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With the Body in Mind

A Phenomenological Exploration of Embodied Cognition in Computer Interaction

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Abstract

For many, interaction with a computer is an overwhelming characteristic of their everyday life. Although the capabilities of computers have changed drastically since their inception, how we interact with them has not. This thesis explores the role of embodied cognition in computer interaction, employing a phenomenological perspective to comprehend the intricate link between the mind, body and environment.

This knowledge has been structured in a theoretical framework, which further informed a phenomenological case study methodology. Through the examination of the individual office as a contextual setting, the aim was to comprehend the practical manifestations of embodied cognition in real-life scenarios. The empirical investigation encompassed two phases, characterised by semi-structured interviews and elicitation diaries, respectively. The study utilised Interpretative Phenomenological Analysis (IPA) to structure the analysis, aiming to capture participants' subjective experiences in their authentic form while interpreting the data in light of the theoretical framework. The framework was modified in response to each phase of investigation.

The main contribution of this thesis is a framework of embodied cognition in computer interaction. The framework consists of four main areas of embodied cognition; tacit knowledge, the body schema, epistemic action and the embodiment of abstract concepts. Each area is defined through respective concepts and real-life manifestations, along with an illustration of their interconnectedness. The framework contributes an understanding of embodied cognition as an inherent aspect of our interaction with the world, in addition to highlighting its manifestation in concrete ways in computer interaction and emphasising the significance of bodily movement in our cognitive experience in this interaction. In addition, the framework allows for operationalisation, generating design insights suggesting the integration of the benefits of physical activity beyond directly goal-related aspects, while also suggesting the utilisation of the expressions of embodied cognition in the surrounding context to reimagine the configuration of computer interaction.

Acknowledgements

Although an individual piece of work, this thesis would have not been possible without the support and encouragement I received along the way.

I would like to first express my gratitude to my supervisor Joshi, whose insightful feedback and frequent efforts to resolve my confusion have been greatly appreciated. This goes along with a special acknowledgement to my friends on the 7th floor, I am thankful that we could share in our confusion together.

An important thank you also goes out to the participants who generously gave their time and shared their experiences for this study. Without their willingness to participate, this research would not have been possible.

The process of writing this thesis has been highly rewarding, while slightly meta in nature, considering I have now spent a year sitting at a desk working on a computer, writing about what it's like to sit at a desk working on a computer.

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Chapter 1

Introduction

"The ever-expanding province of computation is commonplace, the topic of a million coffee-shop conversations, television reports, and newspaper headlines. We talk about how fast it is changing, but we talk much less about the ways in which it is not.

Many things about computers are not changing at all"

- Dourish (2001, p. 1)

The use of computers to accomplish various tasks has become ubiquitous in the developed world. With their ability to provide access to vast amounts of information and expand our capabilities beyond what we could achieve alone, they have become an integral part of our daily lives. While the term "computer" now encompasses a vast range of devices, from radios and traffic lights to satellites and planes, the desktop or laptop computer is arguably the most recognizable of them all.

Although computers are present and utilised in an extensive amount of everyday activities, their original purpose was of a commercial and work-related nature. Today, computers are an unavoidable aspect of office work, and many individuals spend the majority of their workday using them to complete complex and demanding tasks that require significant cognitive effort. Although the capabilities of computers have developed dramatically since their inception, how we interact with them has gone essentially unchanged. Whereas in other spaces within technology the possibilities of innovative concepts such as wearables and tangible interfaces, and various other interaction forms, are being explored, the traditional desktop computer remains the same.

This lack of evolution in computer interaction can be questioned from a multitude of perspectives, particularly with regard to how it affects our embodied experience and cognitive engagement with technology. So far, discussions on the role of the body in computer interaction at work have been largely limited to physical ergonomics, such as the effects of prolonged sitting or environmental factors like lighting and temperature. Alternatively, I propose that adopting a phenomenological perspective can help us better understand the intricate relationship between the mind, body and environment. This perspective views the body as the foundation upon which experience is built, shaping how we

think, feel, and solve problems. Moreover, evidence suggests that our physical presence in any given environment can aid us in unravelling even the most theoretical and abstract of thoughts. By considering the embodied nature of computer interaction through a phenomenological lens, we can gain insights into how our bodily possibilities, and the environment we find ourselves in, are fundamental to how we experience and navigate cognitive tasks.

1.1 Framing of the thesis and research question

"In the debate over specific problems in the design and use of interactive machines, however, no question is raised about the bases for the very idea of human-machine interaction as such."

- Suchman (1987, p. 3)

In her 1987 book *Plans and situated actions: The problem of human-machine communication* Lucy Suchman calls attention to a need for a critical examination of the assumptions and beliefs that shape our understanding of how humans and machines interact. Furthermore, she argues that without such an examination, we risk perpetuating limited and potentially problematic perspectives on technology and its relationship with human behaviour and cognition.

This thesis seeks to introduce a unique, valuable and structured way of talking about the ways in which we interact with computers. To achieve this I have employed a phenomenological perspective which facilitates an in-depth understanding of the value of lived experience, providing a backdrop for the concept of embodied cognition. To examine the lived experience of embodied cognition in computer interaction, I have taken a closer look at the real-life context of individual office work. More specifically, I have inquired with eight individuals on the ways in which they navigate their office space and work tasks, to try and gain insight into how they express and experience embodied cognition.

In my thesis, I have considered the necessity of providing concrete implications for design to contribute to the field of computer interaction research. To explore this question, I drew on Paul Dourish's reflections in "Implications for Design" (2006), where he challenges the assumption that research in this field is only valuable when it leads to specific design implications. According to Dourish, this approach can significantly limit the potential impact of the research by not sufficiently taking into account the context and subjective experiences

that shape the use of technology. Instead, Dourish argues that the more open-ended approach of providing a theoretical framework can be just as valuable, if not more so.

With this perspective in mind, I have chosen to establish a framework of embodied thinking in computer interaction, rather than providing specific design implications. This framework is of a theoretical nature, however, in light of a theoretical discourse, the stipulation of theoretical in the final title becomes redundant. In establishing this framework, this thesis aims not only to provide a foundation for design but also to create a space for ongoing dialogue, engagement and exploration in understanding how we interact with computers. While the importance of practical implications is not ignored, I believe that the theoretical insights gained from this research will provide a more open-minded, flexible and therefore beneficial contribution to the field. This framework can be used as a tool to enhance design processes and deepen our understanding of the role of embodied cognition in our interactions with computers.

Based on the outlined discussion, the research question of this thesis is:

> *How can a phenomenological perspective on the role of embodied cognition in computer interaction provide a structure for design?*

Following the scope of Dourish's reflection, the target audience of this thesis and its findings should be HCI researchers and design practitioners focusing on interaction with computers. This refers to those wanting to incorporate a bodily and contextual understanding, rather than design at a more graphical level. However, given the cross-disciplinary nature of the study, the research could also be of interest to adjacent fields such as psychology or organisational management.

1.2 Thesis structure

In many ways, the structure of this thesis closely aligns with the chronological sequence of activities undertaken to address the presented research question. This alignment provides the reader with the opportunity to follow my theoretical understanding and development throughout the thesis.

Chapter 2 Background and Related Work begins with a brief presentation of the philosophical field of phenomenology, before offering a discourse on conventional viewpoints regarding the role of the body in computer interaction and professional work. Following this, relevant related work is presented, including the existing literature discussing

the body in computer interaction, the work exploring embodied cognition and the discourse on embodiment in computer interaction. Lastly, an outline of the gap in the literature that I wish to fill is provided.

Chapter 3 Theoretical framework consists of a discussion on the role of theory in this thesis, followed by a brief presentation of phenomenology as an epistemological lens and embodied cognition as a theoretical foundation. Following this, the initial theoretical framework of embodied cognition in computer interaction and its components are presented.

Chapter 4 Methodology introduces my research methodology, consisting of a phenomenological case study and interpretative phenomenological analysis. Furthermore, an in-depth description of the chosen case and the methods used is provided. The methodological approach of this thesis consisted of two distinct stages, an initial phase of empirical research characterised by seven semi-structured interviews, and a second phase of empirical research where elicitation diaries were carried out by five participants. The chapter also includes a clear overview of the timeline of activities through the thesis and a description of the structure of the following chapters.

Chapter 5 Establishing the second theoretical framework provides a description of the analysis of data from the semi-structured interviews, leading to the presentation of themes derived from an initial inductive thematic analysis of the data, followed by a deductive analysis of these themes up against the initial theoretical framework. Thereafter, the second theoretical framework of embodied cognition in computer interaction is presented.

Chapter 6 Establishing the final theoretical framework consists of a description of the analysis of data from the elicitation diaries, in a similar fashion to the presentation of analysis from the previous chapter. This leads to a presentation of the final theoretical framework of embodied cognition in computer interaction.

Chapter 7 Findings and Contributions provides a description of 2 main findings, in addition to an outline of the two forms of contributions that can be gained from the study, along with their respective components. In addition, a discussion of the validity of the study is provided.

Chapter 8 Discussion consists of a discussion structured according to the thesis' two forms of contribution, where the contributions' relevance against existing work is reflected upon.

Chapter 9 Conclusion presents a summary of the thesis and discusses opportunities for future work.

1.3 Clarification of terminology

In this thesis, the term *computer interaction* is utilised to describe the interaction with personal computers specifically, rather than to encompass all forms of computer. Furthermore, while the main emphasis of the thesis is on *embodied cognition,* at times, the term *embodiment* is also employed to refer to a broader understanding of the topic. A further explanation of this relationship is provided in Chapter 3.3.

Chapter 2

Background and Related Work

This chapter serves as an introduction to the key ideas and perspectives that underpin the subsequent sections of this thesis. Insights are drawn from other disciplines of knowledge, such as organisational management, ergonomics and psychology. The fields of labour management and ergonomics contribute to understanding prevailing perspectives on the body in computer interaction, while the field of psychology provides a more structured understanding of embodiment, namely embodied cognition.

Structurally, the chapter is divided into two parts: background and related work. In addition, it is divided in terms of the two incompatible perspectives on the connection between mind and body that are presented.

Firstly, I will provide a background to these perspectives. The traditional view, known as Cartesian duality, sees the mind and body as highly separated. Following this, I present the epistemological basis of this thesis, namely phenomenology, which alternatively regards the mind and body as intimately intertwined. Furthermore, the historical underpinnings of the perspective on the role of the body in the workplace and computer interaction are presented, which coincide with the Cartesian duality view generally upholding the notion of a distinct separation between the mind and body.

Moving on to the related work section, I will begin by presenting the existing research on the body in interaction with computers in an office setting, which centres upon discussions of office ergonomics, likely influenced by the aforementioned traditional historical perspective. Next, I will present studies that support the notion of embodied cognition, which perpetuates the phenomenological view of the body and mind being highly connected. This is followed by an overview of the existing literature that explores the role of embodiment in technology design before I finally outline the gap in the literature that I aim to fill, which involves applying a phenomenological and embodied perspective to interaction with computers.

2.1 Background

2.1.1 A brief introduction to Phenomenology

The discussion of the relationship between body and mind dates back to Aristotle and Plato in 300 BC (Svanæs, 2013). This discussion, and the general understanding that our mind and body can in some form be separated, is deeply ingrained in Western culture and language. A

crucial historical presence regarding this separation is that of French philosopher Descartes (1596-1650), who divided the world into two clear domains, a "pure" mental domain *(res cogitans)* and a physical domain *(res extensa)*. According to Descartes, consciousness is a phenomenon that purely belongs in the mental domain, completely detached from the physical domain in which the body resides. It is therefore argued that the mind is capable of existing without the body, however, the body cannot exist without the mind, portraying the body as an object for the mind to act through.

A philosophical standpoint that evolved to firmly reject the cartesian duality that Descartes presented is phenomenology (Dourish, 2001). Two main contributors to this understanding of the human experience were German philosophers Edmund Husserl and Martin Heidegger. Husserl broke away from concepts of theoretical, formalised and abstract reasoning and instead asserted the importance of concrete everyday experience, arguing that experience is a phenomenon that should be studied in its own right. As one of Husserl's students, Heidegger used this perspective as a starting point and from there contributed with highly meaningful modifications. Whereas Husserl and many philosophers before him had prioritised the cogito, the mental phenomena, Heidegger was more interested in the sum, in the being and existing in the world. One could say that Heidegger flipped the notion of "I think, therefore I am" on its head, suggesting alternatively that, "I am, therefore I think". Instead of considering the mind as the seat of reason, where it ascribes meaning to the world to then formulate a plan of action, Heidegger presented a radically alternative view. According to him, our everyday experiences do not acquire their meaning from the mind, but instead from the world itself.

The more recent French philosopher, Merleau-Ponty (1908-1961), also made significant contributions to phenomenology (Dourish, 2001). However, unlike his predecessors, he emphasised the significance of the body in shaping human experiences. Instead of being minds that purely have bodies, Merleau-Ponty argued that *"The body is our general medium for having a world"* (Merleau-Ponty, 1962, p. 169), and therefore the mind and the body are inseparably intertwined. Our self-awareness emerges from the interactions we have with our physical environment, therefore it would be impossible to understand or investigate the human condition with an approach that considers the physical body, and the environment it finds itself in, as detached from the mind.

2.1.2 Historical foundations of the body in the workplace and computer interaction

Traditionally, the body was viewed as a machine that functioned to complete professional tasks efficiently. This view was largely influenced by Frederick Taylor's time and motion studies, which emphasised the elimination of physical movement to increase productivity (Moradi & Wiberg, 2016). Due to this, a fundamental goal within workspace design has been to eliminate physical movement in order to increase productivity. A natural consequence being a highly sedentary work culture, where our bodies are predominantly inactive, and perhaps more importantly insignificant, during interaction with information technologies.

During the early days of computers, their development was primarily for military and commercial purposes (Dourish, 2001). As a result, discussions regarding their usage were largely held from an economic standpoint. During this period, computers were incredibly expensive devices, resulting in computer time being much more costly than human time. This resulted in an effort to minimise the amount of computer time needed to complete a task. Therefore, for example, if a certain input language was faster for the system to compute then this language would be preferred, even if it resulted in employees spending painstaking hours formatting their data into that language. Even though computers have evolved greatly throughout the years and computer time has become significantly less expensive, this perspective of performance trumping human comfort or convenience is still prevalent today.

Dourish (2001) discusses the distinctiveness of this lack of evolution, identifying that due to the rapid advances in price and technology that computers have experienced, one would expect a substantial transformation in their overall composition and possibility for interaction. Despite the radical difference in cost and capability from the computers developed twenty years ago, the interactions we have with them are identical, *"we sit at a desk, watching the screen and typing on the keyboard"* (Dourish, 2001, p. 27).

2.2 Related work

2.2.1 Office ergonomics

The historical roots of the conventional perspective on the body's role in computer interaction and the workplace may have contributed to two characteristics of the current research on the body in computer interaction. Firstly, this research tends to view this interaction in an office setting, and secondly, this research seems to be somewhat limited in scope. This research tends to concern itself with office ergonomics; the study of how to design workspaces and equipment to maximise efficiency, productivity, and comfort while minimising the risk of

injury or strain (Chandra et al., 2009). Discussions of office ergonomics often deal with computer workstation design or characteristics of the physical indoor environment (Chandra et al., 2009). Deficiencies in computer workstation design often include prolonged sitting, repetitive motions and awkward postures, which many link to various musculoskeletal disorders such as carpal tunnel syndrome or back pain (Al-Kindi & Shikdar, 2015; LeBlanc et al., 2017; Wahlström, 2005). In general, research suggests postural variation and movement as beneficial interventions in regard to improving workstation design (Chandra et al., 2009; Davis & Kotowski, 2014; Moradi & Wiberg, 2016). In addition, studies on office ergonomics frequently discuss the physical indoor environment, including factors such as lighting, temperature, air quality and noise level, often investigating their impact on productivity (Chandra et al., 2009; Seppänen, 2006; Haynes, 2008). Bagnara and Pozzi (2015) suggest that this traditional approach to discussing office ergonomics aligns in many ways with the mind-body divide, and fails to incorporate a more embodied view.

2.2.2 Embodied cognition

Embodied cognition refers to the idea that the *"mind must be understood in the context of its relationship to a physical body that interacts with the world"* (Wilson, 2002, p. 625). The argument for this view often resides in an evolutionary narrative, where the need for a tight connection between our sensorimotor processing and cognition was previously essential for our survival (Herold, 2018; Wilson, 2002). The body-specificity hypothesis, presented by Casasanto (2011), suggests that the body shapes our cognition in a way that is specific to our unique sensory and motor experiences. In other words, *"the content of the mind depends on the structure of the body"* (Casasanto, 2011, p. 378).

According to Kirsh and Maglio (1994) and Wilson (2002), as we interact with our environment, we utilise our opportunity to physically engage with it in order to off-load cognitive work onto it in various ways. This includes, for example, the rotation of Tetris blocks to better map out a plan of action (Kirsh & Maglio, 1994) or linking written instructions to objects in the environment during a compass-and-map task (Glenberg & Robertson, 1999). Another example of this act of off-loading cognitive work onto the environment is the act of gesturing. Gesturing has been found to not merely be a byproduct of communication but also seems to serve a cognitive purpose for the speaker by lightening the cognitive load of what they are trying to express (Alibali et al. 2000; Alibali & DiRusso, 1999; Iverson & Goldin-Meadow 1998; Goldin-Meadow, & Beilock 2010). Moreover, it has been found that movement in general can act as a form of cognitive off-loading. A study by

Wang and Nass (2005) showed that their participants talked longer and gave more detailed responses when they were not tethered to a computer, implying that mobility while talking on the phone could foster creativity and information disclosure. Similar findings of cognitive off-loading have been identified in the case of fidgeting, where (Grodner, 2015) found that fidgeting during tasks that demanded high levels of cognitive flexibility increased performance. Karlesky & Isbister (2014) considered these findings on fidgeting and proposed the importance of designing for the physical margins of digital workspaces, referring to the physical space that surrounds a person while they work in a digital environment. Use of their "Fidget Widgets" while performing a variety of tasks was shown to increase productivity and creativity.

Inspired by the findings on gesture and embodied cognition, Slepian and Ambady (2012) investigated the connection between fluid movement and fluid, or creative, thought. Fluid arm movements, compared to non-fluid arm movements, were found to enhance performance in creative thinking tasks. Furthermore, the findings suggest that the abstract concept of creativity may be embodied by fluid movement. Additional studies have found evidence in support of the notion that abstract concepts can be grounded in physical attributes. For instance, Jostmann et al. (2009) identified bodily experiences of weight as an embodiment of the abstract concept of importance, finding that people invested more cognitive effort when dealing with heavier objects, in this case, a clipboard. Perceptions of time have been observed as being grounded in directional movement, including retrospection and prospection being connected to backward and forward movement respectively (Miles, Karpinska, Lumsden, & Macrae, 2010; Miles, Nind, & Macrae, 2010). Furthermore, physical cleanliness has been found to embody the abstract concept of moral purity (Lee & Schwarz, 2010; Zhong & Liljenquist, 2006), the categorization of gender can be associated with proprioceptive experiences of toughness or tenderness (Slepian et al., 2011), and the judgement and expression of interpersonal warmth is influenced by experiences of physical warmth (Williams & Bargh, 2008).

2.2.3 Embodiment in interaction design

Emphasis on the concept of embodiment within the field of Human-Computer Interaction (HCI) has been introduced by several sources, among which the work of Paul Dourish in his 2001 publication *"Where the Action Is"* has been particularly influential. Here it is argued that the future of technology design depends on an understanding of the embodied and situated nature of human experience. Svanæs (2013) extends Dourish's work, utilising

Merleau-Ponty's phenomenology to provide a detailed investigation of two related topics, namely embodied perception and kinaesthetic creativity, in order to provide insights for designing for and with the lived body.

Klemmer et al. (2006) draw on similar theories of embodiment to develop five relevant themes for interaction design. These themes demonstrate various ways in which our physical bodies shape our experience in the world and provide insights into the importance of taking this into account within interaction design. This includes discussions on designing for skilled bodies, referring to ways in which we can take better advantage of our physical capabilities, such as dedicating certain physical actions to certain functions to facilitate motor memory. Furthermore, a significant point is made on the topic of thick practice, where it is argued that to preserve the complex and rich content of physical interactions, we should think very carefully before replacing it with a technological alternative. Also of significance is the notion of thinking through doing, which is presented by the author to emphasise the evidence supporting physical interaction and movement as key factors in cognitive reasoning.

Wensveen et al. (2004) propose a more practical approach to embodiment in interaction design, introducing a design framework that examines person-product interactions based on the coupling between action and function, aimed at achieving embodied freedom of interaction. This idea of developing interfaces to support embodied interaction has been proposed by further sources, where Fishkin et al. (1999) suggest that the possibility of physically manipulatable devices provides an entry to a new paradigm for user interface design, namely Embodied User Interfaces. The authors further present an invisible user interface as the ideal in this new paradigm. Clifton et al. (2016) introduce aspects of spatial cognition, suggesting how findings and theoretical developments on this topic can be used to influence the design of tangible and embodied interfaces (TEIs).

These notions of an embodied interface have in many cases been put into practice by developing a tangible, AR or VR interface and investigating the then embodied or tangible interaction in relation to learning outcomes. Skulmowski et al. (2016) conducted a study where they investigated the use of a tangible interface (TUI), specifically a tabletop display and physical objects, and its effect on learning. The study found that haptic perception and selective pointing improved spatial learning and performance on the task. Furthermore, Malinverni et al. (2012) explored the impact of embodied interaction on learning processes using a physically interactive platform and found that physical activity enhanced engagement and motivation, leading to better learning outcomes compared to a traditional desktop

computer. Likewise, Lindgren et al. (2016) used a mixed-reality simulation where participants could interact with virtual objects using hand gestures and physical movements and found that this approach improved engagement and learning outcomes compared to a traditional, non-embodied situation. Overall, the literature on embodiment in interaction design places a strong emphasis on learning, often explored through the use of unconventional interfaces such as tangible, haptic or embodied interfaces. These interfaces are often studied in comparison to more traditional interfaces like computers. While the positive effect on learning through the use of more embodied interfaces is relevant and intriguing to this study, it is worth noting the significant lack of research on the relevance of the body and embodied thinking in the traditional interfaces that we use in our everyday lives.

2.2.4 Summary of related work and my contribution

The current research on the body in computer interaction generally concerns itself with office ergonomics, adopting a perspective where the influence of bodily experience on cognitive experience is limited to physical discomfort. However, within psychology, many have found support for the fact that our minds and bodies are connected to a much larger degree, illustrated by the concept of embodied cognition. While there is research within interaction design that investigates the embodied nature of interaction, this research has generally focused on exploring tangible, spatial, or immersive interfaces, to see if the embodied characteristics are beneficial when it comes to learning or engagement. Interaction with personal computers, which as previously stated is perhaps the most pervasive form of technology interaction, has been largely overlooked in the existing research on embodiment in interaction design.

Therefore, I aim to offer a novel contribution to the existing literature by examining how embodied cognition manifests itself in the current context of computer interaction, rather than exploring how it could be embodied through new interfaces. By employing a phenomenological approach I hope to provide a more comprehensive and full understanding of the concept of embodied cognition.

Chapter 3

Theoretical framework

This chapter introduces the initial theoretical framework utilised to structure knowledge around embodied cognition and to be tested empirically. Preceding this is a description of the role of theory in this study and the way in which this process was begun. This is followed by a presentation of the epistemological and theoretical basis of the framework, before delving into its specific components. Below is a depiction of the timeline of activities contributing to the development of the initial theoretical framework of embodied cognition in computer interaction (see Figure 3.1).

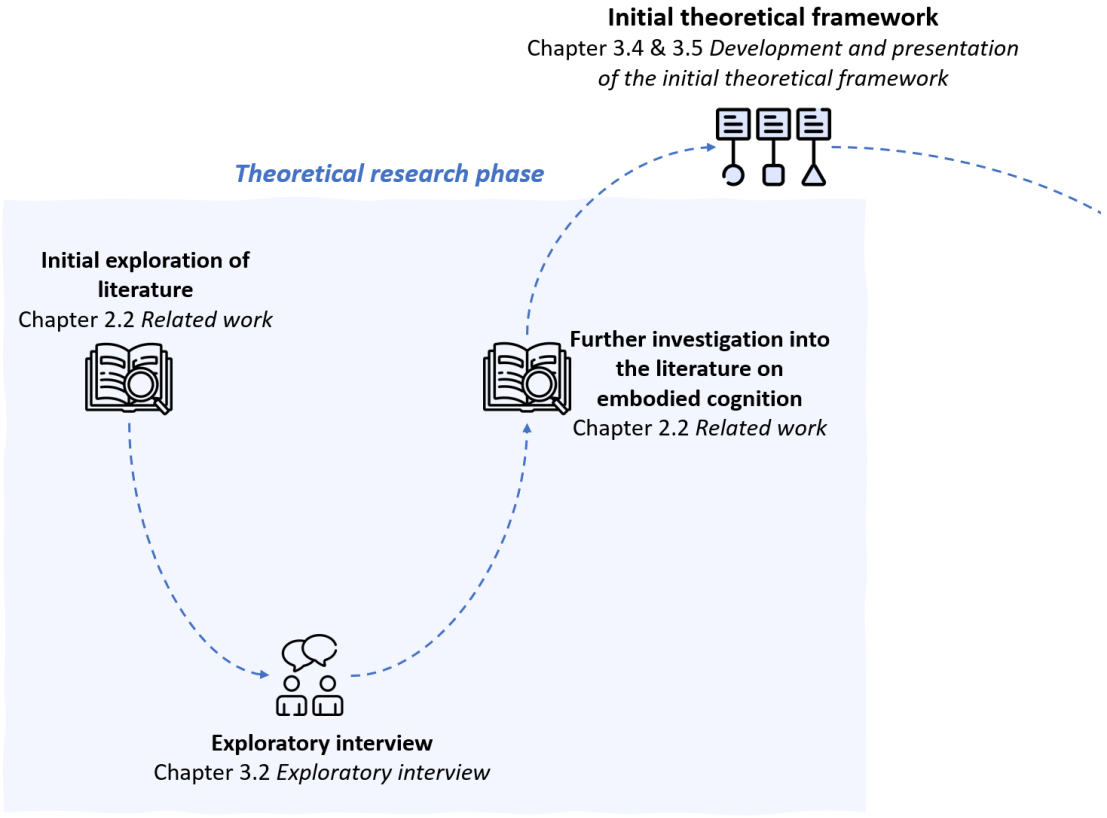

Figure 3.1 Timeline of initial theoretical research phase

3.1 Theory as the object of study

In this thesis the aim is to establish a theoretical structure that provides an understanding of the role of embodied cognition in computer interaction. This theoretical framework is established through a comprehensive dialogue between theoretical components of embodied

cognition and the empirical findings throughout the study. Beck and Stolterman (2016) suggest that in this way, theory can act as the object of a study, where findings can result in a "theory prime" and contribute to a revision of the initial theory (see Figure 3.2).

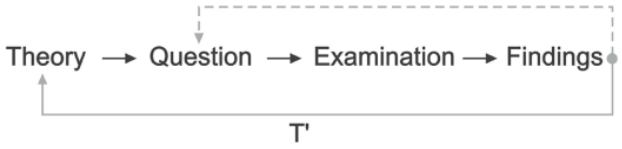

Figure 3.2 The "theory as object" model. Beck and Stolterman (2016)

To initiate this process of theory as the object of the thesis, it was necessary to find a theoretical landscape that was manageable in scope. In order to achieve this, I found it necessary to gain an overview of the existing literature and to gain an initial understanding of the experience of interacting with a computer in an office setting.

3.2 Exploratory interview

Firstly, a review of relevant literature on phenomenology was conducted. Initially, this inquiry focused in part on exploring the potential connection between a flow experience, as described by Csikszentmihalyi (2014), and our bodily experience. Following this, an exploratory interview was carried out in order to gain a preliminary understanding of the experience of computer interaction in office work, and the potential connections to the reviewed literature. This interview had a semi-structured format where the participant was a young adult who worked at a desk, on a computer for the majority of their work day. The findings from this exploratory interview indicated that the participant very rarely experienced flow during interaction with a computer. This was partly assigned to the, in their words, *"unnatural"* nature of the office setting, where the bodily experience of computer interaction in office work was characterised as somewhat ill-fitting or awkward. Furthermore, the participant reflected that the situations that most often led to a flow experience were those involving physical activity, either in the form of walking or working-out. Here they described how during these activities they felt *"more engaged in the activity, instead of you know, when you're just sitting there."*. These findings indicated an intriguing link between the body and our mental state, and compelled me to investigate the possible reasons behind why we may not often experience flow while interacting with a computer and what further implications

this might have for other cognitive experiences. This, followed by further exploration into the literature, led me to the topic of embodied cognition.

3.3 A phenomenological lens and embodied cognition as a theoretical foundation

Understanding the subjective, lived experiences of individuals who interact with computers on a daily basis is crucial for gaining insights into the ways in which the body and mind are intertwined in our interaction with technology. Therefore, to gain a deeper understanding of the relationship between embodied cognition and computer interaction, I will employ a phenomenological perspective. Phenomenology, as previously presented, emphasises the importance of subjective experience and how our lived experiences shape our understanding of the world.

A common theme running through the area of phenomenology is embodiment (Dourish, 2001). Embodiment captures the importance phenomenology puts on the aspect of "being-in-the-world", where the concept refers to the merging of the mind, the body and the context. It illustrates that a thorough understanding of any one of these concepts is contingent upon acknowledging the inseparable interconnectedness of all three. Embodiment brings forth the importance of considering our bodily experience and situational context when attempting to comprehend our thoughts, attitudes and emotions.

Embodied cognition can be seen as a more specific application of the broader idea of embodiment. While embodiment highlights the importance of the body in shaping our experience in the world, embodied cognition provides theoretical structure to understand how this happens and how it affects specific cognitive processes.

The relevance of embodied cognition in computer interaction may not be immediately obvious, however, it is precisely for this reason that the investigation into this topic is important. Aside from the general preoccupation with reducing ergonomic discomforts, the importance of bodily experience has rarely been discussed in computer interaction. Dourish (2001) explains that the mind-body duality that computer system designers have traditionally adopted naturally leads to the assumption of a well-functioning, disembodied brain, inferring that a brain without a body could think and reason identically to a brain with a body. In fact, considering the heavy problematization of physical discomfort during computer interaction in office work, it seems a disembodied brain may even be preferred, and that the body is merely in the way of completing tasks efficiently.

Alternatively, this thesis adopts a phenomenological lens to assess the theoretical notion of embodied cognition, where the body, mind and world around us are inherently and inevitably intertwined.

3.3.1 Addressing the mind and body as separate in order to understand them as inseparable

Before delving into the particular theoretical components that constitute my comprehension of embodied cognition, it is worth noting that this viewpoint may occasionally appear to treat the mind and body as separate entities throughout the thesis. As my thesis is grounded in phenomenology, which emphasises the inseparability of the mind and body, acknowledging instances where the mind and body are discussed as distinct entities is necessary. While the essence of phenomenology recognises their interconnectedness, there arises a need to analyse the intricate ways in which this interconnectedness makes itself apparent. By temporarily examining the mind and body as separate entities, I can better understand their unique characteristics and explore the dynamic relationships that exists between them.

3.4 Development of the initial theoretical framework of embodied thinking in computer interaction

The perspectives from phenomenology and embodied cognition provided a solid foundation to begin addressing my research question. However, a structure that allowed itself to be analysed empirically was needed. Due to this, a framework rooted in the reviewed literature was composed, consisting of relevant concepts and possible manifestations that provided me with an entrance to explore the embodied nature of computer interaction. The role of this initial framework was therefore to provide me with a structured approach to investigate this topic.

The three following subchapters provide a description of the three main theoretical areas of embodied cognition that are focused on in the framework. These areas offer a basis to better comprehend the potential experience and expression of embodied cognition in computer interaction in an office setting.

3.4.1 Body schema

When observing our office space from a distance, our computer, mouse, keyboard, desk and chair exist as external objects. However, when we sit down and use the computer to accomplish a task, these objects change our sense of bodily structure. During computer interaction, we frequently find ourselves engaging with the tools of interaction, such as a

mouse or keyboard, without conscious awareness or active contemplation. Heidegger explains this transformation as objects moving from being “present-at-hand” to being “ready-to-hand” (Dourish, 2001). When we use our computer mouse, we act through it, the mouse is an extension to our hand much like the blind person’s cane. In this case, the mouse is ready-to-hand, and ceases to exist as an independent entity. When however the movement of your computer mouse becomes unsteady or incoherent with your movements, you become aware of its existence as a separate entity, and it is now present-at-hand. This element of unawareness is a key characteristic of objects becoming truly ready-to-hand. In order to act fluently in the world around us it would be highly ineffective to dwell on the tools themselves. Instead, when using tools to interact with technology, the tools themselves disappear from our immediate concerns. What we are concerned with is the task at hand, with the problem that the tools are helping us solve.

In general, we share a common understanding of the physical components of our body, such as our limbs and their functionality. However, as posited, a phenomenological perspective provides an alternative view. As artefacts become ready-to-hand, they become fully integrated into our bodily structure, thus shaping our fundamental experience of the world around us (Merleau-Ponty, 1945). Incorporation into the body schema refers to the idea that certain objects or tools become integrated into our sense of bodily awareness and function as if they were part of our body. The body schema is a cognitive representation or map of the body in space and the way it moves and interacts with the environment. When an object is incorporated into the body schema, it means that the body schema is extended to include the object as if it were an additional limb or body part. This allows for more fluid and efficient use of the object, as it is no longer perceived as an external tool but rather as a natural extension of the body. For example, when driving a car through a tight alleyway, we manoeuvre our way through, sensing continuously if we can fit or if maybe our right side is a little close to the wall, often with a very high degree of accuracy, almost as if the sides of the car were our own shoulders. The body schema therefore simultaneously refers to our nonconscious knowledge of our lived body, in addition to our knowledge of our potential for action in the world. A typical example is a blind person’s cane, by utilising the cane, the person’s potential for action in the world is altered and enhanced.

In order to gain a comprehensive understanding of how the body and mind are intertwined in computer interaction, it is significant to acknowledge that the tools and devices can become

integrated into our body schema. This integration alters our sense of bodily structure, making the tools readily available for use.

3.4.2 Tacit knowledge

The everyday utilisation of any particular space generally results in the development of habitual tendencies and fixed routines, also holding true for the interaction with computers in office spaces. Various objects, areas and tools are provided in this environment, and each individual adopts and adapts these features to support their work experience. To describe this phenomenon, Brereton (2013) presents the term *habituated objects*, formulated through her study of an elderly woman's utilisation of various household objects in order to support feelings of independence and agency. Brereton illustrates how habituation in our environments can be connected to significant emotions and experiences, and that therefore our everyday interactions with our environments are inherently complex and meaningful. In the same vein, investigating the habitual behaviour and routines established in computer interaction may offer insights into how elements in the environment are utilised to express embodied cognition.

However, this task may be easier said than done. The routine action and behaviour an individual carries out during computer interaction within their office is generally done in an unconscious and effortless manner, which can be referred to as tacit knowledge (Eraut, 2000). Polanyi (1966) describes tacit knowledge as "that which we know but cannot tell", therefore one of the most established characteristics of tacit knowledge is that it is very difficult to reflect upon to a degree that allows verbalization. Tacit knowledge allows us to behave and interact in a fluent manner with our environment and is therefore purposefully out of reach of our consciousness. Because of this, gaining insight into an individual's everyday behaviour, and furthermore encouraging them to reflect upon the meaning of seemingly meaningless actions, can be highly challenging. This leads to implications for the methods of inquiry in this study, where much care must be taken in shaping the inquiry in a way that can effectively access the elusive tacit knowledge.

3.4.3 Epistemic action

In the office, as we interact with computers, we may find ourselves carrying out certain actions that are not characterised by solely physical purposes, but instead carried out in order to achieve cognitive goals - such as taking notes, searching for information or drawing diagrams. Physical actions in behavioural science are commonly driven by the desire to

achieve a physical goal, known as pragmatic action (Kirsh & Maglio, 1994). While many actions fit this category, not all external actions are best understood as pragmatic. Epistemic actions, alternatively, involve physical acts that are performed to transform our prior mental state to a more helpful one. Kirsh and Maglio (1994) utilise the game of Tetris and the early rotations of the current shape in play to exemplify this. These rotations facilitate the player in various problem-solving activities, such as identifying the shape in play or saving mental rotation effort. In this way, epistemic action takes the load off our mental computation, indicating that certain cognitive and perceptual problems are more quickly, easily and reliably solved by performing actual physical actions in the world rather than merely performing computational actions in your mind.

Wilson (2002) states that in this way *"we off-load cognitive work onto the environment"* (p. 629). The discussion on off-loading generally utilises examples that show how the world can be used as "its own best model" in spatial and situated tasks. For example, moving around a room to get an idea of where to place furniture or by rotating Tetris shapes to help plan your next move. In these cases, the artefacts being manipulated are not symbols for anything but themselves, and they are manipulated out in the world in the relevant situation. Wilson suggests that off-loading is not limited to spatial and situated tasks, explaining how we can carry out actions that exploit external resources in the environment to gain knowledge that will not necessarily be used in that specific context, but rather at a later time or in a different situation. This type of off-loading is given the name "symbolic off-loading" and includes for example *"counting on one's fingers, drawing Venn diagrams and doing math with pencil and paper"* (p. 629).

Employing an understanding of epistemic action, and more specifically symbolic off-loading, provides an entrance to understanding activities carried out during computer interaction that may otherwise seem somewhat insignificant, but that may portray crucial methods for expressing one's embodied cognition.

3.5 Presentation of the initial theoretical framework

Based on the existing theoretical work presented, I have constructed the theoretical framework shown below (see Figure 3.3). The main foundation of this framework consists of a phenomenological epistemology, emphasising the subjective experience of the individual as a valid source of knowledge. This perspective is consequently used to approach and gain an understanding of the theory of embodied cognition, which is based on the idea that our

cognitive perception is intimately connected with our bodily experiences and surrounding environment. The framework is further structured into three main areas of embodied cognition: *Tacit Knowledge*, *The body schema* and *Epistemic action*, each of which is specified by one relevant concept within that area, *Habituation*, the *Incorporation of artefacts* and *Symbolic off-loading* respectively. Furthermore, the framework presents a concrete example of how each concept may manifest itself, and be put into practice, in a real-life context, where habituation may potentially manifest itself as a *Lack of introspection,* the incorporation of artefacts may lead to a *Seamless interaction* and symbolic off-loading may be expressed through the *Manipulation of artefacts.* The framework enables the movement from broader areas of embodied cognition to narrower concepts and then to practical manifestations, allowing for a transition from a highly theoretical to a more tangible understanding of the subjective lived experience of embodied cognition in computer interaction in an office setting.

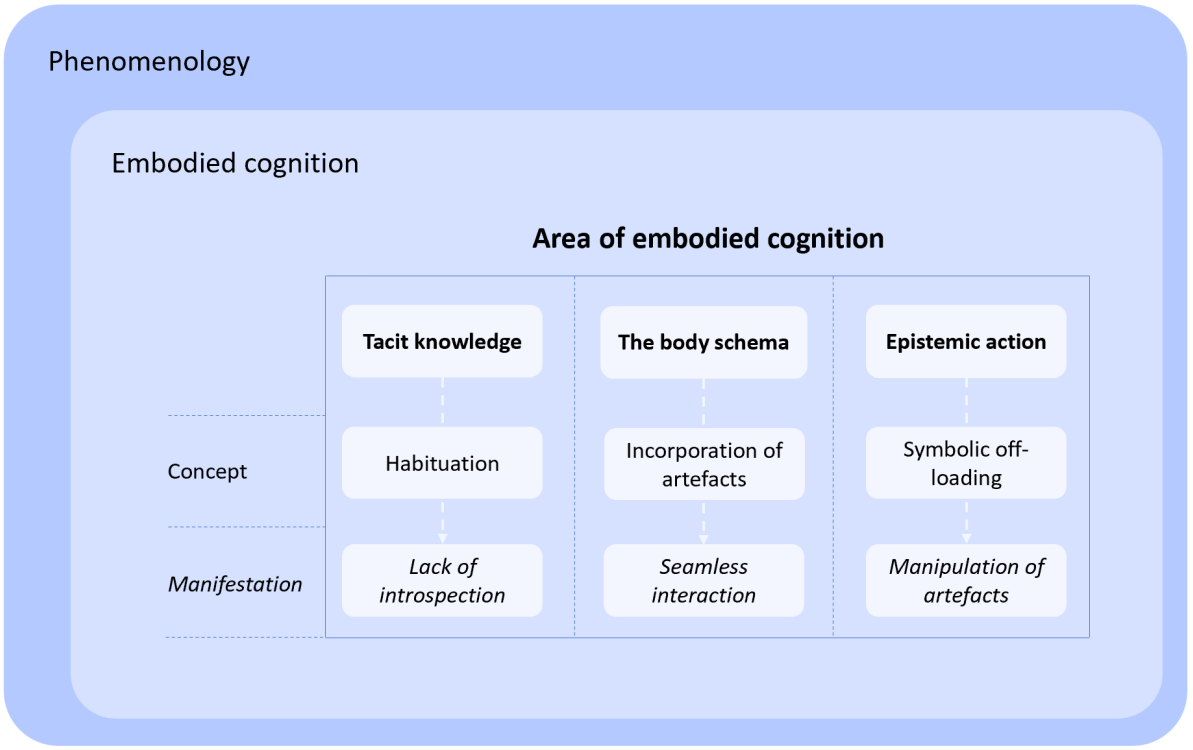

Figure 3.3 Inital theoretical framework

Although the proposed framework provides a valuable foundation for the investigation of embodied cognition in computer interaction, it is important to acknowledge that there are of course many other ways of approaching this topic. Choosing other perspectives, areas and concepts would most likely lead to a different kind and understanding of knowledge.

3.5.1 Application of the framework

The chosen epistemology of phenomenology entails a perception of knowledge that emphasises examining the lived experiences of the individual within a specific context. This leads into the intended use of the framework, where its initial application will be to contribute to a theoretically-informed choice of methodology. Based on the framework, my approach to investigation will attempt to effectively capture the subjective experience of embodied cognition in computer interaction within an office context.

Towards this goal, the proposed concrete manifestations provide an effective way of investigating their underlying theoretical underpinnings. For instance, in my investigation, I can take into account the tacit knowledge that many participants have in this context, which may result in participants' being largely unconscious of the ways in which they may practise embodied cognition, leading to a lack of available introspection. As a result, obtaining the information needed to answer my research question may be challenging, which will be crucial to consider when constructing my inquiry. By utilising the concrete expression of the incorporation of objects, proposed to be seamless interaction, I can examine the participants' relationship with the objects in their office and how they utilise them. To further comprehend the methods in which participants may use these objects for thinking, the possible manifestation of symbolic off-loading of manipulating objects can assist me.

It is worth noting that I did not want to be too rigidly bound by the framework. In this regard, I made a conscious effort to not completely confine my investigation to the proposed theoretical concepts and aimed to remain open to all compelling lived experiences of embodied cognition that may arise. In addition, it was also very important to me to explore alternative ways in which these concepts may manifest themselves that I had not yet considered. Furthermore, despite the lack of proposed connections between the concepts in the framework, I anticipated them to be highly interrelated. Therefore, I considered it equally essential to investigate the interdependence between these concepts, as to analyse them independently.

Chapter 4

Methodology

4.1 Phenomenological case study

In order to answer my presented research question, I need to explore the common experience of embodied cognition during interaction with a computer. To achieve this aim, it is important to gain a comprehensive understanding of the phenomenon and its similarities across various individuals, as well as the real-life context in which it occurs. Due to this, a phenomenological case study has been chosen. Generally, phenomenological studies focus on the lived experiences of multiple individuals with the same phenomenon, while case studies are more directed towards the context (Creswell, 2013). By combining both approaches, this study can provide a nuanced and detailed understanding of the phenomenon being studied, while also highlighting the unique perspective of the case. While some distinguish phenomenology as a methodology and case study as a method, for the purpose of this study I have chosen to adopt Creswell's (2013) perspective and refer to them both as approaches to inquiry or methodologies. Naturally, this study falls within an interpretive paradigm, where I will focus on individuals' subjective interpretation of a phenomenon (Myers & Avison, 2002).

4.2 Interpretative phenomenological analysis

While employing a phenomenological case study as the primary structure of inquiry, Interpretative phenomenological analysis (IPA) provides a structure of analysis. In this study, it is imperative to preserve the participants' personal subjective experience of the phenomenon and how they understand the world around them. However, it is equally important to use these subjective meanings to inform the development of my theoretical framework. This demands a degree of interpretation and moulding of the data on my part as a researcher.

Interpretative phenomenological analysis emphasises exploring the meanings that particular experiences, events, and states hold for participants (Smith et al., 2009). This points to the phenomenological element of this method, where it is highly concerned with subjective personal perception, rather than attempting to produce an objective statement. However, hence the name, this approach also includes an interpretative element, where the research process involves an active role of the researcher. Despite our best efforts to provide an

objective account of a participant's experience, our own preconceptions and biases inevitably influence how we interpret their explanations. However, it is precisely this interpretive process that is a crucial component of IPA analysis.

On the one hand, the analysts' role in IPA very heavily requires the phenomenological aspect of revealing something "as it is in itself", but it also strongly requires the search for meaning beyond this and the very deliberate act interpretation, where we reveal something "as something else" (Larkin et al., 2006). Larkin et al. (2006) therefore describe IPA as having two very distinct aims, where the first aim involves giving a voice to the direct source of the experience, and the second aim is to position this initial description in relation to a wider, perhaps theoretical, context. In this way, the researcher can think about "what it means" for the participants to have described their experiences in the ways they have. This interpretative work can be informed by direct engagement with existing theoretical constructs directed towards answering a pre-formed research question, which is the way the approach will be used in this thesis.

Elaboration on the exact steps to achieve this approach to analysis is provided in Chapter 4.6.

4.3 Timeline of activities

To offer the reader a better understanding of the stages involved in this thesis and its subsequent structure, I have provided a timeline of activities (see Figure 4.1). The figure consists of three roughly defined phases, one characterised by a theoretical exploration, followed by two phases of empirical inquiry. Despite these labels of theoretical or empirical, each phase had elements of both theoretical and empirical investigation, where these labels are merely assigned to differentiate between the stages of the thesis work and provide clarity.

Theoretical research phase

This timeline begins with a phase of theoretical research, consisting of a review of relevant literature and an exploratory interview. This phase is explained in further detail in the previous Chapters 3.1 and 3.2. This phase resulted in the establishment of the initial theoretical framework.

Empirical research phase 1

Following this was the first phase of empirical research, which was begun with the planning and organising of my methodological approach. Seven semi-structured interviews were conducted with participants working in individual offices and whose work involved significant computer interaction, with the purpose of gaining an understanding of their

experience and expression of embodied cognition in this context. The collected data underwent an inductive thematic analysis, followed by a deductive analysis up against the theoretical framework, resulting in the development of the second theoretical framework of embodied cognition in computer interaction.

Empirical research phase 2

Although the first phase of empirical research provided a highly valuable initial understanding of participants' experience and expression of embodied cognition, a second phase of empirical research was deemed beneficial to gain a deeper understanding of underlying or connected factors. To achieve this aim, elicitation diaries were completed by five participants. The resulting data were analysed in a similar manner to the first phase of empirical research but with a greater emphasis on understanding the connections between the reported experiences of embodied cognition. This resulted in the establishment of the final theoretical framework of embodied cognition in computer interaction.

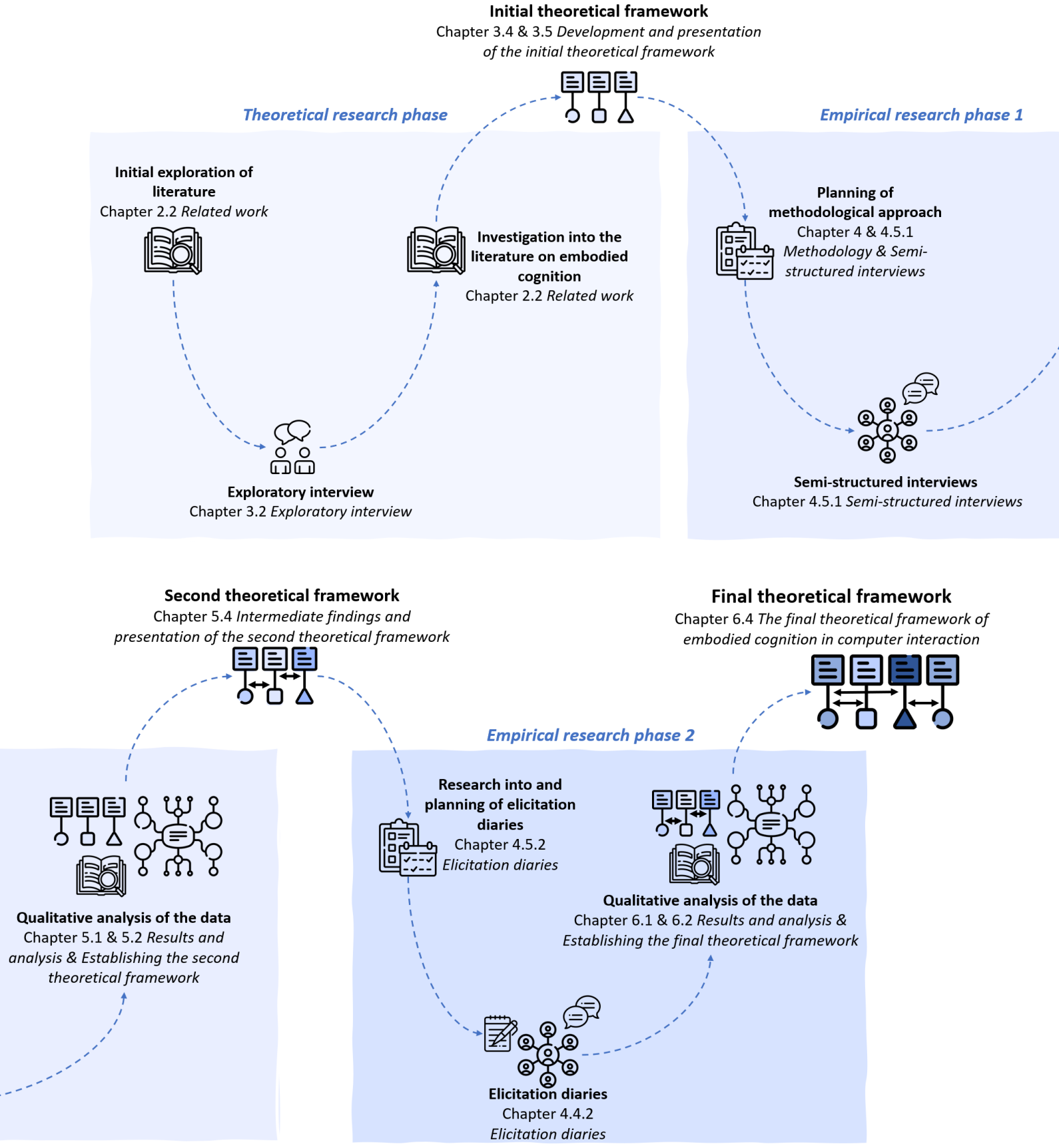

Figure 4.1 Timeline of activities

4.4 Case description

For this thesis, the role of the case is to facilitate our understanding of a phenomenon, as opposed to merely facilitating our understanding of the particular case, indicating that an instrumental case study is most suitable (Stake, 2005). The objective of choosing a case for an instrumental case study is to select one that provides optimal insight into and comprehension of the phenomenon being studied. In this study, in order to gain optimal insight into the phenomenon of embodied cognition in computer interaction, the case of the individual office setting has been selected. This decision was influenced by several factors, including the strong correlation between the perspective on the body in computer interaction and in office work. Additionally, selecting a context where computers are commonly used for somewhat cognitively challenging tasks rather than for casual or recreational purposes offers distinct advantages in exploring the specific aspect of embodied cognition in computer interaction.

Stake (2005) further emphasises the importance of defining the case by very clear boundaries. The chosen individual nature of the office setting allows for an investigation of how individuals shape and interact with their environment without interference from others. In addition, this study does not place a significant focus on the social aspects of work, therefore the stipulation of an individual office space allows for a more detailed insight into other elements of the experience.

Furthermore, the boundaries of the case also include a specification of the conditions for what is considered an office setting. An office setting can in this case be defined as a permanent, external place of work, therefore excluding the home office or work practices with a more flexible location. These two distinctions are due to the importance of investigating the ways in which individuals shape and compromise with a certain space. When working in a permanent setting that is not our own home we are inclined to utilise the provided environment and equipment to create a preferred and habitual way of carrying out our work. This therefore also demands the contents of the office setting to be defined to a certain degree. In this case, the individual office work being completed must mainly be carried out on a computer, sitting on a chair, situated at a desk, in this way, a chair, desk and a computer are all required elements in this distinction of office work.

4.4.1 Empirical context and participants

With a basis on the defined context of an office setting, eight individuals participated in this study, with various job descriptions and places of work. Each participant fulfilled the following inclusion criteria: (1) aged between 25 and 60, (2) worked in an individual[1] office space that included a desk, a chair and a computer, (3) had worked in this office setting for at least a year, and (4) used a computer to complete tasks they experienced as cognitively demanding.

Four of the participants, Paul, Julia, Lisa and Caroline, worked together in the public sector, more specifically for a small municipality in Viken county. Each of these participants had their own office in the same building, all of which had very similar content, such as a large, curved screen, an adjustable desk, a modern office chair and a large window. Two other participants also worked in the public sector, James and Henrik, but within education in the informatics field. Both participants' workspaces included a desk, chair and computer, however, James's workspace also included often-used items such as a sofa, while Henrik's was not actually an individual workspace, but actually a defined space in a shared work area. The last two participants worked within IT within different companies, David and Anne, and had standard individual offices with a non-adjustable desk, an office chair and one or two screens. Five of the participants' individual offices are depicted in Figure 4.2.

Due to the large variation in job description, the tasks carried out at a desk on a computer were also characterised by large variation. Overall, all participants carried out some form of administrative tasks such as answering emails or setting up meetings. Otherwise, the tasks consisted of for example writing legal cases or academic texts, making PowerPoint presentations or other forms of structuring information for further communication, dealing with HR issues or more logic-heavy tasks such as programming.

[1] One of the participants, Henrik, did in fact not work in an individual office, however, his interview data was included due to its significant insights

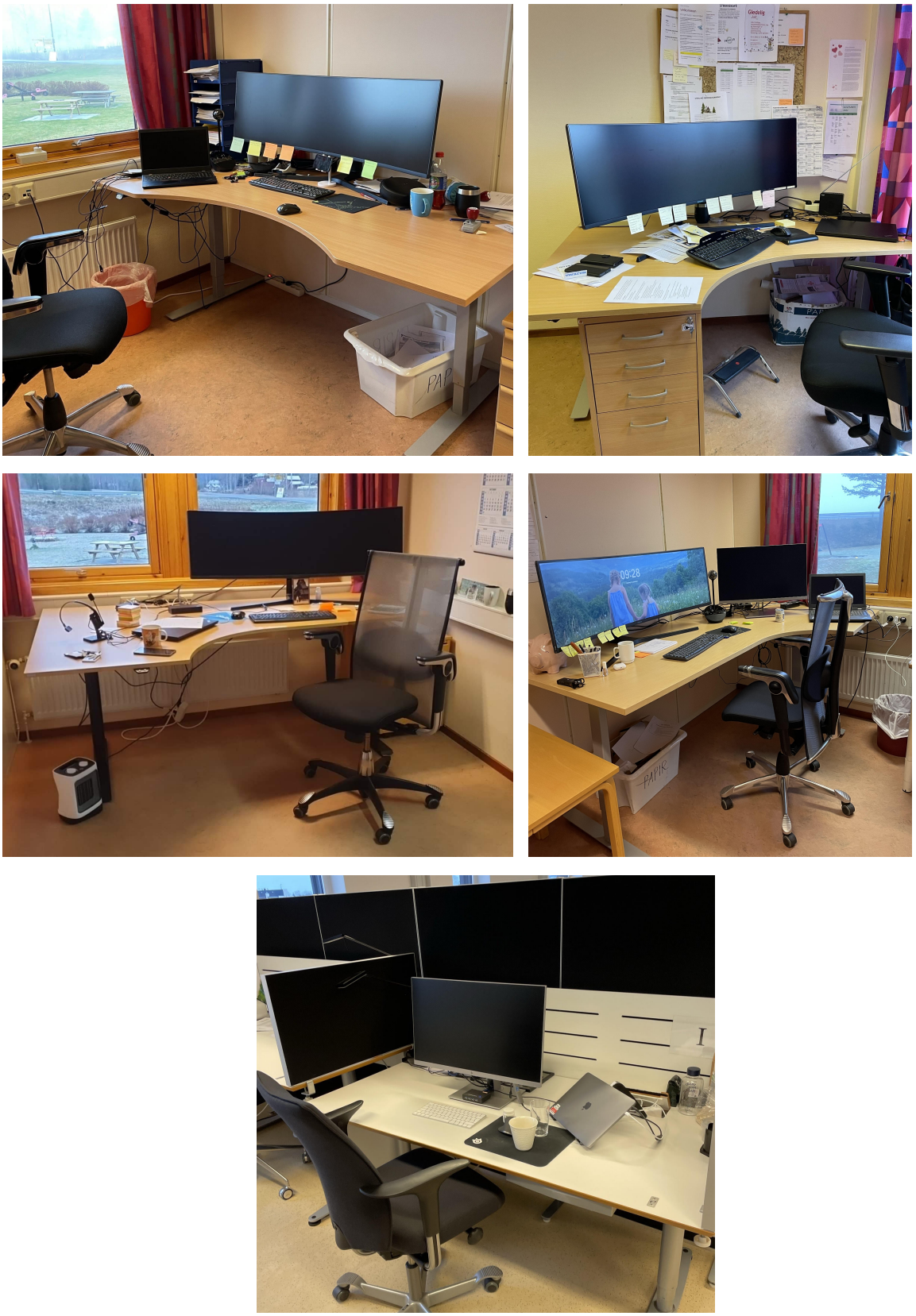

Figure 4.2 The individual offices of five participants

As stated, the participants varied in job location and description. Below I have provided an overview of the participants and their place of work (see Table 4.1), in addition to if and when they participated in a semi-structured interview or elicitation diary. Although each participant possessed various interesting attributes, to maintain clarity, I have chosen to limit their description to the aspects that I deem significant for the study.

Participant	Place of work	Semi-structured interview	Elicitation diary
Paul	Public sector	14.11.22	10.03.23
Julia	Public sector	14.11.22	06.03.23
Lisa	Public sector	14.11.22	
Caroline	Public sector	14.11.22	22.02.23
David	High-tech company	15.11.22	28.02.23
James	Educational institution	06.12.22	
Henrik	Educational institution	08.12.22	
Anne	Consultancy firm		03.03.23

Table 4.1 Overview of participants

Note: The participant names are naturally pseudonyms. Each place of work with the same description indicates the same location of work. In the interview and elicitation diary columns, the date refers to the date of interview, the elicitation diary date refers to the date of the follow-up interview. No date indicates that the participant did not partake in the activity.

4.5 Methods of data collection

The two main methods employed for data collection were semi-structured interviews in the first phase of empirical research, followed by elicitation diaries in the second phase of empirical research. Before data collection, participants provided written informed consent. The study was approved by Norsk senter for forskingsdata (NSD), Meldeskjema number 425559.

4.5.1 Semi-structured interviews

The first phase of empirical research began with the planning and carrying out of semi-structured interviews with seven participants. The aim of employing a phenomenological approach for this thesis is to understand phenomena in the specific way they are perceived by the individuals in the situation. To achieve insight into this perspective,

Creswell (2013) suggests in-depth conversations with 5-25 individuals who have experienced the relevant phenomenon. In this study, semi-structured interviews were carried out with seven participants.

The objective of these semi-structured interviews was to gain insights into how participants act out embodied cognition during computer interaction, in this case in an office setting. The theoretical framework served as a structure for understanding and investigating potential areas of interest that could aid in uncovering aspects of this phenomenon. The inquiry aimed to understand embodied cognition from a phenomenological perspective, emphasising the interconnectedness of the mind, body, and environment. The inquiry therefore aimed to understand the holistic context of computer interaction to gain an overview of its embodied nature, rather than perhaps focusing on specific computer programs or technological details.

Furthermore, in attempting to investigate embodied cognition specifically, understanding the more intricate ways in which bodily experiences and thought processes were connected was significant. To achieve this, the interviews were particularly structured around exploring situations where participants felt cognitively stuck and engaged in active contemplation, and from there attempting to understand participants' feelings and behaviours in these situations.

Regarding the possible manifestation of a lack of introspection due to tacit knowledge, aiding participants in reflecting upon their unconscious experiences was a significant factor to consider. First and foremost, the interviews took place in each participant's individual office, with them naturally sitting at their typical workstation. Furthermore, the questions posed to participants consisted of inquiries into concrete aspects of their day-to-day routine, such as what they generally did when they took breaks or what kind of items they always brought to work with them. This approach attempted to provide participants with easier articulation by building on concrete experiences while present in the relevant context.

The theoretical notion of the body schema provided a perspective for investigating the complex bodily relationship participants may have with their workstations and the elements it consists of. Participants were questioned about their satisfaction level and typical use of the equipment present in their office in order to investigate this relationship, involving everything from their desk, chair and computer screen to filing cabinets and paper waste baskets. The notion of symbolic off-loading opened for an investigation into various ways in which participants may make use of their environment for cognitive aid, which came into particular focus when asking participants about their strategies when feeling stuck on a task. Including

inquiries into what kind of tools may be involved in these strategies or any other behaviour experienced as helpful in these situations.

Lastly, it is important to note that although the theoretical framework was utilised as a beneficial tool for structuring an inquiry that could explore this phenomenon, keeping an open mind and being accepting of unexpected ways in which embodied cognition was expressed was also crucial.

4.5.2 Elicitation diaries

The second phase of empirical research began with the planning and carrying out of elicitation diaries with five participants. The findings from the semi-structured interviews with the seven participants were highly informative and enlightening in gaining an overview of the embodied experience of computer interaction in office work. These findings provided the opportunity to understand how embodied cognition can manifest itself in this context, transforming the constructed theoretical framework, presented in Chapter 5. However, the findings also indicated that there was more knowledge to be discovered beneath the surface. Therefore, the elicitation diaries are utilised with the aim of gaining a deeper, more comprehensive, understanding of the underlying reasons behind the expressions of embodied cognition, in addition to the possible further connections in these experiences.

Bennett (2014) demonstrates how elicitation diaries can be employed within a phenomenological methodology to obtain a more authentic and up-close portrayal of the subjective experiences of a phenomenon, that cannot be equally obtained solely by asking about one's feelings on the phenomenon. Elicitation diaries typically involve participants recording their thoughts and experiences around a predefined subject or occurrence, where this recorded data is used as a prompt during an interview at a later date (Lazar et al., 2017). Five participants took part, and they were asked to make note of what their body was doing and feeling when working with what they perceived as demanding tasks on a computer. In comparison to feedback diaries, where the data collected is limited to the diary entries themselves, the follow-up interview that elicitation diaries entail facilitates getting to the bottom of the more fundamental reasons behind a participant's thoughts or behaviour.

Elicitation diaries allow for the reflection of an action in the same moment that it occurs, where participants are only expected to briefly report the experience by for example taking a picture or jotting down a few words. The choice of media for this documentation should correspond with a media that is naturally used by the participants in everyday life (Creswell,

2013). The findings from the semi-structured interviews indicated that post-it notes, being experienced as an effective and easily accessible tool, were used by many of the participants. Therefore, post-it notes became a natural choice for the study, where participants were instructed to stick the post-it to the bottom of their computer screen, a practice already familiar to the majority of them. Participants were given the option to either allocate a single day or multiple days to complete the task, where the majority opted for the latter. Diary studies are frequently plagued by misunderstandings and lack of participant documentation, so being as explicit and precise about the study's objective as possible is essential. A detailed task description was given to each participant, emphasising the relevant information of interest, namely what they do when they think. As this may seem ambiguous to many, they were also provided with many examples of relevant information, such as getting up and leaving their office, adjusting their position in their seat, picking up items on their desk and the feelings that were associated with various actions. This approach encouraged participants to document all and any behaviours, movements or reflections, no matter how insignificant they seemed.

4.6 Methods of Analysis

This thesis employs Interpretative Phenomenological Analysis (IPA) as the basis for my analytical approach, as outlined in Chapter 4.2. This involves grasping the essence of IPA, meaning the attempt to understand and explore the subjective experiences of participants and how they make sense of the world, while also interpreting these accounts in order to mean something more (Smith et al., 2009). In order to achieve these two aims, the analysis process will balance both an inductive and deductive approach. I have chosen to structure this approach by employing the phases of thematic analysis as described by Braun and Clarke (2006).

Braun and Clarke (2006) suggest that thematic analysis can be conducted in an inductive, data-driven way, where themes emerge from the data itself. The initial stages of the analysis therefore involved taking an open and broad view of the topic of embodied cognition and categorising the data without a pre-existing coding frame, to ensure a strong connection between the themes and the data itself. The stages referred to here are Steps 2 - 4, as presented below in Figure 4.3. Braun and Clarke (2006) further describe a more deductive, theoretical approach where pre-existing theoretical or conceptual frameworks are used to shape the analysis. This characterises the last phase of the analysis, where the theoretical framework and its predefined elements were used to gain a more theoretical understanding of

the themes generated from the prior phases of analysis. This is naturally referring to Step 5: Examination against the theoretical framework, in Figure 4.3.

4.6.1 Steps of analysis

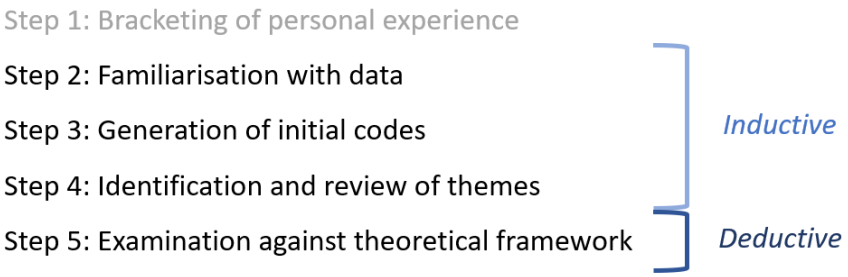

Figure 4.3 Steps of my analysis

Step 1: Bracketing of personal experience

Before these phases of thematic analysis, the analysis process started off with the exercise of bracketing, a highly recommended element of phenomenological studies (Creswell, 2013). The purpose of this exercise is for the researcher to describe their own experiences with the phenomenon in question in order to set aside, as much as possible, their own attitudes and assumptions of the topic they are studying. In this way ensuring that the experiences and perspectives of the participants formed the basis of the findings, rather than my own preconceptions. This step was only carried out once, in the first phase of empirical analysis.

Step 2: Familiarisation with the data

The first phase Braun and Clarke (2006) suggest to begin a thematic analysis consists of familiarisation with the data. This often entails a transcription of the data or the use of interview notes, and then a process of reading and re-reading these transcriptions or notes in order to form initial thoughts and ideas.

Step 3: Generation of initial codes

In this step, the data is broken down into smaller units of meaning that are labelled with a descriptive code that summarises what the segment is about. This process involves reading through the data thoroughly and identifying words, phrases or sentences that capture something meaningful. It is important to remain close to the data during this stage, avoiding over-interpretation or theoretical assumptions.

Step 4: Identification and review of themes

For my analysis I have chosen to group together the three steps *"Searching for themes" "Reviewing themes"* and *"Defining and naming themes"* from Braun and Clarke's (2006) description of the process. The reason for this is to maintain simplicity, but more importantly, to avoid making the inductive process appear disproportionately large against the final phase of analysis.

As presented by Braun and Clarke (2006) these phases consist of initially looking for patterns, connections, and relationships between the identified codes, in order to establish potential themes. Following this is an iterative process of reviewing and refining the themes, by considering whether they accurately capture the essence of the data and whether they are distinct enough from one another. This process may include initial codes going on to form main themes, and themes being merged or divided or discarded completely. This step could in theory continue infinitely, therefore it is important to recognise when the refining of themes is not contributing anything particularly significant or useful. Lastly, the themes are defined and named, where a clear and concise description for each theme, that reflects the underlying data, is provided.

Step 5: Examination against theoretical framework

This final phase of analysis is not present in the thematic analysis process of Braun and Clarke (2006), however, this phase is inspired by their description of taking a more deductive, theoretical approach to the analysis. However, by initially taking an inductive approach in establishing codes and themes I hope to have somewhat avoided their criticism of how a more deductive approach may provide a less rich description of the data.

At a more fundamental level, this phase is influenced by the element of interpretation in an IPA approach. As formerly presented, this aspect can be fulfilled by positioning the initial descriptions of subjective experiences in relation to a theoretical context.

4.6.2 How the analytical focus shifted in Phase 1 to Phase 2 of Empirical Research

While the process of analysis for the data obtained from the semi-structured interviews and elicitation diaries followed the same steps, the focus of each analysis differed. The analysis of the semi-structured interviews followed a more traditional approach to thematic analysis, with an emphasis on a comprehensive stage of identifying codes and finding themes in the data. In contrast, the elicitation diaries analysis aimed to gain a more complete and nuanced understanding of the findings from the previous empirical research phase, rather than

attempting to identify an abundance of new codes and themes. Therefore, this analysis placed a larger emphasis on Phase 4 and Phase 5 of my presented analysis process, where substantial time was spent attempting to understand the possible connections and dependencies between the themes and uncover their meaning.

4.7 Limitations

The methodological approach employed in this study brings about several limitations and reflections to be considered. First and foremost, due to the phenomenological nature of the inquiry, it is important to acknowledge that the results and findings of the study are contingent upon the subjective experiences of the eight individuals who participated. While their perspectives offer valuable insights, the small sample size inherently limits the generalisability of the findings to a broader population. Additionally, the study did not involve a prolonged observation of the participants' routines, which may have provided a more comprehensive understanding of their experiences over time.

Furthermore, while the office context was selected as an entry point to explore embodied cognition in computer interaction, it is crucial to recognise that certain aspects of the findings are inevitably context-dependent. Although the study's outcomes hold relevance for computer interaction in general, contextual factors specific to the office environment will have influenced the participants' experiences.

Another reflection to consider is that the theoretical framework influenced the structuring and content of the data collection methods, which could have led to an overemphasis on certain aspects of the data and a neglect of others. It is also impossible for a researcher to completely exclude their own preconceptions from influencing the study's interpretations.

Lastly, it is worth noting that participants may have been influenced by societal norms surrounding the sedentary nature and prolonged screen time associated with computer interaction. The current trend of considering physical activity as important and extended screen time as negative may have subtly influenced participants' perceptions and experiences, potentially introducing a bias in their responses.

Chapter 5

Establishing the second theoretical framework of embodied thinking in computer interaction

This chapter provides an account of the establishment of the second theoretical framework of embodied thinking in computer interaction, concluded with a presentation of the resulting framework and the intermediate findings. This framework was established through an analysis of the qualitative data obtained from the seven semi-structured interviews, where uncovered themes were considered in relation to the elements of the initial theoretical framework. It is worth noting that although Chapter 5.2 Establishing the second theoretical framework is not contained in Chapter 5.1 Results and analysis, it is also a crucial step of the analysis, illustrated in Figure 5.1.

5.1 Results and analysis

The analysis followed the structure presented in Chapter 4.6.1, where Figure 5.1 provides an overview of the presentation of these steps of analysis.

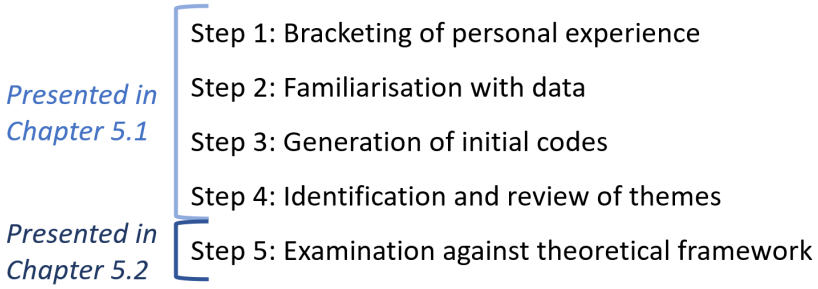

Figure 5.1 Steps of analysis for Empirical Research phase 1

5.1.1 Developing themes

As presented in the previous section, bracketing in phenomenological research involves setting aside preconceptions to approach a phenomenon in an as unbiased way as possible. As computer interaction is a significant part of my life, especially while working on my thesis, I noted down my attitudes and routines in relation to computer work in order to become more mindful of this relationship. In summary, I in many ways find computer work uncomfortable and impractical while undertaking challenging cognitive tasks, and often experience a general feeling of malaise and fatigue after spending a long day sitting at a desk on a computer. I was

conscious of my attitude and experience towards the phenomenon during data collection and analysis, but also acknowledged that my subjectivity would inevitably influence my thesis and its contribution.

The next step was to familiarise myself with the data, which was initially done by transcribing each interview recording, which was used as a method for re-assessing the data and establishing initial ideas. An important component of this transcription was also recording participants' physical actions throughout the interview, for example; "*That would not be satisfying, I need to really cross it off, the more I can cross it off the better [draws more lines through the task that was previously crossed out] actually.*" (extract from the transcription of Caroline's interview). This allowed me to preserve a more complete image of the participants' bodily connection to the topics discussed, and therefore gain a more genuine understanding of their embodied experiences.

The initial generation of codes began with pulling extracts from the transcription that I thought could be interesting when considering the topic of embodied thinking. Furthermore, each extract was given an initial code, which gave a superficial description of the data. This provided me with the opportunity to assess the preliminary frequency of specific topics and the possible connections between them. Table 5.1 illustrates an example of this initial coding process.

Data extract	**Code**
"I use the standing function sometimes, but it's usually when… yeah it's really mainly for variation"	Variation
"things where I'm kind of stuck or maybe I'm a bit like how am I going to figure this out, who should I talk to or how… Well those tasks are you know, that's when I start tidying @"	Tidying "leaving it alone"
"If I really hit a brick wall I either going to just drop it and say, and you know I don't consciously think "I'm gonna have to put that on the back burner", but I think, I know myself and I've got as far as i can with it, and it's like I know that if I give myself a bit of time then I will probably come up with a solution"	"leaving it alone"

Table 5.1 Example of initial coding process

Following this, the process of organising these codes into themes began. In this process, I found it critical to maintain the original expressions of the participants to ensure that the phenomenological essence of the study was upheld and that their subjective experiences were preserved. In order to achieve this, direct extracts from the interviews were used continuously throughout this process of identifying themes. Below is an example of how direct quotes were used to compare experiences between participants and interpret the possible meanings behind participants' accounts (see Figure 5.2).

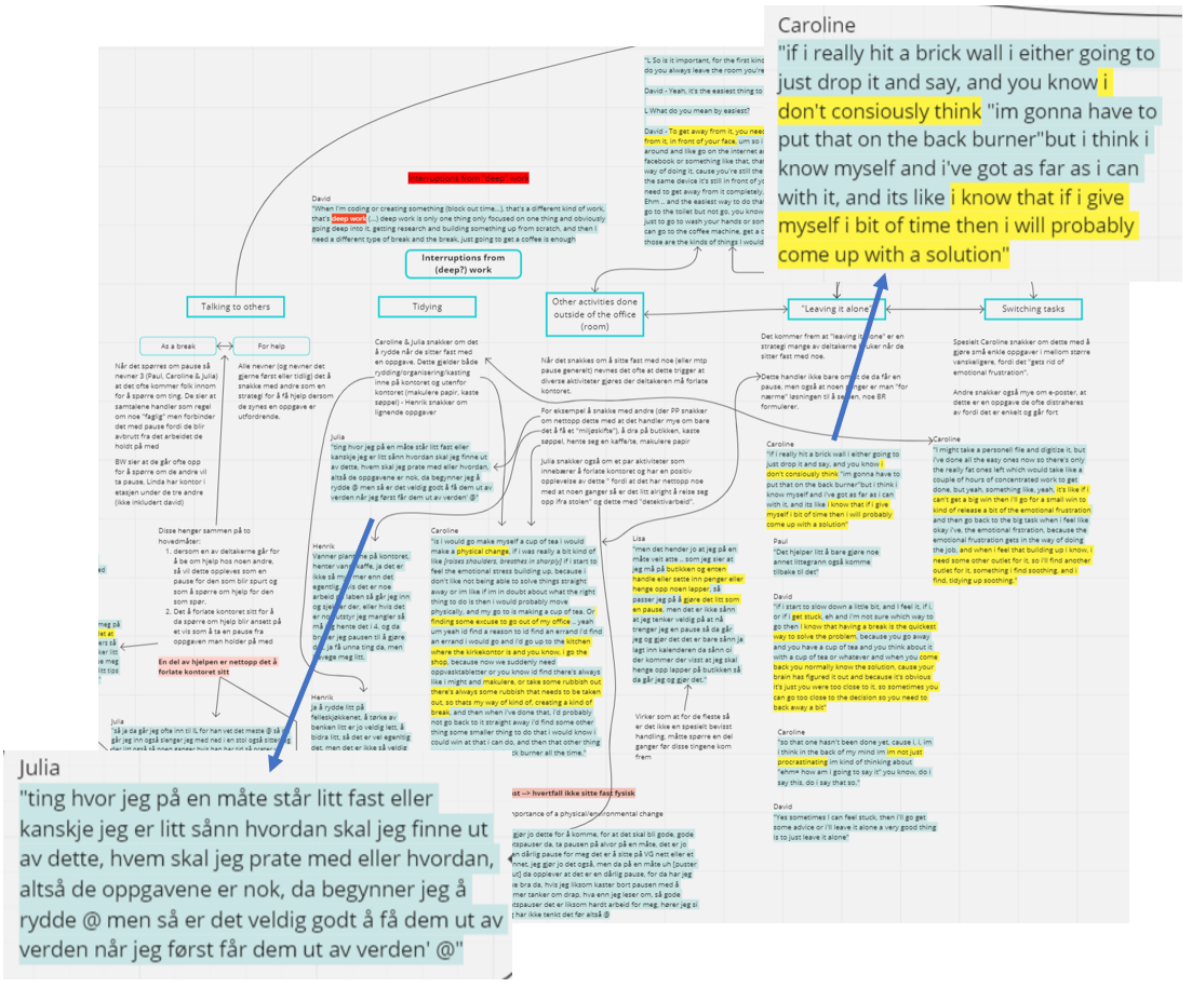

Figure 5.2 Extract from thematic analysis process illustrating the use of direct quotes

Following the identification of initial themes, was an iterative process of reviewing and reconsidering each theme and its contents, working with the data until I felt the themes were able to sufficiently represent the essence of the data. An example of this process is where the codes *talking to others*, *"leaving it alone"*, *grooming of office space* and *task switching* initially formed the theme "*mitigation of "deep" work"* (inspired by a definition of "deep" work provided by David, meaning work that required deep concentration). Upon closer examination, I noticed that the actions of participants, such as talking to others, switching

tasks, or taking breaks outside the office, all shared the common intention of leaving a task alone. In this way, the initial code "leaving it alone" emerged as a main theme of the analysis. In another example, this iterative process uncovered that the themes of fidgeting and handwriting were essentially grounded in the same experience, namely some form of kinesthetic preference. Figure 5.3 below shows a shapshot of the thematic map during this process.

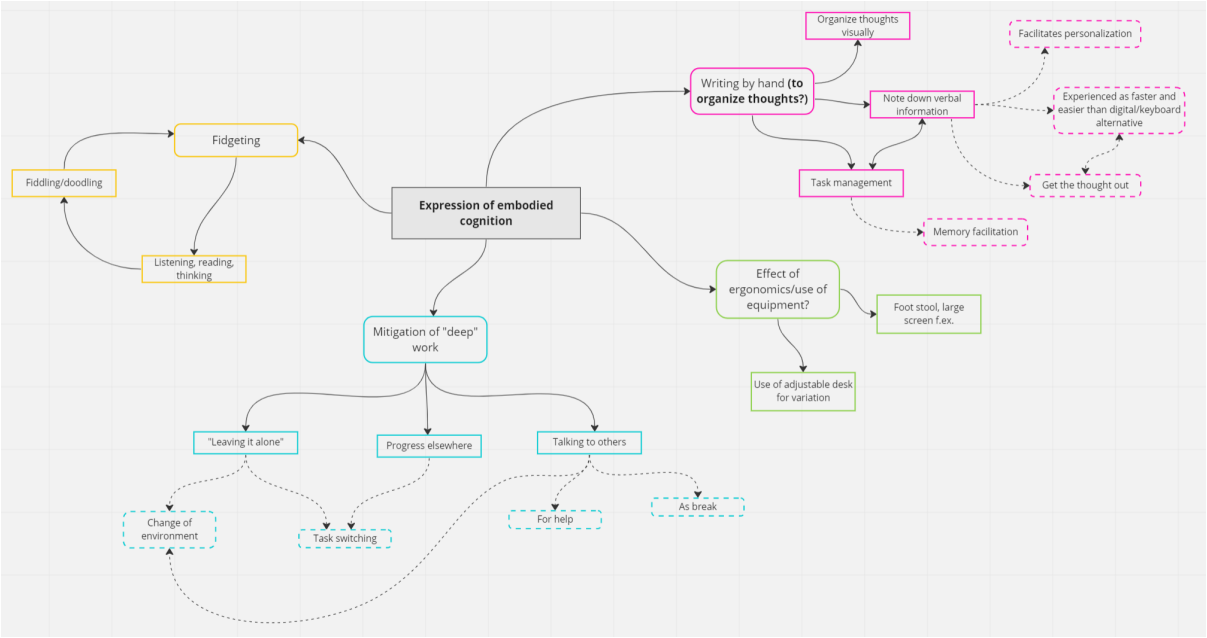

Figure 5.3 Snapshot of thematic map during the review of themes

5.1.2 Presentation of themes

The final themes established from this described analysis of the data from the semi-structured interviews were; *Navigating the workstation, "leaving it alone", The kinesthetic preference* and *First-time reflections.*

Navigating the workstation

During the semi-structured interviews participants expressed various ways in which they navigated their workstation, providing a narrative of their experienced relationship with this context. Overall, the participants expressed satisfaction with their office setup, which could be attributed to the fact that most of them had access to modern and recently updated equipment. All the participants made use of desktop computers with a large and or multiple screen(s), along with an external mouse and keyboard. They also used office chairs that were designed for comfortable seating during work hours, and six out of seven had desks with an adjustable height. Additionally, some participants highlighted the significance of other items

in their workspace, such as Lisa and Julia who emphasised the importance of having an object to rest their feet on while working. While Lisa used a footstool, Julia improvised by using a paper waste box, both objects appearing to hold equal significance for each of the participants. Caroline described her particular experience of navigating her workstation by recounting how, due to her arm getting sore from prolonged use of a computer mouse, she had started to use her left hand when using her mouse. This then led to a change in the position of her mouse, which now was placed in the middle of her desk, where she would easily switch from her right to left hand in order to switch between screens. This led her to become ambidextrous in using her computer mouse.

Lisa, who seemed knowledgeable and enthusiastic about her office equipment, mentioned that previously she did not have such amenities, which she unfavourably described,
"No before there was only a tiny little old desk that couldn't be adjusted [shows the size with her arms], I couldn't get my legs under it [shows with her legs that her knees would hit the edge of the desk] and there was a really bad office chair with no functions [touches her chair and the levers] so I couldn't adjust, and throughout the day I couldn't adjust it, because sometimes you know right now I'm sitting like this [sits in a certain position, puts weight to one side] but now you know I can adjust the chair so I can sit a bit more like this [sits back into chair] and yeah, I can even stand and work if I want." (Lisa, 06:41)

Linda's quote also indicates the importance of bodily variation when sitting at her desk, a point brought up by all of the participants. Paul, Julia and Caroline explained using the standing function on their adjustable desk when they felt they had been sitting for too long or needed a change of perspective, with Paul stating,
"It's if you're stuck (on a task), then it can be good to try and change your perspective a bit, changing your position or you know, how you, how your body is" (Paul, 15:17)

The majority of the participants emphasised the necessity for getting up and leaving their workstation throughout their day, where Henrik had an app to tell him to get up and move every 20 minutes.

Like his peers, James also identified with the need for variation, portraying a general dissatisfaction with having to sit at his desk for prolonged periods of time. Instead, he preferred laying on his sofa, which allowed him to use tools such as his remarkable or his notebook, as alternatives to his desktop computer. The importance of incorporating variety into the workday was highlighted further, as participants recounted instances where they felt

the need to step away from their current task and engage in other activities. This concept is expressed through the following theme of "leaving it alone".

"Leaving it alone"

While working on a somewhat challenging task, participants described the need to "leave the task alone" when they experienced feeling stuck. Although this strategy was executed in different ways, the underlying concept remained consistent - that stepping back from the task would aid in its resolution.

"If I really hit a brick wall, I'm either going to just drop it and say, and you know I don't consciously think "I'm gonna have to put that on the back burner", but I think I know myself and I've got as far as I can with it, and it's like I know that if I give myself a bit of time then I will probably come up with a solution" (Caroline, 18:40)

It seemed that participants often removed themselves from a task in order to unknowingly "put it on the back burner", allowing their unconscious state to work on the problem. The participants recounted that taking simple breaks such as getting a drink or going to the toilet could aid them in achieving this new headspace,

"If I start to slow down a little bit, and I feel it, if I, or if I get stuck, eh and I'm not sure which way to go then I know that having a break is the quickest way to solve the problem. Because you go away and you have a cup of tea and you think about it with a cup of tea or whatever and when you come back you normally know the solution, cause your brain has figured it out and because it's obvious it's just you were too close to it, so sometimes you can go too close to the decision so you need to back away a bit" (David, 25:15)

Participants also consistently mentioned going and talking to other colleagues when feeling stuck on a task. Although this was often to gain insight on that specific task, it seemed this activity often actually facilitated in leaving the relevant task alone and achieving an environmental change.

"So yeah, then (when stuck on a task) I would often go and speak to Paul, because he knows most things @, so then I just go in there and flop down on a chair and I just sit there for a bit, so sometimes if he has time then we'll talk, but sometimes I'll just sit there and avoid being in my own office for a second @, because you know there's often something in that, you know just needing a change of environment." (Julia, 27:19)

Paul speaks similarly on this topic, stating that,

"Usually I'll go to someone else and sit in another office, to get a little change, and then usually we end up talking about something completely different" (Paul, 18:04)

In this way, an important element of this strategy seemed to be the change of environment, as participants recounted the importance of physical change, more specifically leaving their workstation, when feeling stuck on a task,

"I would go make myself a cup of tea, I would make a physical change, if I was really a bit kind of like [raises shoulders, breathes in sharply] if I start to feel the emotional stress building up, because I don't like not being able to solve things straight away or I'm like if I'm in doubt about what the right thing to do is then I would probably move physically, and my go to is making a cup of tea. Or finding some excuse to go out of my office .. yeah, um yeah, I'd find a reason to, I'd find an errand, I would go and I'd go up to the kitchen and you know, I'd go to the shop, because now we suddenly need washing up tablets, or you know I'd find, there's always, like I might shred some paper, or take some rubbish out there's always some rubbish that needs to be taken out, so that's my way of kind of, creating a kind of break, and then that other thing would be going in my back burner all the time." (Caroline, 24:58)

This description from Caroline also portrays how participants often engaged in other tasks as a part of this strategy of leaving their original task alone. Henrik explains how he often waters the office plants, cleans the communal kitchen or goes and retrieves needed equipment when taking a break from his current task. Furthermore, Julia describes feeling the urge to tidy or organise her office when dealing with a task where she is not sure of the solution,

"...things where I'm kind of stuck or maybe I'm a bit like how am I going to figure this out, who should I talk to or how… Well those tasks are you know, that's when I start tidying @" (Julia, 20:54)

James also emphasises the significance of task switching and how he incorporates it into his breaks, explaining how he enjoys juggling or folding origami birds, most importantly he needs to be away from his computer screen, engaging in an alternative activity,

"Yes, I do those things (juggling, folding birds) so that I have good, good quality breaks, to take my break seriously I guess, I mean, a "bad" break for me is sitting looking at VG nett or something, I mean I do do that as well sometimes, but then I kind of [breathes in sharply] I experience that as a bad break, because it doesn't make me feel good, if I waste my break. So

good quality breaks, they're actually hard work for me, I hear myself say now, I haven't thought of that until right now though @" (James, 25:37)

The kinesthetic preference

Following the analysis of the interview data, a theme emerged regarding participants preference towards a kinesthetic experience, often during inherently non-physical tasks. This preference appeared in various ways including taking notes, doodling, fidgeting and fiddling.

Although the majority of the participants had digital company calendars that they made use of for time and task management, all the participants, apart from Henrik, also chose to manage their tasks by writing them down physically by hand in some form. Paul, Julia, Lisa and Caroline, possibly as a result of an established company culture, all made use of post-it notes to track their current tasks, where all of them except Caroline stuck these post-its to the bottom of their computer screen. David did not use post-it notes but recounted that all throughout his adult life he had used notepads for task management purposes, having recently replaced the notepad with a Remarkable[2]. James and Caroline also owned and made use of Remarkables, however, James still also made use of a physical notepad.

Generally, participants tended to note down these tasks initially when receiving a verbal message about them, either over the phone, in a meeting or from someone coming by their office.

"I write things down while people are talking to me, that's just to make sure I've got the information I think" (Caroline, 08:19)

"My tasks often come in over the phone or by someone stopping by, so then I'll just [reaches for a post-it note] instead of going on my computer" (Paul, 11:45)

When inquired about why they preferred to write certain things by hand, there seemed to be a general consensus that writing things down physically in these situations was less time-consuming and easier to organise. Paul, in his previous quote, illustrates how reaching for a post-it note was experienced as more effortless and straightforward than interacting with his computer. James elaborated on this point,

"(when writing something on a computer) it involves you know, more activities in the world, pushing of buttons and stuff to get into it, even with this [picks up Remarkable], but then I

[2] A Remarkable is a brand of digital paper tablet that allows users to take notes, draw, and read e-books, using a stylus to write on the device's e-ink display (https://remarkable.com/).

have this [picks up notebook] and "boosh" [opens the book quickly] and I get right into what I need, and I have a better overview, I know it's all physically here" (James, 09:18)

Both Lisa and Julia recounted using a digital post-it alternative, but they both quickly went back to physical post-its.

"I've tried having post-its in here [points to bottom right corner on screen, smiles and shakes head] but no, I like having them here [touches physical post-its stuck to bottom of screen] (...) *It was so messy (about digital post-its), bringing up and finding the post-its, because you know they're in a [points to bottom left on screen] in a post-it thing, and then I have to go in there to see them all, sorry it's difficult to explain @"* (Lisa, 14:24)

"And you know there are [touches post-it notes, removes one] oh I can actually get rid of this one, yes you know there are digital post-its now, but I tried those [points to screen], I mean I used digital post-it notes before, but then they kind of disappeared from my view @ there's always something else open [waves hand to show that there is always a window covering that part of the screen]" (Julia, 10:18)

As Julia remarks, the practice of writing by hand seemed to also serve some form of benefit within attention and memory. While showing the ways in which he uses his Remarkable for task management, I noticed David had drawn multiple "explosions" throughout the pages. Inside of these, he would write what he called an action, a task that needed to be done, and he emphasised the importance of them being easy to spot, hence the "explosion" symbol (see Figure 5.4).

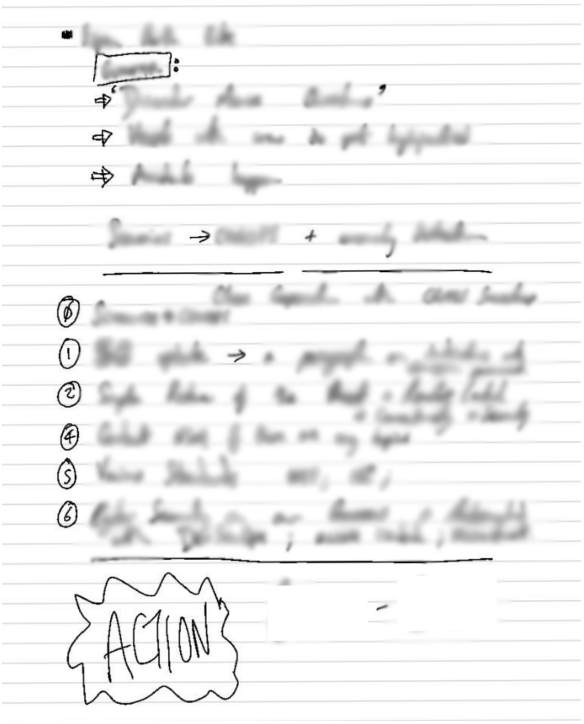

Figure 5.4 A page of David's notes showing an "explosion"

Writing using a physical tool seemed to play some kind of role in cognitive facilitation for the participants, with many of the participants reflecting that the practice aided them in remembering things. For example, Caroline described how she used post-its to trigger her memory, and when Paul was asked if he ever directly put tasks into his digital calendar he explained that,

"I would most likely write it down on a post-it first, but I think that's got something to with that I remember things better if I write it down physically" (Paul, 12:37)

It seemed that writing by hand also had extended perceived cognitive benefits, when asked why he prefers writing by hand James reflected that,

"That's a good question, it's because its physical I think, you know there's a slogan like "thinking with your hand", it's like that, I think more, better, I work better" (James, 17:35)

James also showed me how he often uses his notebook to organise thoughts and solve problems,

"I can show you an example [picks up notebook and shows a page where he has drawn various shapes and arrows between them] yes for example here there was some kind of relations problem, something where I thought "wait what is even going on here", you know

my feelings, others intentions that I.. then I drew it, I had to draw it to explain what's happening, who has what agenda, that's when I draw. It clarifies it, I get an overview of the situation and then there is no problem anymore, or at least I have a way out now." (James, 13:16)

Henrik also describes similar practices, writing down on post-it notes and moving them around into different positions to organise his thoughts. Furthermore, the physical aspect of writing by hand was also remarked on by Caroline, where she described how when she takes notes in meetings it's not only to jot down the relevant information,

"...but it's a little bit kind of, that's a bit of doodling as well, I don't doodle, but I do write things down just for the kind of like, the satisfaction of, having a physical activity at the same time as I'm listening if you know what I mean, because I often write things down that I don't really need to write down, but it just makes me feel, you know, like I'm taking action" (Caroline, 11:16)

This preference for stimulation during non-physical tasks was also experienced by other participants,

"I fiddle with all kinds of things, I make swirls and doodles on post-its, all kinds of stuff, I'll fiddle with my pen, especially if I'm just sitting and reading" (Paul, 23:45)

"I like to just have something, if I'm in a meeting I just get a bit like, like [frantically touches items on desk] need to pick something up @" (Julia, 15:13)

After realising they both tended to fiddle a lot with pens, Paul and Julia decided to purchase fidget pens, that have what they experience as a very satisfying spinning function. They both reflect that they tend to use these pens when in digital meetings, while reading or while on the phone, all fairly passive activities. David describes a similar experience, in his case with the pen for his Remarkable, additionally reflecting upon the cognitive aspect of this activity,

"Yes I play with, I play with the pen [picks up Remarkable pen] I'll swivel the pen while I'm thinking, do that [taps pen on chin/mouth], hold it in my mouth, that's what I will do. It's usually when someone is presenting something and I'm thinking, that's what that signifies usually, me thinking, if I'm playing with pens usually I'm thinking, I'm not looking at the pen or the person talking, I'm just thinking, gazing into space thinking, about what they mean by what they've said, or trying to figure out how to rephrase something." (David, 14:16)

James remarked on a similar experienced connection between thinking and some form of activity,

"I very rarely sit here and think (referring to workstation). I do that when I'm folding birds, which means when I'm doing things, or when I'm in conversation with others, or when I'm writing. (...) Thinking, for me, is connected to activity" (James, 30:53)

First-time reflections

A general theme that emerged from the analysis of the interviews was the participants' general lack of prior reflection upon the topic of inquiry. This became apparent through a few factors, for example, most of the more insightful reflections came towards the end of the interview when the topic had sufficient time to mature in their minds. In addition, participants consistently remarked, after expressing a thought or an attitude, that it was not something they had ever really thought about before. For example, James expressing that,

"(...) So good quality breaks, they're actually hard work for me, I hear myself say now, I haven't thought of that until right now though @" (James, 25:37)

Also Caroline, following her explanation of how she would go and run an errand if feeling stuck remarked that,

"Yeah I guess I will just find an excuse to leave the office, yeah.. I've not thought about it like that before, but yes, that's what I do" (26:12)

Julia also humorously commented after her interview that she felt like she had "analysed" herself, saying that the content of the interview was not something she would have ever thought about otherwise. During an interaction with David, it became even more evident that several of the experiences in question were unconscious. Initially, when asked if he ever fiddled with anything while working, David denied it. However, upon noticing the Remarkable pen in his hand, which he had even though he was not writing at the time, he realised that he might occasionally fiddle with it. Consequently, he provided me with the previously presented explanation of why he might engage in this behaviour.

Furthermore, participants' ability to reflect on their experiences and behaviours appeared to be significantly influenced by the interview setting. As shown through the presented quotes, participants often used body language and gesturing to explain their experiences, including reaching for or using the object they may be referring to, for example;

"Yes I play with, I play with the pen [picks up Remarkable pen] I'll swivel the pen while I'm thinking, do that [taps pen on chin/mouth], hold it in my mouth, that's what I will do." (David, 14:16)

"My tasks often come in over the phone or by someone stopping by, so then I'll just [reaches for a post-it note] instead of going on my computer" (Paul, 11:45)

The purpose of these actions may have been partly to help my understanding of what they were explaining, but it seemed these gestures also served a personal purpose, which became evident when one participant did not have their familiar context available. Due to a misunderstanding, the interview with Henrik ended up not taking place at his actual workspace, since his workspace was actually in a shared area. Although this interview did not follow the original plan, it served a significant purpose and provided crucial insight. The interview with Henrik was significantly shorter than with the other participants and it was comparatively harder for him to reflect upon his own behaviour. It could be thought that this was merely due to personal factors, however interestingly, when the interview ended, Henrik sent multiple follow-up messages when he returned to his workspace. Previously, when asked why he used a stand for his laptop, he answered that he didn't really know, however after the interview he sent a message with the following,

"my laptop takes up less space on the table with the stand. It's between the outlet with my charger and my mouse mat, so I get more space to move my mouse if I use the laptop stand".

This showed how as soon as Henrik was back in the context where his ingrained experiences had been formed and were used, he was able to more easily reflect upon them.

5.1.3 Thematic map and summary of themes

These themes have been visualised through the thematic map below (Figure 5.5),

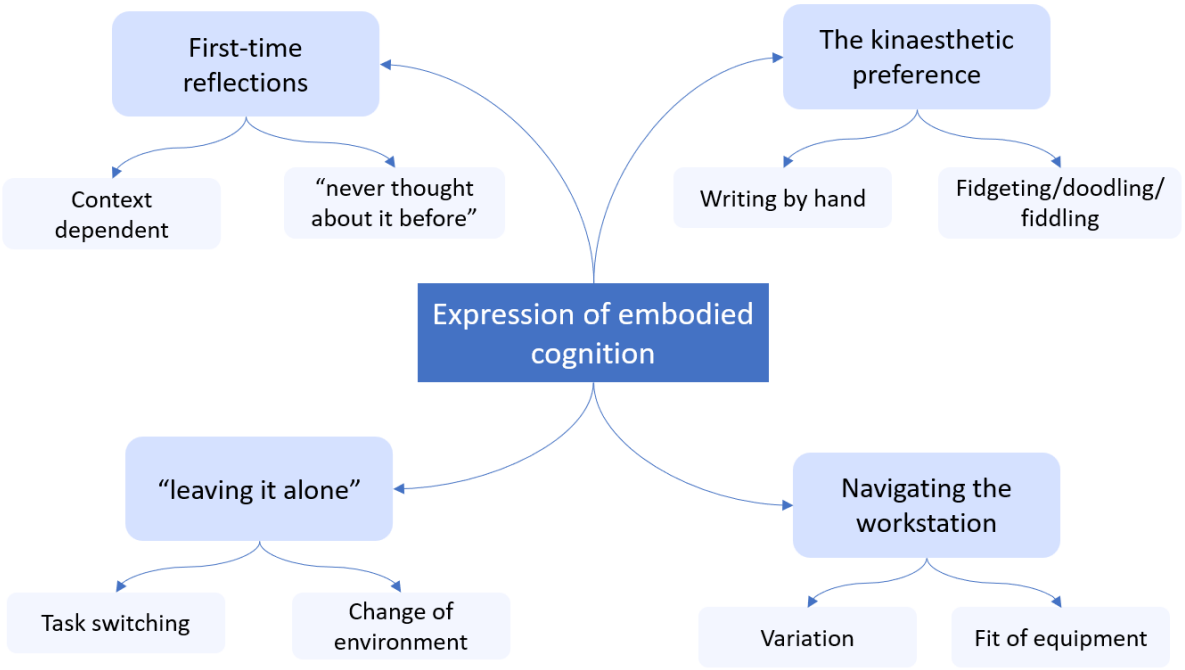

Figure 5.5 Thematic map Empirical phase 1

Below is an additional, more detailed overview of these identified themes (Table 5.2).

Theme	Sub-theme	Description	Key quote(s)
Navigating the workstation	Variation	Participants expressed a need for variation in their bodily position, often connected to feeling stuck on tasks	*"It's if you're stuck (on a task), then it can be good to try and change your perspective a bit, changing your position or you know, how you, how your body is"* (Paul)
	Fit of equipment	Participants remarked on their relationship with their equipment, often emphasising the importance of the equipment being a good fit	*"No before there was only a tiny little old desk that couldn't be adjusted [shows the size with her arms], I couldn't get my legs under it [shows with her legs that her knees would hit the edge of the desk]"* (Lisa)
The kinaesthetic preference	Writing by hand	Participants often leant towards writing certain things by hand, finding it gave a feeling of taking action and was often experienced as easier, more flexible or more helpful than a	*"That's a good question, it's because its physical I think, you know there's a slogan like "thinking with your hand", it's like that, I think more, better, I work better"* (James) *"..because I often write things*

		digital alternative	*down that I don't really need to write down, but it just makes me feel, you know, like I'm taking action"* (Caroline)
	Fidgeting	Participants often fiddled with pens physically inactive tasks and/or contemplation	*"Yes I play with, I play with the pen [picks up Remarkable pen] I'll swivel the pen while I'm thinking, do that [taps pen on chin/mouth], hold it in my mouth, that's what I will do. It's usually when someone is presenting something and I'm thinking, that's what that signifies usually, me thinking (...)"* (David)
"Leaving it alone"	Task switching	Participants often engaged in other tasks or activities when feeling stuck on a task	*"things where I'm kind of stuck or maybe I'm a bit like how am I going to figure this out, who should I talk to or how… Well those tasks are you know, that's when I start tidying @"* (Julia)
	Change of environment	Participants often felt the need to leave their office space when feeling stuck on a task	*"...so then I just go in there and flop down on a chair and I just sit there for a bit, so sometimes if he has time then we'll talk, but sometimes I'll just sit there and avoid being in my own office for a second @, because you know there's often something in that, you know just needing a change of environment."* (Julia)
First-time reflections	Novelty	The topic of inquiry is not one the participants have typically offered much thought previously	*"Yeah I guess I will just find an excuse to leave the office, yeah.. I've not thought about it like that before, but yes, that's what I do"* (Caroline)
	Context dependent	Being in the context of the interaction being inquired about seemed to be significant for the ability of reflection	No quote Key example: Henrik found reflection away from his workstation challenging, this being facilitated when arriving back at his workstation

Table 5.2 Overview and summary of themes from thematic map

5.2 Establishing the second theoretical framework

In the final step of the analysis, Step 5: Examination against the theoretical framework (see Figure 5.1), the themes that emerged from the data were considered in relation to the initial theoretical framework of embodied cognition. The qualitative analysis of the data up to this point was of an inductive nature, where the themes were generated based on the data itself, not the pre-existing categories of the framework. At this point in the analysis, the approach shifts from inductive to deductive, where the theoretical framework was applied to guide further analysis of the data.

The participants' descriptions of their experiences were understandably more grounded and practical, rather than theoretical. As a result, the themes that emerged from the analysis were also more concrete in nature. Therefore, I found it appropriate to introduce these themes at the level of tangible and concrete manifestation in the framework. From there, the relationship between these themes and the chosen theoretical areas of embodied cognition could be explored in order to understand how participants' experiences of the phenomenon may fit within the framework. Initially, each area of embodied cognition is considered separately, before the possible relationships and interdependencies between them are discussed Chapter 5.3.

5.2.1 The body schema

"The relation between body and world unfolds as a conversation"

Guenther (2017, p.144)

During the interviews, participants provided various accounts of their relationship with, and navigation of, their workspace. Overall, participants had surprisingly little to remark about their immediate workspace, referring to their desk, chair and computer. These items appeared to be relatively unnoticed by the participants, as their interactions with this equipment seemed generally automatic and instinctive. The equipment appeared to have become readily available for the participants, allowing them to act through it in a seamless way to carry out tasks and accomplish goals. This was highlighted through Lisa's account of her previous office situation where she did not experience this seamless interaction. She provided a vivid description of how her body simply did not fit with the equipment, making her highly aware of it, even remembering how her knees would bang against the edge of the desk even though

she had received her new desk over a year ago. It seemed when the equipment did not fit, or said in another way, when the participant did not negotiate well with the equipment, it was experienced as present-at-hand, and remained prominent in the participants consciousness. Alternatively, when the equipment fit well, and the participant was satisfied with it, it was experienced as ready-to-hand. In this case, the equipment had become invisible to the participant and was used efficiently without much reflection. Participants expressed different ways in which they try to negotiate with their workspace in an efficient way to allow the equipment to become ready-to-hand. For example with Lisa and Julia's use of a footrest, to achieve a more comfortable position and allow the equipment to even more easily fade into the background. Caroline showed how the prolonged use of her mouse had led to discomfort and therefore a bad negotiation, she then repositioned the equipment, which ended up allowing her to switch between screens, and therefore use the equipment even more efficiently. Other participants spoke of the use of the raise and lower function on their desk in order to achieve some variation and concentrate better on the task at hand.

In the presentation of the initial theoretical framework, the example of a car being incorporated into our body schema was used. When we drive a car, we rely on the equipment present - the seat, steering wheel, pedals - to help us access the car's capabilities and travel faster than we could on foot. We frequently modify this equipment, such as adjusting the height of our chair, to facilitate a smoother and more fluent interaction with the car. In this way we can incorporate the car's structure into our bodily awareness, allowing us to concentrate more efficiently on the task at hand, namely driving. This approach seems to also apply to computer interaction, where participants negotiate with their workstation to better focus on their work tasks. Participants aim to make the interaction as seamless as possible by incorporating the equipment into their bodily structure, to feel as if they were accessing their own capabilities.

In this way, it seemed that as participants sat down at their desk, their body schema shifted to now include the desk, chair, computer, mouse and any other equipment necessary for fluid access to these capabilities. This notion is finds further support in another observed expression of embodied cognition, namely the act of "leaving it alone". During the interviews, each participant conveyed a clear need to leave their workstation when experiencing the feeling of being stuck on a task. Many reported finding various excuses to leave their workstation, including taking coffee or toilet breaks, running small errands or cleaning and tidying. It seemed that it was important for participants to engage in an activity

that had different attributes than the activity of sitting at a desk and interacting with a computer. James explained that for him to experience a break as a *"good quality break"* he needed to engage in some form of alternative activity, where staying at his workstation and for example reading the news was not experienced as a beneficial break. Assuming the workstation had been incorporated into the body schema, participants' perceived potential for action may have been altered. As a result, they may feel the need to adjust their body schema in order to change their perceived potential for action and possibly improve their perceived cognitive ability to solve the task at hand. Furthermore, participants made it quite explicit that the change of environment that leaving their office provided was a crucial element of aiding them in coming back and solving whatever task they were working on. Caroline for example explained how she would most likely find an excuse to leave her office if feeling stuck on a task and Julia recounted how she would sometimes visit Paul's office just to *"not be in her own office"*.

The apparent need to leave their office space entirely suggests the possibility of not only objects being incorporated into the body schema, but also space. In other words, the boundary of the lived body could perhaps extend to encompass an entire room. In this way, our familiar everyday spaces could become the spatiality that is part of our subjectivity, in the same manner as a computer mouse or a workstation. Merleau-Ponty (1945) states that *"To be a body, is to be tied to a certain world, as we have seen; our body is not primarily in space: it is of it."* (p. 171). Similarly, Guenther (2017) comments on the pathological space of solitary confinement, where the prisoner's body and the cell become inextricably intertwined. In this way, our bodies are not just objects that exist in space but are intimately intertwined with the spaces they occupy. As such, our body schema includes not only our physical bodies but also the space around us. This idea is further echoed by Morris (1997), who argues that the places in which we live and work can become part of a "larger body" that extends beyond our physical selves. Morris also describes the body schema as a *"primordial habit"*. This refers to how the body schema behaves continuously with a world laced with human meaning and that therefore exterior places can be incorporated into our lived body and our sense of bodily space. Therefore, if we assume that the whole office as a room is incorporated into the body schema, then we can assume that this incorporation would alter our perceived potential for action in the world. In situations where we are struggling with a task, and we feel our capabilities for action are limited, we may feel the urge to leave the office space to then adjust our body schema and, in turn, readjust our perceived potential for action in the world.

The previous description of this concept, in the initial theoretical framework, was *Incorporation of equipment*. Initially the alteration I contributed to the second theoretical framework was to add the concept *Incorporation of space*, however, upon closer analysis, I realised that the process of incorporation of objects or tools and the incorporation of whole spaces could be thought of as a process along a horizontal axis, instead of two separate processes. Therefore, instead of having two distinct concepts, I consolidated them into the concept of *Incorporation of space,* which includes the incorporation of all elements that were originally part of the external environment.

The concept of the *Incorporation of space* seemed to manifest itself in this examined context in two ways. On the one hand, participants adjusted and negotiated with their workstation in order to achieve a more seamless interaction, allowing the equipment to fade into the background and be integrated into their bodily structure. On the other hand, participants also frequently expressed the need to alter their bodily state by leaving their workstation, and preferably their office, in order to perhaps gain a more advantageous cognitive perspective. Therefore the manifestations of the concept of *Incorporation of space* are at this point described as *Bodily negotiation* and *Alteration of space*. These changes are depicted in Figure 5.6.

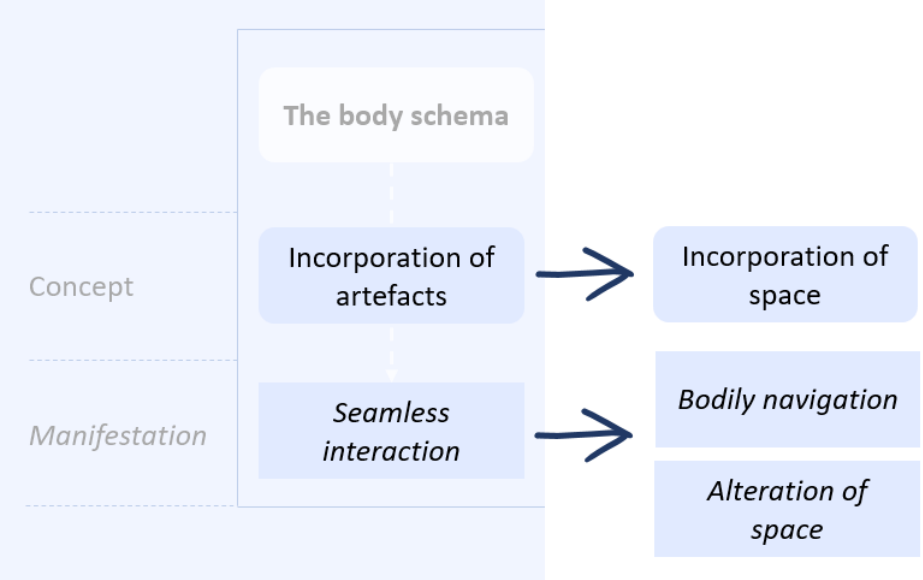

Figure 5.6 Alteration of the concept and manifestations within The body schema from the initial theoretical framework to the second theoretical framework

5.2.2 Tacit knowledge

"Tacit knowledge is defined variously as that which is gained experientially or, stressing the privacy of personal experience, in terms of its incommunicability. It is probably more informative to focus on tacit knowledge's inseparability from the processes of its creation and application…"

- Spender (1995, p. 67)

As presented in the initial theoretical framework, one of the main characteristics of tacit knowledge is that it consists of knowledge that is in many ways impossible to express verbally. A general theme of the interviews was the participants' lack of prior reflection on the topic of inquiry. It was clear that their knowledge of how they interacted with their workstation was of an unconscious nature and that articulation of their behaviour and attitudes was at some points challenging. The participants had all worked in their respective offices for at least a year, and spent on average the majority of their time at work in their office, allowing substantial time for the development of habits and routines in this space. I suggest that through this process of habituation, the participants' experiences became embedded in the physical environment of the workspace, creating implications for their ability to verbally articulate these experiences. Polanyi (1966) suggests that tacit knowledge can in some situations be communicated, provided that we are given *"adequate means for*

expressing ourselves". Here he points out the way in which police provide pictures of facial features in order to aid witnesses in remembering faces, however, he still emphasises the fact that this still does not involve much need for verbal articulation. However, Spender (1995) proposes an alternative definition of tacit knowledge, with a stronger focus on the epistemological status rather than the aspect of communicability, stating that tacit knowledge is *"that which has not yet been abstracted from practice"*(p. 67). This implies that tacit knowledge is deeply rooted in practical experience and is therefore ingrained in the situation and context in which it occurs. It became clear through the interview with Henrik that the setting of the interview was of large importance, and that the act of being present in the context where the experience takes place is highly conducive to participants' reflections on said experience. To try and gain a more direct perspective of how this process works, one can imagine trying to teach someone how to drive a car. When attempting to teach someone how to drive a car, most people would find it very challenging to sit in their living room and verbally explain at what speed you should release your foot from the clutch and at what point to push down on the accelerator. However, if you were to explain these intricate actions while actually carrying them out, while actually driving a car, it would probably be experienced as more effortless. Furthermore, you could imagine that even just being present in the driver's seat of a car, instead of your living room sofa, would aid in your ability to express this tacit knowledge.

As soon as Henrik returned to his workspace, the surroundings seemed to jog his memory, or tap into his tacit knowledge. The remaining participants all used their environment actively when explaining their routines and behaviours, often picking up post-its, pens or logging into their computer to show me how they arranged windows on their screen. This indicated that their tacit knowledge was embedded in the physical context and the bodily experience of this context. Therefore, the previous suggested manifestation of habituation *Lack of introspection* has in this framework been altered to *Context reliant introspection.* This change is depicted in Figure 5.7.

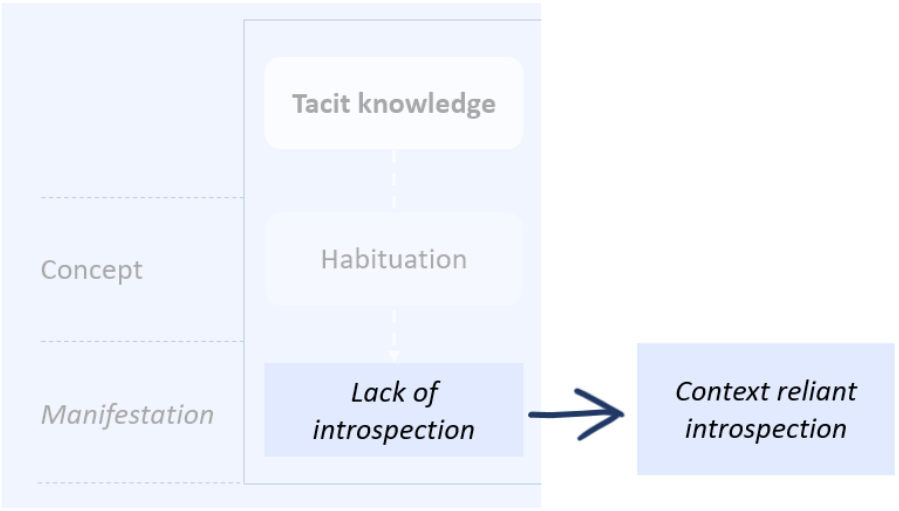

Figure 5.7 Alteration of the manifestation of Tacit knowledge from the initial theoretical framework to the second theoretical framework

5.2.3 Epistemic action

> *"It should be noted too, that symbolic off-loading need not be deliberate and formalized, but can be seen in such universal and automatic behaviors as gesturing while speaking"*
>
> - Wilson (2002, p. 629)

When it comes to the area of embodied cognition that is epistemic action, it seemed that the use of the environment in order to aid their cognitive state was something participants often engaged in. The way they utilised the environment in these cases was however not of a spatial or situated nature. Alternatively, these actions were performed in the service of cognitive activity about something else, something not physically present in the immediate environment, indicating that understanding these actions as symbolic off-loading is fitting.

A theme that emerged from the interviews and initial analysis was the participants' preference towards writing by hand, even when having a digital alternative. The practice of writing by hand was experienced as less time-consuming, more accessible and more flexible. The participants often expressed experiencing various cognitive benefits from the practice of writing by hand, for example where it aided in memory and problem-solving. James directly described *"thinking better"* when writing in his notebook, and various other participants had routinely returned back to the practice of writing by hand, after not receiving the same satisfaction from digital alternatives. In many ways, the preference towards writing by hand

does not make complete sense from a symbolic off-loading standpoint. The use of a digital tool should in many ways provide participants with equal opportunity to off-load their cognitive load onto the environment. However, Mangen and Velay (2010) argue that due to the significant haptic distinctions between handwriting and typing on a keyboard, they are inherently dissimilar in their cognitive and phenomenological characteristics. When writing by hand, the writer's visual attention is strongly focused on the tip of the pen, whereas during typing, the writer's visual attention is not connected to the physical act of hitting the keys. This creates two, spatiotemporally separated spaces: the motor space (keyboard) and the visual space (the screen). In addition, when writing by hand the writer must graphomotorically form each letter or stroke of the pen, however, in typewriting there is no such need for fine motor control for expression. Furthermore, the distinct phenomenological impact of writing by hand was directly commented on by Heidegger (1982 [1942], pp. 118-119) who describes that when we write by hand, the word *"passes through the hand"* and is *"acted authentically"*. He claims that the use of the typewriter mechanises the act of writing and separates the hand from the essential realm of the word. Heidegger's concerns with the typewriter can be transferred to the modern digital computer, where the interaction can be viewed as equally impersonalised and disembodied (Mangen & Velay, 2010). Participants in the studied context appeared to experience significant cognitive relief when able to tangibly express information by writing by hand. It seemed that by making use of tangible tools and practices, participants were able to in many ways articulate their inner dialogue.

Participants also appeared to benefit from articulating their inner dialogue in a more traditional verbal way. While conducting the previous steps of the data analysis, the code of *talking to others* did not seem to align with any of the emerging themes, only seeming relevant as a form of achieving a change in environment. Nonetheless, with the incorporation of the theoretical framework into the analysis during this step, and the concept of symbolic off-loading was being examined, the notion of *talking to others* resurfaced as a relevant topic. When participants recounted the common strategy of talking to others when feeling stuck on a task, it seemed that this was done not necessarily to get a direct answer from the individual they chose to talk to. Sometimes this seemed to be the case, but participants generally emphasised the act of going and talking to someone about it as a helpful strategy in and of itself. The concept of verbalisation being beneficial in problem-solving activities is not a new one, as literature in the field of psychology has continuously found support for this idea (e.g. Gagne & Smith, 1962; Ahlum-Heath & Di Vesta, 1986). However, I suggest that the helpful

aspect of verbalisation can be understood as a form of symbolic off-loading, and therefore significantly connected to the concept of embodied cognition. When participants speak to others about a challenging task, they are in many ways off-loading onto their surrounding environment by verbalising their inner dialogue. They are making use of the available environment, in this case making use of their colleagues, to off-load the cognitive demand by putting it out into the world.

The two forms of symbolic off-loading presented thus far represent ways in which the participants consciously and deliberately engaged in the behaviour. However, it appeared that participants also often off-loaded cognitive strain onto the environment in much more subliminal and unintentional ways. Multiple participants described an inclination to fiddle or doodle during their workday, especially during particularly static and inactive tasks such as reading or listening. Julia and Paul reported often finding themselves fiddling with their pen while talking on the phone, in meetings or while reading long reports, while David directly connected the small gesture of tapping his pen against his lips with contemplation during listening to someone speak. Furthermore, Caroline described her note-taking in meetings as in a certain sense a form of doodling, where the physical activity made her feel like she was *"taking action"*. In describing symbolic off-loading as a concept, Wilson (2002) notes that symbolic off-loading does not necessarily entail deliberate and formalised action, and that it can instead manifest itself as more general or automatic behaviours such as gesturing while speaking. It has been found that gesturing serves as a cognitive aid for the speaker and the movement in itself seems to stimulate thoughts the speaker may be trying to express (Alibali et al. 2000; Alibali & DiRusso, 1999; Iverson & Goldin-Meadow 1998; Goldin-Meadow, & Beilock 2010). It seems that the small movements that are cognitively beneficial during gesturing may be present during other kinds of activity, such as fidgeting or doodling. As discussed in the presentation of related work, several studies have provided evidence for the cognitive advantages of fidgeting and doodling (Grodner, 2015; Karlesky & Isbister, 2014). It seemed that participants found cognitive assistance in engaging in subtle physical activity during inherently non-physical tasks, in this way off-loading onto the environment in the form of utilising various tools in order to engage in this subtle physical movement.

It also became apparent that participants routinely engaged in another form of unconscious symbolic off-loading. Many participants reported the strategy of "leaving it alone" in regard to situations where they felt stuck on a challenging task. They described feeling too close to the answer, and expressed the need to put the task "on the back-burner". This strategy has

actually been found by Dijksterhuis and Nordgren (2006) to be quite advantageous, supported by their concept of Unconscious Thought Theory, where it is presented how not consciously thinking about the task at hand actually tends to lead to us making better decisions regarding that task. It seems that "putting it on the back burner" and letting our unconscious mind deal with the problem leads to better information organisation and higher objectivity. For participants, it seemed there were some important methods that should be implemented in order to efficiently gain access to all the benefits of unconscious thinking. For example, participants consistently remarked on the importance of physically leaving the workstation, and more preferably the office room entirely, in order to help them approach the task from a different perspective. Furthermore, participants often reported the beneficial aspect of accomplishing other tasks away from the workstation, in many ways in order to keep their mind off the pertinent task and efficiently "leave it alone". These behaviours can be regarded as a type of symbolic off-loading, wherein individuals employ their surroundings, such as physical activity or tasks within their environment, to externalise some of the cognitive load involved in problem-solving. In this way, participants use external cues to help them solve the problem, rather than relying solely on their own internal cognitive processes.

Fidgeting and doodling as well as leaving a task aside share a common characteristic; both strategies are often unconscious and automatic, meaning that individuals often do not intentionally engage in them as problem-solving strategies, but rather they may arise naturally as a way to cope with cognitive demands. Due to this, I have chosen to refer to their usage in this context as *Unintentional symbolic off-loading*. Furthermore, participants' preference for writing by hand and their commonly used strategy of talking to others can both be described as forms of *Articulation*, of a tangible or verbal nature respectively. These changes are depicted in Figure 5.8.

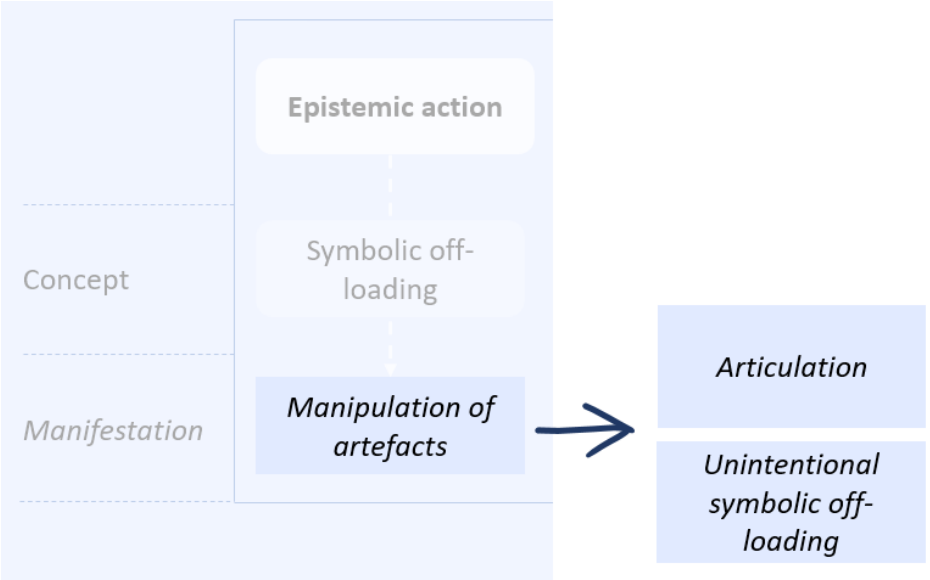

Figure 5.8 Alteration of the manifestations of Epistemic action from the initial theoretical framework to the second theoretical framework

5.3 Intermediate findings and presentation of the second theoretical framework

The previous sections present how participants' lived experiences of embodied cognition in computer interaction in an office context could be understood in relation to each of the chosen theoretical areas. At this stage, the areas were discussed in isolation and were perceived as independent from one another. However, in this section, I will offer a concise overview of the conclusions drawn regarding each area of embodied cognition, which includes a consideration of the meaningful connections and interdependencies between them.

The body schema

Regarding the body schema, it seemed that participants had formed automatic and instinctive interactions with their workstation, where they had negotiated with the equipment to achieve this seamless and ready-to-hand experience. In this way, the immediate elements of their workstation had become incorporated into their bodily structure to allow efficient access to the computer's capabilities. Furthermore, participants expressed a need to leave their workstation when experiencing the feeling of being stuck, seeming to need a change of perspective. This suggests the possibility of the boundary of the lived body encompassing an entire room, where altering their current bodily space by leaving their workstation could lead to an altered sense of potential to solve the task. These conclusions led to the adjustment of the original concept *Incorporation of objects* to the concept *Incorporation of space.*

Furthermore, this concept is suggested to manifest itself as *Bodily negotiation* and *Alteration of space*, rather than the former manifestation *Seamless interaction.*

Tacit knowledge

The tacit knowledge participants had developed appeared to be deeply rooted in practical experience and was embedded in the physical context of their workspace, often making it challenging for them to articulate verbally. The participants' reflections on their experience were aided by being present in the context where the experience took place. Therefore, the proposed manifestation of the concept of *Habituation* was changed from *Lack of introspection*, to the more fitting *Context reliant introspection.* Furthermore, the theoretical concept of habituation is highly connected to this process of incorporation of the external environment into the body schema. The ability for us to incorporate space into our body schema is naturally through a prolonged process of habituation (Merleau-Ponty, 1945). Morris (1997) describes how external elements in the world that exist initially independently from us, can be *"habitually subsumed as integral to our motor-perceptual habits"* and therefore consumed into our bodily structure. Therefore, the concepts of *Habituation* and *Incorporation of space* are linked on a theoretical conceptual level.

Epistemic action

In regards to epistemic action, the participants engaged in various forms of symbolic off-loading where they utilised their surrounding environment to aid their cognitive state. These strategies included the tangible or verbal articulation of inner dialogue through the act of writing by hand and talking to colleagues respectively. This led to the proposed manifestation of symbolic off-loading that is *Articulation.* Participants also off-loaded cognitive strain onto their environment in more unintentional and subliminal ways such as fiddling or doodling, or by removing themselves from their workstation and engaging in other tasks. This last described behaviour, which can be referred to as "leaving it alone" appears to have a significant connection to the manifestation of the *Incorporation of space* that is *Alteration of space.* It seems that the symbolic off-loading practice of engaging with alternate elements in the environment that are not the workstation can be understood as a strategy that aids participants in altering their current bodily space, that in turn seems to aid them cognitively. Therefore, the arrow symbolising a connection between the manifestations *Alteration of space* and *Unintentional symbolic off-loading* indicates a distinct connection between *Alteration of space* and the specific manifestation of unintentional symbolic off-loading that is "leaving it alone".

5.3.1 The second theoretical framework

The initial theoretical framework, presented in Chapter 3.5, consisted of proposed areas of theoretical interest with underlying concepts and potential practical manifestations of these concepts. Through the first phase of empirical research in the form of semi-structured interviews this framework was able to be evaluated against the real-life experience and expression of embodied cognition. Through analysis this led to influential findings that led to changes in this iteration of the framework.

In the initial framework the areas of embodied cognition, their concepts and their proposed manifestations were considered independently from one another. In this iteration of the framework the possible connections and interdependencies were explored, leading to the discovery of connections on both a more theoretical level, where the connection is not specifically dependent on the manifestation, and on a manifestation level. In addition, the initial framework only presented one proposed manifestation of each theoretical concept, however in this revised framework, manifestations have been altered and added in accordance with the findings from the empirical research.

The second theoretical framework is depicted in Figure 5.9 below.

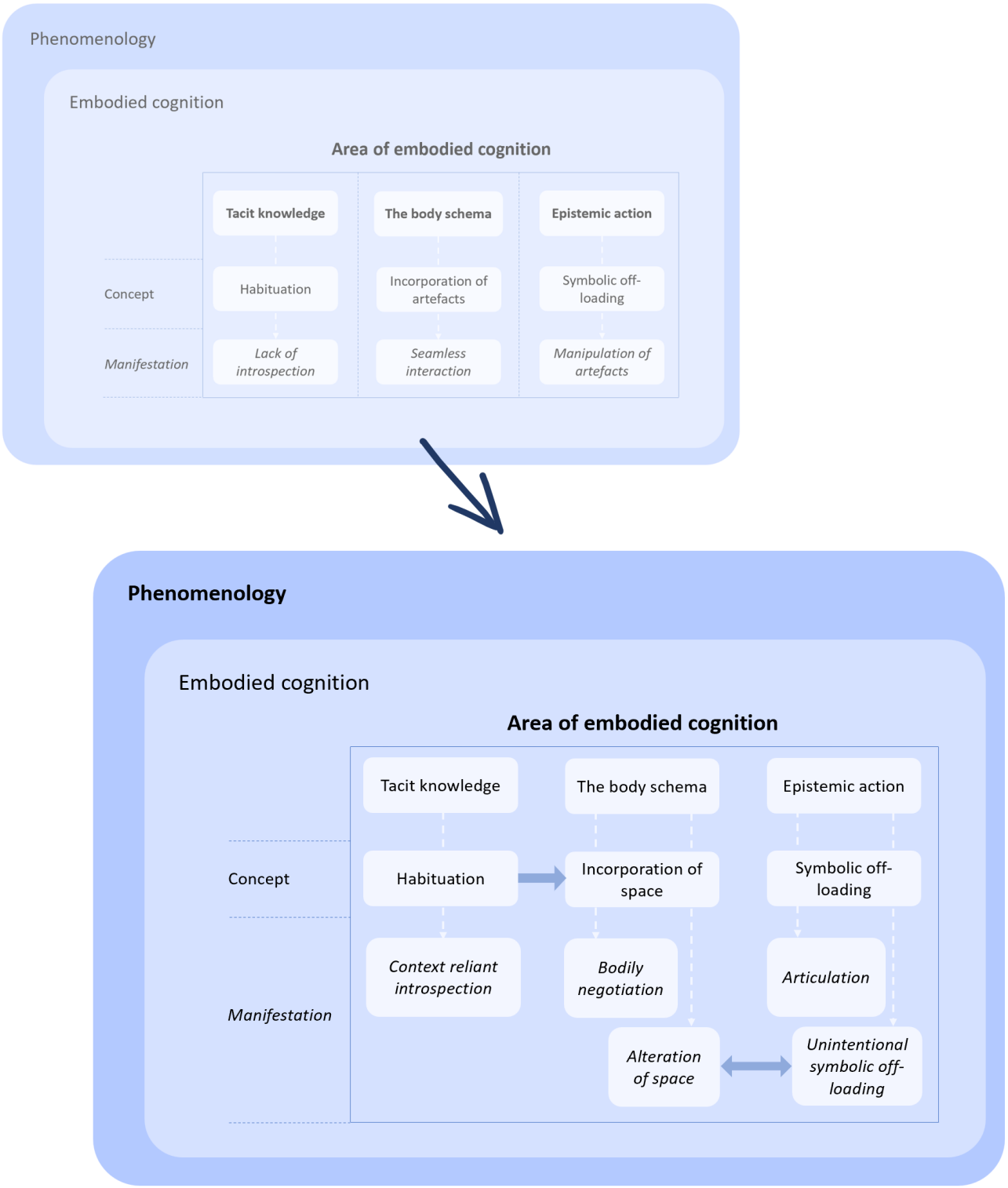

Figure 5.9 Transformation of the inital theoretical framework to the second theoretical framework

Note: The manifestation *Alteration of space* is specifically connected to the manifestation *"leaving it alone"* within *Unintentional symbolic off-loading*

Chapter 6

Establishing the final theoretical framework of embodied thinking in computer interaction

Following the establishment of the second theoretical framework, the second phase of empirical research began. Elicitation diaries were carried out with five participants, four of whom were a part of the previous phase of empirical research. This chapter initially presents the analysis of the resulting data from the elicitation diaries, followed by a presentation of the established themes from the analysis. Furthermore, these themes were evaluated against the second theoretical framework, resulting in the establishment of the third and final theoretical framework, simply referred to as a framework of embodied cognition in computer interaction

6.1 Results and analysis

As stated in Chapter 4.6.2, the second phase of empirical research had a different goal from the first, which required a different approach to analysis. In the first phase the main goal was to keep an open mind and discover the ways in which the participants expressed embodied cognition during computer interaction in their office. The insights gained from this initial phase provided a foundation for understanding key aspects of embodied cognition to consider in the subsequent phase of empirical research. The goal of this second phase was therefore to gain a deeper and more complete understanding of these experiences and their possible connections. To achieve this goal, the method of elicitation diaries was used to collect data from primarily the same participants from the first phase. In addition, the analysis process of the data from the elicitation diaries lay a heavier focus on the last two steps of analysis; *Identification and review of themes* and *Examination against theoretical framework.* This allowed for a more comprehensive and nuanced understanding to be contributed to the final theoretical framework. See Figure 6.1 below.

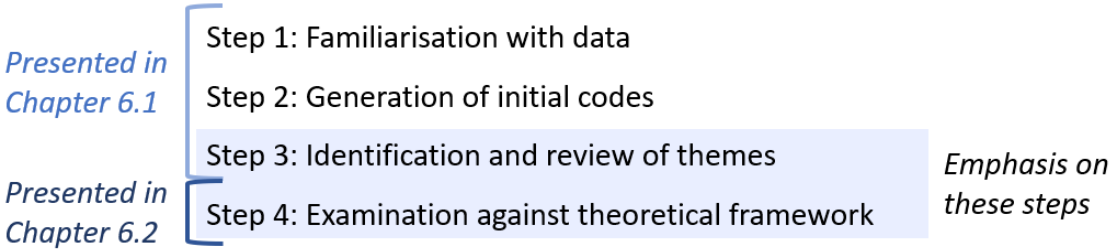

Figure 6.1 Steps of analysis for Empirical Research phase 2

6.1.1 Developing themes

As previously stated, the exercise of phenomenological bracketing was conducted prior to commencing the first phase of empirical research and was not incorporated into the second stage of analysis. Follow-up interviews for the elicitation diaries were not recorded or transcribed. Instead, notes were taken during the interviews and subsequently filled in to include any missing context or explanation, while thoughts and impressions were still fresh in memory. This process initiated my familiarity with the data, which was further enhanced by reviewing and re-reading the notes from each interview.

Following this, codes were assigned to each section in the notes that appeared to represent a unique element, described simply, for instance as *"fiddle with pen"*. While this process was carried out systematically, my efforts in the analysis were primarily devoted to the next stage, where codes and corresponding snippets from the notes were arranged into potential themes.

This clustering was carried out by assessing the degree to which each snippet shared similarities, and arranging these snippets along a scale where themes could merge and flow into each other. By using this approach, I was able to recognise connections between behaviours and experiences of the participants that may have multiple interdependent sources and may therefore be linked to multiple themes. In instances where snippets were related to multiple themes, they were positioned between the themes and identified with a colour that represented a blend of each theme. While this approach may not provide meaning to all, it offered flexibility in understanding the deeper implications of participants' explanations. The image below shows a transient representation of this process (see Figure 6.2).

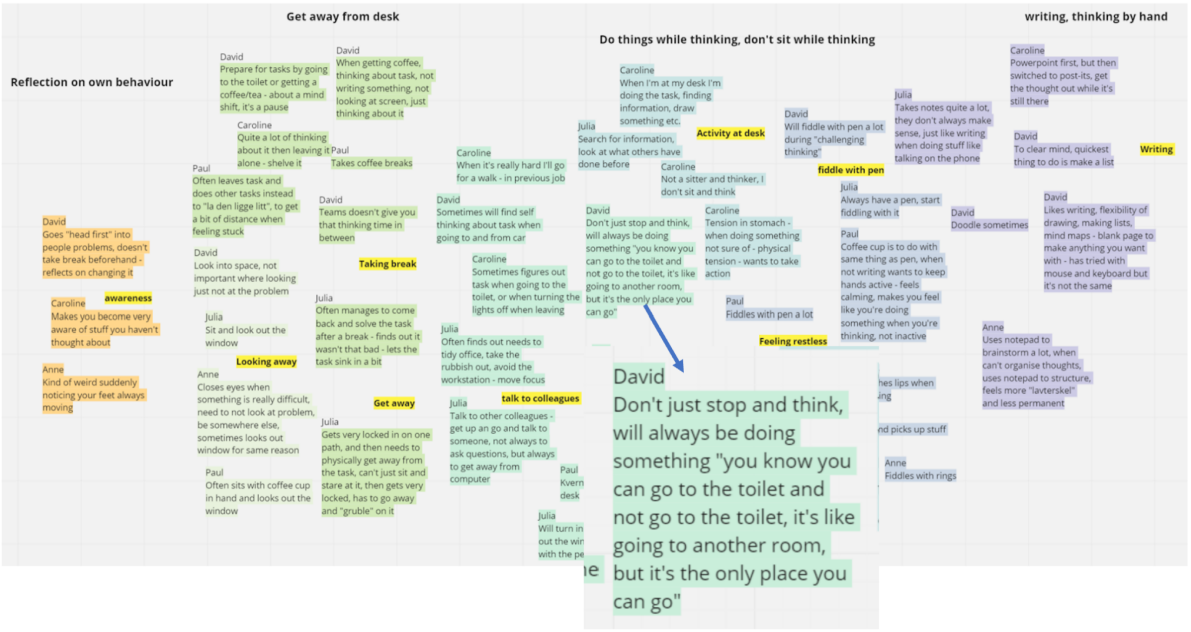

Figure 6.2 Clustering of themes to review their connectedness

6.1.2 Presentation of themes

Although the themes were closely intertwined, this step of the analysis ultimately led to the identification of three overarching themes; *The power of thinking away from the desk, The physicality of contemplation* and *Writing by hand's facilitation of "getting the thought out".*

The power of thinking away from the desk

Throughout the follow-up interviews a recurring theme was participants' tendency to want to leave a task alone and leave their office when feeling stuck on a task and feeling the need for a new perspective. David explains how when found himself preparing to engage in a challenging task, he would often go to the toilet or go and get a cup of coffee or tea. He explained that he does these things as a way to *"shift his mindset"* - since he will be working on the same computer in the same context, he feels the need for some kind of mental break to help him relax and shift gears. Furthermore, he comments that this *"is the problem with virtual meetings"*, as physical meetings often require you to walk to a different room, allowing for crucial thinking time and a change of perspective. However, in virtual meetings, even if there is a brief break in between, everyone is still in the same virtual room, which may hinder this important process.

Julia describes that a common strategy she used when not sure how to move forward with a task was to go and talk with colleagues, not necessarily to ask them questions, but simply to get away from her desk and shift her focus. Julia describes other activities that she carries out for this same purpose, such as tidying her office or taking out the rubbish. She notices herself avoiding her workstation, feeling like she needs to shift her attention away from the task at hand. Julia explains that she often "locks" herself onto one way of thinking, and that just sitting and staring at it never helps. She needs to instead go and *"gruble"* (norwegian word for "ponder"), which she emphasises must happen away from her desk. After taking these "gruble" breaks, she often returns to her workstation and is able to figure out the task much more easily. She explains that often, when she initially receives a task, her first thought is *"Oh that's probably going to be difficult"*, but then she will step away from it and do something else first. When she returns, she often realises that the task was not as challenging as she originally thought, having allowed the task to sink in a little before diving into it. Julia's post-it entries are depicted below in Figure 6.3.

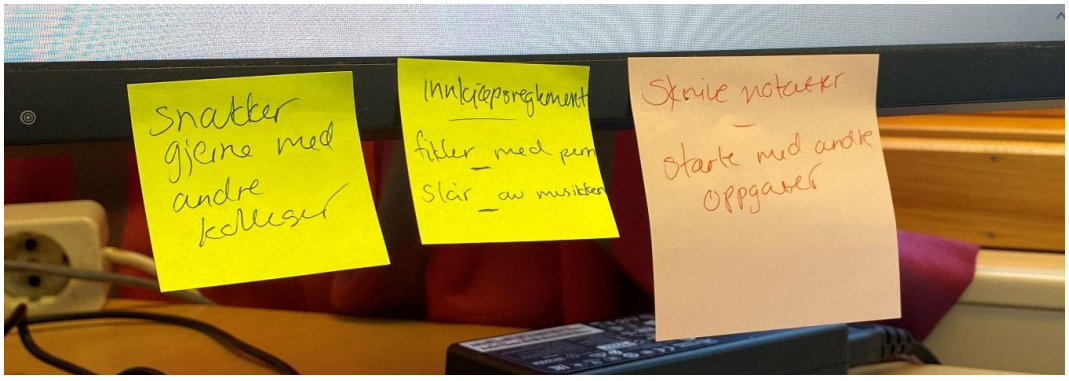

Figure 6.3 Julia's post-it entries for the elicitation diary

Caroline recounts a similar experience, where she often found herself "shelving" the task in question - where she would sketch it out in her mind a little, and then leave it alone. She would catch herself thinking about the task in various seemingly random contexts, such as when she went to the toilet or when she turned off her office light when leaving for the day. During the discussion, Caroline reflected on the fact that she would rarely reflect deeply on the task while sitting at her desk, but rather in these other unplanned moments. Paul describes similar strategies, remarking that often when he felt stuck he would leave his desk to get a coffee or to chat with colleagues. He explained that these behaviours made him feel like he got some distance from the problem and gave him some time to "kverne" (Norwegian word for "grind", in relation to thinking).

When asked if he noticed anything in particular about his contemplation strategies David reflected on the fact that he didn't often "stop and think" at his workstation - either he was working on the task on his computer, or he was going to the toilet, or getting a coffee. This he explains further by stating that *"You know you can go to the toilet and not go to the toilet. It's like, you need to go to another room, but it's the only place you can go",* and also describes how he often finds himself pondering a difficult work task while walking to and from his car before and after work. In addition, David remarked that he only took the former described "mind-shift"-breaks before certain types of tasks, and not others. He further reflected that he experienced the tasks where he didn't take a break beforehand as much more frustrating. As describing this, he reflects inwardly that *"Hmm, that's not a good thing, maybe I should change that"*.

Anne also describes these "thinking sessions" while not at her desk, explaining how she found herself often going to the toilet to *"speak with herself"*, where she would have conversations internally with herself where she would consider what to do next. When working from home one of the days, she caught herself actually having one of these conversations out loud, where one of her inner dialogues had spilled out due to now being alone. Anne further explains how it is often during these "conversations" that she has somewhat lightbulb moments where she will think *"oh yeah that's how i could do it"*. Anne also describes another behaviour she noticed while dealing with very cognitively challenging tasks, where she often found herself closing her eyes. Although she found it difficult to clarify exactly why she does this, she explains how she *"just can't look at the problem, it's like I need to be somewhere else"*, reflecting further that perhaps this is why she often likes looking out the window. Both Julia and Paul also describe this behaviour of looking out the window to gain a perceived distance from the problem, while David describes a strategy of fiddling with his pen and staring into space when thinking, not looking at anything in particular, just making sure to not look at the problem.

From these accounts from the participants, it appears that taking breaks and gaining a physical distance from a cognitively challenging task often helped them gain a new perspective and shift their mindset. These breaks from their office space involved activities such as talking with colleagues, going to the toilet or walking to and from a meeting room. Many participants found that from these periods away from their desk that they were able to approach the task with a refreshed mindset and ultimately help them complete the task more

effectively. In addition, it seemed participants also at times merely imagined themselves as somewhere else to achieve this experience.

The physicality of contemplation

Another theme that arose from the data was the tendency for participants to associate contemplation with physical movement. For example, Caroline described that when first taking on a task that she found challenging, she would often feel a physical tension in her stomach and a strong urge to take action. Furthermore, as presented in the previous section, Caroline would often find herself thinking about difficult tasks in somewhat random situations, like when going to the toilet or switching off the light, and that she rarely found herself in deep reflection while sitting at her desk. She mentioned that this approach was mainly effective, as she did not find the tasks in her current line of work overly challenging. However, in previous jobs where she had tasks she experienced as more cognitively demanding, Caroline recounted feeling a more distinct urge to get up and move. She explained it eloquently as feeling a need to *"exert physical effort in order to exert mental effort",* and would in these situations take long walks, rather than just short bathroom breaks. Caroline further stated that *"I don't sit and think"*, and described that while at her desk she would take action, go and find information, write down subtasks on post-its, draw something or do a different task. She described that sitting and thinking did not make sense to her when experiencing actively doing something in her head.

In the previous section on thinking away from the desk, David shared a comparable experience. According to David, he rarely paused to reflect at his desk, as he was either engaged in the task at hand or taking a break to visit the toilet or grab a cup of coffee. He also recalled reflecting on challenging work assignments while walking to and from his car. Another interesting reflection from David was that when he was carrying out tasks that entailed what he described as *"challenging thinking"* then he noticed he would fiddle with his pen. Julia also recounts often finding herself fiddling with her pen while thinking, while Paul identified fiddling with his pen as the main behaviour he found himself engaging in when figuring out a task. Paul also noted that if he was not holding a pen, he was most likely holding his coffee cup. He elaborated on this preference for having something in his hand, whether it was a pen or a coffee cup, he liked to keep his hands busy, especially when sitting for extended periods. He reflects that if he was not able to do this, then he would most likely feel more stressed, as he felt more at ease and productive when his hands were occupied. He

explains that it's *"like you're doing something while you're thinking, so you don't feel inactive"*. Paul's post-it entries are depicted below in Figure 6.4.

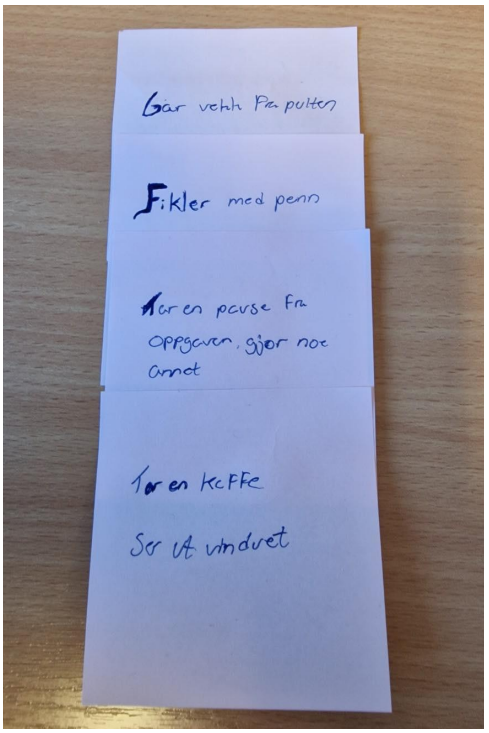

Figure 6.4 Paul's post-it entries for the elicitation diary

Anne also seemed to experience an association with subtle movement and thinking. She explained that one of the behaviours she most often found herself engaging in was moving her feet while sitting at her desk. This could consist of her taking her shoes off and pulling her feet up on her chair, or just moving them in circles. She explained that she would do this when she felt kind of restless, or if she felt she wasn't moving forward with a task. She also remarked that she often felt a small surge of extra motivation or confidence with a task. when shifting position in her chair and pulling her feet up under her. Anne also described that often when she felt stuck on a task she would find herself touching or picking up random items on her desk, or fiddling with her rings or earrings. She also noticed a slightly random tendency to touch her lips a lot, but put this in the same category as the previously mentioned behaviours, explaining that although she couldn't explain why, they made her feel like she was thinking.

From these accounts, it appears that the participants may tend to associate contemplation with physical movement. Where some participants described rarely finding themselves in deep

reflection at their desk, others explained engaging in subtle physical behaviours such as fiddling with a pen or moving their feet while trying to solve a cognitive task.

Writing by hand's facilitation of "getting the thought out"

When recounting the strategies they tended towards when working on a task, multiple participants explained making use of ways to express their thoughts by hand. Caroline explains how when faced with a task she was unsure on how to tackle, she began with trying to brainstorm using the powerpoint application on her computer. However, when this didn't work, she used post-its instead, where she described that this method felt more accessible and that it helped her "get the thought out" more quickly. She also experienced that this method let her try out lots of options, where she could crumple up the post-it and start again. Julia also described taking notes when initially approaching a task, and Anne described often using her notepad to brainstorm when feeling stuck on a task. She explains further that she often used her notepad when she felt like the computer couldn't seem to help organise her thoughts, where she found that the notepad felt much more *"lavterskel"* and less permanent. When using her computer she feels like her thoughts need to already have some sort of structure, something she doesn't feel when using the notepad.

David described similar situations, where he explained that when faced with a difficult task where he felt he couldn't seem to organise his thoughts, he found the quickest way to clear his mind was to use his Remarkable. He used this tool to take notes, make lists or draw mind maps, where he describes how he enjoys its flexibility; *"you get a blank page and you can start wherever you want, make anything you want of it"*. He recounts trying applications on his computer that attempted to give a similar experience, but he found it just wasn't the same, that the mouse and keyboard just didn't give the same feel.

In this way, several participants described their preference for using manual methods, such as post-it notes, notepads, and Remarkable tablets, to brainstorm and organise their thoughts when facing challenging tasks, as they seemed to find these methods to be more accessible, flexible and perhaps less intimidating than using digital tools.

6.1.3 Thematic map

These themes have been visualised in Figure 6.5 below. This thematic map takes a slight different form from the thematic map presented in the previous phase of empirical research

(see Figure 5.5), where it reflects the process of analysis of allowing the themes to flow into each other to get a grip on their possible interconnectedness.

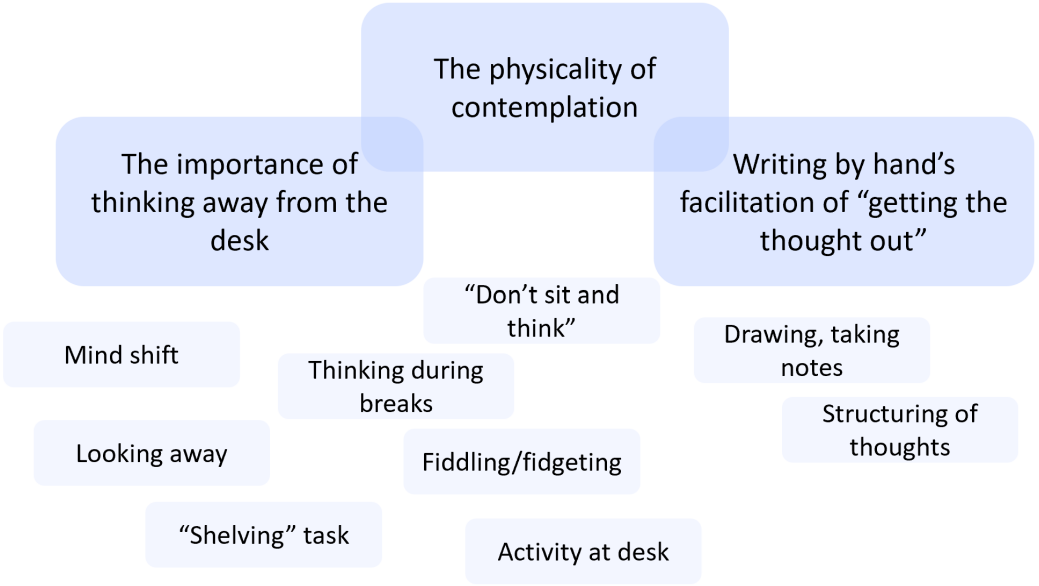

Figure 6.5 Thematic map empirical phase 2

6.2 Establishing the final framework

As opposed to the previous iteration of the framework, where areas of embodied cognition were initially discussed independently, in this section as each area of embodied cognition is presented their possible connections and interdependencies within the framework will also be discussed. This is due to a central goal of the elicitation diaries being to gain a better understanding of how the different experiences and expressions of embodied cognition may be connected.

In describing the development of the final framework I have chosen to begin with discussing the most substantial change to the former framework. This refers to the introduction of a new area of embodied cognition to stand alongside *Tacit knowledge*, *The body schema* and *Epistemic action*, the new introduction being *The embodiment of abstract concepts*. I have chosen to begin with a discussion of this new addition because of its connection to, and therefore facilitation of elaborating on, the aforementioned areas of embodied cognition.

6.2.1 The embodiment of abstract concepts

"I don't sit and think"

- Caroline (participant)

During the discussion of related work regarding embodied cognition (see Chapter 2.2.2) the notion of the embodiment of abstract concepts was introduced. This idea proposes that our cognitive processes are closely intertwined with the body and its interactions with the environment, and that therefore, our understanding of abstract concepts can be embodied by real-life physical experiences. An example of this includes the physical embodiment of the abstract concept of importance, where participants who held a heavier clipboard while making a decision rated the decision as more important than those holding a lighter clipboard (Jostmann et al., 2009). A perhaps even more significant example is that of the connection between fluid movement and creativity, where fluid arm movements, compared to non-fluid arm movements, were found to enhance performance in creative thinking tasks (Slepian & Ambady, 2012).

In the first phase of empirical research it became clear that participants often engaged in various forms of physical movement when feeling stuck on a task and engaging in deep cognitive thought. This included a need to leave their workstation and engage in other activities such as tidying or running errands, visiting other colleagues offices, getting coffee, but also smaller actions such as fiddling or doodling during characteristically static activities. In the establishment of the second theoretical framework these results were suggested to be connected to the concepts of the incorporation of space into the body schema and symbolic off-loading as unintentional bodily actions. Following the results of the elicitation diaries I suggest that these connections still hold true, however I additionally suggest that the connection between physical movement and thinking can be additionally understood by considering the notion of the embodiment of abstract concepts.

During the follow-up interviews of the elicitation diaries the occurrence of physical action during deep contemplation was present among all the participants. David and Caroline both describe quite clearly that they rarely engage in deep contemplation while sitting at their desk working on their computer. Instead, while on the computer they describe the active solving of tasks, more reflective contemplation was done elsewhere. They describe that this reflection tends to happen while doing other trivial activities, such as going to the toilet, getting a drink, walking to and from their car or while switching the light off when leaving. Furthermore,

Caroline directly comments on her experienced connection between physical exertion and mental effort, explaining that when she was faced with more cognitively demanding tasks in a previous job, she often felt a much stronger urge to for example go for a more lengthy walk outdoors. She also explains further that to her, the act of sitting while actively doing something in her head didn't make sense. Julia described carrying out activities such as tidying or taking out rubbish in order to get away from her desk, where she often finds she "locks" herself onto one train of thought. She explains that she needs time to "gruble", which she finds is done more effectively during these activities than when sitting at her desk. Paul uses his own similar term of "kverne" to describe the activities done to give himself some thinking time, which for him partly consisted of getting a coffee or switching to another task.

Paul's description of switching to another task emphasises the fact that this engagement in physical activity does not need to imply large physical movements such as leaving your workstation or office. Participants also seem to connect the experience of contemplation to more minute physical behaviour. Paul for instance also describes the preference for keeping his hands active while sitting at his desk, often either finding himself fiddling with a pen or holding his coffee cup. He explains that it's *"like you're doing something while you're thinking, so you don't feel inactive".* Anne describes how she often moves her feet in situations where she feels as if she is not moving forward with a task, where she finds that often when she adjusts her sitting position she experiences newfound motivation for the task in front of her. She also describes small actions such as fiddling with items on her desk or fidgeting by touching her lip and suggests that these actions often happen during some form of contemplation.

It is also possible to look back on the findings from the semi-structured interviews and see the relevance of the introduction of this new understanding of embodied cognition. James explained in his interview that *"I very rarely sit here and think (referring to workstation). I do that when I'm folding birds, which means when I'm doing things, or when I'm in conversation with others, or when I'm writing. (...) Thinking, for me, is connected to activity"*, clearly suggesting that for him, there is an experienced connection between thinking and activity. In addition, David remarks on his own understanding of why he often fiddles with his pen during work,

"I'll swivel the pen while I'm thinking, do that [taps pen on chin/mouth], hold it in my mouth, that's what I will do. It's usually when someone is presenting something and I'm thinking,

that's what that signifies usually, me thinking, if I'm playing with pens usually I'm thinking, I'm not looking at the pen or the person talking, I'm just thinking, gazing into space thinking"

This implies that the inclusion of the embodiment of abstract concepts into the framework is not only a consequence of the results of the elicitation diaries, but rather a product of these results stimulating new lines of thinking about previous findings, ultimately providing a renewed outlook on embodied cognition in the relevant context.

Based on these findings, I propose that thinking can be perceived as embodied through a range of physical movements. This entails an urge to engage in some form of physical movement during substantial bouts of contemplation, which could involve actions such as fidgeting or leaving the workstation, or carrying out some other alternative activity. This newfound understanding resulted in the addition of the area of embodied cognition the *Embodiment of abstract concepts* to the framework, specified by the narrower concept of *Embodiment of thinking*, which appears to be manifested by *Active contemplation*. Figure 6.6 below depicts this addition.

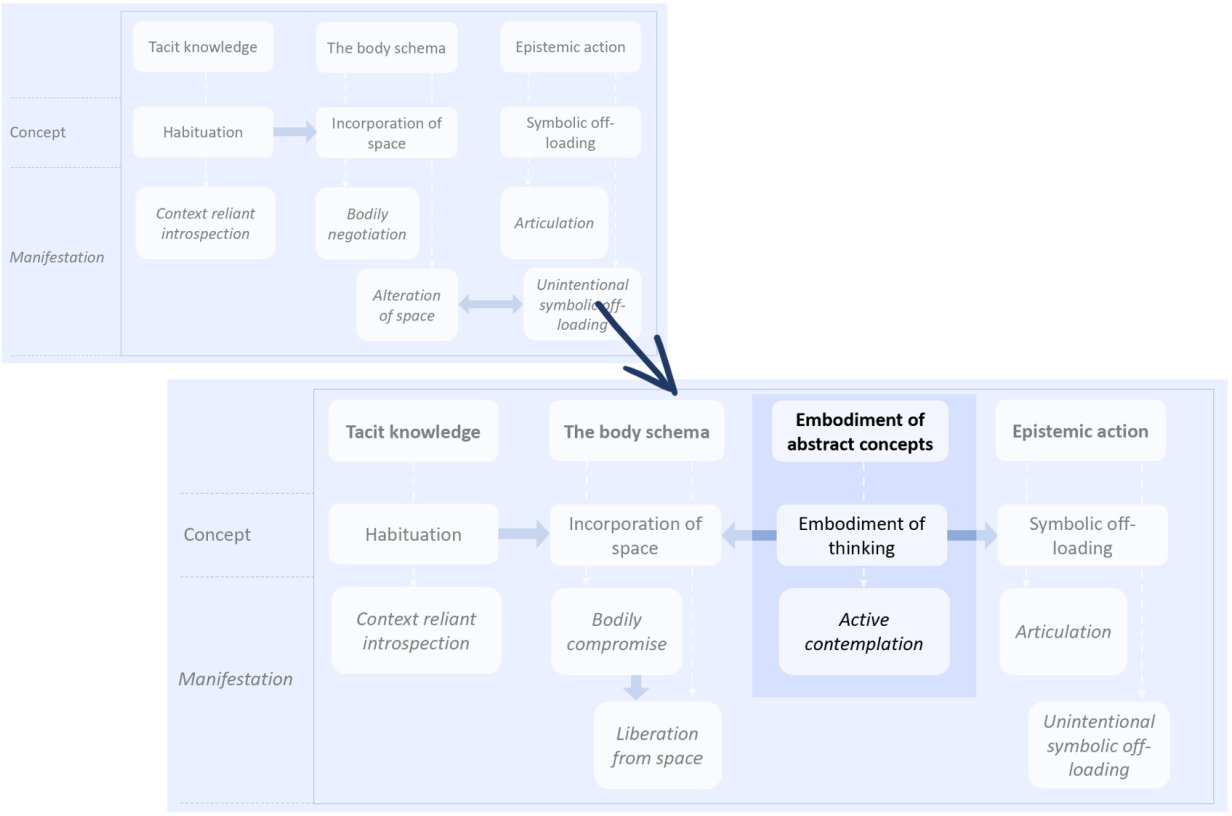

Figure 6.6 Addition of a new area of embodied cognition, the Embodiment of abstract concepts, to the theoretical framework

6.2.2 The body schema

The topic of the body schema is also pertinent to the discussion of participant's desire to physically detach themselves from their workstations in order to facilitate their cognitive processes. Participants explained how they often felt the need to leave their office in order to adopt a different point of view. David spoke directly on this topic, explaining how he deliberately takes breaks before starting a new task in order to "shift his mindset", and proclaiming how it is problematic that virtual meetings do not provide this change in context. Furthermore, all the participants described the urge to be away from their workstation in order to gain some mental clarity while feeling stuck on a task, where Paul described needing distance from the problem and Julia recounted how she would avoid her workstation in order to shift her attention. These results are in line with the findings from the semi-structured interviews and are coherent with the concept of participants integrating their office space into their body schema. In the former framework, it was suggested that participants often felt a need to alter their perceived potential for action in the world by altering their body schema, and therefore leaving their office space. The results from the elicitation diaries allow for elaboration on this point, as it seems this change of space is not merely about an alteration, but also a liberation.

The previous section on the embodiment of thinking reveals that participants may perceive thinking as being embodied by various forms of physical activity, and as a result, may feel inclined to move physically when experiencing cognitive roadblocks. This brings us to consider the possible implications of the incorporation of the workstation into the body schema. For instance, considering the example of the blind person's cane, the cane elongates their body in a certain direction, altering their body schema and enhancing their potential for action in the world. However, the use of the cane can also limit their potential for action, such as if they tried to carry a large box with both hands. Incorporating artefacts and space into our body schema requires us to adjust our body in a way that allows their use, implying a degree of compromise.

The incorporation of the computer into our body schema demands a mainly inflexible and sedentary bodily position that limits our opportunity for movement and action in the world. While participants may use various equipment and techniques to make this position more comfortable, it still requires significant compromise on their part. In contrast, the computer's configuration for interaction is largely uncompromising and inflexible. As Dourish (2001, p.27) explains, *"Interaction with screen and keyboard, for instance, tends to demand our*

direct attention; we have to look at the screen to see what we're doing, which involves looking away from whatever other elements are in our environment, including other people. Interaction with the keyboard requires both of our hands. The computer sits by the desk and ties us to the desk, too.". While incorporating the workspace into our body schema can extend our capabilities for completing complex tasks, it also restricts us to an inflexible bodily position. This highlights how the incorporation of our environment into our body schema is a double-edged sword: it expands our potential for action in certain ways, but also constrains it in others. In this way, if the office space or workstation is experienced as being incorporated into their body schema, then this incorporation may make participants feel as if their opportunity for movement, and therefore also cognitive action, is limited. Therefore, whereas the importance of a change in environment to gain a new perspective in itself still appears to be relevant, participants may also feel the need to liberate themselves from the space incorporated into their body schema to feel a newfound opportunity for physical action and therefore cognitive action. Due to this, the manifestations of the incorporation of space have been adjusted from *Bodily negotiation* and *Alteration of space* to *Bodily compromise* and *Liberation from space* respectively. In addition, a connection has been drawn between these manifestations, illustrating that the degree of bodily comprimise involved in computer interaction can lead to a desire for a liberation from one's current space. The discussed influence of the embodiment of thinking as physical activity has further led to a unidirectional connection on a theoretical level. These changes are depicted below in Figure 6.7.

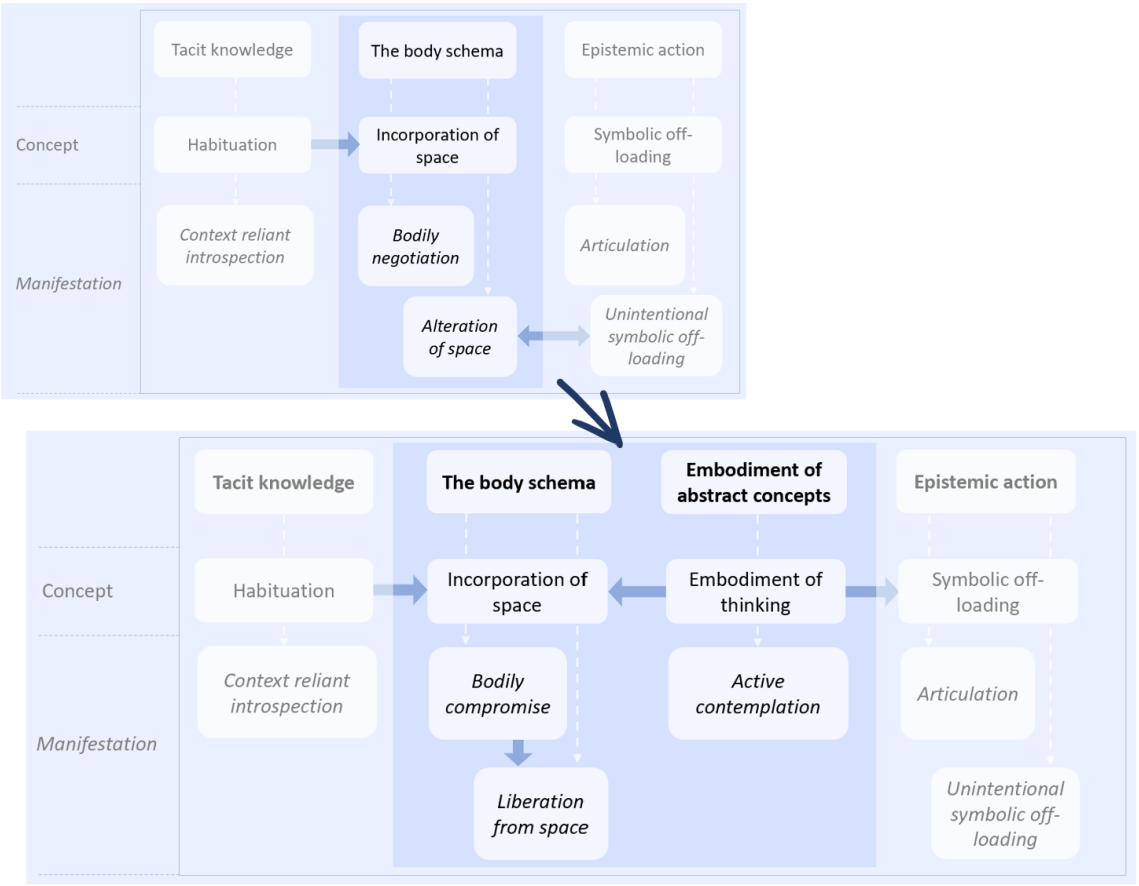

Figure 6.7 Alteration of the manifestations and connections within the Body schema

6.2.3 Tacit knowledge

The notion of habituation manifesting itself as context reliant introspection still seems to hold relevance, as participants seemingly found that the elicitation diary exercise led them to become more aware of many of their behaviours. By allowing participants to reflect upon their own behaviour in the setting that felt the most natural to them, while they were actually carrying out the behaviour, the tacit knowledge became more readily available to them, providing a deeper understanding their embodied experiences. Participants became aware of what actions they did in which situations, for example, Paul describes looking out the window with his coffee cup specifically when he had completed a task. Furthermore, David discovered a crucial difference in his strategy when approaching different types of tasks, as he realised that he only took a break before more technical tasks that he associated with a relaxed feeling, and not before people related tasks that he generally experienced with frustration. This sudden awareness seemed to make David reconsider his strategy. This

suggests that if an individual becomes aware of their ways of embodied thinking, then they are also given the opportunity to change these strategies. However, since this experience was only expressed by one participant, it has not led to any alteration in the framework. Therefore, while the understanding of the role of tacit knowledge in embodied cognition in computer interaction was deepened, the area of embodied cognition remained structurally the same from the second to final theoretical framework.

6.2.4 Epistemic action

In the development of the second theoretical framework, various manifestations of symbolic off-loading behaviours were identified, including tangible and verbal articulation and more unintentional forms of symbolic off-loading such as fiddling with objects or making use of their environment in order to leave a task alone. From the results of the elicitation diaries, many of these behaviours were maintained, however in addition it became more clear how these activities actually aided in improving participants' cognitive state.

Articulation

The findings from the semi-structured interviews indicated that writing by hand was a crucial strategy used by participants in order to off-load cognitive work onto their environment. The results from the elicitation diaries also indicated the prevalent use of this method, where multiple participants recounted this behaviour as beneficial in helping them contemplate difficult tasks. Moreover, the participants also further explained why they preferred this method over digital options. Caroline recounted a situation where she began brainstorming using the PowerPoint tool on her computer, however when she found this was not effective, she made use of post-it notes instead. She described how this method had a degree of accessibility and helped her *"get the thought out"* more effectively, in addition, she describes how it allowed her to try out many options, merely crumpling up the post-it note and starting again when she needed to. I feel Anne's norwegian term *"lavterskel"* captures this experienced characteristic of writing by hand well. For Anne, this refers to the feeling of not needing to have structure in her thoughts when articulating them by hand, something she feels her thoughts need when utilising a computer. David describes a similar experience where he felt that the possibilities of a physical blank page to jot down thoughts on could not be replaced by other computerised alternatives. Overall, participants seemed to find brainstorming by hand to be more flexible and in need of less mental preparation than brainstorming using digital tools. It seemed that often, participants would utilise a tangible option for the initial stage of figuring out an issue, and then when this initial mental

preparation was done and they had achieved some degree of mental clarity then they would make use of their computer.

With the introduction of the new notion of the embodiment of abstract concepts to the theoretical framework, we can now consider the act of writing by hand in connection with this notion. In the presentation of the former theoretical framework the physical aspect of writing by hand was discussed, consolidated by participants' accounts of the act of writing by hand feeling like they were "taking action". It is now possible to suggest that the reason participants show a preference towards writing by hand is because the physical act of writing is cognitively associated with the abstract act of thinking. Although writing on a computer obviously also includes some form of physical activity, it is possible that the interface acts as a sort of barrier for participants' natural actions, not allowing them to *"get the thought out"* in the same way.

When it comes to the articulation of the verbal nature, this strategy was also present in the results from the elicitation diaries. Furthermore, the account of one participant also partially perpetuates the notion that the act of articulation is helpful for the participant regardless of the response from a discussion partner. Anne describes having internal conversations with herself while taking bathroom breaks, where these conversations often lead to cognitive breakthroughs. Other participants also recount the feeling of pondering tasks, and often finding solutions, during various breaks or other activities. Although the other participants do not refer to these contemplation sessions as internal conversations, perhaps they are exactly that, where these sessions allow them to internally articulate their thoughts on the task.

Unintentional symbolic off-loading

The second category of manifestation of symbolic off-loading presented in the second theoretical framework was unintentional symbolic off-loading. This was described as more automatic and subtle behaviour that participants engaged in in order to aid their cognitive state. One of the specific manifestations of this more unintentional symbolic off-loading was the behaviour of fiddling or doodling. This behaviour was also reported in the second phase of empirical research, however, with the introduction of the notion of the physical embodiment of thinking, this behaviour can be understood in a new light.

Participants described engaging in various symbolic off-loading activities, such as fidgeting with a pen, moving their feet, or holding a coffee cup, while they were engaged in cognitive tasks. They noted that these physical actions seemed to facilitate their thinking process. For

example, Paul described finding he almost always had a pen or a coffee cup in his hand, describing a feeling of being more at ease and productive when his hands were occupied, stating that it feels *"like you're doing something while you're thinking, so you don't feel inactive"*. Anne noticed she tended to move her feet when feeling stuck on a task and needing to engage in deeper contemplation, while David and Julia both report fiddling with their pen while thinking.

As stated in the discussion of the previous iteration of the framework, these activities can be understood as forms of symbolic off-loading where participants make use of their environment in order to aid them cognitively. However, I suggest that through this further investigation it has become more clear why this behaviour seems to have this positive cognitive effect. If the abstract act of contemplation is embodied by physical movement then engaging in forms of physical activity while thinking may facilitate the thinking process by providing a way for individuals to off-load some of their cognitive burden onto physical actions. This reflection also applies to the the second form of unintentional symbolic off-loading participants reported engaging in, in both the first and second phase of empirical research, namely "leaving it alone". The participants explained leaving their workstation as a strategy when feeling stuck on a task, often by going and getting a coffee, going to the toilet or doing other tasks. These activities may not only provide a change of environment and an opportunity to get away from the task, but also allow for the outlet of some physical activity, possibly aiding cognitive activity.

In addition, the results from this second phase of empirical research also suggest that the participants engage in more subtle behaviours in order to gain distance from the task at hand. When trying to figure out a challenging task, David reports fiddling with his pen and staring aimlessly into space, only making sure to not look at the task at hand. Paul, Julia and Anne all describe staring out the window during contemplation, where Anne relates this behaviour to attempting to be somewhere else, away from the problem. When feeling particularly stuck, she sometimes simply closes her eyes. These small strategies can be explained as behaviours unconsciously done in order to help participants achieve a more advantageous cognitive state, and can therefore also be considered as unintentional symbolic off-loading. As in the former framework, the manifestation of participants attempting to leave a task alone strongly relates to the participants' desire to change their bodily space and alter their body schema when feeling stuck. It is possible that participants may also try to free themselves from the

constraints of their new altered body schema by merely imagining themselves to be in another context.

Furthermore, as now presented in the previous sections, it seems the symbolic off-loading behaviour of "leaving it alone" may be experienced as advantageous because it allows for a liberation of the body schema, in turn allowing for a degree of physical activity that may trigger or facilitate thinking. The introduction of considering thinking as being embodied by physical activity allows for a more complete understanding of the reasons behind participants behaviour and in this way allows us to understand the intricate connections between the theoretical areas of embodied cognition. While the specific concept and manifestations of Epistemic action remain the same, a new influence of the embodiment of thinking has been introduced, providing a unidirectional connection between these concepts on a theoretical level. This change in the framework is depicted below Figure 6.8.

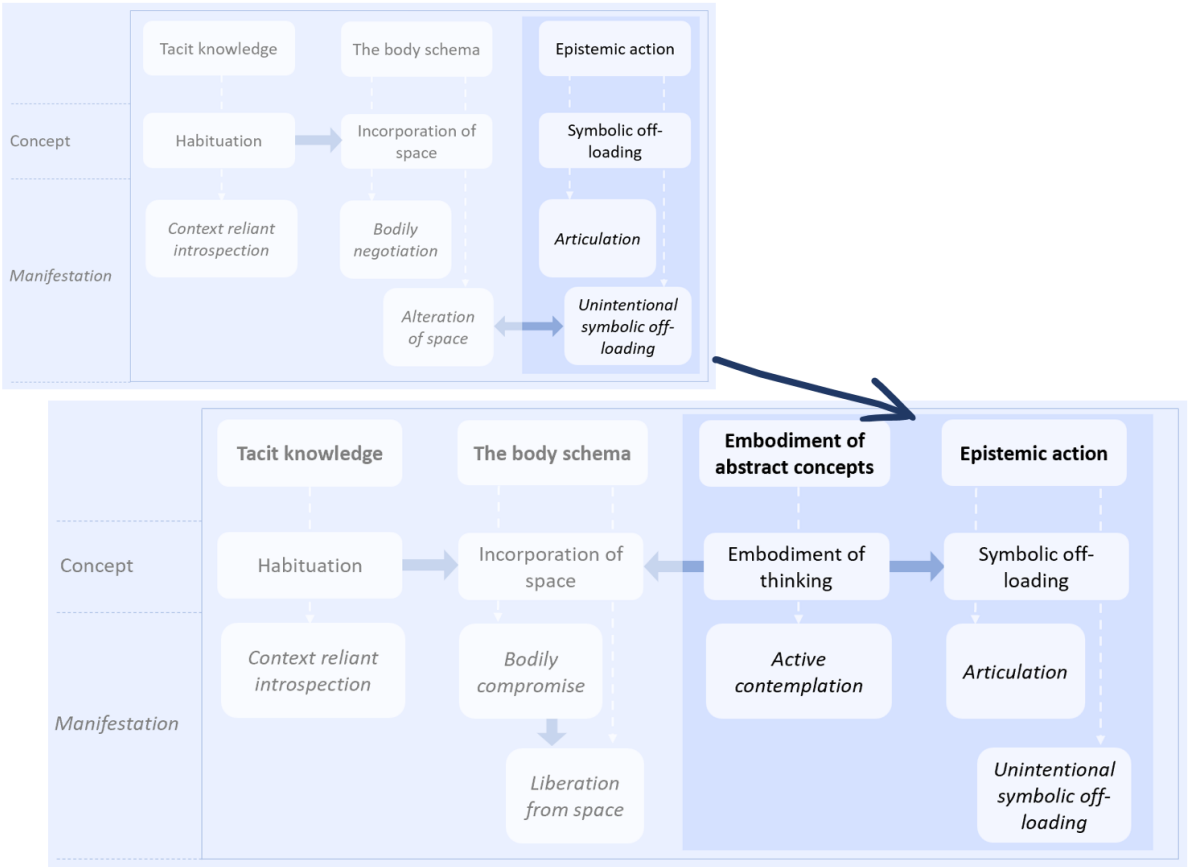

Figure 6.8 Alteration of the connections within the area of embodied cognition Epistemic action

6.3 Intermediate findings

The second phase of empirical research allowed for a deeper understanding of the ways in which participants engaged in embodied thinking in computer interaction within an office setting, and therefore also an examination of the proposed elements of the previous framework. This phase provided an improved understanding of the connections and relationships between the theoretical concepts in the framework. This was to a large degree facilitated by the introduction of the new area of embodied cognition; *Embodiment of abstract concepts*, which aided in a valuable perspective on why embodied cognition may manifests itself in the ways that have been observed.

The embodiment of abstract concepts

This new introduction is based on the notion that highly abstract concepts can be embodied by physical attributes. Participants reported various ways in which they engaged in physical movement during periods of deep contemplation, where the most salient examples include fidgeting or leaving the workstation to engage in a different activity. I propose this indicates that the participants perceive a connection between the abstract concept of thinking and the tangible act of physical movement. This leads to the introduction of a new area of embodiment in the framework, namely *Embodiment of abstract concepts*, specified by the narrower concept of *Embodiment of thinking*, which appears to manifest itself as *Active contemplation*.

The body schema

The exploration of the previous topic of the embodiment of abstract concepts revealed intricate connections with the other areas of embodied cognition in the framework, leading to a newfound clarity in understanding the previous findings. In the former framework, the *Incorporation of space* was suggested to manifest itself as *Bodily negotiation*, whereas the second phase of empirical research indicated that this process perhaps can instead be considered as an uneven compromise. As participants incorporate the office space into their body schema in order to achieve a more seamless interaction, they must also compromise their freedom for movement, as the typical workstation demands a highly sedentary and inflexible bodily position. Considering the previous notion of contemplation being embodied by physical movement, I suggest that this restriction of physical action is also experienced by participants as a restriction of cognitive action. As participants express the need to physically detach themselves from their workstation to facilitate their cognitive processes, it seems this change of space is not only about altering but also liberating their perspective. Therefore, I

suggest that the manifestation of *Alteration of space* is better described as a *Liberation from space*. Furthermore, this desire for liberation appears to be a result of the high degree of *Bodily compromise* that is undergone in the incorporation of the workstation into the body schema, where this unidirectional connection is indicated by an arrow in the framework.

In addition, the physical embodiment of thinking can therefore lead to significant implications for the effectiveness of incorporating space into our body schema. When we incorporate space into our body schema, we generally do so in order to improve our performance on tasks. However, if the task is primarily cognitive in nature, then a limited range of movement may result in suboptimal outcomes. In my framework, I suggest that this influence of embodiment occurs on a theoretical conceptual level. This is because I suggest that the physical embodiment of thinking has implications for the incorporation of space in more ways than the manifestations presented. If the link was examined at the more practical manifestation level, the opportunity to consider other potential implications may be missed.

Tacit knowledge

Regarding tacit knowledge, the elicitation diary exercise appeared to allow participants to become more aware of their behaviours, as they reflected on their actions in their natural setting, making tacit knowledge more available to them. This increased awareness also seemed to allow at least one participant to discover new strategies and change their embodied thinking patterns. Due to the fact that this was only experienced by one participant, I have chosen to not make any alterations to this section of the framework.

Epistemic action

Within the area of epistemic action, further support was found for the suggestion that participants engage in various symbolic off-loading behaviours, including tangible and verbal articulation, fiddling with objects, and leaving tasks alone. In addition, this second phase of empirical research provided a new way of understanding the reasons for which some of these behaviours may provide a more advantageous cognitive state. Writing by hand, fidgeting, leaving the task physically alone and leaving the room in order to talk to a colleague, or even yourself, all include some form of physical activity. By adopting the notion of thinking as being embodied by physical movement, it can be suggested that these activities are helpful because they allow participants to off-load cognitive movement into physical movement. This link is also proposed to be relevant at a theoretical conceptual level, rather than between specific manifestations. I suggest that the physical embodiment of thinking can explain why we chose to engage in certain off-loading behaviours, and moreover why these behaviours are

experienced as beneficial, where I believe this link can manifest itself in more ways than discovered in the context of this study.

6.4 A framework of embodied cognition in computer interaction

Through the application of a phenomenological lens and drawing upon theoretical underpinnings of embodied cognition, a comprehensive framework has been established to structure an understanding of the intricate relationship between the mind, body and environment in computer interaction. Through two empirical research phases, these lived experiences were explored and facilitated through the setting of the individual office, allowing for a conversation between the theory and real-life manifestations of embodied cognition. This led to the establishment of a framework consisting of four theoretical areas of embodied cognition; *The embodiment of abstract concepts, The body schema, Tacit knowledge* and *Epistemic action*. In each of these areas, a specific concept has been identified as particularly relevant to comprehending how embodied cognition influences computer interaction, including *Embodiment of thinking, Incorporation of space, Habituation* and *Symbolic off-loading* respectively. Manifestations of each of these concepts have been identified in the ways the participants expressed embodied cognition in their available environment. Thus, a framework of embodied cognition in computer interaction has been established.

Despite the absence of theoretical in its title, the framework is evidently still of a theoretical nature, however, as I begin to discuss the findings and contributions and engage in a theoretical discourse, referring to the framework as theoretical becomes redundant.

Below, the main components of the framework are structured through the four areas of embodied cognition;

The embodiment of abstract concepts

- The embodiment of abstract concepts, specifically the embodiment of thinking, is experienced in many ways as physical movement. This creates important implications for the areas of embodied cognition the body schema and epistemic action.

The body schema

- The body schema is a dynamic construct that, through the process of habituation, can integrate physical and spatial elements to optimise access to capabilities. As space is incorporated into the body schema, it may be experienced as beneficial to free oneself

from this space when feeling cognitively stuck on a task, in order to achieve a new sense of potential for action. Furthermore, the greater the bodily compromise of physical movement an incorporation entails, the stronger the desire for liberation may become.

Tacit knowledge

- Our experience of embodied cognition consists of tacit knowledge that is deeply rooted in practical experience and embedded in the physical context of our workspace. This makes it challenging to articulate verbally, and our reflections on experience are aided by being present in the context where the experience took place.

Epistemic action

- Embodied cognition can be expressed through various forms of epistemic action, more specifically symbolic off-loading, where cognitive work is off-loaded onto the environment. This includes the use of tangible or verbal articulation of inner dialogue, as well as more subliminal actions such as fidgeting, doodling or engaging in activity away from the workspace. These concrete expressions of symbolic off-loading are suggested to in part be beneficial due to their somewhat physical nature, this suggestion being rooted in the proposed experienced connection between physical activity and cognitive progress.

This framework of embodied cognition in computer interaction is presented below (see Figure 6.9), where the evolution of the framework is also depicted.

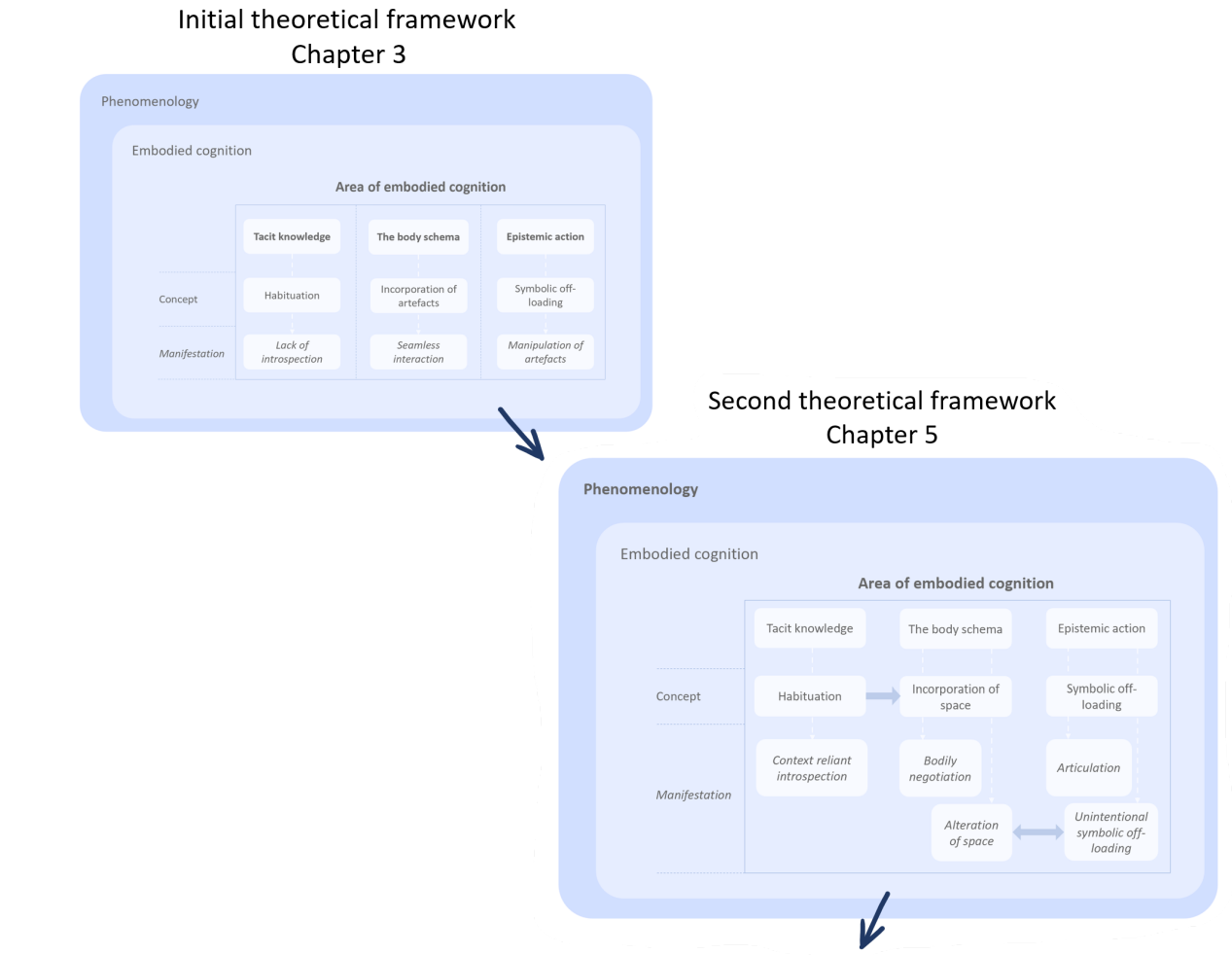

Figure 6.9 Framework of embodied cognition in computer interaction
Transformation of the theoretical framework from the initial theoretical framework to the second theoretical framework to the final theoretical framework

As stated, the second phase of empirical research led to a better understanding of the interconnectedness of the elements within the framework. The concept of the *Embodiment of thinking*, implying the embodiment of thinking as physical activity, is proposed to influence both the *Incorporation of space* and *Symbolic off-loading* behaviours. The physicality of thinking has implications for the incorporation of space into our body schema, as an incorporation that limits the possibility for physical expression may also limit the experienced potential for cognitive expression. This connection between physical activity and cognitive activity also leads to implications for symbolic off-loading behaviours, providing an understanding of why subtle or less subtle physical movement can be experienced as cognitively advantageous. The unidirectional connection between the concept of *Habituation* and the *Incorporation of space* still holds true from the second theoretical framework, where it is through this process of habituation that space can become incorporated into our bodily structure. All of the discussed connections are relevant on a conceptual theoretical level, due to a proposal that their interconnectedness may give implications for further practical manifestations of these theoretical concepts. The influence of *Bodily compromise* on the *Liberation from space* is instead at a manifestation level, illustrating that the lived experience of bodily compromise may lead to a desire to liberate oneself from the current space.

Chapter 7

Findings and Contributions

This chapter presents the main findings and contributions of the thesis. In addition, a discussion of the validity of the study is provided.

7.1 Findings

In this section I will present the main findings in relation to the research question:

> *How can a phenomenological perspective on the role of embodied cognition in computer interaction provide a structure for design?*

In order to answer this question I have established the presented framework of embodied cognition in computer interaction. In addition to the insights gained from the main components of the framework, the framework has also contributed the following two main findings;

Finding 1: An overarching characteristic of the expression of embodied cognition in interaction with computers is the experienced connection between physical movement and thinking or cognitive progress.

The theoretical framework presents the embodiment of abstract concepts as a way of understanding how participants expressed an experienced connection between physical activity or movement and thinking. This included relating activities such as fiddling with pens, writing by hand, taking breaks to other areas or carrying out errands to an experience of enhanced contemplation. Furthermore, this had an impact on the ability to engage in deep contemplation while having limited freedom of physical movement. The characteristics of computer interaction appeared to often be experienced as physically limiting, therefore also leading to a sensation of cognitive limitation, and subsequently a desire to free oneself from this context when feeling stuck on a task.

Finding 2: The ways in which embodied cognition manifests itself in computer interaction are generally not in direct interaction with the computer, but rather in interaction with the surrounding context of interaction.

Based on participants' accounts, the theoretical framework presents various manifestations of how embodied cognition is explicitly expressed in this context. This included various ways in which participants interacted with various elements in their direct environment, for example taking certain breaks, note-taking or fiddling. In this way, embodied cognition was generally not observed as being expressed in direct interaction with computers, but rather through the surrounding environment and context of interaction.

7.2 Validity of the study

In order to reflect upon the validity of this study I have chosen to discuss the four dimensions presented by Shinebourne (2011) that can be used to assess the validity and quality of an Interpretative Phenomenological Analysis (IPA). These dimensions were originally presented by Yardley (2000), and I have chosen to also include her own descriptions of these criteria in my discussion, as I feel this account includes significant discussions not present in Shinebourne's (2011) presentation. These four dimensions consist of; sensitivity to context, commitment and rigour, transparency and coherence, and impact and importance.

Sensitivity to context

The first criterion, sensitivity to context, can be fulfilled in various ways (Yardley, 2000). One way is to show sensitivity to the existing theoretical context that you find yourself in. This can be done by having a fairly extensive overview and understanding of the themes and concepts that are relevant to the topic being studied. For my thesis, a thorough investigation into and understanding of the existing literature on embodied cognition, phenomenology and current perspectives on computer interaction was heavily prioritised. This was done by consistently checking in with relevant literature throughout the project as new topics became relevant, and by considering multiple sources of information regarding various theoretical concepts to ensure a complex and complete understanding. By being sensitive to the theoretical context in this way, Yardley (2000) suggests the researcher is better equipped to make informed decisions about the analysis and interpretation of the data.

Although theory can profoundly influence interpretation, Yardley (2000) also states the importance of the analysis remaining sensitive to the data itself. In this way, sensitivity to context must also be brought into the analysis of the data, by ensuring a high degree of attention to detail (Shinebourne, 2011). Due to the aim of IPA to capture the subjective experience of participants and ground the analysis in these experiences, this sensitivity to the raw data can be shown by including a *"number of verbatim extracts from the participants'*

material to support the argument being made, thus giving participants a voice in the project and allowing the reader to check the interpretations being made" (Smith et al., 2009, p. 180-181). Throughout my presentation of results and analysis, I prioritised the inclusion of quotes directly from the participants, in order to allow the point to come across in their own words, and for the reader a more transparent understanding of the source of my interpretations. It should be noted however that due to the lack of transcriptions from the elicitation diary follow-up interviews, the presentation of these results and analysis in Chapter 6.1 has considerably less direct quotes than what is presented in Chapter 5.1. However, a substantial attempt was made to include significant short quotes from participants to ensure this further sensitivity to the data. Furthermore, sensitivity should also be shown in the writing of the study, by providing explanations that are supported by the data and relating the study back to the relevant literature (Shinebourne, 2011). In this study, this is achieved by giving a rich presentation of the data and making it clear from where in the data I am drawing my interpretative conclusions, and further by directly relating back to theoretical literature in order to establish my theoretical framework.

Commitment and rigour

The second measure of validity, commitment and rigour, can be established through prolonged engagement with the topic and extensive immersion into the data (Shinebourne, 2011). This may include ensuring the completeness of the data by having a sample that is able to supply enough information that is needed to ensure what can be referred to as "saturated data" (Yardley, 2000). Moreover, this may imply a degree of triangulation in order to gain a more rounded and multilayered understanding. In this study, although the sample only consisted of 8 individuals, the investigation into each participant's understanding and experience with embodied cognition was comprehensive and thorough. In addition, two distinct methods were used for data collection, semi-structured interviews and elicitation diaries, in order to further ensure the completeness of the data. Yardley (2000) also speaks directly on this criterion in relation to phenomenological analysis, stating that in this kind of research commitment and rigour may be established by exploring the topic through deep contemplation and sophisticated theorising. Here the intuition and imagination of the researcher is emphasised in helping *"transcend superficial "commonsense" understandings"* (Yardley, 2000, p. 222). Thought experiments have been a large part of the analytical process of this thesis, where unconventional and abstract possibilities have been explored in order to break away from a more basic understanding of the meanings in the data. An example of this

is the investigation of the possibility of the incorporation of space into the body schema. Typically, in discussion on the body schema, incorporation is limited to specific tools or equipment, which is where my own discussion of the topic began. However, by looking into the deeper meanings behind the experiences of participants and allowing my imagination access, the possibility of the incorporation of space, rather than merely objects, emerged. It is important to note of course that these thought experiments, however open and flexible, were of course primarily grounded in and committed to the raw data and reported experiences of the participants.

Transparency and coherence

Transparency and coherence are the focus of the third criterion. The transparency element of this dimension largely concerns the clarity of the description of the stages in the research process, referring for example to a detailed description of data collection methods or the specific stages of the analysis (Shinebourne, 2011). In my portrayal of the research process in this thesis, I have attempted to give a clear and transparent description of all relevant activities and the reasoning behind their carrying out. This has been done through the use of detailed explanations and a timeline outlining the sequence of activities along with their relevant place of description in the thesis. Transparency also refers to the importance in qualitative research to openly reflect on how our own assumptions, intentions and actions as researchers may have affected the reached findings. Yardley (2000) suggests that this disclosure may include a reflection on the motivations which led the researcher to the topic of the study, including their own experiences with the topic. Through the process of phenomenological bracketing, I was able to be more aware of my own possible assumptions and preconceptions with the topic of investigation and therefore be better equipped to separate my own experience from the participants' experience, even though a complete separation is of course impossible.

Regarding coherence, this aspect refers in part to the alignment between the research question, philosophical perspective, and method of investigation and analysis used in the study (Shinebourne, 2011). As such, an IPA study should be consistent with the principles of IPA, which involves closely attending to participants' experiences and applying an interpretative perspective to these accounts. This study accomplishes this in part through a combination of an inductive and deductive approach to analysis. Furthermore, in an IPA study, the aspect of coherence can also refer to the presentation of a logical and cohesive argument. According to Yardley (2000), this is highly reliant on the quality of the narrative

presented and to what degree this presentation appears convincing by *"creating a reality which readers recognise as meaningful to them"*. The experience of interaction with a computer is familiar to many, allowing for an easier job in making the reader feel as if they are in the shoes of the participants. Furthermore, in the presentation of the relevant theoretical concepts and the process of establishment of the framework, various everyday examples have been used from driving a car to the way a blind person may use their cane. This has been in an attempt to provide the reader with a more realistic and personal understanding of the experiences and suggestions being explained.

Impact and importance

This leads to the fourth and final criterion, impact and importance. Here the relevance of engaging and resonating with the reader is accentuated, where Smith et al. (2009, p. 183) state that *"the real validity lies in whether it tells the reader something interesting, important or useful"*. Yardley (2000) emphasises that regardless of the fulfilment of all other validity criteria, impact and importance are the decisive factors in the evaluation of a qualitative study's validity. This value is often judged in terms of theoretical value, and to what degree a study is able to draw upon existing work in order to present its own novel perspective, that opens up new ways of understanding the topic. In this way, a study must be able to influence beliefs and actions, and in addition have a substantial degree of utility, where a novel insight can appear as worthless if its application or utilisation is unclear or unrealistic. In existing research, the notion of embodiment or embodied cognition in interaction design is often approached by suggesting innovative tangible, embedded or otherwise physically engaging interfaces, that in many ways can be viewed as unrealistic in their possible implementation. I suggest that the study's approach of assessing the embodied nature of the interaction we already have with traditional technology allows the possibilities of harnessing the embodied nature of our interaction and applying it to interaction design to become much more accessible. Support for this point is elaborated upon in Chapter 7.3 and the subsequent discussion in Chapter 8.

7.3 Contributions

The main contribution of this thesis is a framework of embodied cognition in computer interaction. By identifying key areas of embodied cognition in interaction with computers and their interconnections, I suggest this framework can further contribute to both designers and researchers within HCI in two distinct ways. Firstly, I suggest the framework contributes

a valuable perspective and understanding of embodied cognition in computer interaction, fostering a discussion on and exploration into how we interact with the computers that are a large part of our everyday lives. In the introduction of this thesis, I gave a brief description of why the goal of this thesis was to provide a theoretical structure for understanding embodied cognition in computer interaction, rather than providing concrete design implications, as is often a contribution of much HCI work (Dourish, 2006). As Dourish (2006) argues, providing design implications alone may overlook the analytical and conceptual work that underlies them, where these analytical contributions can provide new ways of imagining the relationship between people and technology. Therefore, this thesis provides a crucial analytical and theoretical understanding of embodied cognition in computer interaction.

However, Dourish emphasises that his argument is not that design implications are useless or unworthy of inclusion, but rather that their significance lies not only in what they are but also in how and why they were formulated, the intellectual commitments they entail, and the models they reflect. Dourish explains that theoretical interpretation and work often have profound implications for design, but that this work goes beyond specific design instances. This leads me to the second application of the framework: to operationalise it for the purpose of informing insights and considerations for design, rather than specific design implications. This contribution can be used by other researchers to create design implications for embodied cognition in computer interaction that are based on a comprehensive theoretical and empirical understanding of the subject.

Based on this the framework can be utilised in two ways; the thesis provides a contribution in the form of structure to the understanding of embodied cognition in computer interaction, in addition, the thesis provides a contribution in the form of design insights to inform the further establishment of design implications.

Contribution 1: Structuring an understanding

- The role of the body, and bodily movement, in computer interaction is not limited to a discussion of ergonomics, but is instead a fundamental aspect of our cognitive experience and ability in such interaction, where this connection between physical activity and cognition emphasises the significance of the subtle simultaneous nature of this activity.

- Embodied cognition is an inherent feature of our interaction with the world, and is not a limited characteristic of specific technologies.

- The framework contributes to an understanding of embodied cognition as not only an important theoretical notion but also as a phenomenon that manifests itself in concrete practical ways in our interactions with computers.

Contribution 2: Considerations for design

- The ways in which embodied cognition is expressed in the context of interaction can be used to reimagine the ways in which our interaction with computers is configured, instead of altering the surrounding context.
- The cognitive advantages of movement in interactions can be integrated into interactions beyond those directly connected to the goal aimed to be completed.

While the first contribution is more closely linked to the presented related work, the second contribution should be seen in light of the following discussion. The following discussion will naturally also make the relevance of the first contribution more clear.

As stated initially in the thesis, the target audience suggested to draw from these contributions consists of HCI researchers and design practitioners with the goal of incorporating a bodily and contextual understanding into the design of interaction with computers. Due to the cross-disciplinary nature of the study, the findings and contributions may also be of interest within fields such as psychology, especially for those investigating features of embodied cognition. Lastly, considering the examination of cognition and task completion in a work context, this study may also be of potential interest to the field of organisational or human resource management.

Chapter 8

Discussion

The previously presented contributions of this thesis will provide a structure for the following discussion. As a result of this, the discussion will be split into two parts, namely *Adding structure to understanding embodied cognition in computer interaction* and *Insights and considerations for design.* Each distinct contribution will be examined in relation to the work of others, creating a discussion around the relevance of each contribution. Concrete findings from the thesis will also be utilised in this discussion where beneficial.

8.1 Adding structure to understanding embodied cognition in computer interaction

The discussions in this section are structured around Contribution 1 in the following way;

How movement matters

- The role of the body, and bodily movement, in computer interaction is not limited to a discussion of ergonomics, but is instead a fundamental aspect of our cognitive experience and ability in such interaction, where this connection between physical activity and cognition emphasises the significance of the subtle simultaneous nature of this activity.

Embodiment as a feature of interaction, not of technology

- Embodied cognition is an inherent feature of our interaction with the world, and is not a limited characteristic of specific technologies.

Acting out embodied cognition

- The framework contributes to an understanding of embodied cognition as not only an important theoretical notion but also as a phenomenon that manifests itself in concrete practical ways in our interactions with computers.

8.1.1 How movement matters

By the theoretical framework providing a foundation for understanding the role of embodied cognition in interaction with a computer, this allows us to perceive the role of the body in computer interaction as complex and multifaceted. As presented, the framework contributes to an understanding of the role of the body, and bodily movement, in computer interaction is

not limited to a discussion of ergonomics, but is instead a fundamental aspect of our cognitive experience and ability in such interaction, where this connection between physical activity and cognition emphasises the significance of subtle simultaneous activity.

The literature investigating the importance of the body in interaction with a computer generally concerns itself with issues of physical ergonomics (Chandra et al., 2009; Al-Kindi & Shikdar, 2015; LeBlanc et al., 2017; Wahlström, 2005). This approach provides an understanding where the body's role in our experience of interaction with computers is limited to physical discomfort. Other studies emphasise the importance of incorporating more movement into interaction with computers in office work, for example in order to prevent musculoskeletal disorders (Davis & Kotowski, 2014). Moradi and Wiberg (2016) discuss this topic in light of how we occupy the office workspace, and design various artefacts with "Moving bodies" in mind in order to promote movement in the workplace.

The framework also emphasises the importance of movement in computer interaction. However, this emphasis on movement is in regard to the identified connection between physical activity and the experience of efficient contemplation. In regards to the consideration of movement and cognitive functioning as having a significant association, studies have often investigated the possible effect of physical activity on the preservation and enhancement of cognitive functions. Various studies have found evidence for the positive association between physical activity and executive control, referring to our cognitive ability for decision-making, self-control and problem-solving (Hillman et al., 2006; Kamijo & Takeda, 2009; Padilla et al., 2013). In these studies, physical activity is understood as routine engagement in physical exercise such as running, cycling or swimming. In this way, the connection between physical activity and cognition is understood in terms of how leading a physically active lifestyle may positively affect cognitive functioning. Herold et al. (2018) consider these findings and from this explore the topic of simultaneous motor-cognitive training, referring to the engagement in physical and cognitive tasks at the same time. The paper suggests and outlines this as an insufficiently explored field in physical activity-cognition research.

The framework contributes an understanding of bodily experience movement in computer interaction as being influential beyond ergonomics, presenting these factors as having significant implications for our cognitive experiences. Furthermore, the framework provides support for the significance of non-strenuous physical activity in regard to cognitive

processing, in addition to emphasising the significance of engaging in this physical activity simultaneously as contemplation occurs.

8.1.2 Embodiment as a feature of interaction, not of technology

The "embodied interface" has been posited in the literature on embodiment within the design of technology (Clifton et al., 2016; Fishkin et al., 1999). This notion seems to imply embodiment as a distinctive feature of technology, instead of recognising it as a constant aspect of our interaction with the world. This view appears to colour the current approach to understanding embodiment and embodied cognition in interaction with technology, where several studies associate embodied interaction with particular forms of technology, such as physically interactive interfaces, mixed reality simulations, and tangible interfaces. Malinverni et al. (2012) conducted a study that investigated the influence of embodied interaction on learning processes, where the term "embodied interaction" was specifically assigned to a physically interactive interface. Similarly, Lindgren et al. (2016) explore the possibilities of enhanced learning and engagement through embodied interaction within a mixed-reality simulation. In doing so, embodied interaction is proposed as a defining feature of mixed reality simulations. Moreover, the study compares the learning outcomes of this embodied interaction to those of interaction with a traditional desktop computer, which is considered to lack the quality of embodied interaction. Skulmowski et al. (2016) equivalently investigate the element of embodied learning by using a tangible interface. While these studies are influential in understanding how specific interfaces can facilitate embodied cognition, they may unintentionally reinforce the notion of embodiment as a feature of technology, rather than a consistent aspect of our interaction with the world.

Svanæs (2013) uses the, as he describes it "more mundane" example of the scrolling wheel on a computer mouse to suggest that an embodied interaction perspective applies to all technologies, not just tangible, embedded or other physically interactive technologies. Furthermore, Dourish (2001, p. 188) explains *"embodiment is a feature of interaction, not of technology. It does not distinguish one sort of interface from another - embodied from non-embodied. Certainly, some systems may lend themselves more to a more embodied form of interaction than others, but in general, embodiment is a question of how the technology is used."*.

Another way in which embodiment is often linked to specific technologies is through the connection of specific perceptual-motor preferences to specific technologies. Svanæs (2013)

presents multiple variations of a page-turning or scrolling function, from buttons, the scrolling wheel and EyeScroll that involves gaze-controlled scrolling, connecting embodiment to specific navigational preferences while reading and from there to specific technologies allowing different forms of interaction. Similarly, Wensveen et al. (2004) present specific practical characteristics for coupling action and information in order to explore embodied freedom of interaction. Here characteristics such as the coupling of location, time, dynamics or expression are connected to the possibility of enhancing embodied freedom. While these studies provide crucial knowledge on the more specific ways in which an embodied interaction may be facilitated, they also exist at a very concrete specific tool-based level and focus heavily on the embodied nature of specific perceptual motor elements.

The framework employs a phenomenological approach to examine the broader and more fundamental ways in which we demonstrate embodied cognition, in a world where all our experiences are unavoidably and inherently embodied. This includes finding strategies and opportunities to express embodied cognition even in the use of technology that may not be designed with embodiment in mind. As embodied cognition involves the constant connection between the mind, body and environment, it cannot be fully understood when restricted to specific perceptual motor factors or specific technologies. By prioritising the understanding of how embodiment is facilitated beyond specific features of a technological interface, the framework's understanding of embodied cognition may be more robust to the rapid pace of technological advancements.

8.1.3 Acting out embodied cognition

As described in the previous section when approaching the topic of an embodied interaction emphasis is placed on the possible interfaces and technology that can represent how embodiment could or should be done, for example through tangible interfaces, physically interactive platforms or mixed reality simulations (Lindgren et al., 2016; Malinverni et al., 2012; Skulmowski et al. 2016). This approach emphasises the exploration of embodied interaction through the introduction of new technology, instead of the exploration of how embodiment or embodied cognition is already done in a given context. In addition, when attempting to gain an understanding of embodiment to inform the design of embodied interaction, this understanding is often mainly theoretical, where an investigation into the ways in which embodied cognition manifests itself already in that particular context is often missing.

Klemmer et al. (2006) present aspects of embodied engagement in the world that they present as influential for interaction design, which includes the discussion of the theme of thick practice. Here it is argued that *"because there is so much benefit in the physical world, we should take great care before unreflectively replacing it"* (p. 147), where an emphasis is placed on understanding how people already interact with their environment, and what ways these interactions are meaningful to them. A few examples illustrating this importance and how it can be respected in the design of interfaces are presented. Heath and Luff (1996) investigated the use of paper documents in health care, observing their persistent use despite the deployment of a computer system designed for information distribution and record-keeping. By examining these everyday practices, they identified crucial aspects of paper medical records valued by workers, and how the new computer system fell short in incorporating them. On a similar note, Books with Voices carried out a contextual inquiry into the practices of oral historians (Klemmer et al., 2003). In this way, Book with Voices was able to understand and embrace existing reading practices, where the printed paper page was the primary artefact around which interaction is structured, and integrate this into a technological system. The system Final Scratch also shows this respect for existing physical practice. The system allows DJs to access digital music using specially encoded vinyl records, in recognition of their appreciation for the sensory richness and nuanced manipulation offered by physical records.

Although these examples do not touch directly on the topic of embodied cognition, they illustrate an emphasis on an in-depth comprehension of the existing practices and experiences within a particular context. As presented, *the framework contributes to an understanding of embodied cognition as not only an important theoretical notion, but also as a phenomenon that manifests itself in concrete practical ways in our interactions with computers*, in this way emphasising a focus on understanding what embodied cognition already is, how it happens and how it is experienced.

8.2 Insights and considerations for design

The discussions in this section are structured around Contribution 2 in the following way;

Incorporating movement as part of the journey, not the destination

- The ways in which embodied cognition is expressed in the context of interaction can be used to reimagine the ways in which our interaction with computers is configured, instead of altering the surrounding context.

Treat the illness, not the symptoms

- The cognitive advantages of movement in interactions can be integrated into interactions beyond those directly connected to the goal aimed to be completed.

8.2.2 Incorporating movement as part of the journey, not the destination

The second main finding of this thesis was that *a significant aspect of the expression of embodied cognition in interaction with computers is the experienced connection between physical movement and thinking or cognitive progress,* where this movement could manifest itself as activities such as taking coffee or toilet breaks, fiddling or doodling or running errands. This finding indicates the significance of incorporating a higher degree of physical movement in our interactions with computers.

In other efforts to grasp the connection between cognition and movement, the benefits of directed, task- and goal-related movement have been investigated. Thomas and Lleras (2009) discovered in their study that engaging in directed bodily movements related to the task at hand, specifically swinging movements in Maier's two-string problem, had a positive impact on problem-solving insight. Studies conducted in order to investigate embodiment in interaction seem to often build upon this same notion, where tangible or physically interactive interfaces are introduced in order to complete a specific task (Malinverni, 2012; Skulmoski, 2016). For example, Lindgren (2016) examined in which ways a physically immersive simulation affected the conceptual understanding of gravity and planetary motion, finding positive outcomes.

Karlesky and Isbister (2014) alternatively investigated the possibility of utilising the physical "margin" surrounding software, in this case exploring actions such as doodling, fidgeting, and fiddling, as a means to support thinking. Here artefacts named "Fidget widgets" were introduced to facilitate tangible interactions with the physical space surrounding digital workspaces, and were found to increase productivity and creativity. This study highlights the benefit of incorporating movement into elements of interaction that are not directly connected to the task at hand.

The presented finding and the ways in which movement was experienced as cognitively beneficial indicates that the benefits of incorporating movement into computer interaction are not limited to movement directly connected to the goal aimed to be completed. If movement were perceived as only beneficial when directly linked to a specific task one might be inclined to envision a physically interactive method of writing emails where augmented

reality is utilised to select each letter by reaching out for it. However, many would likely judge this idea as ineffective and unrealistic. The framework instead promotes the consideration of incorporating movement in ways that are not directly tied to the immediate task, in this way opening up for a more flexible and creative approach to incorporating movement into computer interaction.

8.2.3 Treat the illness, not the symptoms

In previous evaluations of the body in interaction with computers, a centre of focus has been on making changes to the surrounding environment, such as considering specific aspects of ergonomics such as better suited equipment or recommendations of postural variability (Chandra et al., 2009; Davis & Kotowski, 2014; LeBlanc et al., 2017; Wahlström, 2005). Moradi and Wiberg (2016) placed their emphasis on space and movement in the context of interaction with computers and designed the "NEAT lamp" as an artefact to be placed in contemporary work settings with the goal of promoting movement. Similarly, and with a direct consideration of embodied cognition, Karlesky and Isbister (2014) designed "Fidget widgets". These artefacts had the goal of allowing for non-disruptive physical activity while sitting at a desk and working on a computer. While important areas of investigation, these examples further illustrate the emphasis on adding or adjusting elements of the environment in which computer interaction takes place. It seems less attention has been given to considering changes in the computer's configuration itself as a way of improving the interaction between the body and computer and in turn facilitating the expression of embodied cognition.

A main finding of the theoretical framework was that *the ways in which embodied cognition manifests itself in interaction with a computer are generally not in direct interaction with the computer, rather in interaction with the surrounding context of interaction,* indicating the significance of the surrounding context of computer interaction in the expression and experience of embodied cognition. An understandable assumption may therefore be that the framework can be employed to inform considerations related to the design of elements in the surrounding environment, such as providing more active breaks or more post-its. However, the framework's insights into how our environment is utilised to express embodied thinking can instead be used to reimagine the configuration of our direct interaction with computers. In this way, the framework contributes an insight for design that suggests that the cognitive advantages of movement in interactions can be integrated into interactions beyond those directly connected to the goal aimed to be completed.

Chapter 9

Conclusion

This thesis began with a motivation to examine the, mainly unchanging, ways in which we interact with computers and delve deeper into the embodied nature of this interaction. I have utilised a phenomenological perspective to develop a theoretical framework, further used to investigate the practical manifestations of embodied cognition in real-life scenarios. A phenomenological case study, exploring computer interaction in an office context, was used to structure the inquiry, and Interpretative Phenomenological Analysis (IPA) provided structure to the subsequent analysis.

The main contribution of this thesis is a framework of embodied cognition in computer interaction. The contribution of this framework is two-fold, contributing structure to the understanding of the phenomenon and allowing for an operationalisation to contribute design insights. This consists of an understanding of the role of the body and bodily movement in computer interaction as highly influential to our cognitive state, in addition to providing an understanding of embodied cognition as an inherent feature of our interaction in the world, rather than a characteristic of specific technologies. Furthermore, the framework contributes an understanding of embodied cognition beyond a theoretical idea by investigating and presenting the ways in which embodied cognition in computer interaction is expressed in real-life practical ways. As stated, the framework is also operationalised to contribute design insights. The framework contributes an argument for integrating movement into the interactions with computers beyond those directly connected to specific task goals. In addition, rather than merely implying alterations to the context of computer interaction, the insights from the framework can be utilised to reimagine our interactions with computers.

9.1 Future work

This thesis has shed light on the expression of embodied cognition in computer interaction within an office context, recognising that these manifestations may be context-dependent. Consequently, it is valuable to explore how embodied cognition may unfold in various other contexts of computer interaction. By doing so, we can broaden our understanding of embodied cognition and its contextual nuances across diverse settings. Moreover, it would be beneficial to explore the possibilities of utilising the theoretical framework to provide

meaningful insights into the design implications for technologies to be built on an understanding and facilitate our embodied cognition.

Further possible future work for this study also includes examining the social aspects of embodied cognition in computer interaction to gain a deeper understanding of the influence of interpersonal dynamics on embodied experiences. Additionally, investigating the effects of embodied cognition over an extended period could provide valuable insights into the possible long-term benefits of facilitating embodied cognition in computer interaction.

Ultimately, I hope to see future work continuing the discussion on the bodily-cognitive experience of interacting with computers, inspiring new innovative reimaginations of this interaction that hopefully are designed with the body in mind.

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Appendix

A.1 Consent form

Vil du delta i forskningsprosjektet

«Hvordan kroppen hjelper deg med å tenke: Rollen til rettet epistemisk handling i problemløsning i en individuell kontorsetting»

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å få en forståelse av strategier for problemløsning i en individuell kontorsetting. I dette skrivet gis det informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Jeg er en student ved Universitet i Oslo som går på 5. året på en master innenfor Informatikk: Design, bruk og interaksjon. Jeg skal skrive masteroppgaven min i løpet av høsten 2022 og våren 2023 der masteroppgaven min går ut på å undersøke hvilke metoder blir brukt av kontorarbeidere i problemløsning og hvilken rolle epistemisk handling har i deres fremgangsmåte.

I masteroppgaven ønsker jeg å svare på forskningsspørsmålet: *«Hvordan kan det å forstå bruken av rettet epistemisk handling i problemløsning hjelpe i fremtidig design av grensesnitt?»*

Dataene samlet inn til dette prosjektet skal ikke brukes til andre formål enn masteroppgaven.

Hvem er ansvarlig for forskningsprosjektet?

Universitetet i Oslo er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?

Du får spørsmål om å delta i dette prosjektet fordi den målgruppen som er relevant for dette prosjektet er kontorarbeidere i aldersspennet 18 til 67 år.

Hva innebærer det for deg å delta?

Dersom du velger å delta i prosjektet vil dette innebære at du deltar i intervju og deltakende observasjon. Intervjuet vil ta omtrent 30-40 minutter og observasjonen vil ta omtrent 20 minutter. Intervjuet inneholder spørsmål om din arbeidshverdag, om dine typiske arbeidsoppgaver og om din fremgangsmåte når det gjelder å løse diverse arbeidsoppgaver. Observasjonen vil gå ut på at du snakker gjennom arbeidsprosessen din mens du gjennomfører, samt viser frem og snakker gjennom sammensetningen av kontorområdet ditt.

Jeg ønsker også gjerne å ta lydopptak og notater underveis.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan dine opplysninger blir oppbevart og brukt

Opplysningene om deg vil bare bli brukt til formålene jeg har fortalt om i dette skrivet. Opplysningene blir behandlet konfidensielt og i samsvar med personvernregelverket. Det er kun jeg som vil ha tilgang til informasjonen som blir gitt. Dataen vil bli lagret slik at ingen uvedkommende kan få tak i den.

Hva skjer med personopplysningene dine når forskningsprosjektet avsluttes?
Prosjektet vil etter planen avsluttes/oppgaven blir godkjent. Prosjektet skal etter planen avsluttes 30. juni 2023. Etter prosjektslutt vil datamaterialet anonymiseres. Det er kun de anonymiserte dataene som vil være tilgjengelig som en del av masteroppgaven vår, disse dataene vil ikke kunne spores tilbake til deg.

Hva gir meg rett til å behandle personopplysninger om deg?

Opplysningene om deg blir behandlet basert på ditt samtykke.

På oppdrag fra Universitetet i Oslo har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke opplysninger vi behandler om deg, og å få utlevert en kopi av opplysningene
- å få rettet opplysninger om deg som er feil eller misvisende
- å få slettet personopplysninger om deg
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger

Hvis du har spørsmål til studien, eller ønsker å vite mer om eller benytte deg av dine rettigheter, ta kontakt med:

- Laura Catherine Murphy, på e-post lauracm@ifi.uio.no eller på telefon +47 95 07 02 05
- Universitetet i Oslo, ved Suhas Govind Joshi, på e-post joshi@ifi.uio.no eller på telefon +47 22 85 24 16

Hvis du har spørsmål knyttet til hvordan Universitetet i Oslo håndterer personvern, kan du ta kontakt med:

- Behandlingsansvarlig ved Universitetet i Oslo, på e-post behandlingsansvarlig@uio.no

Hvis du har spørsmål knyttet til Personverntjenester sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon +47 55 58 21 17

Med vennlig hilsen

Laura Catherine Murphy Suhas Govind Joshi

(Masterstudent/forsker) (Veileder)

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet «Hvordan kroppen hjelper deg tenke: Rollen til rettet epistemisk handling i problemløsning i en individuell kontorsetting», og har fått anledning til å stille spørsmål. Jeg samtykker til:

- □ å delta i intervju
- □ å delta på observasjon
- □ at mine anonymiserte data kan brukes i denne masteroppgaven

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

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(Signert av prosjektdeltaker, dato)

A.2 Datagathering guide: Semi-structured interviews

Intervjuguide

Formål: undersøke hvordan individer løser arbeidsoppgaver som er primært kognitive i en individuell kontorsetting. Kartlegge vaner og arbeidsstrategier for å få innblikk i hvilke metoder som hjelper et individ i problemløsningen. Å observere og få innsikt i hvordan ulike verktøy og andre gjenstander i omgivelsene brukes vil være hensiktsmessig å undersøke.

Intervjuguide:

Litt innledende spørsmål for å så kartlegge en typisk arbeidsdag og typiske arbeidsoppgaver

Hva slags arbeidsstilling har du?

Hvor lenge har du hatt denne stillingen?

Nå vil jeg gjerne spørre litt mer steg for steg om hvordan en typisk arbeidsdag er, *fra øyeblikket du går inn døren i bygget til øyeblikket du drar, altså ikke bare om arbeidsoppgaver*.

- Når kommer du som regel på jobb? *(tidspunkt)*
- Hvilke ting tar du alltid med deg på jobb? *(og hvorfor)*
- Hvilke ting gjør du før du setter i gang med arbeidet ditt?
- Kan du ta meg gjennom gårsdagen *(hvis det var en arbeidsdag, eventuelt flere dager for å få et mer helthetlig bilde)* og fortelle hva slags arbeidsoppgaver du gjennomførte?
    - Er dette en typisk arbeidsdag for deg?
    - Er det andre arbeidsoppgaver som er typiske for jobben din?
- Har du noen faste pauser gjennom arbeidsdagen din?
    - Hva gjør du i disse pausene?
- Hva gjør du når du skal dra fra jobb?
- Når drar du som regel fra jobb?

Nå vil jeg gå litt dypere inn på arbeidsoppgavene dine *(ta utgangspunkt i de arbeidsoppgavene som blir nevnt tidligere)*

- *(Tar utgangspunkt i en viss nevnt oppgave, kan snakke om andre hvis de er mer relevante)*
    - Hvilke utfordringer møter du gjerne på når du gjennomfører denne arbeidsoppgaven?
        - Hvordan går du frem for å løse disse utfordringene?
- Hvilke av arbeidsoppgavene liker du best?
    - Hvorfor?
    - Hva slags egenskaper har denne oppgaven?
    - Hva slags utstyr bruker du for å gjennomføre den?
- Hvilke av arbeidsoppgavene bruker du mest tid på?
    - Hvorfor?
    - Hva slags egenskaper har denne oppgaven?
    - Hva slags utstyr bruker du for å gjennomføre den?
- Hvilke av arbeidsoppgavene synes du er vanskeligst?
    - Hvorfor?
    - Hva slags egenskaper har denne oppgaven?
    - Hva slags utstyr bruker du for å gjennomføre den?

A.3 Datagathering guide: Elicitation diaries

Dagbokstudie: *Hva er det du gjør når du tenker?*

Dagbokstudier blir som regel gjennomført for å få et mer ufiltrert og upåvirket inntrykk av det deltakeren opplever. Her skriver som regel deltakeren ned noe på ark eller digitalt om deres opplevelse av en situasjon som dukker gjennom dagen. Her tenker man ofte at deltakeren får reflektert på en mer naturlig og genuin måte enn i en situasjon der forskeren er tilstede og styrer datainnsamlingen.

Formålet med akkurat denne dagbokstudien er å få innblikk i **hva er det du gjør når du tenker?** Med andre ord - når du sitter med en oppgave som du opplever som kanskje litt vanskelig eller vrien, hva er det du får lyst til, og eventuelt ender opp med, å gjøre?

Går du på toalettet? Begynner du på en annen oppgave? Går du ut med søpla? Snakker du med en kollega? Begynner du å fikle med noe? Bruker du noe verktøy for å organisere tankene dine? Justerer du pulten, stolen eller skjermen din? Føler du deg sulten? Eller noe helt annet?

Det kan være hva som helst - det er altså ingenting som er for simpelt eller som er uinteressant.

Dagbokstudien

Når skal du skrive ned noe?

- Når du føler du sitter med en oppgave du synes er litt vanskelig/vrien, dette er kanskje typisk en oppgave du ofte utsetter.

Hva skal du skrive?

- Skriv ned på en post-it lapp kort hva det var som fikk deg til å føle det sånn (hva slags oppgave du drev med). Klistre post-it lappen nederst på skjermen din. Skriv ned stikkord på lappen om hva merket at du gjorde i denne situasjonen. Du kan skrive ned hva som helst, gjerne notér alle refleksjoner og småting. Dette kan du gjøre med en gang eller mer fortløpende i tiden etterpå når du merker/kommer på ting - akkurat da det føles naturlig. Ta vare på post-it lappen.

Du kan bruke disse spørsmålene som innspill til stikkordene:

- Hva gjør/gjorde kroppen din? *(Reiser du deg opp, eller går fra kontoret? Justerer du pult/skjerm stol på noe måte?)*
- Hvilke ting bruker du/tar du i? *(Kaffekopp? Penn? Datamus/tastatur?)*
- Hvordan føler du deg? *(Frustrert? Kjeder du deg? Avslappet? Rastløs? Glad?)*

Tips til gjennomføring:

- Det kan være hjelpsomt å tenke deg ut en oppgave på forhånd, som du opplever som litt slitsom/vanskelig/kjedelig, som du vet at du skal drive med i den neste tiden. Da kan du skrive ned den oppgaven som tittelen på en post-it lapp og henge den opp som en påminnelse, slik at hver gang du setter i gang med den oppgaven så kommer du på å notere ned på lappen.
- Du kan som sagt sette av kun én dag/en kort periode av dagen til å gjennomføre dette. Du velger helt selv hvor mye tid du vil bruke.
- Ta vare på post-it lappen, eller ta bilde av den, sånn at det blir lettere å snakke om det som ble skrevet ned i samtalen i ettertid.

Oppfølgingssamtale

Det tenkes, som sagt, at samtalen kan gjennomføres i slutten av neste uke (uke 8), men det er heller ikke noe problem å utsette. Her er hensikten bare at samtalen bør skje ikke alt for lenge etter man har gjennomført aktiviteten, slik at opplevelsen og refleksjonene ligger ferskt i minnet.

Samtalen vil være veldig uformell og bør vare i mellom 10-20 minutter. Her skal vi snakke gjennom det du skrev ned på post-it lappen(e) og eventuelle refleksjoner du gjorde deg mens du holdt på med aktiviteten. Jeg tenker at samtalen godt kan gjennomføres over telefon, der jeg ikke skal ta opptak, men heller bare skrive ned litt notater i løpet av samtalen.