metaphors, merged into one, and they shape the ways in which the interaction unfolds. It talks to play and human development from the perspective of children interacting with objects that incorporate human body figures in continuous movement (e.g. Hutt, 1981).

**Extending notion of “joint action” emerging as a peer response to self-identification**

This study extends the enactive cognition notion of “joint action” (Gallagher, 2020) as a response to the situated action that revolves around children identifying themselves in the body metaphor. In this way, it supports a social identity forming as a kind of “we-intentionality” (e.g., Zahavi, 2016, p. 246) to emphasise how framing the presence of the body metaphors as “spectators” may afford a layer of important reciprocity and reflective capacity in the interactive situation. There is something about children discovering agency in all examples, and in examples 1 and 2, that foster other children to join in. Perhaps it is the joyfulness and assertion of discovery, that makes the “sense of embodiment” (e.g., Inoue and Kitazaki, 2021, p. 1004) more publicly available – thus making the body metaphors more actively available and interesting for other children. Perhaps a heightened emotional connectedness, and suddenly seeing and realising the enactive potentialities with the body metaphors that leads to joint action. Sheets-Johnstone (2013) writes about Husserl’s concept “I can” that fosters a positive understanding about one’s own effect on the environment, and the positive feedback that it brings. In this way, the strong affective response becomes a kind of a shared affect – there is intentionality to share the experience of learning the function of the body metaphor, and this in turn motivates other children to join in not only in joint action, but in joint action that suggests a form of “shared positive affect”. They
also demonstrate the potential of the use of whole-body metaphors to support positive social outcomes of interaction, social relating, and the roles between interactants in a situation where whole-body interaction is at its heart. This will be further explored in the context of empathy and joint action in Chapter 7.

**Contribution to Design with Enactive Metaphors**

Data suggests that the metaphorical object was discovered by children, and them enacting on it, suggesting that the ‘translation process’ from Exploratory Study into First Iteration (this Study) supported enaction. The ‘action framing’ supported an ‘action cycle’ with a metaphor. This speaks to the notion of “narrative practices” (Gallagher, 2020, p. 160) and how these could be used to engage and frame interaction and support the identification and accessibility of pre-determined metaphors. On the other hand, there also seemed to be disparity over what was found, and what was thought of or perceived as more enactive worthy. In this case, it was suggested that there was a hierarchy – the whole-body metaphors were more likely to evoke enaction, rather than the hands one. More research is needed in order to establish this. Considering plain body metaphor vs more complex metaphor designs, and how these lend themselves more to symbolic plays, expose different interactive layers over time. While metaphorical object was noticed, and enacted on by most participants in this study, their primary interest was in exploring the moving whole-body metaphor.

### 6.5 Limitations

There were a number of technical and design limitations in this study. The sound being too high frequency because children held their hands most of the time in a position where the frequency would be in the higher end of the continuum. Another aspect was time: if children had more time to explore the stickman on its own before embarking on the virtual tool and the sound this may have supported exploratory (epistemic) behaviour stage. Given that the epistemic/ludic line here is so blurry, and children drift in and out of that experience, it may be useful to look more at how multisensorial experience can be sequenced and altered during interaction – how novel features such as
bringing in sensorial feedback can alter or shape the experience. The moments where in the middle of a complex movement, where a child is on their own and shouts “That’s me!” that could be because they have not been able to see or detect themselves on a small screen in front of them – on the other hand, the other children are able to detect each other, but the experimental setup doesn’t know this because there is no recording of the screen.

6.6 Conclusion

This study demonstrated that children engage in enactive processes with body metaphors that foreground relationality with affordances. The study noted this relationality was linked to the fact that the body metaphors represented bodies, and foregrounded ideas regarding self, otherness, and agency. Furthermore, the opportunity to identify one’s own effect on the body metaphor was a positive experience and discovery for children. This in turn fostered joint action with shared affect. This study opens up new questions about the use and function about virtual bodies with enactive metaphors and embodied learning. The role of self-awareness in agency over virtual bodies. Also, the trajectory of interaction when self-awareness is involved in learning to use an object that foregrounds the “self” may be beneficial, as it may, again speak to forms of embodiment effect.
Chapter 7  In the Presence of Different Bodies

7.1 Introduction

This study extends the notion of ‘relationality’ (Gallagher, 2020, p. 10) in young children’s ‘joint action’ (Gallagher, 2020, p. 113) with body metaphors (Chapter and Chapter 6). Findings from Chapter 5 suggested that young children’s interaction with body metaphors can be conceptualised as a form of ‘attunement’, meaning that children’s enactive processes of focused mirroring movement with body metaphors shared similarities to mirroring movements of another person. Furthermore, Chapter 6 expanded on the notion of ‘relationality’ with findings demonstrating it as a process of building a ‘sense of embodiment’ with body metaphors.

This study builds on the work in Chapters 5 and 6 by studying ‘relationality’ in the context of family interaction. Given the enactive mirroring processes of ‘attunement’ between carers and young children (e.g., Schaefer et al., 2008; Haft and Slade, 1989), which fosters ‘shared attention’ towards an object or event, this study investigated qualities of interaction with body metaphors in family context. The study found that family interaction with body metaphors accentuates reflecting on and attending to each other’s bodies and body movement and fostered forms of ‘kinaesthetic intersubjectivity’ (Samaritter and Payne, 2013). This was evident in the ways that family interactants shared attention towards the body metaphor, synchronised their movements, or attended to the enactive metaphor action. The findings from this study speak to the enactive cognition notions of ‘joint action’ and ‘joint attention’ (Gallagher, 2020), in the sense that shared attention to body metaphors shapes subsequent interaction that foregrounds positive, kinaesthetic intersubjectivity between the participants. The contributions of this study can help children in social bonding through affording another platform for ‘embodied reflection’ on action. It also demonstrates that there is a different bodily stance towards each other during family interaction in comparison to previous studies using peer interaction -intimacy is foregrounded.

Research questions guiding this study:
(1) What enactive processes foster companionship during family interaction with mirroring body metaphors?
(2) What does this tell us about affective engagement?

The study makes three interrelated, yet distinct, contributions:

(1) Builds on the enactive cognition notions of “joint action” and “relationality” within the context of family interaction with mirroring body metaphors.
(2) Extends the developmental concept of ‘companionship’ during family interaction with mirroring body metaphors.
(3) Design contributions from the perspective of reflective attending, being able to see one’s own mirror etc.

7.2 Methodology

7.2.1 Research design

This study took place over two days at a science club in the middle of England. The study was facilitated by a primary school teacher, and the club was targeted at home-schooled primary school aged children, who attended the club with their parent. The children took part experiential workshops throughout the day, in a room with enough floor room to move around in front of the technological system. The room was adjacent to the main classroom, where the children were participating in a science lesson conducted by the primary school teacher around the theme of sound. The children partook in different sound-related activities such as sitting in a ring on the floor eyes closed, whilst different people were selected to “knock” on the floor and others are asked to point at the person from where they thought the sound as coming; making phones out of cups; and drawing different types of sound waves.

7.2.2 Participants

Parents of participants were approached by the researcher via their home-schooling science teacher, and twenty-four children aged 2-10 were recruited on a voluntary basis. However, data was analysed from fourteen children (M=4.92, SD=1.39) and eight parents from the groups of dyads involving
children within the research project’s age range (2-7 years). The children participated in the workshops in eight groups; four of these were dyads (a child with a parent), two of them were trios (two children and a parent), two of them had three children interacting (with parents present in the room). All participants were informed they could withdraw at any time. No participants withdrew from this study. Names in this study are pseudonymised to maintain privacy of the children.

7.2.3 Materials

Materials used in this study were:

(1) Movement-based digital interactive (see Chapter 6)
(2) Cards displaying different types of sound wave visualisations

After the study presented in Chapter 6 three changes were made to the interactive prototype:

(1) the sound wave visualisations were changed so that they were drawn on the display with a thinner red line
(2) the stickman figure was drawn with a thinner line than previously
(3) the sound could be added by researcher pressing a button during interaction

These modifications aimed to make it easier for children to perceive the visual feedback about the changes in the sound wave visualisation whilst they were interacting through movement. It was also hypothesised that they would engage with the sound and the metaphorical action more if they could have the visualisation and the sound added separately. This hypothesis was based on findings from Chapter 5, where groups of children had found it challenging to interact sustainably with the enactive metaphor during the digital interaction, and from Chapter 6, which found that children spent time discovering their agency whilst interacting with digital other, and their attention was drawn towards the stickman figure instead of the metaphorical representation and enactive metaphor. The order of introducing the sensorial feedback elements was as follows:
Once children had explored each sensorial feedback element, the second one was introduced to present all sensorial feedback elements simultaneously.

The display used was the same as described in Chapter 6.

7.2.4 Procedure

Each group participated separately in their own interaction session with the digital interactive.

At the beginning of the interaction when the stickman figure and the sound wave visualisation were present on the screen, the children and their parents were invited to explore what they were seeing on the display in front of them. Once they had interacted with this iteration for a while, the researcher told the participants that it can make sound as well. Then the sound was turned on and the participants were invited to freely explore the technology.

Participants interacted with the digital platform for thirteen minutes on average. Typically, the researcher brought the interaction to a close when close to fifteen minutes had been spent in the workshop space at the request of the children’s teachers so they would not miss out on the other activities. All interaction sessions were video recorded using two static cameras, positioned to both face the interactants, as well as gain a view of those who were outside the interaction (usually parents), and record all participants interacting with the interactive.

During the interaction in the experiential workshops, the children were asked to interact with the digital movement-based interactive “Body metaphors” with two sequenced modes: stickman and sound wave visualisation, and then after a while, an iteration of the technology demonstrating sound (so the sound modality was added afterwards, after the children had had the opportunity to interact with the other modality first). The children were also shown different visualisations of sound waves on cards that were purpose-built for the study.
to ask if they could match these – these were presented at the end of the interaction.

7.2.5 Analytical process

This analysis focuses on the moment of interaction with the and the stickman visualisations and the sound, the iteration will be mentioned in the illustrative example.

This study took a phenomenological-microinteractional (e.g. Goodwin, 2018; Nemirovsky et al., 2012; Nygren et al., 2022) approach to studying “joint action” (Gallagher, 2020) during family interaction with mirroring whole body metaphors. Out of a corpus of eight interaction videos, a subset of six videos were selected for further analysis on the basis that they contained episodes of sustained family interaction with the “body metaphors”. Specifically, they included instances of (1) family members interacting with each other and the “body metaphors” in a sustained manner, (2) verbal and bodily family reflective practices on their body positions, movement or action and undertaking further investigation of their movement’s effect on their world, and (3) forms of family “joint action” depicting forms of kinaesthetic empathy. For this study, four videos were selected which illustrate distinct ways in which family members participated in the interaction through bodily action depicting forms of “joint action” with “body metaphors” that indicate companionship processes in action. From each of these four videos, one shorter interaction video ‘clip’ that represented events with these qualities were selected (Derry et al., 2010).

The approach to video analysis followed a method of ‘progressive refinement of hypotheses’ (Engle et al., 2007) where a general theory-driven question about family interaction with “body metaphors” and enactive metaphors was formed prior to data collection, and specific explanatory hypotheses were developed inductively across multiple viewings of the video data.

The iterative qualitative multimodal analysis begun by watching the eight videos twice over and making notes about instances where family interaction was taking place especially through gesture and action – where there seemed to be an “action exchange” around the “body metaphors” between the family...
members. In addition, descriptive notes were made about how families used gestures or body actions to communicate about their interaction with the “body metaphors” and “enactive metaphors”. The author then discussed broad themes emerging from these viewings with colleagues focusing on family interaction and companionship in interaction.

The analysis focused on processes of bi-directional building processes that the data suggested consisted of two steps: attention, followed by action. It emerged within the specific situated context of action of interacting in the presence of mirroring body metaphors, and how these shapes and foregrounds bodily relationality in terms of reciprocity in body movement and reflecting on each other’s body movements and the movements’ effects on the world. This two-way action-reflective process is about how becoming aware of the participants’ movements and their effect on the world turned attention to each other’s movement or bodies. This ‘turning to the other participant’ was here seen as an instance of “joint attention”, which then shifted the action focus and reflection back to the participants. This happened through a shift in the ‘contextual configuration’ (Goodwin, 2018, p. 171) of the ‘social situatedness’ (van Dijk, 2018). In this way, it demonstrates the varied ways in which intersubjectivity can transform and become shaped by participants’ shifting reflection within the social-material context, and shape subsequent interaction, in this way extending Gallagher’s concept of “joint action” (2020). The enactive potentialities (Noë, e.g., 2006), shift from the body metaphors that are visualised in front of the participants, to the “real bodies” present in the situation, and this “shift” or “turn” has a quality of reciprocity, unveiling something new in the situation. The moments that are captured here are those when the participants’ turn to each other reciprocally, meaning that there is a kind of seeking of empathy between the participants resulting from the reflective process. A kind of discovery of “hey, you and your body are here” kind of thing and “I’m making note of it” – like a coming back to a ‘Here and Now’ situation.

Specifically, how processes of “joint action” gave emergence to kinaesthetic intersubjectivity (Samaritter and Payne, 2013) as enactments of different kinds
of participant reciprocity and bodily relationality. Specifically, the participants’ kinaesthetic intersubjectivity was not only directed towards the digital “other bodies”, but simultaneously, they were aware, and thus connecting with the other participants in kinaesthetic intersubjectivity with each other. Their awareness of their own movement, and possibly another’s movement on the display was shared between “the two modes” of action – the “real life flesh-and-bone” action, and the digital bodies action which they could follow on the screen in front of them.

7.3 Findings

These findings illustrate enactive processes of young children and their parents’ “joint action” with body metaphors foregrounding ‘togetherness’. What is meant by the notion of ‘togetherness’ in the context of this study is a process that involves the child’s attention to the physical presence of other participants through attending to the mirroring body metaphors, and enactively responding to the other person’s physical presence that foregrounds ‘reciprocity’ through enaction. By reciprocity it is meant that a relation with the body metaphors, and each other, is mutual (Gallagher, 2020: 188), and that the presence of the body metaphors shapes this “mutuality”. In this way, they speak to forms of “joint action” from an enactivist perspective, where the perception of the body metaphors fosters moments of reciprocal action.

7.3.1 Kinaesthetic empathy: Michael and his mother (30 secs)

This example draws from an interaction between Michael (6 yrs.) and his mother and the body metaphors to demonstrate that interaction with mirroring body metaphors fosters a form of “joint action” during family interaction. Three episodes illustrate this process.

Interaction episode 1. Michael’s mother foregrounds connection between herself, Michael, and the body metaphors

In this episode, Michael’s mother’s verbal assertion foregrounds the connectedness and relationship between the couple’s bodies and the body metaphors (Figure 7-1). After investigating for a while with her own body, she,
and Michael stand in front of the display. Leaning closer to Michael, she asks Michael if it’s “her and him” on the display. By identifying them both in the body metaphors simultaneously, the mother evokes connectedness with the body metaphors that foregrounds a form of ‘togetherness’.

Michael stands in front of the mirror display, gazing at it intently. Mother stands up, moving her arms straight out and wide on her sides. She then leans down closer to Michael, stopping her head by his head.  
Mother: “Is that me and you, Michael?”

Figure 7-1 Michael and mother stand in front of the display, gazing at the body metaphors. Michael’s mother asks if it is “her and him” that Michael can see.

With her question about whether the body metaphors are “her and him”, Michael’s mother foregrounds the connectedness between their physical bodies, and the bodies of the digital mirroring body metaphors. The way she uses “me and you” in her verbal assertion is different from findings presented
in Chapter 5 and 6, where children were questioning the connectedness between the body metaphors and their own movement. Furthermore, by saying “me and you”, the mother foregrounds the mirror-like quality of the body metaphors, which in this episode suggest that there is a closer connectedness with the body metaphors that is mirror-like, rather than the body metaphors being “them”, someone else”, or “another” or even “outside”. When two people are facing each other, the simple act of gazing “is enough to establish genuine togetherness” (Schmid in Zahavi, 2015, p. 409). Here, however, a ‘togetherness’ is evoked not by the interactants gazing at each other, but by them gazing at each other’s mirroring body metaphor. The mirroring presence of the body metaphors, which affords the seeing of two bodies being close together, mimicking the poses and the bodies of the interactants, the mother and her son. There “we” is accessed perceptually on the screen in front of them, and the mother’s assertion of them being “you and me” further emphasises an interpretation.

Interaction episode 2. Michael explores the body metaphor through his movement

In this episode, Michael explores the body metaphors by engaging in repetitive jumping motions whilst gazing at the display, smiling (Figure 7-2). His mother, standing behind him, reiterates that he is “in front”. As Michael jumps to the right, he exposes his mother’s mirroring body metaphor on the display. Jumping back in front of his mother, he hides his mother’s body metaphor. In Michael’s jumping exploration that both hides and exposes the mother’s body metaphor, the ‘connectedness’ between both his and his mother’s physical bodies and the body metaphors is foregrounded.
Mother: “That’s you! You’re in front.”
Michael jumps in front of his mother forming side-by-side jumps.

Figure 7-2 Michael jumps from side to side whilst gazing at the display and smiling, exploring different positions in relation to his mother who stands at the back. In jumping in this way, his mother’s body metaphor is first exposed and then hidden.

Michael’s jumping motions enable him to explore how the body metaphors respond and move, and how they are displaying their physical bodies depending on the movement. While in the real physical space both bodies are present, the body metaphors only display the parts of the body that it can track, thus appearing to “hide” parts of a body just like in a mirror when a person moves in front of another person.

*Episode 3. Michael grabs his mother’s hand*

This episode demonstrates Michael turning towards his mother, grabbing her hand and whilst gazing at the display, positioning himself next to his mother
whilst holding her hand and smiling. In this way, Michael’s enaction with the body metaphor exposes a deeper layer of connectedness that includes physical touch whilst gazing at the body metaphors.

Michael turns back towards mother, grabbing her hand. He then turns around to look at the display saying “Look, look!” They hold hands and gaze at the screen. Michael is smiling.

Figure 7-3. Michael turns back to grab his mother’s hand, and then turns back to gaze at the screen smiling and shouting “Look! Look!” excitedly whilst they hold hands next to each other.

Michael’s action of bringing his arm or hand to his mother’s hand, to hold his hand, answers that they are jointly together, and it is not just incidental, but an act of communication that has significance and meaning – it rearranges the social situation from the perspective of empathy and connectedness, creating a sense of togetherness, which is taken further by Michael when he extends his hand to his mother. It offers “reciprocal awareness” (Schmid in Zahavi,
that brings to the fore the experience between the mother and the child with a mirror like display. It is as if the body metaphors reminded the pair of their shared presence in the “Here and Now”, and Michael acts on this by reinforcing reciprocity through the act of touch and handholding. Michael is perceiving the body metaphor actionable as something that he can use to relate to his mother, physically (Gallagher, 2020, p. 33).

7.3.2 Movement synchrony: Roger and his mother (2 mins 30 secs)

This example draws from an interaction between Roger (5 yrs.), and his mother to demonstrate interaction with the body metaphors fostering synchronised movement with the body metaphors, marked by intimate intersubjectivity in joint action to investigate changes in their experience of the body metaphors as they do so. The purpose of this example is to demonstrate a form of ‘togetherness’ through movement that is marked by reciprocity, evident in the investigative, slow body movement in which the pair move in synchrony as they descend towards the ground. Three interaction episodes convey Roger and his mother’s movement ‘togetherness’ with body metaphors. After an initial episode of investigation using their hands and arms movement, the pair begin to move down towards the ground together (Interaction episode 1). Roger reaches the ground first, lying down on the floor on his stomach, which quiets his sound down but not his mother’s (episode 2). Finally, as they both lie on the ground together, no sound is audible anymore (episode 3). In this way, this example speaks to the notion of ‘intimacy’ in “joint action” with body metaphors, suggesting that specific qualities, such as movement in synchrony, can be shaped by the body metaphors.

Interaction episode 1. Roger and his mother investigate ways to move their bodies to create a ‘really quiet sound’

In this episode, Roger and his mother are exploring how they could quiet the sound using their body movement. The purpose of this episode is to demonstrate that Roger’s mother is inviting Roger to engage in a form of “joint action” where they both move together downwards to investigate change in sound. Roger’s mother leads the investigation by prompting questions. Roger explores some arms movements first, then the mother reminds him that there
is “one other way”. The mother suggests that lowering the body can also quiet the sound. Roger’s mother’s demeanour gets softer, and she gets closer to Roger as she suggests going “down like that”, as she models for him how to go down, whilst gazing at him. In this way, he is contacting Roger standing next to him, although Roger’s attention is towards the body metaphors in this instance. Roger’s mother’s attentiveness to Roger emphasises the notion of “going down” and investigating moving in different ways to explore how to go down, and quiet the sound.

Mother: “How could you make a really, really quiet sound?”
Roger: Put your hands together. (Smiling, putting hands together)

***

Mother: “And one other way, I think. Remember, how else could you “look quiet”? What could we do to look quiet?”
Roger: (gazing at the display, putting his arms lower down): “I don’t know.”
Mother: “Could we go down like that?” (Bends upper body down, quieting and softening voice, gazing at Roger on her side.)
Figure 7-4 Roger’s mother descends down close to Roger, and gazing at him asks softly, “Could we go down like that?”

*Interaction episode 2. Roger and mother descend in movement synchrony*

This episode demonstrates that Roger and his mother move down towards the ground in a descending motion, marked by movement synchrony. Gallagher writes how it is the “intercorporeal coordination of interaction” that matters in affective engagement, rather than a “psychological coordination of propositional attitudes” (Gallagher, 2020, p. 109). The purpose of this episode is to demonstrate another dimension of intimacy in “joint action” with body metaphors. The pair’s continuous gaze at the body metaphors, and them descending slowly towards the ground, is marked by quiet investigation and sensitivity to the changes in the environment and the feedback. In this way, it demonstrates a relational quality of interacting with the body metaphors where the presence of each of their physical bodies descending, as well as the mirroring body metaphors, are both held in the minds of the interactants. His
mother crouches down as well, staying in a position that’s a bit higher than Roger’s (Figure 7-5). In this way, it demonstrates a form of “joint action” that foregrounds intimate and slow movement synchrony, marked by careful gazing of the body metaphors as they proceed with the movement.

Roger looks up once at the display. Then moves all the way down (up until now the sound has still been sounding).
Roger: “Please, mom.”
Mother: “Do you want me to go down as well?

Figure 7-5 Roger and mother descend towards the ground. After laying down, Roger asks for his mother to join him on the floor.

By ascending his head, a little bit, resting on his forearms, Roger is making a connection with the body representations via his gaze. This suggests a kind of “checking” to see if the body metaphors are still present. While Roger is gazing
at the display, his mother is still in Roger’s “empathetic awareness”, as he asks for his mother to join him down on the ground. Here, the mirroring body metaphors “remind” Roger about his mother’s body position, and he can see his mother’s body even though he is not directly gazing at her. In this way, the visual feedback from the system “guides” Roger’s interpretation of the event, and what he would like to happen next.

*Interaction episode 3. Roger and his mother descend downwards*

In this episode, Roger and mother explore how having descended all the way down to the ground together has changed the sound (Figure 7-6). The purpose of this episode is to demonstrate movement synchrony through whole body movement, and a moment of quiet that reveals dimensions of interaction. It speaks about physical intimacy during joint interaction with body metaphors, and it also speaks about a moment of “rest” where interaction, or the connection with body metaphors, does not need to be continuous, but they can still be considered.

(Mother moves down onto the ground next to Roger).
Mother: “What’s happened?” (Laying down on the ground).
Roger: “Sound stopped.” (Roger lifts his head up a little bit, the sound gets a little bit louder again.)
[Laughter]. Roger goes back down.
Roger: “Because our hands are completely down.”
Mother: “Is it just our hands, though?”
Roger: “All of us.”
Mother: “All of us, isn’t it? It’s very quiet now.”
Figure 7-6 Both Roger and mother have descended all the way down onto the ground with their bodies stretched out on the floor with only feet showing in the still image taken from the video data. The pair discuss reasons as to why the sound has stopped, to which Roger replies how “all of us” are “completely down”. They lie on the ground for a while exploring silence as their bodies are flat on the ground, no sound is audible, and the body metaphors are not present as they have disappeared given there are no bodies to track when nobody can be seen by the system.

The above example has discussed how Roger and his mother simultaneously grasp each other’s action through reflecting on the feedback about their movement on the display via the dynamically responding and moving “body metaphors”. This is an example of “kinaesthetic intersubjectivity” where it is like a dance lesson in front of the ballet mirror. However, the presence of the mother, in some way, as well as the fact that these are “others” that afford different quality feedback than your own image. Instead of the interactants exploring their own image, they are also exploring the other’s image – Roger is continuously aware of his mother’s body metaphor and the sound that it is
making. In this way, the activity becomes “socially centred” that is not just about “what I’m doing and how I’m moving” but also, “what you are doing and how you are moving”. There is a curiosity, and an intentionality to move together, a type of “we intentionality” that this device or system foregrounds. In this way, it brings about joint action in this system, which is highly synchronised.

7.3.3 (Almost) re-enactment: Jacob, Lesley, and mother (46 secs)

This example draws from an interaction between Jacob (6 yrs.), Lesley (2 yrs.) and their mother to demonstrate young children’s (almost) re-enactment as a form of “joint action” that foregrounds attentiveness to enactive potentialities with the body metaphors that differ depending on the qualities of the body (e.g., taller, shorter) has on the interactive experience as a way of “companionship” where the action, and the willingness to act jointly and re-enact, becomes the focus of the interaction, thus supporting exploration as a way of also socially bonding the participants to the task at hand – supporting their reflection and attentiveness, and motivates their participation to explore “what one can do”. This difference encourages further exploration with the body metaphor.

Interaction episode 1. Jacob, Lesley, and mother explore whole body movement with body metaphors

In this episode, Jacob, Lesley, and their mother are moving down towards the ground to explore what happens to the body metaphors and the sound as they move. Jacob jumps up in the air holding his hands up, changing the sound and volume as he ascends (Figure 7-7).

Researcher: “What is happening?”
Jacob moves up and down with his body, holding his arms up in the air, gazing at the display. The sound is changing as he moves his body up and down. Mother and Lesley stay low crouched on the ground, gazing at the display.
Figure 7-7 Jacob ascends holding his arms up in the air as Lesley and his mother stay down on the ground.

This episode demonstrates Jacob is engaged in exploring the enactive metaphor through his own movement. He is holding his arms up in the air, and he moves his body up and down, lifting himself up, and then lowering himself onto the ground. The sound is changing as he explores body movements. He is attentively gazing at the screen and begins to move faster and faster to see what effect it might have.

Interaction episode 2. Mother creates a new sound

In this episode, mother mimics Jacob’s movement. She stands up and brings her arms up in the air, widening the width between them. Moving in this way, mother creates a very low and loud sound that the group has not yet heard. Jacob turns towards his mother with amazement, and Lesley stands up gazing at the display with a smile on her face, bringing her arms up in the air.

Mother lifts herself up and changes the width between her hands. The sound makes a really low sound. Jacob turns to look at his mother, and chuckles. Lesley gazes at the display, smiling, then walks towards her mother, holding her arms up in the air. Researcher: “Do you hear that?”
Mother makes a loud sound. Jacob turns to look at mother, Lesley arrives close to mother, touching her body.

Mother’s action produces a sound that hasn’t been heard during the interaction before. The quality of the sound is marked by its loudness and its lowness – as the mother, standing up much taller than her children, stretches her arms wider – much wider apart than would be possible for the children. It is the novelty of this action-feedback effect that attracts attention from Jacob and Lesley as they attend to their mother whilst she is doing the action. The direction of attention shifts to the mother, who is creating a new kind of sound through her body. This in turn, also attracts attention from Jacob and Lesley. It is the mother’s body, her ‘hexis’, that enables her to create this change in the body metaphor feedback.

*Interaction episode 3. Jacob and Lesley re-enact mother’s enaction*

This episode demonstrates Jacob and Lesley re-enacting their mother’s previous action. The purpose of this is to show how in family interaction, those with ‘different bodies’, such as an adult’s body, may produce a different effect with body metaphors. This novelty engages children to re-enact the ideas. However, the system does not respond in the same way, given that their bodies are different sizes.
Lesley: “I want to, too…”
Mother: “You want to as well.”
Mother lifts Lesley up, Lesley puts her arms out wide.
Jacob (moving his arms on his side): “I can do it. I can. Look. When I do this with my arms you can kind of see lines.” Tries different arms movements. Mother lifts up Lesley.

Figure 7-9 Jacob and Lesley re-enact mother’s action.

Jacob and Lesley are attempting to recreate the action and the feedback that their mother has created. There was strong interest to recreate mother’s action and sound. Jacob attends to the lines on the display, and Lesley is creating the same arm movement. Jacob is creating a similar action; however, the sound is not as large because his ‘hexis’ is not large enough to create the effect with his body. The purpose of this example has been to demonstrate that the attentiveness to the body can come from creating new and different feedbacks, and this can lead to further experiments. However, with whole body interaction environments, one’s hexis may affect how the feedback is given from the system. Different bodies can create different effects, and these can act as motivators. In family interaction, this can be particularly interesting, as parents can feel that they are contributing through what they can bring to the experience through their physical presence. This can create further connectedness and attention and reflection to “howabilities”, how one’s body
can create an effect in the environment, and how these are different depending on what size your body is, for example.

7.3.4 Outside ‘togetherness’: Timothy, Elias, Jonny, and mother (2 mins 35 secs)

Interaction episode 1. Timothy makes an interpretation about the sound

Timothy is enacting on the metaphorical object (here without sound, first), and reflects on what he is experiencing. His younger brother, Elias, is also exploring the change of the movement using a much faster pace of movement. The youngest brother, Jonny, joins the brothers, taking his place in the middle of the group. Each brother is gazing at the screen enacting on the metaphor moving their hands apart and closer together horizontally. Timothy is focused on interpreting the changes of the metaphorical object (here still without sound):

Timothy: “When they’re wider apart it’s louder and when they’re close together it’s a lot lower.” (Continuing a repetitive motion of moving his hands wider apart and closer together).
Next to Timothy, Elias and Jonny are engaged in a boxing game whilst gazing at the screen.

Figure 7-10. Timothy, Elias, and Jonny interacting with the body-based metaphors.
Interaction episode 2. Mother gestures to Timothy about sound waves

Mother: “Did you notice what the tighter ones are, whether that’s a higher or lower pitch than the… what’s it… do you remember? So, what’s the tighter ones?”
Timothy: “The tighter ones are the higher ones” whilst making changes with arms (Gazing at mom whilst continuing to stand still and interacting using metaphorical action movement.)
Mother: “So if you’ve got it in,” (Sitting on the sofa, gazing at Timothy, and gesturing with hands pressed closer together) “then it’s going to be a higher pitch than if you got out” (Gesturing hands taken wider apart) “isn’t it?”

Figure 7-11 From the side, the mother enacts a lower versus higher pitch moving her hands wider apart and closer together to demonstrate to Timothy how these movements are mapped onto the virtual body-based metaphor object and the sound's change in terms of a ‘sound wave’ representation.

Interaction episode 3. Timothy re-enacts his mother’s gesture

(Timothy re-enacts his mother’s enaction with quick repetitive motions to change the width between his hands.)
Mom: “Oh, don’t get too quick!”
(Timothy repeats the action again, this time slower)
Figure 7-12. With his slow re-enactment of the metaphorical action (bringing hands together slowly), Timothy responds to his mother’s metaphorical guidance on the quality of the action, to not to “get too quick” but slower and become aware of how the sound changes when the hands are in different positions, wider apart or closer together.

7.4 Discussion

This study makes two contributions. One, to extending enactive cognition notion of “joint action” (Gallagher, 2020). The second contribution this study makes is to the concept of “companionship” (Trevarthen, 2001) with body metaphors during family interaction.

Joint action

1. Joint attention and attunement “focus on shared affect and interest”. Joint attention emerges when a caregiver through pointing, or verbal cues draws a child’s attention towards a specific object or an event, and “shares that focus with the child” (Siegel quoted in Schaefer et al., 2008, p. 91). By attunement, it is meant broadly to describe caregiver’s “constant reliance on cues from the child to adjust his or her own behaviour to match the needs, affect, and interests of the child” (Schaefer et al., 2008, p. 91). The notion of ‘matching affect’ means that the caregiver offers the same vitality or intensity of an emotional state “rather than the content, especially if the feelings are negative”. The matching creates a feeling to the child sensing
“both a sympathetic understand of the feelings and acceptance of the feelings” (Trevarthen et al., quoted in Schaefer et al., 2008, p. 91). Scaffolding relates to caregiver’s supporting the child’s exploration (Cooper et al. quoted in Schaefer et al., 2008, p. 91) where a simple guidance or demonstration can help child find their own way to complete a task and let the child continue their play.

2. Another quality of joint attention in the context of this study is that body metaphors seem to foreground attentiveness to the quality of body movement. The different forms of feedback, the visual and the audible sounds, both foreground movement in a mirroring way. Attending to the detail of interaction led, for example, Jacob to explore the nuances of the interaction with his hands, and the lines that he could see on the display after his mother’s interaction had aroused his interest towards the body metaphors. Gallagher writes how we tend to be aware of what we are doing, rather than the details of how we are doing it (Gallagher, 2020, p. 45). It seems that body metaphors had the effect of attending to the details of our movement, and sometimes interactant’s explorations could foreground this nuance or notion. Gallagher writes how “neither attending to others nor joint attention is reducible to a mere geometrical relation or a set of lines with interest and affect.” (Gallagher, 2020, p. 112). Instead, he continues, “[J]oint attention is invested with interest and affect.” This is important for considering joint action with body metaphors. The attentiveness and the joint attention from participants are foregrounded, as the attention to each other’s bodies is foregrounded. The body metaphors invite this relational quality of “looking” and being mindful and holding each other’s actions and body position and presence in mind continuously during the interactive time. Interaction with body metaphors foregrounds joint attention not only towards the mirroring “body metaphors”, but also towards each other between interactants. This was evident in the way that children enacted during their interaction on the notion of “togetherness”, or on the fact that there are multiple people present. Their interaction, in this way, revealed that they are very much aware of each other’s presence. And that this wasn’t only a “gaze” issue, but as Gallagher writes, there is interest and affect present in joint attention. This attention transforms into actions,
taken up by responsive actions both by children and the parents in the examples given in the above.

Companionship

The body metaphors seemed to have fostered a sense of ‘togetherness’, suggesting that experiences with these technologies may foster positive intersubjective experiences. During the interaction with the body metaphors, this is present in a kind of building of joyful companionship (Trevarthen, 2001, p. 95), especially in the examples with Michael and his mother, and Roger and his mother. The mirroring body metaphors afford an accompanying presence of mirroring “others”, who are intimately connected to the way in which the couple in those both examples relate and jointly act on the moment. The slow movement synchrony and the descending of the pair together in the example with mother and Roger foregrounds intimacy and attentiveness to their body movement, as well as willingness to explore the experience through quite strong movements together. In a way, it almost reminds of a dance piece, where dancers are not afraid to explore the different dimensions of body movement, even if it involves laying on the ground. This also highlights the opportunities from enactive potentialities perspective – how in whole body interaction the room and its relationship with the whole body moving, and the body metaphors that invite to explore whole body movements, can then result in quite extravagant movements, such as those involving going all the way down on the ground. On the other hand, other movements, and modalities, such as wanting to hold hands when realising that it is “them” in the body metaphors, as in the case of Michael and his mother, there is a simplicity to their movement, yet it demonstrates and foregrounds, again, the togetherness and reciprocity that in that example extends to reciprocity evident through touch and holding of hands. In these examples, there was a sense that the body metaphors’ presence fostered a sense that ‘we are and act here together’ – and I want to be close to you. Similar processes have been done with physical bodies in movement psychotherapy.
7.5 Limitations to this study

There was no time to include the story from the previous studies in this research project due to time constraints. However, because the children had an opportunity to engage with sound related topics, it indicated the possibility to explore enaction in classroom ecology, and especially the sequentiality of activities in the classroom that foreground abstract concepts accessibility from different perspectives. The study design produced a kind of scientific narrative (extending narrative work from Chapter 5 especially, add ref here). There wasn’t too much play when it was parent-child dyad, but rather, a seeking to connect through the body. This was different experiences from other studies in this research project. At times, the light was too low, and this affected the detection capacity of the system, which created some “jigging” of the human representation or the “digital other”. This may have affected the quality of the feedback and shaped the interaction in ways that are at present unknown – it may have shaped engagement and disrupted the flow, but this was not evident from children’s interaction with the system directly.

7.6 Conclusion

This study builds on work from chapter 6, extending the enactive cognition notions of “relationality of affordances” and “joint action”. Through investigating enactive family interaction with mirroring body metaphors, the study contributed to understanding of companionship through enaction with body metaphors. In this way, it contributes to the notion of “we intentionality” from phenomenology, that considers body metaphors as a part of a social entity. Furthermore, it demonstrates how family interaction with body metaphors can afford an experience foregrounding positive intersubjectivity between participants, and especially their bodily actions. In this way, it also speaks to the notion of ‘reflective practices’ that have been known to support companionship in learning and professional environments.
Chapter 8 Young children’s affective imagination with body metaphors

8.1 Introduction

This study investigates “narrative practices” (Gallagher, 2020, p. 160) that young children adopt during their interaction with body metaphors. In this way, it builds on the work conducted in Chapter 5, where children improvised with play themes whilst interacting with body metaphors. The purpose of this study is to demonstrate that children build upon each other’s movement through movement iterations and improvisations, which draw from children’s own cultural movement references and the movement palettes. In this way they speak to the enactive cognition notion of “meaningful action chains” (Gallagher, 2020, p. 113). This may benefit research into utilising specific gestures and actions, which are often implemented and designed for, for example in embodied learning (e.g., Abrahamson, 2016).

This study is guided by the following two research questions:

1. What forms of enactive processes do young children engage in with enactive metaphors in a whole-body interaction environment with “body metaphors”?
2. What does this tell us about affective engagement?

This study makes three contributions:

(1) Extends enactive cognition notion of ‘meaningful action chains’ in young children’s interactive processes when interacting with enactive metaphors in a specific physical-digital context
(2) Extends notion of ‘affective imagination’ during interaction with body metaphors
(3) Gives guidance for designers and educators wishing to use body metaphors in their educational designs with enactive metaphors
8.2 Methodology

8.2.1 Research design

This study took place at a South England-based primary school during a single school day. Five groups of children took part in the experiential study workshops with plenty of space to move whilst positioned next to each other, or behind each other. During the research, children were invited to interact with the picture books and a new iteration of the digital movement-based interactive “Body metaphors”. In this study, the analysis focuses on children’s affective engagement with the enactive metaphors during their interaction with the digital interactive.

8.2.2 Participants

Parents of participants were approached by the researcher via their school’s teacher and fourteen children aged 6 and 7 years (M=6.14 years, SD=0.34) were recruited on a voluntary basis. The children participated in the workshops in groups of three and one dyad. All participants were informed they could withdraw at any time. No participants withdrew from the study. Names in this study are pseudonymised to maintain privacy of the children.

8.2.3 Materials

Materials used in this study were:

1. Picture book (see Chapter 5)
2. Movement-based digital interactive (see Chapter 5)

Following study 7 (Chapter 7) three changes were made to the interactive prototype: the sound wave visualisations were modified so that each participant (up to three) would have their own sound wave visualisation, and the stickman figure was depicted with a thinner line. The rationale for this was to make it easier for children to differentiate between each other’s sounds and see the sound wave visualisation more clearly. This hypothesis drew from the findings in Chapter 6, where groups of children had found it challenging to interact sustainably with the enactive metaphor during the digital interaction. These sensorial modifications were assumed to support children in interacting...
with the metaphor. In addition, the different sensorial feedback elements were introduced sequentially. This modification was based on findings from Chapter 6, which showed that children spend time discovering their agency whilst interacting with digital other, and their attention was drawn towards the stickman figure instead of the metaphorical representation and enactive metaphor. In Chapter 7, the children’s parents supported their discovery of the metaphorical action. Thus, in the present study the assumption was that presenting feedback individually (rather than as a group) after giving children time to interact with each element, would support children’s interaction with the metaphor. The sensorial feedback elements were introduced in the following order:

1. Stickman figures  
2. Sine tone sounds  
3. Sound wave visualisations

Once children had explored each sensorial feedback element, the next one was introduced until all the above listed three sensorial feedback elements were present on the screen simultaneously.

The external display was slightly larger than those used in previous studies, given the premise that children would be able to see the details of the sound wave better if they were visually larger.

8.2.4 Procedure

At the beginning of the interaction, each group of children were invited to explore what they were seeing and what they thought the stickman figure was. When the sound was turned on by the researcher, the children were asked what kind of sound they thought it was, and if they could identify any connection between the sound and their movement. During the final multisensory feedback element addition, displaying of the sound wave visualisation, the children were asked what they saw that had appeared on the display, and whether they could create different types of visualisations or sounds through their interaction with the “body metaphors”.

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On average children interacted with the digital platform for fourteen minutes. Typically, the researcher brought the interaction to a close when they sensed that the group’s engagement had dipped, or when the children needed to go to their next activity, such as lunch or a class. All interaction sessions were video recorded using one static camera, positioned to face and record all participants interacting with the interactive.

8.2.5 Analytical process

In the first round of analysis, the researcher watched all five experiential workshop videos through twice, making notes of episodes of groups of young children’s interaction with the designed-for metaphorical action simultaneously (as a form of “joint action”, Gallagher, 2020). Interacting with the enactive metaphors in the context of this study analysed as interaction when a group of children, engaged in widening the width between their hands’ (pitch change) and/or lifting their arms up in the air or moving them down (volume change), all the while whilst gazing at the display and body metaphor visualisations, and facing their body towards it. For more details about the designed-for metaphorical action see Chapter 5 Methodology section.

The second round of analysis focused on episodes of metaphorical action identified in the first round of analysis more deeply. The purpose of this round of analysis was to identify and make notes about forms of whole-body movements that children incorporated during their interaction with the designed-for enactive metaphor (designed for arm movement) and understand how this contributed to the notion of ‘affective engagement’.

The third round of analysis involved a microinteractional analysis of children who were “jointly” enacting on the enactive metaphor (Gallagher, 2020). This round of analysis took account of both action and children’s verbal accounts. The analysis looked for indications, either bodily or verbal, as indicators of frames for action such as “These are my hands, my bear hands” and then other children ‘sharing’ that experience through re-enactment, mimicry, or entrainment, for example. This meant that the children engaged in a form of ‘joint action’, enacting on the metaphor simultaneously, either synchronously moving their arms or bodies at the same time (as in ‘entrainment’, e.g. Clayton
et al., 2020). Furthermore, this ‘pretend play’ stance suggested a form of “affective imagination” (e.g., Fleer, 2013; Vygotsky, 1978).

The fourth round of analysis involved a further microinteractional analysis of children’s joint enactment and what narrative they adopted, such as through an adoption of a cultural reference, or a form of play. This was often present in words, but it could have also been a form of bodily pose, or a stance adopted by the children – a new dynamic they would all share in the moment, that revealed a dimension of the narrative dimension. This was the analysis of social affective imagination. In this way, this round of analysis contributed to the enactive cognition notion of “narrative practices” (Gallagher, 2020), by understanding ways in which narrative frames were adopted, shaped, and reconfigured by children during their interaction with the body metaphors.

The fifth round of analysis focused on looking at the different phases of narrative frames changing over the course of the episodes from the perspective of “flow” (e.g., Csikszentmihalyi and Csikszentmihalyi, 1990) of the interaction. The purpose of this analytical layer was to further understand the overall shape or ‘arc’ of the way in which children adopted or shaped their narrative practices during their interaction. From an enactive cognition perspective, the analysis suggested these arcs as being forms of “meaningful action chains” (Gallagher, 2020). Specifically, this included instances of (1) children jointly enacting the metaphorical action whilst interacting with the digital platform, (2) children interpreting or creating narrative arches for their metaphorical action during interaction through improvisation, and (3) children bringing their own, cultural movement-memories to their interaction.

8.3 Findings

The findings demonstrate enactive group processes of young children interacting with the designed-for enactive metaphor. The findings are presented in three themes: bodily improvisations, narrative frames, and body memories. Each theme foregrounds a different enactive process to demonstrate the movements that children draw from when interacting with the enactive metaphor.
Bodily improvisations demonstrate the ways in which children engaging in whole-body interaction engage with the designed-for metaphor beyond the designed-for action to incorporate wider bodily movements. It includes a social element: how these become (or not) adopted by others in the group.

Narrative frames demonstrate children enacting with a specific adopted cultural reference in mind: Superman and investigates how this changed whole body engagement with the enactive metaphor.

Body memories presents specific movement references children re-enacted with the enactive metaphor. It is a collection of different movement frames that demonstrate specific movement-based cultural ideas that children enacted whilst engaging with the body metaphors.

Collectively, the findings convey how young children extended and improvised enactive ‘joint action’ with the enactive metaphors conveying notions of ‘shared affect’. In this way, it speaks to different forms of ‘narrative practices’ (Gallagher, 2020, p. 160).

The findings are reported here based on two interaction videos to illustrate the distinct ways in which the children enacted on the metaphorical action. Furthermore, two other videos were selected which illustrated other types of cultural movements children utilised during interaction. From each of these videos, shorter interaction ‘clips’ that represented events with these qualities were selected (Derry et al., 2010).

8.3.1 Bodily improvisations: Abaan, Lewis, and Aurora

The episodes presented here illustrate how young children interacting with "body metaphors" discover ways to incorporate other body movements to a prescribed enactive metaphor – a marker for affective engagement. It draws on an interaction between three classmates – Abaan (6 yrs.), Lewis (6 yrs.), and Aurora (6 yrs.), and the researcher, to illustrate from an enactivist perspective, how interaction with an enactive metaphor evolves through adopting of different ‘narrative frames’ (Gallagher, 2020). This example focuses on three episodes of interaction between the children. The function of
these excerpts is to provide evidence about the children’s affective engagement through action-on-action building involving playful improvisation and meaning making that is evident through their enaction (quality); and how the social situatedness of the experience, grounded in whole body movement and feedback affording whole-body sensorial feedback, resulting in a playful encounter reveals the complexity of “meaningful action chains” and routes to it.

The interaction moves through three consecutive interaction episodes; each episode is important in illustrating the development of interaction with enactive metaphors for an affective whole-body perspective. The first episode shows the children jointly acting on the enactive metaphor, adopting narrative frame of a story to their enaction. The second episode presents subsequent movement of children exploring ‘big’ sounds with the enactive metaphor through their bodies. The final episode follows from exploration of ‘bigness’ to a playful engagement with the enactive metaphor where they make an inference about the sound.

*Interaction episode 1. Narrative frame for enactive metaphor interaction*

After a period of initial playful exploration with the two sensorial feedback modalities, the visualisation of the stickman figures (“body metaphors”), and the audible sine tones, the researcher made the sound wave visualisations visible on the display. Lewis first pointed out how they were “your hands” on the display, immediately followed by an appointing of symbolic meaning to the sound visualisation – the “wolf hands”. Lewis called it the “wolf hands” thus evoking a narrative frame for the enaction, which was adopted by the rest of the group as they joined in joint action in exploring the metaphor through “stretching” the visualisation.
Abaan: “What’s that red line?” (Standing in front of the display, gazing at it, and pointing at it).
Lewis: (Lifting his hands up in the air). “That’s your hands.” (Puts hands back down. Takes a couple of steps towards the display. Standing at the back, behind Abaan, gazing at the screen). “The wolf hands!”
Abaan lifts his hands up in the air. Aurora lifts her arms up in the air.
Aurora: “It’s the wolf hands!”
Lewis: “If you stretch it, it can be longer.”
All children participate in “stretching” the line.

Figure 8-1. Children enact on the enactive metaphor, adopting a narrative frame of “wolf hands” for their joint action

At the beginning of this episode, Abaan and other children are gazing at the display intently. Abaan points out the red line on the display. Lewis brings his arms up in the air, saying “that’s your hands” and then begins to move his hands closer and wider apart, saying “The wolf hands”. As he says it, the other two, Abaan and Aurora join in a moment of movement synchrony, a type of entrainment where they repeatedly enact on the metaphor. Aurora smiles echoing Lewis’ comment by repeating it “it is the world hands”. They adopt a narrative frame from the picture book story, that affords a symbolic value to the gloves. They are affectively engaging with it and demonstrate shared affect through synchronous movement.
Episode 2. Abaan, Lewis, and Aurora improvise around “bigness” (to show different kinds of movement exploration)

Once the children had explored enaction with the metaphorical action, the researcher asked if they could find a way to make a “Really big sound?”. This was followed by exploration into the different forms of enlarged sizes, such as wider arms. They explored stretching their arms wide apart. During the exploration of bigness in this way, which in scientific terms results in a “low” pitch sound, the children began to explore different types of actions. Abaan rotated his arms massively. Aurora engaged in spinning movements and explored a jumping motion then rotating her arms like Abaan, accompanied by laughter.

Researcher: “Can you find a way to make a really big sound?”
Everyone stretches their arms wide.
Abaan engages in a rotating motion sound.
Aurora whirls around, looking at the display when she turns back round.
She begins to jump on the spot, moving her arms in a rotating motion, and laughs.

Figure 8-2 Aurora (front L), Lewis (back L), and Abaan (R) attempting to make a “really big sound” stretching their arms out wide whilst gazing at the body metaphors.
Figure 8-3 Abaan (R) engages in a “rotating motion”. Aurora (L) turns to look at Abaan’s movement.

Figure 8-4 Abaan (R) moves to the side of the room, then jumps up and across the display whilst gazing at the screen. He sways both of his arms up high and rotating his body in mid-air. Aurora (L) and Lewis (C) attend to the body metaphors on the display. Abaan lands on the ground. Everyone laughs.

This was followed by the children engaging in a variety of different exploratory movements through their whole-body, involving arm movements e.g., rotating arms, spinning, and jumping, expanding the enactive metaphor to the wider body. The children were laughing whilst doing this, exerting bodily effort
through dynamic enaction such as pushing the arms up and own when rotating, stretching hands very wide apart, or jumping—all “forceful movements”. As if the dynamics or bodily effort they were exerting had an effect on the bigness of sound – not just sound itself.

The above ‘movement improvisations’ are interesting from the perspective of “enactive metaphors”. Discussing concepts, Bermeitinger and Kiefer (2013, p. 123) talk about how “knowledge can be transferred to new objects”. While the meaning making from a conceptual development perspective was not the focus of this study, from an engagement perspective there seems to be a plausibility for considering the inclusion of children’s own cultural movements as part of the enactive metaphors when designing for whole body interaction type environments.

*Episode 3. Combining enactive metaphor action with other movements to create a new sound*

Actions from improvising around the theme of “big sound led children to explore different types of whole-body movements which incorporated the enactive metaphors. Lewis noticed how Abaan’s exploration furthered by Aurora, created a “boing” sound. He said it out loud and asked, “everyone to make a big sound.”

Lewis: “It makes a “boing” sound!”
Abaan jumps across the screen with his arms up in the air.
Lewis: When you move your hands, and you jump it says “boing!”
Everyone is jumping and making the boing sound with their arms.
Figure 8-5 Everyone is combining jumping action with a modified enactive metaphor.

Sound combined with movement became the main focus and the children joined again in a moment of entrainment as a synchronous jumping combined with rotating arms – all creating a new “boing sound”. Through their interaction with the “dialogic others”. This was reminiscent of a jazz band coming together after a period of improvisation (e.g. Clayton et al., 2020); the joining together in a synchronous affective-movement experience that is marked by playfulness. This final episode furthermore is reminiscent of and bears similarities to dancing; however, it shifts between narrative frames.

In this way, children are imaginatively creating and transforming the narrative frame for action during the interaction. They transform ‘enactive metaphor actions’ into new ‘action improvisations’, which overall suggest a form of ‘meaningful action chain’. Whilst still exploring the functions of the enactive metaphor – how movement relates to sound as well as what is being ‘detected’ – they incorporate other movements into their interaction beyond enacting on the metaphor with the arms and hands’ action.

The above example demonstrates how children explored the metaphorical action re-enactment through adopting the narrative frame from the storybook they had been exploring at the beginning of the workshop. This suggests that the children can adopt ideas almost as an enactive “metaphor instruction”
(e.g., Böger, 2013, p. 187), where an image schema of an action (the picture book’s bear hands and action displayed) supports the formation of a re-enactment of an action, as well as being supported by the digital visualisation of the same symbol (albeit in different colour). The children enacted on the metaphorical action, also including verbal utterances referring to the picture book’s action they had seen earlier. Another form of ‘metaphorical instruction’ in this case, without referring to the picture book, was the way in which the children adopted the researcher’s note of a ‘big’ sound’. And while this was asked in reference to the sound and the system, the children began to explore the notion of ‘bigness’ through their bodies. Furthermore, their ideas about ‘stretching it’ alluded to hands being able to ‘change’ something, although it was not clear at the beginning whether the ‘stretching’ was more linked by the children with the visualisation, or the audible sound. Later, during the action where the narrative arc seems to have transformed to exploration of ‘bigness’, it was more explicit that the children were exploring the bigness of sound, and they were actively listening to the sound, which was apparent from the way that they were alluding to the sound in their exploration. It almost seems that in this example, the bodily improvisation indicates what Sheets-Johnstone (2003) described as a dimension of “corporeal powers, the I-can and I-cannot” (Di Paolo et al., 2014, p. 75) – so not necessarily a ‘flickering’ in the sense that Vygotsky (1978) described it, but something more about the ‘howability’, which relates to some notions made earlier during this research project.

8.3.2 Narrative frames: Devan, Georgia, and Lucas

In this example, a group of classmates, Devan (7 yrs.), Georgia (7 yrs.), and Lucas (6 yrs.) enact on the body metaphors and adopt a shared group narrative frame for enacting with the body metaphors themed around “Superman”. This theme demonstrates how specific movement quality and fictional ideas are drawn into action and adopted as narrative frames over the course of interaction. Three episodes depict how children develop movement themes with the enactive metaphor that draw from their own cultural references over time. These episodes speak to the theoretical notion of “narrative practices” (Gallagher, 2020, p. 160) demonstrating how cultural references from children’s own experiences with certain types of movements
can be brought in, and that can shape moments of interaction, and in particular, “joint action” (Gallagher, 2020, p. 116).

*Interaction episode 1. Enacting on an enactive metaphor in a “powerful way”*

In this episode, Devan notices the added visualisation of the sound wave first and brings his hands together. Soon enough, other children re-enact his enactment with his effortful motions that are rigid arms, strong posture and each making a “wwwzzzz” sound on top of the aural sound that is audible in the space. They then begin to “compete” in taking space in front of the display.

Devan is moving his arms in a powerful way up in the air. Lucas moves his hands next to each other in a powerful way. Georgia: “I’ve got the power.” (Moves her arms together in a powerful way).

![Figure 8-6 “I’ve got the power”](image)

*Interaction episode 2. Finding superman*

Continuing from episode 1, Lucas moves in front of the screen noting his “bigness”. He stretches his arms out wide, making a very low and loud voice whilst he says, “I’m Superman”. Devan moves behind him with one big leap, shouting that he is Superman, also stretching his arms out wide similarly to Lucas. In this way, they are both embodying “bigness”, with Devan extending
the notion into a cultural character with specific bodily powers that denote force and power. This is evident in his movements and the way he holds his body.

Lucas: “I’m super big” (moving his arms wide in front of the display)
Devan: (behind Lucas): repeats Lucas’ action “I’m superman” (Bringing his arms higher up in the air)

Figure 8-7 In this image, Lucas evokes “super big” as a narrative arc, followed by Devan, stationed behind him, mentioning “superman”.

Here, there is a shift from one narrative arc or frame for action into another. It begins with “bigness” and Lucas mentioning super big and shifting his performance of bigness not only through his body, but also with his tone of his voice and what he is describing. This is re-enacted, but slightly differently, by Devan who leaps behind Lucas. In this way, he is displaying interest in joining him in the motion and extends Lucas’ enactive narrative frame for action through making Lucas’ “super big” into “Superman”.

Interaction episode 3. Entrainment enaction with superman

In this episode, Devan moves to the back of the room asking everyone to “look at this”. Others move towards the back of the room as well. Devan begins to jump, simultaneously others, too, as “supermen” from the back of the room towards the front of the room towards the display. They are all holding their
arms up in the air to “use” the enactive metaphor in a way that combines it with a superman like motion.

Figure 8-8 “I’m superman”, everyone jumps with their arms up in the air. Another moment of entrainment. Jumping towards the screen, especially Georgia and Devan, while Lucas stays more at the back. 24:58

This episode demonstrates how children take up a “pretend play” role and this is evident through their bodies. The researcher prompting questions around “bigness” prompted the children to explore the notion of “bodily bigness” with the “body metaphors”. Starting with Lucas, children began to “embody” the notion of bigness, which through iterations of playful ideas became about embodying and pretending to be a Superman. This all whilst still enacting on the metaphor, and thematically exploring the sound (although this was not a prominent feature as in example 1). As Garvey and Berndt (1975) write “[I]n most cases, pretending requires a manipulation of the ways things are believed to be”. Furthermore, in a Gallagherian (2020) sense, these “ways” are the type of contextual framing that is adopted to action, and ‘enactive potentialities’ (e.g. Noë, 2006) that are revealed in the course of exploration make new meanings and new framings during the course of interaction.

8.3.3 Body memories

This section illustrates how children brought other types of movement-experiences as types of “body memories” into the setting. These actions were
not always shared/joined in by other children. These were not typically combined explicitly with the enactive metaphor exploration in a motion-like way.

*Interaction episode 1. Ava, Amani, and Rai re-enact “the Floss” dance*

Here, the children create a moment of “joint action” with a shared body memory of the Floss dance during the interaction with the body metaphors. Rai initiated the movement describing it as “the floss”, and soon after Ava and Amani joined him. They all shared the action, re-enacting the floss repetitively whilst gazing at the screen. Doing the dance together seemed to foster a moment of positive shared affect marked by laughter and a general feeling of mutual enjoyment.

Rai: “I’m doing the floss.”
Ava and Amani join Rai in re-enacting “the floss” together. All children gaze at the screen, laughing, whilst re-enacting the dance move repetitively.

*Figure 8-9 From left to right: Ava, Amani and Rai re-enact a popular dance movement called “the floss”.*

It seems that the visualisation of the hands as a soundwave heightened the motivation to create something with a hand’s movement, and this may have been a motivator for Rai to engage in interacting with the enactive metaphor. The floss dance was accompanied by shared positive affect. This may be a
useful note for designers using enactive metaphors to gain ideas for how to dance with enactive metaphors or incorporate cultural movements to enact with designed-for movements.

Interaction episode 2. Mia re-enacts a Fortnite emote during interaction with body metaphors

This episode demonstrates Mia (6 yrs.) re-enacting a cultural movement reference with body metaphors. During the interaction, she stops in front of the display and takes a pose from a popular video game aimed at children called “Fortnite” that incorporates movement-based interactives as “emotes”. Whilst gazing at the screen, she threw both of her arms to the left in a diagonal angle. Mia’s re-enactment of this metaphor was soon after repeated by Amelia on several occasions.

Figure 8-10 Mia (R) evokes a pose from Fortnite game during her interaction with the body metaphor. Alana (L) is finding it funny and is laughing laying on the floor.

While there is no specific response to any poses from the body metaphor or the enactive metaphor, it does evoke questions about modifying or allowing enactive metaphors, such as those designed for ‘hands’ movements, to elaborate and expand on cultural body memories. These could add to the playfulness and the enrich children’s experience, as well as give them the
pleasure of exploring with familiar and non-familiar elements, such as those designed-for actions, but also their own narrative frames.

Interaction episode 3. Aurora enacts on the enactive metaphor as a musical instrument

This episode demonstrates Aurora (6 yrs.) enacting on the designed-for enactive metaphor repetitively and fast, whilst verbally describing it as an “instrument”. While this action is not exactly a body-memory, it suggests Aurora is drawing from a previous action experience with a musical instrument. This speaks to the notion of “narrative practices” in the sense that Aurora is enacting on the designed-for enactive metaphor by giving it a symbolic meaning from her own cultural background. For her, the enactive metaphor action evokes an idea about an instrument one plays with one’s hands.

All three participants explore a variety of movements changing hand and arm positions, whilst gazing at the body metaphors on the display.
Aurora begins a fast, repetitive movement with moving hands wide apart and further away from each other again as if playing an accordion.
Aurora: “I’m playing this instrument!” (Smiling, laughing).

Figure 8-11 Aurora (front L) enacts on the designed-for enactive metaphor with a repetitive and fast expanding and closing motion saying, “I’m playing this instrument”.
When Aurora evoked this symbolic meaning for the enactive metaphor, she was doing it on her own. While the other children did continue exploring with the enactive metaphor through repetitive enaction, they did not adopt Aurora’s idea of a musical instrument, through repetitive and fast enaction. While some body memories are common, an instrument may not be a frame for action that all children can relate to.

The above episodes speak to the previous studies that already noted some “body memories”, by showing how some actions were “entrained” or “re-enacted”, also including some that were not re-enacted by other children, such as the “instrument”. The notion of ‘body memories’ has been described in scholarship for over thirty years, with dancing being one of the most well-known examples of the phenomenon. All habits such as dancing, walking or swimming can be described as ‘body memories’, and as such they are “automatic acts that can be performed without thinking and that may occur spontaneously” (e.g., Alarcón Dávila, 2013, p. 106; Casey, 1987). These movements, given their prevalence in the data, or the ways in which children engaged in and with them, suggest them as “cultural forms of body memories”, which suggest spontaneous engagement in dance-like movements when experiencing “body metaphors” – in this way, they can become dance, or game partners. However, these body memories did not explicitly relate to children making meaning about the enactive metaphor. They may have been attempts at trying out different types of feedback, but during these movements there was no specific metaphorical instruction from the researcher. This may be a fruitful area of future research, given the increasing prevalence of movement-based interaction opportunities. This may possibly be included from an affective engagement perspective in movement instruction, or metaphorical instruction, or engagement with enactive metaphors, or other types of movement situations, such as, again, building social cohesion or bonding through this type of joint action.
8.4 Discussion

This study makes four contributions.

**Joint action**

This theme demonstrates that young children’s ‘joint action’ with enactive metaphors within a social context with mirroring “body metaphors” involves a continuous process of adopting, configuring and reconfiguring different narrative frames (Gallagher, 2020) for a continuous and repetitive re-enactment with the ‘enactive metaphor action’. The examples presented in this study echo findings from the previous chapter in this thesis (Study 7) about the ‘joint re-enactment of the metaphorical action’ remaining a focal and an anchoring feature of children’s interaction, marked by continuous gaze at the display, making verbal inferences about the metaphorical action in relation to the sound and the sound wave visualisation, and their repetitive re-enactment of the designed-for enactive metaphor action. Extending this finding, this study has demonstrated that sustained engagement with enactive metaphor action remains even when children adopt and shift between different ‘narrative frames’ (interactional gestalts). It is the interplay between the focused action (metaphorical action), and the freedom with the rest of the body, that brings about engagement in this context. Further engagement is marked by different things in “joint action”: constantly shifting narrative frames, children improvising around the movements with the enactive metaphor, and joining each other in movement trials.

**Narrative frames**

In a group setting, this includes both individual improvisation through the body, as well as moments of synchronised ‘joint action’ which is similar to forms of entrainment. The aim of this study is also to demonstrate how these ‘narrative frames’ shift during interaction from one to another, thus creating ‘meaningful action chains’ for interaction. And this study’s aim is to demonstrate core components of ‘meaningful action chains’ during interaction enactive
metaphors with “body metaphors”. Why are they so rapidly shifting? Why are they so engaged in this way of ‘narrative framings? In this way, it also contributes to research on in active cognition and embodied learning, studies have reported experiences of “becoming one” with an experience through pretend play (e.g., Lindgren, Enyedy, Abrahamson). Yet less is understood about the enactive processes of this experience.

Flickering

Furthermore, these processes, which suggest specific types of ‘meaningful action chains’ (Gallagher, 2020), bear features of different types of movement-experiences and thematic movements that emerge from children’s own cultural context, their recent experience, or are suggested by the researcher. These ‘narrative frames’ suggest ‘affect in joint action’ through processes that through the body suggest enactive metaphor being engaged with through a narrative frame of ‘pretend play’, ‘symbolic play’ and ‘body memories’. What is specific about these types of ‘narrative frames’ from an enactive cognition perspective is the way that the enactive potentialities of the environment that are afforded by the “body metaphors” bodies where narrative frame may be instructed and adopted, or it can also emerge in the moment. This study argues that this emerges from the abstract human body shape that affords multiple types of interpretations about ‘who is in the mirror’, thus affording the possibility for narrative framings to shift for action. This creates unique opportunities for sustained engagement that includes movement variability and experience variability. For designing with enactive metaphors, it suggests that enactive metaphors and purpose-designed actions may be let loose and free by incorporating more and other movements apart from the enactive metaphor, so that children can move in and out of action, involve different types of play, and utilise the sequencing of different actions or multisensorial elements to support interaction. “In fact, most young children of about five do make this distinction between work and play. In general, those activities in which they feel constraints do constitute work, those they have fun doing constitute play. Epistemic behaviours which require effort, sustained attention, and persistence tend to be considered more like work, and therefore distinct from
the more light-hearted, enjoyable ludic behaviours. It is suggested that the distinction the children are making in this differentiation is between feeling constrained and feeling free.” (Hutt, 1981, p. 285). Collectively, the process of adoption, configuration and reconfiguration resembled forms of ‘meaningful action chains’. The shifting may bear similarities to Vygotsky’s notion of ‘flickering’, which in this specific physical-digital space seems to emerge both from interacting in the social but also having the enactive potentialities of the human body representation that sustains engagement process (the flickering process).

‘Meaningful action chains’

Collectively, the findings from this study demonstrate how children are through these processes forming forms of ‘meaningful action chains’ (Gallagher, 2020). This speaks to a specific ‘embodiment effect’ that draws from the multitude of enactive potentialities regarding the feedback system and bodily movement. In addition, it speaks about the specific design of the system that involves an ‘abstract conceptualisation’ of the human body as a simple stickman figure. It is argued that it is this simple design that enables children to continuously create and refresh the ‘narrative frames’ for their enaction with the enactive metaphor, thus affording opportunities for prolonged affective engagement and affective imagination with the “body metaphors” and each other. The purpose of these findings is to demonstrate how these chains developed during group interaction with enactive metaphors from an affective engagement perspective the adoption of and movement improvisation with different ‘narrative arcs’ that children formed during interaction either by drawing from their previous experiences or on the suggestion from the researcher.

Design contribution: Other movements beyond designed-for enactive metaphors

It is the narrative adoption that suggests “we intentionality” to adopt a playful frame for action that seems to deepen engagement. While designed-for metaphorical action involves two types of dynamics movements with the arms
(hands moving up and down at level, and hands moving wider and closer apart at level), the ‘narrative frames’ which children adopt for their interaction manifest in ‘other’ body movements beyond the metaphorical action. These ‘other body movements’ are, for example, rotating arms as in illustrative example 1, or jumping whilst holding arms up in the air in illustrative example 1. These ‘other movements’ are larger ‘narrative actions’ that suggest adoption of different frames for action as ‘interactional gestalts’. This study suggests that these ‘other movements’ are cases of children adopting ‘narrative frames’ for their action, and that this supports their engagement with the metaphorical action and positive intersubjectivity with each other and the “body metaphors” – and at times, also meaning making about the sound.

8.5 Limitations to this study

There were several limitations to this study. The children who participated in exploring the whole-body interaction environment just before lunchtime, reported feeling hungry after exploring the movement-based interaction platform. Furthermore, children who participated in the workshops right after lunch reported feeling tired after interacting with the whole-body interaction environment. Furthermore, the researcher-facilitator could have made more of the children’s own movements that they were bringing in, asking if they can combine it with the enactive metaphor.

8.6 Conclusion

This study investigated young children’s interaction with whole body interaction environments. Specifically, it studied the ways in which, through their whole bodies, children participated in interacting with emergent motives, and how they drew from existing interactive motives during interaction. The study found that children’s whole-body improvisation can be conceptualised as forms of “affective engagement” where children’s flickering between themselves and their role play becomes foregrounded.
Chapter 9  Discussion

This thesis makes contributions in four key areas: conceptual, theoretical, methodological and design.

There are four conceptual contributions that emerge from the empirical work undertaken as part of this thesis in Chapters 5-8. The four concepts, “enactologuing”, “mirroring self-others”, “reflective bonding”, and “enactive identity playground” convey specific ideas relating to young children’s enactive processes (e.g., Gallagher, 2020) with body metaphors, foregrounding their social situatedness (van Dijk, 2018). These will be explained in detail in the section 9.1 below.

This thesis presents three key theoretical contributions. These relate to the theoretical notions of ‘mirroring’ (e.g., Barsalou et al., 2003; Niedenthal et al., 2005; Gallese et al., 2005; Schaefer et al., 2008; Trevarthen, 2001; Inoue and Kitazaki, 2020), ‘belonging’ (e.g. Di Paolo, et al., 2014; Sheets-Johnstone, 2014), and ‘affective imagination’ (Fleer, 2013; Vygotsky, 1978; Garvey and Berndt, 1975; Hutt, 1981; Gallagher, 2020). Each of these contributions brings together several theoretical perspectives, contributing to the notion of ‘affective engagement’ (e.g., Reschly et al., 2020; Bond and Bedenlier, 2019) from an enactive cognition perspective, thus foregrounding the motoric, emotional, and hedonic dimensions of interaction. These will be detailed in section 9.2.

The methodological contribution consists of the development of new method, Affective Imagination in Motion, over the course of the empirical studies and iterative design work with the body metaphors. The method gives access to ‘affective engagement’ from four perspectives, thus enabling access to ‘affect’ in young children’s enaction. The four perspectives are: narrative framing of action, joint enactive processes, identifying phases of interaction, and translating enactive metaphors from physical to digital. Section 9.3 below describes methodological contributions in detail.

Finally, the work undertaken makes four key contributions to whole body interaction design from an enactive cognition perspective. The first design
contribution ‘Whole Body in Interaction Design’ discusses the notion of ‘enactive potentialities’ from a whole body and group interaction perspective, detailing how embodied design can benefit from an enactive cognition perspective to design in areas such as learning. The second design contribution relates to group interaction and the notion of interactants engaging in interaction in movement-based interactives and having a different body, such as an adult and a child interacting simultaneously. The third design contribution offers a perspective to whole body interaction and pretend play, and children’s own cultural references in terms of interacting with body metaphors. The fourth design contribution discusses the notion of ‘reflection’ during interaction. The final design contribution, Positive intersubjectivity, discusses the notion of shared affect and kinaesthetic intersubjectivity in the context of whole body interaction design. Design contributions are discussed in section 9.4 below.

9.1 Conceptual contributions

This research project makes four conceptual contributions.

9.1.1 “Enactologuing”

“Enactologuing” as a concept draws from DuBois’ work in dialogic syntax and the concept of ‘dialogue’ (e.g., Du Bois 2014; Goodwin, 2018). More specifically, by the term ‘enactologue’ and the derivative verb ‘enactologuing’, it is meant that young children’s enactive processes during interaction with body metaphors undergo enactive transformations, shaped by the social situatedness (e.g., van Dijk, 2018), and reproduce aspects of prior enactions (Goodwin, 2018, p. 42). The purpose of this term is to emphasise and foreground the importance of multimodal, and specifically enactive, participation of young children.

This research suggests that this concept can be useful in capturing those nuances of communication that go beyond dialogue and an exchange foregrounding verbal exchange. In particular, such concept may be beneficial when studying specific aspects of interaction where there seems to be a “dialogue” between the bodies, such as the notion of “kinaesthetic bonding” as
studied in Chapter 7. The concept of “enactologue” may be able to capture more of the physical dimensions and the quality of a communicative exchange. Furthermore, given that young children’s expression relies on physical cues and meaning making, it may be supportive of framing of interactive and dialogic situations as a reminder.

In the context of this work, enactologues formed especially around the designed-for metaphor during interaction, where participants would enact and re-enact, transforming each other’s action and contributing to meaning making by expressing their own ideas through enaction. These happened during the picture book reading (as exemplified in Chapter 5), and during interaction with designed-for enactive metaphors with the digital interactive as detailed in the Findings in each empirical study chapters (Chapters 5-8).

9.1.2 “Mirroring self-others”

The concept of “mirroring self-others” draws from young children’s interaction with body metaphors. The mirroring denotes the quality of the body metaphors, as any movement-based interactive, “mirroring” the interactant’s body movement. The second part of the concept, the “self-others”, captures young children's enactive patterns of investigation themed around self-referentiality. As both the notions of “self” and the “other” were equally present in children’s interaction throughout the empirical work, this concept captures the way in which children would perceive the body metaphors.

Using the concept of “mirroring self-others” makes a distinction from the notion of “avatars” (e.g. Freeman et al., 2020; Inoue and Kitazaki, 2021; Teng, 2017; Lugrin et al., 2016;), which is often used in human-computer interaction literature to describe a “third person” entity, separate from self. By developing a new concept of “mirroring self-other”, this thesis seeks to convey more of the intimate quality that was present in young children’s interaction with body metaphors, often marked by a shift between experiencing body metaphor as a “self” and an “other”. At times, verbs such as “to follow” or “to do the same thing that I’m doing” were voiced out by children during interaction as a form of “self-explanation”, or “like thinking to oneself” (Chi, 1989, p. 169).
The concept also speaks to the phenomenon of “mirror self-recognition” (e.g. Brandl, 2018), a classic experiment from developmental psychology on self-referentiality in young children’s encounters and meaning making with a mirror. As Brandl (2018) writes, recognition of agency happens gradually when a child interacts with a mirror. Self-awareness in these contexts emerges from gaining feedback from the environment on one’s own actions, which results in recognition. However, with mirroring body metaphors, young children spend at least a period of time investigating their agency, often playing with pretend play themes such as the metaphor being “alien”, or “instrument”, or, for example, a “magic mirror”. Because of this period of indeterminacy and playfulness, perhaps the “mirroring self-others” can convey this multifaceted quality of the body metaphors for young children, where enactive potentialities are rich and ever-changing, nourishing for the imagination.

Each study in this work emphasises a particular form of “mirroring self-others”:

- In **Study 5** the “mirroring self-others” took a longer time for younger children to process, the “others” was very much foregrounded first, whereas the “self” became evident for some children especially.
- In **Study 6** the “mirroring self-others” were present in the way that children investigated both dimensions, but more often first as an “other”, with a few exceptions
- In **Study 7** the “mirroring self-others” were present in the sense that the “other” became more like “us” – the social of the interactants and their social relationship was foregrounded more in this study than with other studies. This related especially to the notion of perceiving something “jointly, as a ‘we’” (Schmid in Zahavi, 2015, p. 409).
- In **Study 8** the aspect of the concept “mirroring self-others” that was more foregrounded than any other aspect was that the children investigated and established “self” in the metaphor, yet creatively established different “roles” to the metaphors as a form of “other”, therefore, there was less negotiation back and forth, which was in contrast to Study 5 and 6.
9.1.3 “Reflective bonding”

The concept of “reflective bonding” derives from the notion of ‘reflection on each other’s action’ - one of the core enactive processes and common themes that featured in interaction across the four empirical studies (Chapters 5-8). It draws from the evidence present in the data highlighting a fellow interactant’s movements becoming perceivable and thus enactable through the ongoing movement feedback afforded mirroring body metaphors on the display. Reflection on each other’s action often produced kinaesthetic intersubjectivity, which was specifically noted in Chapter 7 as forms of positive, shared affect amongst participants, but also as forms of creativity that invited entrainment and movement improvisation with shared play themes. In this way, the “reflective bonding” in this specific environment derives and speaks to a form of “companionship”. Furthermore, this speaks especially to ‘mirroring’ from the perspective of movement psychotherapy (e.g., Martin, 2014). Martin writes how the process of mirroring affords reflection that can increase oneself of “self-activation” (Martin, 2014, p. 550).

9.1.4 “Enactive identity playground”

The findings suggested a type of social space was created by children with the body metaphors had three types of “rooms” within it. One was when it had been established that the interactant was moving it, another when they were being someone else who was following them, and third, a symbolic or pretend element in play. All of these were present in each workshop in one way or another. This shaped the social dynamics between the interactants, which ranged from being fearful or hiding, to trying to create empathy with other interactants (the ones with real bodies). In interaction, this also suggested different types of actions and meaningful action chains, depending on what type of experience children were having. And it shaped their affective engagement with the display or the system. In this way, they could be described broadly as different types of “narrative frames” that children adopt to their action, and these are formed during interaction with the “body metaphors”. Social play field, similar to Sims or other types of experiences that foreground identity and gaming, but more from the physical body perspective.
In this “enactive identity playground” the children would go through “action cycle loops” that, especially as Chapter 8 demonstrated, would renew the enactive potentialities of the environment, thus giving children an idea, or a theme, for a new play identity – such as transforming from “wolf hands” to “body bigness”, for example.

9.2 Theoretical contributions

So far, research has mainly focused on ‘belonging’ and ‘affective engagement’ as separate from other forms of engagement such as cognitive and behavioural engagement (e.g., Bond and Bedenlier, 2019, p. 2), where positive experiences towards one’s learning environment and peers constitute this notion. Traditionally, behavioural components have not been studied as part of the notion of ‘belonging’, and thus participatory elements, which include the motoric aspects such as action, have not been considered as belonging to this engagement category. However, in the enactive cognition approach, action in interaction always considers the motoric, emotional, and hedonic aspects of action. This study sought, through a microinteractional lens, to examine specific aspects of affective engagement that incorporate the motoric qualities, by studying the contextual matters of action in its social situatedness, and in the “Here and Now” (Garvey and Berndt, 1975, p. 3) of children’s experience.

The data in this work suggests that young children’s interaction with mirroring body metaphors consists of specific forms of enactive patterns. These patterns were seen to be afforded and shaped by the specific AR technology used in these studies. Two important overarching ideas that captures the forms of young children’s interaction are the notions of “flow” (e.g., Csikszentmihalyi, 1990) and “meaningful action chains” (Gallagher, 2020, p. 113), that were foregrounded across young children’s interaction across the data. These two theoretical concepts are helpful in framing the overall quality of enaction in this setting: that the activity was “focused”, “achievable” and “enjoyable” making it an intentional, positive experience (Csikszentmihalyi and Csikszentmihalyi, 1990, p. 216). Furthermore, this intentionality to act with the body metaphors was also shared between participants, and during interaction “joint action” was naturally present (Gallagher, 2020, p. 113), meaning children adopted each
other’s actions, and build upon each other’s movements and actions to build ‘meaningful action chains’.

It is against the background of these two overarching notions foregrounding intentionality and mutuality in young children’s interaction with body metaphors, that three specific theoretical contributions emerge. The three contributions are in the theoretical areas of ‘mirroring’ (e.g., Barsalou et al., 2003; Niedenthal et al., 2005), ‘belonging’ (e.g., Lear et al., 2010) and ‘enactive play’ (e.g., Di Paolo et al., 2014). First, the notion of ‘mirroring’ builds on the concept of ‘embodiment effect’ (e.g., Barsalou et al., 2003) from the perspective of interacting with technologies that incorporate body metaphors. Within the wider theoretical frameworks of social embodiment and grounded cognition, “embodiment effect” suggests that “embodied representations” (e.g., Barsalou et al., 2003, p. 56) elicit mirroring responses, which has a neurological origin (e.g., Rizzolatti et al., 2002). Second, the notion of ‘belonging’ speaks to the notion of young children’s “affective engagement” (e.g., Bond and Bedenlier, 2019), and in particular, how young children’s sense of belonging and wellbeing may be improved through opportunities to interact with body metaphors. Third, the notion of ‘enactive play’ speaks to the notion of bodily improvisation, narrative enactments and objects that involve human metaphors. In the following, each theoretical contribution is discussed in detail.

9.2.1 Mirroring

Theoretically, the process of ‘mirroring’ relates to embodied cognition and the notion of “embodiment effect” (e.g., Niedenthal et al., 2005, p. 187) (see Literature review for more information), one of the key ideas in social embodiment theory about body representations producing enactive responses that mirror the representations in question (for an in-depth description, see Theoretical Underpinnings/Literature Review). The findings in this study suggest young children’s action response as a mirroring of displayed action is a form of ‘embodiment effect’. Children participated in the dialogue around the picture book enactive metaphors by drawing from the illustrated metaphors. Gallese (2005, p. 27) writes how “the sight of an object at a given location, or the sound it produces, automatically triggers a “plan” for a specific action
directed toward that location”. The form of embodiment effect was children producing a corresponding or reflective action drawing from a static pictorial representation of an action. In addition, the researcher’s demonstration of the sensorially augmented enactive metaphor using a slinky produced an ‘embodiment effect’ when Klara participated in partial vocal enaction, evident in her expression and attention to the researcher in the dialogic moment. The body representations hold, in this way, a “simulated potential action” (Gallese, 2005, p. 27), and resonate with studies where ‘communicative mirror neurons’ (e.g., Ferrari et al., 2003) have been studied specifically to understand mouth-related mirror neurons that are activated during facial actions performed by the experimenter in front of a monkey.

Interaction with the body metaphors afforded a realm for young children to reflect on one’s own and each other’s movement, or the movement of the “digital other”. In this way, they afforded a continuous reinforced perceptual monitoring of one’s own movements, and what one’s own actions, in whole body movement “flow”, and an understanding about what these movements are “accomplishing in the world” (Gallagher, 2020, p. 57) in relation to the body metaphors. Normally, as Gallagher writes “[W]e don’t do not attend to the details of our bodily movements in most actions. We do not stare at our own hands as we decided to use them; we do not need to look at our feet as we walk, we do not attend to our arm movements as we engage the joystick.” (Gallagher, 2020, p. 59). Yet reflective practices in learning and meaning making are said to be a “powerful training tool” (e.g., Rania et al., 2021, p. 3). Reflection can support development of self-awareness and improve decision-making process (Greenberger, 2020 in Rania et al., 2021, p. 3). One core idea in reflective practice in professional practices is the development and questioning of their sense of self (e.g., Bruno and Bracco, 2016 in Rania et al., 2021), which for young children may be beneficial given that modally, it is something that they can access and do. All children were aware of their movement, or each other’s movement during the studies, and this was something that was very much foregrounded in children’s interaction. Thus, the importance of whole-body interaction environments that utilise mirroring body metaphors may support children as “active and responsible agents of
their own learning” (Rania et al., 2021, p. 3), and where the evaluation is “not focused on the expected results, but on the process of acquiring knowledge and the development of interpersonal communication skills” (Bruni and Dell-Aversana, 2018 in Rania et al., 2021, p. 3).

Furthermore, this study suggests that there was another form of ‘embodiment effect’ emerging during the digital activity when children enacted with the body representations using their body movement. They engaged in a sustained and ongoing movement-based interaction through their whole bodies whilst being attentive to the pictorial representation. The embodiment effect here, as a movement response, drew not only from the mirroring digital body representation, but also from the response children had to each other’s whole-body movement. In this way, the embodiment effect had two dimensions, both mediated by the digital body representations in a group setting. As Gallese (2005, p. 42) writes, “the somatosensory system is not only responsible for the somatotopic mapping of incoming sensory stimuli, but is also crucial in producing the body’s self-awareness, by means of the peculiar experience of double-touch”. He means that when we are touching something, we are also being touched (Husserl, 1989). In the case of interaction with body metaphors, we see each other, but we also see each other’s bodies in front of us on the display.

The multiple layers of actions, conducted by different persons who are sharing the same space, are all observed by everyone simultaneously through the display, and through each other’s presence in their peripersonal space. Perhaps it is this reflective quality on one’s own movement being followed in the digital system that supported the ongoing embodiment effect – the continuous exploration that was a response to body-based feedback. Perhaps this continuous movement engagement is not dissimilar to that of moving with a dance partner. This notion suggested that further research could be conducted to investigate embodiment effect fostering sustained movement-based interaction with body metaphors. The notions of ‘reflecting on one’s own action’ and ‘embodiment effect’ were explored in this thesis to explore notions of processes of enactive processes building agency over and with the digital
body representation (Chapter 6) and investigating how the reflective process afforded by the system shapes on social interaction between participants whilst interacting with body metaphors (Chapter 7). Chapter 8 presented the notion of ‘embodiment effect’ and how different conceptualisations of it emerge during the flow of interaction.

Traditionally, with studied on embodiment effect that discuss “social contagion” of yawning, for instance, there is an action response that follows an initial simulation of an embodied activity as a form of mimicry (Barsalou et al., 2003, p. 79). Furthermore, specific poses may be adopted by another person, or entrainment may occur such as during times of synchronised walking. This links to existing work in neuroscience on mirror neurons. Because the moving body metaphor is initiated by one’s own movement, the embodiment effect is kind of a “self-perpetuating loop” – it isn’t, especially at the beginning stages of the interaction clear whether the interaction is because the children are attempting to understand “who” or “what” is initiating the movement, and if they detect it is them, then “how” does their movement affect the body metaphor’s response. The findings from this thesis suggest that the quality of ‘embodiment effect’ with moving body metaphors is “ongoing” and responsive, although as if the body metaphor was another person, such as a dance partner, with whom an engaging movement-exploration is taken in an open-ended exploration. The specific contribution from this study has to do with time – the continuous feedback that responds to movement in real time. This adds a new dimension to existing accounts of embodiment effect – the dimension of time, and the opportunity to have an “ongoing” embodiment effect with real-time mirroring.

When someone is moving, and they can see a non-real looking body representation synchronising to their movements, it can be argued that a “category” of the “body” as a perceptual system is established (Barsalou, 2017). This work also taps into the “stickman”-like figure, or a very simplistic and abstract representation of the human body. Barsalou writes how “[S]imulations need not be complete, conscious, or veridical, often being vague, unconscious, and biased instead; they can potentially be implemented at carrying levels of granularity and vividness” (Barsalou, 1999 in Barsalou,
The body metaphor on the display reminds more of a human body representation drawn by children themselves – a stickman – which potentially suggests multiple types of metaphors on different levels.

The findings give preliminary evidence about body metaphor representations encouraging young children’s enactive participation through a process of ‘mirroring’ during interaction. Mirroring is a multifaceted process and fundamental to the development of human cognition (e.g., Gallese, 2005), as exemplified in empirical neuroscience research specifically on ‘mirror neurons’ (e.g., Gallese et al., 1996; Rizzolatti et al., 1996; 1997) which lay basis for neural correlates of social cognition. Mirror neurons, studied extensively in macaque monkeys, belong to a specific class of “premotor neurons” (Gallese, 2005, p. 32) and these neurons charge when a monkey does an action. However, this is also the case when monkeys observed other individuals, that is, monkeys or humans, conducting these actions. Gallese describes this phenomenon as a visual stimulus evoking “directly the simulation of the congruent motor schema which, regardless of whether the action is executed or not, maps the stimulus position in motor terms.” (Gallese 2005, p. 26).

Second, it extends the notion of “reflective practices” – technologies that support reflection on one’s own movement and another’s movement - as a form of enactive practice from the perspective of whole-body movement feedback as affording processes that may support companionship practices and may support social cohesion through different movement-based forms. And how this seems to shape and support interaction that fosters positive intersubjectivity in the forms shared affect such as empathy, and sometimes kinaesthetic empathy (synchronised movement), increasing willingness to experience and partner-up. In this way, the embodiment effect afforded an avenue for reflection. It has been said that self-reflection and group reflection on one’s own practice is a useful skill for group coherence and understanding about oneself, as well as giving valuable information about individual’s own abilities. In movement-based interaction, reflecting on one’s own motion can be beneficial when interacting with parts of the objects that are available for meaning making. However, it is a practice we do not continuously engage in
(e.g., Gallagher, 2020). As he says, ‘We do not attend to the details of our bodily movements in most actions.” (Gallagher, 2020, p. 59). The moments were captured where there was attention directed to movement, and the movement’s effect on the world, and “movement became the shared object of attention between participants” (Gallagher, 2020 talks about something like this in his writings.

Merleau-Ponty: “I observe external objects with my body, I handle them, examine them, walk around them, but my body itself is a thing which I do not observe in order to be able to do so, I should need the use of a second body which itself would be unobservable” (Merleau-Ponty, 1966, p. 107)

Globally, these processes suggest a special ‘embodiment effect’ that arises from this specific physical-digital space with body-based metaphors. This space affords dynamic feedback of one’s movement, which in turn affords reflective capacity for the interactants’ actions. There was evidence in the data that reflection is done as a process of moving and reflecting, and this reflection shifts between the person who is interacting reflecting on their own body movement, but they also shift to become interested in the person who is interacting with them movement.

9.2.2 Belonging

The findings from this study suggest that children’s actions and each other’s action responses contribute to the understanding of affective engagement as a form of ‘belonging’ that accounts for both the positive experience in the learning environment and the peers, and the motoric and hedonic aspects – which have been discussed separately as different forms of engagement in the literature of learning sciences (e.g. Bond and Bedenlier, 2019, p. 2), but which enactive cognition may help us identify as something that is more about how an action is conducted in the moment as part of participatory meaning making. The findings suggest young children’s affective engagement with body-metaphors as form of ‘belonging’ in a group (e.g., Clément and Dukes, 2019, p. 245). Two key theoretical ideas were formulated around the notion of ‘belonging’:
1. Interaction with body metaphors fostered relationality

This builds on the notion of ‘reflection’ as discussed in the above section around ‘Mirroring’. However, the notion of ‘relationality’ in this context focuses on the social dimensions of ‘belonging’, and the way in which interaction with body metaphors afforded quality of relationality with the body metaphors as a kind of ‘play mate’, but also, fostered relationality through the reflective processes fostering “joint action”.

During the digital movement-based interaction, there were moments of 'shared affect' present. The quality of the active participation that is visible in the enaction through the body and in its dynamic, attentiveness to another through gaze, rather than deciding on the specific emotional states or that these emotional states are shared. Emotion that is present in the doing, in the pragmatic task of sharing the tools and the objects and the materials during the interaction, not as observant third person guesses about whether the child was experiencing joy or disappointment. Not what Gallese (2005: 38) has described as emotion imitation, which is the perception and production of emotion-related facial expressions, but rather what Barsalou describes as embodied attitudes or states – he takes a more whole-body perspective to this concept and idea of emotion, and how it is shared in action. And that the simulation does not just produce mimicry, but a response that draws from the original action, yet undergoes a transformation, and this transformation is telling about the person’s intentionality, willingness, and idea about why they are participating in the way that they are participating.

The experience that suggests ‘relationship building’ with the body representation, can be described as an instance of ‘social embodiment effect of affective states’ (Barsalou, 2003, p. 43). Becomes an extension of one’s own physical social space and extends into a digital space where the social dimension is also shared.

In this way, a phenomenological perspective of “reciprocal relation” adds a unique feature to the relating enactively, which is happening especially between the oldest brother in the group. The mother notices how the boy is
using the metaphorical action and responds to him by asking him to make the action slower to be able to notice and observe the wave changing shape. In this way, because the boy is engaged in gazing at the body representation, he is communicating with his mother, who is enactively gesturing in a guiding and focused manner, and their action and enactive strategies are focused around making meaning about changing the metaphorical object. The primary “relationship” in this instance is that between the boy and his mother, and the body metaphor plays a “metaphorical role” – there is less emphasis on the body representation on the screen, only as a “holder of the object”, but there’s less, at this time (different from the beginning), meaning or significance of the body metaphor. For the two younger brothers, however, although they go in and out of the metaphorical action, they aren’t verbally giving indications of changing the sound, or making meaning about this aspect. Rather, they seem to be engaged in a playful exploration of the bodies of the body metaphors. This is perhaps most significantly present in the moment where the middle brother pretends to be “boxing” in air the youngest brother without truly touching him, playfully laughing. Even though everyone does engage in the metaphorical action, it seems apparent that the mother and the oldest brother do not forge a relationship with the metaphorical action that is face-to-face, or any relationship with the body metaphor being perceived as “another being” that has relational qualities. As Zahavi writes, “we can find far more impersonal, anonymous, and linguistically mediated forms of we-intentionality” (Zahavi, 2016, p. 249). What is interesting is how different persons, in the presence of the body metaphors, flicker between having we-intentionality that is forged as a relational quality with the body metaphor, yet that this is not obvious and does not happen all the time, but majority of the time is present.

2. Accessibility through the whole body

During children’s enaction in the experiential workshops, the processes describe actions that depict children’s affective engagement as (1) curiosity in movement exploration around their own agency and the “body metaphors” functionality that is evident in the ways that they engage in unusual movement patterns that are not like any other movement style in general culture, as (2)
empathy that comes out especially as reflection on each other’s movement and different forms of joint action, and (3) joy that comes from creating through movement especially in engaging in different forms of pretend and symbolic play.

Another theoretical perspective to ‘belonging’ from an enactive cognition perspective is the notion of ‘accessibility through the whole body’, and the notion that children could access interaction with body metaphors through their whole-body movement, and the findings demonstrated that children in each workshop participated in exploring movements that incorporated “whole body movements”, i.e. main limbs movements, arm movements, head movements, jumps, different forms of dances etc. In this way, the enactive potentialities were discovered and enacted upon by children, and oftentimes this was done in conjunction with others, affording moments of entrainment (e.g., Clayton et al., 2020) and shared positive affect. In this way, this contribution on ‘belonging’ demonstrates that whole body environments, or any environment, can consider the ‘enactive potentialities’ (Noë, 2006) and the ways in which these may support young children’s participation, enactively, and thus foster a sense of ‘belonging’ with peers, and in the activity at hand. To consider the ‘palette’ of enaction in school and learning environments.

A kind of “I-can” attitude that has been written about by Sheets-Johnstone (2003). With the digital technology, the children had the experience of belonging in two ways – they found their own enactive agency over the digital metaphor through a relational performative actions – they then played with it sometimes exhibiting pretend play, sometimes assigning a ‘role’ for their playmate, such as when Lisa was shouting “Hey, why are you following me?” – this suggested that Lisa was really thinking of the digital other as a playmate and created a playful social occasion involving the digital other in the play. In this way, they both exhibited willingness and intentionality to belong with the digital other, as well as invite the digital other into the play sphere as having a role – such as following them. Gallese speaks of intentional attunement with “the other” becomes “much more than a different representational system; it becomes a person, like us” (Gallese, 2005, p. 31). In this way, we can access
and study dimensions of affect in the context of body metaphors from the perspective of the “functional nature of our social cognitive operations that cut across, and neither necessarily depend on, not are subordinate to any specific cognitive mind ontology” (Gallese, 2005, p. 31). In intentional attunement, we are “attuned to the intentional relation displayed by someone else”, without categorising or objectifying perceptions.

### 9.2.3 Affective imagination

This theoretical contribution speaks to the notion of ‘affective imagination’ (e.g. Fleer, 2013) with body metaphors. Here, it extends the concept, which was first explored in Chapter 8, further, to highlight what it means in the context of interacting with objects that have a human form. Discovering new aspects of objects during exploratory play have been discussed through young children’s trajectories of actions as they discover new aspects of these objects (e.g., Hutt, 1981). However, less has been studied the types of affordances and objects that foreground the human body and its movement in mirroring type displays.

Vygotsky (1978) argued that there is a double and mutual dependence between imagination and emotional experience. Doubled, because imagination is based on experience and experience is based on imagination. Every experience a child has a specific image associated with it, and this image has a corresponding feeling, an affective tone. Imagination begins with accumulation of experiences. Children engage in imaginative play, their predominant activity. We know that there are specific types of trajectories children engage in with objects (e.g., Hutt, 1981), that follow specific formulas, such as focused exploration that transforms into relaxedness, followed by play. This contribution highlights the notion of ‘affective imagination’ with body metaphors and engagement over time in terms of exploring features of an object.

Over the course of the empirical studies, especially Chapters 5, 6, and 8 which featured pretend play, featured a notion of ‘flickering’. This contribution suggests with body metaphors, enactive potentialities are “refreshed” continuously. Interaction did not stop after function had been discovered. Of course, this could be done with any toy – that is the main theme of pretend
play and symbolic play, that imagination lends itself for a pen to become a skyrocket or a sock to become a snake. But the particular play and flickering quality that the body metaphor affords suggests a particular motivational factor, which keeps children engaged in exploring the enactive metaphor, and the whole-body interactive body metaphor.

Young children’s interaction with body metaphors foregrounds the nuanced iterations of actions during interaction and action-on-action chains: a re-enactment or a ‘copying’ of an action during the process of mirroring are not directly copied from the body metaphor, but rather individualised in the responding action, thus creating iterations and meanings of body metaphor actions within the ‘social situatedness’ of the dialogue and interaction (van Dijk, 2018, p. 17). The meaning in these instances come from playfulness, the joy of discovery and imagining (enactive) potentialities for the body metaphor in the ongoing flow of interaction. In this way, the notion of ‘affective imagination’ speaks to the enactive cognition concept of ‘narrative practices’ (e.g., Gallagher, 2020) and ‘enactive play’ (e.g., Di Paolo et al., 2014). While ‘pretend play’ (e.g., Hutt, 1981; Garvey and Berndt, 1975) has been studied for a long time, it is with this particular object that ongoing time-based and open-ended experiences can be studied from young people’s perspective.

The concept of ‘flickering’ is another theoretical notion developed originally by Vygotsky, and closely related to ‘affective imagination’. Fleer (2013, p. 2088) writes how “[C]hildren flicker between real and imaginary worlds” during play, and “find themselves in the borderline between these worlds.” The function of ‘flickering’ is to create a “dialectical relation” and an “emotional tension” which helps children imagine ideas that are not always “easily observable” (Fleer, 2013, p. 2088). The notion of ‘flickering’ was visited in Chapter 8 that focused on ‘affective imagination’ with body metaphors. As part of a theoretical contribution, it draws the reader’s attention towards two dimensions of ‘flickering’ with body metaphors from enactive cognition perspective. The two dimensions are accessibility and repetitive continuity. The notion of accessibility in the context of young children interacting with body metaphors relates to the idea that children could access novel ‘identities’ continuously.
with the experience. These identities would relate either to ‘self’ or a ‘pretend play’ role. The notion of repetitive continuity relates to the notion of “flow”, but highlights in relation to flickering, the notion that children would change their identity in an ongoing fashion. Their play identity with body metaphors would change as their peers would change their play identity, or a play theme. They would adopt and change their play identity, and then go back to, for example, making meaning about the enactive metaphor and changing the sound. In this way, the ‘flickering’ with body metaphors had qualities that were specific to this environment.

From an enactivist play perspective… this further manifested as a kind of an “I can attitude”-attitude (Sheets-Johnstone, 2003). There was motivation for children to explore through their whole bodies with this object, and it had the pretend play, and identity focus as well. In this way, this theoretical contribution speaks to Di Paolo et al.’s (2014) call for developing the enactivist framework beyond mere “contextual framing”, to afford empirical theory/experiment cycles, by looking at specific enactive processes of joint action, joint attention and the formation of meaningful action chains in the context of young children’s interaction with body metaphors.

9.3 Methodological contributions

The methodological contribution consists of a method, Affective Imagination in Motion, that was developed over the course of the empirical work in this thesis. The method drew especially from social embodiment theory (e.g., Niedenthal et al., 2005) and the notion of “embodiment effect” and foregrounded embodied simulations through the use of body metaphors as prompts for enaction. The method gave access to three dimension of affective engagement from enactive cognition perspective: narrative practices, joint action, and meaningful action chains. In this way, the methodological contribution extends the notion of ‘affective engagement’ (e.g., Reschly et al., 2020; Bond and Bedenlier, 2019) by paying attention to enactive dimensions of engagement. In this way, it brings together the elements of engagement, the cognitive, the behavioural, and the affective, which are often treated as separate in analysis of children’s engagement. Through the method, it was
possible to access the motoric, emotional, and hedonic aspects of interaction, which are regarded as a single unit of experience in an enactive cognition approach (Gallagher, 2020).

The analytical framework took a grounded theory approach drawing from three qualitative analytical frameworks: embodied participation (e.g., Goodwin, 2018), microinteractional analysis (e.g., Goodwin, 2018; Nemirovsky et al., 2012; Nygren et al., 2022) and interpretative phenomenological analysis (e.g., Smith et al., 2022) to understand young children’s affective engagement in a new social space with “body metaphors”. This research contributes to enactivist accounts/theories of the notion of ‘affect’ through identifying specific affective-enactivist processes of young children’s interaction within this physical-digital setting.

The contributions to method accessing “narrative practices” suggests that children can access different parts of enactive metaphors and their meaning through a purposely designed narrative intended to frame an action from a fictional perspective. Children affectively ‘engage’ with a body metaphor representation, such as in Chapter 5, and express their own meaning through embodying the represented idea. Their vivacity (Gallagher, 2020) is transformed from a static picture and idea in their re-enactment that is not only a re-enactment, but them telling a story about it in the moment. Within a story framing, the narrative action may become more focused. Gallagher talks about the types of perceived environments and objects, and how “[W]hen, for example, I perceive something, I perceive it as actionable. That is, I perceive it as something I can reach, or not; something I can pick up, or not; something I can hammer with, or not, and so forth. If I perceive an event rather than an artifact, I perceive it as something I can intervene in, or not.” (Gallagher, 2020, p. 33).

This approach enabled accessing ideas around framing an action within a specific narrative or fictional context. Some of these emerged naturally for children, whereas other times, these were suggested by the researcher, such as from interacting with the story book first. In this way, it suggests that there may be benefit for framing an action using a picture book, and that can not
only give access to the meaning of the action, but also the emotional and the hedonic aspects of the action. It appeared that there were moments of great emotional intensity, and joint action, when movement constituted actions with personal and culturally derived signification (Gallagher (2020, p. 63). Gallagher calls this ‘Landscape of action’ and the interest here was how children frame their actions, in other words, how they frame their own action and how this is evident in the way that they act during their embodied participation, and exploratory workshop participation. The first was a methodological approach to studying enactive engagement from an affective perspective with specific prompts and materials, and their iterations from a pragmatic perspective, within interaction. This enabled affective engagement to be studied more broadly in a context-specific way.

9.4 Design contributions

This thesis makes two contributions to whole body interaction design from an enactive cognition perspective. The contributions are: (1) Fictional framing of action, and (2) Translating enactive metaphors from physical to digital.

A separate guideline and a quick checklist for designers wishing to conduct work from an enactive cognition perspective are discussed in the next chapter (Chapter 11).

9.4.1 Fictional framing of action

The findings demonstrated children’s strategies in enacting on the body metaphor representations giving insight into how young children engage, interact and express their ideas about different layers of metaphors about motion in an illustrated picture book and with digital movement-based interactive platform foregrounding whole body figures. It speaks to earlier evidence about the ideas in embodied learning design of the notion of children’s experience of ‘being there’ with digital, movement-based interactives, and highlights the possibility use to study the early encounters (Ackermann, 2004) with artefacts before beginning the true design work with a digital technology. This could be a good resource for embodied sketching (e.g. Márquez Segura et al., 2016b) protocols or methods when designing with
young children and movement-based interactives and enactive metaphors. The way in which children accessed notions of the metaphor suggests that the action and attending to action in design situation can be a beneficial way to explore different fictional framings for enactive metaphors. While the children responded to the picture book’s narrative framing of the metaphor, and made connections, during the digital interaction they also imagined new ways of using a tool – the whole body representation. This suggests a way to explore fictional framings for enactive metaphors that go beyond a repetitive pattern of interaction or action to look at more of the meaning that emerges, and what the action suggests meaningfully for children in that environment.

In addition, there were limits to children enacting the connection between the action and the voice during the slinky toy activity. However, it still demonstrated children’s ability and accessibility to combine ideas of multisensory combining with different objects and demonstrate their willingness to engage, despite limitations of expression in that situation. Overall, the data suggests that there is reason to approach exploring young children’s participation in building metaphors that are multisensory, where their affective participation can be used to draw on their experience, which indicates further changes and opportunities for design opportunities with the materials, and activities, and each other, and the social situatedness of the interaction with enactive metaphors.

9.4.2 Imagination through the body

The body metaphor acts as a kind of “simulation” of human body movement. This was not always correct, as the light in the environment was not sufficient, and the detection suffered from it. However, it does provoke further questions and discussion around the notion of the centrality of the visual, and our oculocentric culture. As Luft says (quoted in Turkle, 2009, p. 80): “Don’t be fooled by the graphics.” The young children who participated in this study demonstrated that simulation has shown that in minimal design setting, children’s own imagination was evoked. The simulation is not real, but it allows for the imagination to flourish, and come up with novel ways of interacting with the object such as running behind a chair, talking to it, such as a playmate
“Stop following me!”, or imagining that it is a well-known cartoon superhero, such as the Superman. Therefore, with young children and body metaphors, which in this study remind more of a stickman character that a child themselves would draw, seemed to hold an affective allure to children, as it presented to them as a tabula rasa. This asks for more research to be conducted with simple designs where the minimal bare bones of interaction with systems can be accessed: what does it feel like, what does it mean, for a computer system to follow your movement? What do you make of it? What does it feel like to see each other on the display moving around? These simple technology ideas can open doors into young children’s meaning making, enactive cognition and much more, beyond the engagement factor of pretty pictures and ready-made tools and designs. As Kinney writes, (quoted in Turkle, 2009, p. 80): “As technology becomes more and more sexy, the problem is that we get lured into it, the seduction, and we actually come up with what we think are good displays but actually they’re bad.” It is, then, perhaps the versatility of the use of installations such as body metaphors that prove out to be most useful for embodied learning designs, and enactive metaphor implementations.

9.5 Limitations

There were methodological challenges emerging from this work, that future work can address. In future work, it may be beneficial to include several characters in the picture book, rather than a single one. Furthermore, supporting enaction during experiential workshops: the youngest children enacted the picture book character’s actions, but only if they were not being held on a lap. Timing: it may be most beneficial to explore whole body interaction with young children during early hours of the day, rather than later during the day. In the school settings, some children reported feeling hungry, as they were interacting minutes before their lunchtime would begin. In addition, children who participated immediately after lunch were excited to participate, yet had less concentration in the picture book activity, or in the whole-body interaction technology. Also, the temperature of the room affected some children’s participation, as well as the location in the school: for example in art class, some children would want to go and bring different objects to
interact with in front of the display. These are flaws in qualitative work especially in microinteractional work that seeks to study phenomena in the participant's own environments.

It's important to take into consideration the fact that this research project utilised a Google-based platform for interaction that is readily and freely available and can be developed by anyone as a free software. Movement-based technologies are not without critical issues, and in fact, many issues remain. However, tools for research are needed, and we can tell those children are simultaneously positive engaged, yet also critical about their experiences, and sustainably interested and attended to, despite the technical glitches experienced during the research workshops. What this research project’s findings support is building transparency around the technology, while acknowledging its positive use potential especially when considering whole body interaction technologies for embodiment. However, it is essential to understand that any emergent technology comes with a set of critical questions about the technology’s place in society. It has been an attempt of this research project to attend to these critical issues while acknowledging otherwise the opportunities and challenges this type of technology may afford to building experiences for embodied learning and beyond. Children’s interest in the technology could have been built more space for - transparency of how a system functions could be built into the experience. There must be an opportunity for further dialogue around the technology, not just interaction with the technology.
Chapter 10  Designing with enactive metaphors in whole body interaction environments

Increasingly, informal learning environments such as science museums develop and include digital exhibits that engage visitors via movement-based interaction (e.g., Wishart & Triggs, 2010; Price et al., 2016; Tscholl & Lindgren; 2016; Price, 2017). While museums have always relied on visitors’ engagement through visceral, emotional and sensory level (e.g., Levent and Pascual-Leone, 2014), recent developments in digital technology offer designers tools to create novel types of multisensory interaction experiences. For learning scientists, these increasingly more accessible, accurate and affordable technologies provide an opportunity to study how specific aspects of movement-based interaction design may support embodied learning.

This Chapter makes two practical design contributions. First, it presents guideline to designing whole body interaction environments that draws from the findings and experience from the empirical work conducted as part of this thesis. Second, it presents a summary checklist as an overview of an enactive cognition design approach to whole body interaction design. Together, these two design components present an accessible and generalised entry to considering a design process from an enactive cognition perspective.

10.1 Designing for whole body interaction environments from an enactive cognition perspective

As discussed in the previous chapter (Chapter 9), a theoretically framed design guideline can give richer and deeper meaning to the design work that is undertaken. It can lean back to findings from research conducted using empirical methods, and thus leans to verifiable data. Here, a simple design guideline draws from the empirical and theoretical development conducted as part of this work. Ten principles emerged from this work as the main guideline for conducting design work with whole body interaction environments. In the following, a list of the ten components will be given, with descriptions of each one.
1. Stories are important

Framing an action with a story, such as one presented with a picture book prior to interaction, can prompt children to enact within that narrative frame during whole body interaction. The movement-based installation does not require to be visually designed to cater for this narrative necessarily – children can imagine acting as if they were, for example, a character from a picture book.

2. Better in groups than alone

Children are motivated to interact in whole body interaction environments together. Exploring different feedback modalities collaboratively through movement is exciting for children. Learning about functions and how one’s action affects the world encourages joint action in whole body interaction environment.

3. Allow time for self-identification

Children were engaged in exploring how their own movement affected the feedback in the whole body interaction environment. For example, they enjoyed discovering “their own sound” which would respond to their arm movements, and this would engage them in further exploration. Making the connection between the movement and feedback as clear as possible can help children discover their own agency quicker. However, at times, this may not be technologically possible if, for example a shadier room affects the detection quality. At these, the process of identification may be changed, but it may still be engaging for children, adding a layer of mystery to their exploration.

4. Maximising engagement with enactive metaphor

Developing digital tools and artefacts in the system that relate to the science topic can be developed to cater through whole body movement, not necessarily just one part of the body (such as hand-based gestures). The use of lo-fi prototypes, such as picture books, prior to translating enactive metaphors into a digital platform may support designers to work with intended actions in more depth, and gain understanding about different affective
dimensions and opportunities and challenges for designing for action and joint action.

5. Seeing one's own face vs not seeing it

Seeing one's own face as ongoing visual feedback in a whole body interaction environment can shape the interaction to be more about the face, and less about the whole body movement.

6. Flickering and time

Timing sensorial feedback features, such as introducing them in a sequence, may afford opportunities to move into and out of an open-ended interactive experience into enaction that focuses, for example, on specific enactive metaphors. This approach to design may afford opportunities for children to engage with whole body movements and improvised pretend play experiences at one point during the interaction, while foregrounding specific enactive metaphors at other times.

7. Choosing technology with regards to accessibility

This consideration foregrounds young children’s participation and accessibility to explore ideas, such as science phenomena, through digital technology. It reminds us that whole body interaction technologies can afford specific opportunities for interaction that afford experiences that enable children to engage in meaningful activities such as pretend play and interacting together in a group or in a family situation.

8. Ethics and privacy

It is important to acknowledge and respond to young children expressing interest in the function of movement-based technologies when they encounter them. During interaction, children may make note about the system for example “following” their movements. These may be opportune moments to “open” the technological “black box” and demonstrate how the technology actually works by showing them the camera and explaining the function of the software detecting the interactant’s joint movements and drawing an image on
a display. Furthermore, the movement-based technology software that was used in this thesis did not record or store any video of children’s interaction. However, because the technologies do use the webcam feature of a computer, they may seem to record such videos. This may be an issue that for example parents of young children, or children themselves, may ask questions about. It is therefore an important issue for a designer to understand and make explicit. In this way, the interactant’s can be sure that their privacy during interaction is respected.

9. Allowing wide gestural palette

From an affective engagement perspective, it may be beneficial for a whole-body interaction environments to allow for a wide range of different kinds of gestures and actions that match activity. These may not need to provide feedback or be present at all times but incorporating whole body movements can encourage movement exploration and thus increase enjoyment and motivation for explore.

10. Adults and children interacting together

Adults and children can enjoy and find new ways of interacting together through whole body movement. It doesn’t matter what your height is, or if you need to stay seated during the interaction, for example, all bodies can participate. Adults can scaffold for young children to find dimensions of the interaction that they weren’t yet aware of. Feedback can be designed to be the same for any different body that interacts, or it can be designed so that each body and its differences, for example, in height, creates different types of feedback.

10.2 ANEMONE - Enactive participation checklist

A short checklist consisting of main design points of consideration that may support designers working to create whole body interaction experiences and environments from an enactive cognition perspective. With seven key points drawn from the guideline above, it summarises the core elements of an approach that foregrounds enaction.
1. **Accessible.** Consider young children’s capacity to participate in interaction through whole body movement.

2. **Narrative.** Stories are important to evoke imagination about a future whole body interaction design and its contextual matters.

3. **Enactment.** Look for opportunities for enactment, re-enactment, and the whole body enactive potentialities.

4. **Movement.** Allow playful whole body movement around the designed-for action.

5. **Ownership.** What is happening? What happens when you move?

6. **Neighbour.** A child like to interact with the design together with someone.

7. **Ethics.** Ethics and Privacy placed at the heart of installations using motion detection.
Chapter 11 Conclusions and Future Work

This thesis, *Landscapes of Affective Interaction: Young Children’s Enactive Participation with Body Metaphors*, investigated enactive processes of affective engagement. Adopting an enactive framing and microinteractional analytical approach, the thesis demonstrated, through four empirical studies, that the traditional definition of affective engagement in learning sciences (e.g., Reschly et al., 2020; Bond and Bedenlier, 2019) may benefit from a wider conceptualisation that incorporates the motoric, emotional, and hedonic qualities of action and interaction (Gallagher, 2020). The enactive approach to studying young children’s affective engagement in group interaction with mirroring body metaphors has demonstrated that such theoretical-analytical approach can give insights about how young children make meaning in movement-based interactive experiences through joint action, how they build relationality both with each other and mirroring body metaphors, and how these experiences can foster positive intersubjectivity. In this way, it foregrounds the essentially embodied, or grounded, nature of cognition, action, and affective engagement.

Would a technology that mirrors movement using a body metaphor afford a shift in a technological landscape? Would young children and their families benefit from interactive environments utilising whole body movement beyond button-pressing, finger-tapping, or scrolling? Is so, then there is a need to understand more deeply what it is like for children to *experience* whole body interaction environments, as it may shape the design, and given children more opportunities to participate meaningfully. Can it afford exploration about what it means to relate to each other, and to digital “others”? And even if movement-based technologies were not to salvage some of the pitfalls of our technological landscape that considers the whole body in quite simplistic ways, the powerful social processes of mirroring, joint action, and play from the perspective of movement that may contribute to our understanding of affective engagement, and support the understanding of body movement and its role in embodied meaning making at large, foregrounding the physical, sensing body that makes meaning as an embodied whole.
From an enactive cognition perspective, this reflective capacity afforded by the mirroring body metaphors then, this thesis argues, increases the ‘enactive potentialities’ of the environment with body metaphors and one’s own body movement. Once children became aware of the mirroring process, they begun to interact more and in novel ways, continuing their movement exploration, trying out countless types of jumps, dances, poses, and so on. This highlights the ways in which the participants are in the environment together (e.g., in Chapter 7). It highlights that it is a body, which brings about more play opportunities (Chapter 8). It reminds the people who are interacting that they have a whole body, and that they can move and play with it in this space. It engages and invites to playfulness – to Landscape of Interaction (Gallagher, 2020, p. 42). The reflective capacity was accentuated “intentional feedback”, “a perceptual sense that my action is having an effect on the world” (Gallagher, 2020, p. 59). But because it is not always entirely clear what the body metaphor affords, what the action is accomplishing, this is not always clear with the body metaphors if the technology is not at a suitable state.

11.1 Proposals for future research with whole body interaction environments and body metaphors:

The following points emerged from the Findings and form possible new avenues for exploring mirroring body metaphors.

11.1.1 Mirroring body metaphors as supporting group reflection

This as a group reflection skill, which can also contribute to companionship. The body metaphors accentuate a reflection on one’s own action, and another’s action – an activity we don’t engage as much (Gallagher, 2020, p. 59). This may support companionship especially from the perspective of affording a reflection via mirroring body metaphors. Being aware of the other participant and responding to their actions via gazing at the display simultaneously. The body metaphor gives a kind of a playful mediator to the action, where different “howabilities” and “I can’s” can be exchanged. There is a warmth to the quality of attending to each other’s body and body movement, that doesn’t involve competition or striving, but children can just be, like in the
Given experiences with positive intersubjectivity, children may benefit from interaction with body metaphors, and it may support companionship and other areas such as ‘kinaesthetic empathy’. Areas that may benefit from the use of body metaphors may be, for example, body psychotherapy with mirroring technologies. Mirroring is already a well-known intervention to engage a child actively in the process. For example Tortora discusses the details of such activity as “a process that involves a therapist literally embodying the exact shape, form, movement qualities, and feeling tone of another person’s actions, as if the therapist were creating an emotional and physical mirror image” (Tortora, 2006, p. 259). Through mirroring, a connection between the client and the therapist can be developed, which can further encourage “meaningful imitation skills and social engagement” (Martin, 2014, p. 549).

Given children’s interest and engagement with body metaphors, specific groups such as children with autism, may benefit from future research with body metaphors especially from an enactive cognition perspective. For example, dance and movement therapists have worked with autistic children since 1970s, with Janet Adler pioneered the field. They used the activities of reflection, attunement, synchronous movement interactions, mirroring, and rhythm as ways of connecting with and encouraging communication with children with autistic spectrum (Martin, 2014, p. 549). Exploring support and interaction with body metaphors may be beneficial in this area of research. Feeling of safety is important. Addressing the sensitivities of the children. The children’s initial assessing of the environment: confronting the stickman. “Several studies have now linked the DMT intervention of mirroring to the MNS as a means to increase empathy, attunement, and social interactions with a client, including those on the autism spectrum (Martin, 2014, p. 549).

11.1.2 Enactive metaphors vs. whole body interaction environments

In terms of incorporating enactive metaphors in embodied meaning making, this study suggests that in design there’s a need to look at creativity through the body in relation to enactive metaphors. This has already to some extend
been studies in narrative practices and studies, but in design this affords both opportunities and challenges. The embodiment effect of staying in tune affords a constant connectedness that keeps the interaction sustained, so over longer periods of interaction, this incorporating of other body movements may prove beneficial for play, for example.

In Laban/Bartenieff analysis (Wahl, 2019, p. 8), for example, there is a concept called “style stretch” whereby humans develop movements “that you have been less likely to inhabit, thus expanding your range of physicality.” Talking about locomotion movement patterns, Lacquaniti et al. (2012) describe in their review paper how these are not fixed but highly flexible. They continue: “Variability and flexibility of behaviour may be instrumental for learning and exploration of different solutions in different environmental contexts.” (Lacquaniti et al., 2012, p. 825). Infants display a high degree of variability in their movements, even during foetal stages (Lacquaniti et al., 2012, p. 825). From crawling, which can be down in a variety of ways including on hands and knees, or hands and feet, or hands and buttocks or the belly. This versatility, Laqcuani et al. (2012) describe “reflects a flexible coupling between cervical and lumbosacral CPGs (controlling upper and lower limbs respectively) that persists till adulthood.” (Lacquaniti et al., 2012, p. 825). These types of conceptualisations may frame future work when exploring hexis, howability and intergenerational interaction with whole body metaphors.

11.1.3 Embodied metaphorical instruction

There has been much discussion about the embodiment effect of having someone “demonstrate” to you how an action is done, and how this has supported, for example, long term memory formation about a task. However, less has been written about enactment as a “metaphorical instruction in a family interaction situation, where an adult participates in an interaction, that includes “reciprocal relation” (e.g., de Bruin et al., 2012), that there is a relationship between the person who is “outside” the interaction “looking in”, in an enactively “scaffolding” capacity. Their relationship with the metaphorical body representation remains as an observer as they do not directly, mirror-like, face the body representation, but rather, due to the limitations of the
interaction maximum capacity (three persons), need to stay outside the “eye” or view of the technological system.

11.1.4 Enactive play with body metaphors
This research project has demonstrated that one of the key themes of young children interacting with body metaphors is the notion of playfulness. Benefits of play and human development are “crucial to healthy brain development” (e.g., Brown, 2010), yet it has been demonstrated that young children play less these days. Considering how digital technology landscape has created several novel interactional modalities and ways to access novel types of play, it may be worth researching children’s play especially in terms of their social engagement and their body movement in whole body interaction environments.

11.1.5 ‘Habitus’ and ‘hexis’ in embodied meaning making
Different bodies have different effects on the world, and some of this comes down to the notion of ‘bodily ability’. Bodily abilities come down to many factors, and ‘habitus’ is one of them. This is a well-known research area in sports research, where physical requirements to a particular sport are explored to enable someone perform at their best (e.g., Wellard, 2007, p. 85). Chapter 7 briefly discussed the bodily notions of ‘hexis’ and ‘habitus’ (e.g, Bourdieu, 1990) and how physical differences of participants’ bodies, such as the height of an adult’s body, or the width that their arms can reach in comparison to their children’s, can shape the interaction. From an enactive cognition perspective, there is valuable research opportunity to design environments that consider these types of differences, especially in whole body interaction environments where adults and children, for example, interact together. They can foreground the rich diversity of bodily and movement qualities, and “howability”. The body has been framed through considerations around the ‘ability to participate’ in embodied ways has been explored to a great length for example in disability studies (e.g., through notion of “howability”), and in sports through “physical identities” (e.g., Wellard, 2007). There has been less discussion about the role of the ‘habitus’ in embodied participation and participatory sense-making from the perspective of meaning making with
whole-body interactives themed around science, and how the different ‘habitus’ affects and shapes children’s experience of science, action, and movement, and having an effect on the world.
Bibliography


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Appendix A1: Information Sheet (Chapter 5)

Institute of Education

Student Research Project / Move2Learn
October 2017 - October 2020

Information Sheet for Parents

UCL Research Ethics Committee Approval ID Number: 26364105/2018/03/147

Title of Study: Embodied Cognition and Science Learning
Department: Department Culture, Communication and Media
PhD Researcher: Minna Nygren
Supervisor: Professor Sara Price (Move2Learn Co-PI)

Your child is invited to take part in this research project. Before you decide it is important for you to understand why the research is being done and what participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish for your child to take part. Thank you for reading this.

Who is conducting this research?

This is a doctoral research study funded by the Wellcome Trust and ESRC, and run in conjunction with Move2Learn project (http://www.move2learn.education.ed.ac.uk). The aim of this study is to understand how we can improve the educational design of future science exhibits and installations in the context of informal science learning (2-7 years). In particular, through a better understanding of the role of bodily action and gesture in facilitating young children to think, learn, and communicate about science in informal environments when interacting with play-based science installations.

We hope that you would like your child to take part. This information sheet will try and answer any questions you might have about the project, but please don’t hesitate to contact us if there is anything else you would like to know. Please explain the research to your child and discuss whether or not they want to take part. The researcher will always ask the children before any interaction/ tasks interviews and make it clear that they can drop out if they wish, with no negative consequences.

Why are we doing this research?

Understanding how body-based gestures, actions, hands-on) experiences that are aligned with science concepts will help us to design interactive exhibits that will better support young children to express, communicate, integrate, and develop their scientific skills, and so doing to inform the design of interactive experiences in museum contexts.

Why is my child being invited to take part?

We are specifically studying young children’s (aged 2-7 years) interaction with science ideas.

We are currently exploring the kinds of actions and gestures which might support young children’s scientific thinking. We are inviting your child’s nursery/school to take part in studies which will help inform our thinking on this topic.

What will happen if my child takes part?

A researcher will visit your child’s nursery/school. The researcher will invite children to interact with toys that relate to exhibits which feature at the London Science Museum (Theremin Bollards, Sound Wave Generator). Children will be asked a few questions about the science ideas relating to these toys. They will be invited to freely interact with these toys and will then be asked about their experience. Each of these interactions will take about 10-15 minutes and will also be video-recorded.

Will anyone know if I have been involved?

Your child’s participation in the research will be kept confidential and data will only be shared within the project team. A governance agreement between all partners is in place to ensure safe a secure sharing and use of research data within the project team. Video and other digital data will be stored securely on UCL Data Safe Haven, with access only to the research team. The data will be kept for 10 years, after which time it will be destroyed. Where possible data will be anonymized during transcription and analysis, and video data de-identified. No names of participants will be released outside of the project team. Your consent is specifically sought for use of images or video data excerpts of your child to be used in dissemination activity. You are not obliged to give consent for any or all of these.

Could there be problems for my child if they take part?

The research should not interfere with your child’s nursery/school day. If your child expresses or shows any signs of being uncomfortable during any of the research activities outlined, we will immediately stop engaging them in the research activities.

What will happen to the results of the research?

The research results will be shared through conference and journal publications, social media, project website and blog posts. Your child’s name will never be disclosed in any published results, and your consent is sought for use of video data, since anonymity cannot be guaranteed in this instance.

Do I have to take part?

It is entirely up to you whether or not you choose for your child to take part. We hope that if you do choose for them to be involved and that they will find it an enjoyable and valuable experience.

Thank you very much for taking the time to read this information sheet.

If you would like to be involved, please complete the following consent form and return to your child’s nursery/school by July 31st.

If you have any further questions before you decide whether to take part, you can send me an email.
Appendix A2: Information sheet (Chapter 6 and 8)

Institute of Education

Student Research Project / Move2Learn

Information Sheet for Parents

UCL Research Ethics Committee Approval ID Number: Z6364106/2018/03/147

Title of Study: Designing for Embodied Science-Themed Digital Installations for Children

Department: Department Culture, Communication and Media

PhD Researcher: Minna Nygren

Supervisor: Professor Sara Price (Move2Learn Co-PI)

Your child is invited to take part in this research project. Before you decide it is important for you to understand why the research is being done and what participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish for your child to take part. Thank you for reading this.

Who is conducting this research?

This is a doctoral research study funded by the Wellcome Trust and ESRC, and run in conjunction with Move2Learn project (www.move2learn.net). The aim of this study is to understand how we can improve the educational design of future digital science installations in the context of informal science learning (2-7 years). In particular, through a better understanding of the role of bodily action and gesture in facilitating young children to think, learn, and communicate about science in informal environments when interacting with play-based science installations.

We hope that you would like your child to take part. This information sheet will try and answer any questions you might have about the project, but please don’t hesitate to contact us if there is anything else you would like to know. Please explain the research to your child and discuss whether or not they wish to take part. The researcher will always ask the children before any interaction/ tasks / interviews and make it clear that they can drop out if they wish, with no negative consequences.

Why are we doing this research?

Understanding how body-based (gestures, actions, hands-on) experiences that are aligned with science concepts will help us to design interactive exhibits that will better support young children to express, communicate, integrate, and develop their scientific skills, and so doing to inform the design of interactive experiences in museum contexts.

Why is my child being invited to take part?

We are specifically studying young children’s (aged 2-7 years) interaction with science ideas. We are currently exploring the kinds of actions and gestures which might support young children’s scientific thinking, and how these may inform the design of an interactive installation design. We are inviting your child’s nursery/school to take part in studies which will help inform our thinking on this topic.

What will happen if my child takes part?

A researcher will visit your child’s school. The researcher will invite children to participate in an interactive storytelling session that includes playful activities with toys that relate to the science-themed installation. Children will be asked a few questions about the science ideas relating to these toys. They will be invited to freely interact with these toys and will then be asked about their experience. Each of these interactions will take about 10-15 minutes and will also be video-recorded.

Will anyone know if I have been involved?

Your child’s participation in the research will be kept confidential and data will only be shared within the project team. A governance agreement between all partners is in place to ensure safe a secure sharing and use of research data within the project team. Video and other digital data will be stored securely on UCL Data Safe Haven, with access only to the research team. The data will be kept for 10 years, after which time it will be destroyed. Where possible data will be anonymized during transcription and analysis, and video data de-identified. No names of participants will be released outside of the project team. Your consent is specifically sought for use of images or video data excerpts of your child to be used in dissemination activity. You are not obliged to give consent for any or all of these.

Could there be problems for my child if they take part?

The research should not interfere with your child’s school day. If your child expresses or shows any signs of being uncomfortable during any of the research activities outlined, we will immediately stop engaging them in the research activities.

What will happen to the results of the research?

The research results will be shared through conference and journal publications, social media, project website and blog posts. Your child’s name will never be disclosed in any published results, and your consent is sought for use of video data, since anonymity cannot be guaranteed in this instance.

Do I have to take part?

It is entirely up to you whether or not you choose for your child to take part. We hope that if you do choose for them to be involved and that they will find it an enjoyable and valuable experience.

Thank you very much for taking the time to read this information sheet.

If you would like to be involved, please complete the following consent form and return to your child’s school by May 20th.

If you have any further questions before you decide whether to take part, you can send me an email.
Appendix A3: Information sheet (Chapter 7)

Institute of Education

Student Research Project / Move2Learn

Information Sheet for Parents and Children

UCL Research Ethics Committee Approval ID Number: Z6364106/2018/03/147

Title of Study: Designing for Embodied Science-Themed Digital Installations with Children

Department: Department Culture, Communication and Media

PhD Researcher: Minna Nygren

Supervisor: Professor Sara Price (Move2Learn Co-PI)

You and your child are both invited to take part in this research project. Before you decide it is important for you to understand why the research is being done and what participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish for yourself or your child to take part. Thank you for reading this.

Who is conducting this research?

This is a doctoral research study funded by the Wellcome Trust and ESRC, and run in conjunction with Move2Learn project (www.move2learn.net). The aim of this study is to understand how we can improve the educational design of future digital science installations in the context of informal science learning (2-7 years). In particular, through a better understanding of the role of bodily action and gesture in facilitating young children to think, learn, and communicate about science in informal environments when interacting with play-based science installations.

We hope that you and your child would like to take part. This information sheet will try and answer any questions you might have about the project, but please don’t hesitate to contact us if there is anything else you would like to know. Please explain the research to your child and discuss whether or not they want to take part.

Why are we doing this research?

This is a doctoral research study funded by the Wellcome Trust and ESRC, and run in conjunction with Move2Learn project (www.move2learn.net). The aim of this study is to understand how we can improve the educational design of future digital science installations in the context of informal science learning (2-7 years). In particular, through a better understanding of the role of bodily action and gesture in facilitating young children to think, learn, and communicate about science in informal environments when interacting with play-based science installations.

We hope that you and your child would like to take part. This information sheet will try and answer any questions you might have about the project, but please don’t hesitate to contact us if there is anything else you would like to know. Please explain the research to your child and discuss whether or not they want to take part.

What will happen if my child takes part?

A researcher will visit your child’s STEM club. The researcher will invite you and your child to participate in an interactive storytelling session that includes playful activities with toys that relate to the science-themed installation. The researcher will chat both with you and your child about the science ideas relating to these toys and activities. You will be invited to freely interact with these toys. Each of these interactions will take about 25 minutes and will also be video-recorded.

Will anyone know if I have been involved?

Your and your child’s participation in the research will be kept confidential and data will only be shared within the project team. A governance agreement between all partners is in place to ensure safe and secure sharing and use of research data within the project team. Video and other digital data will be stored securely on UCL Data Safe Haven, with access only to the research team. The data will be kept for 10 years, after which time it will be destroyed. Where possible data will be anonymized during transcription and analysis, and video data de-identified. No names of participants will be released outside of the project team. Your consent is specifically sought for use of images or video data excerpts to be used in dissemination activity. You are not obliged to give consent for any or all of these.

Could there be problems for my child if they take part?

The research should not interfere with your child’s STEM club activities.

What will happen to the results of the research?

The research results will be shared through conference and journal publications, social media, project website and blog posts. Your name or your child’s name will never be disclosed in any published results, and your consent is sought for use of video data, since anonymity cannot be guaranteed in this instance.

Do I have to take part?

It is entirely up to you whether or not you choose for yourself or your child to take part. We hope that if you do choose for them to be involved and that they will find it an enjoyable and valuable experience.

Thank you very much for taking the time to read this information sheet.

If you would like to be involved, please complete the following consent form and return to your child’s STEM club by Wednesday 7 August.

If you have any further questions before you decide whether to take part, you can send me an email.
Appendix A4: Consent Form (Chapter 5, Chapter 6, Chapter 8)

Institute of Education

Student Research Project / Move2Learn
Title: Designing for Embodied Science-Themed Digital Installations with Children
October 2017-October 2020
Parental Consent Form

If you are happy for your child to participate in the activities outlined, please complete this consent form and return to your child’s school or researcher Minna Nygren.

I have read and understood the information leaflet about the research. [ ] Yes [ ] No

I agree for my child to have a chat with the researcher about science-themed stories as outlined on the information sheet. [ ] Yes [ ] No

I agree that my child’s interaction can be audio/video recorded for research purposes. [ ] Yes [ ] No

I agree that data can be shared with all project partners (written in information sheet). [ ] Yes [ ] No

I consent for research video/images to be used in academic papers and conferences and other media promoting the research e.g. project website, reports, leaflets [ ] Yes [ ] No

I understand that my child can withdraw from the project at any time, and that if I/they choose to do this, any data they have contributed will not be used. [ ] Yes [ ] No

I understand that I can contact researcher Minna Nygren at any time. [ ] Yes [ ] No

I have discussed the information sheet with my child. [ ] Yes [ ] No

-------------------------------------------------------------------------------------------------------------------------------
Name ________________________
Signed _______________________   Date ____________________
-------------------------------------------------------------------------------------------------------------------------------
Researcher’s name ______________
Signed _______________________   Date ____________________
Appendix A5: Consent Form (Chapter 7)

Institute of Education

Student Research Project / Move2Learn
Title: Embodied Cognition and Science Learning
October 2017-October 2020
Parent and Child Consent Form

If you are happy for yourself and your child to participate in the activities outlined, please complete this consent form and return to the researcher or your child’s STEM Club.

I have read and understood the information leaflet about the research

☐ Yes  ☐ No

I am happy for my and my child’s interaction to be video/audio recorded

☐ Yes  ☐ No

I understand that if any of my or my child’s words are used in reports or presentations they will not be attributed to me or my child

☐ Yes  ☐ No

I consent for video/audio of my and my child’s interaction to be used in academic papers, conferences and other media for promoting the research e.g. project website and reports.

☐ Yes  ☐ No

I understand that I can withdraw from the project at any time, and that if I/they choose to do this, any data I/they have contributed will not be used

☐ Yes  ☐ No

I understand that I can contact Researcher Minna Nygren at any time

☐ Yes  ☐ No

I understand that the results will be shared with the research project partners

☐ Yes  ☐ No

I have discussed the information sheet with my child.

☐ Yes  ☐ No

Name _______________________
Signed _______________________   Date ____________________

----------------------------------------------------------------------------------------------------------

Researcher’s name ______________
Signed ________________________   Date ____________________

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Appendix B: Development of Game Design 2

For purpose-built game design 1, please refer to Exploratory Study (Chapter 5).