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Louise Petersen Matjeka

Designing Movement-Based Play and Games - in Theory and Practice

Doctoral thesis

NTNU
Norwegian University of Science and Technology
Thesis for the Degree of Philosophiae Doctor
Faculty of Information Technology and Electrical Engineering
Department of Computer Science

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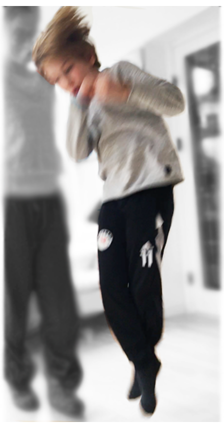

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Trondheim, June 2022

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ABSTRACT

This thesis investigates movement, bodily experiences and play and game design to advance the fields of HCI and interaction design, game studies in general and (movement-based) play and game design in particular.

The interest in designing technologies for and with the body has been a topic for decades, consolidating with the entrance of phenomenological perspectives to bodily experiences into the HCI, interaction design and game design fields. The assumption behind this interest is grounded in an understanding that designs, particularly digital designs and play and games, are bodily experiences. However, within this interest, little attention has been given to investigating the role of movement for bodily experiences and the connection to (movement-based) play and game design. Even less attention has been given to what such knowledge can tell us about the relationship between humans and technologies. In other words, how humans and non-humans are enmeshed.

Addressing this gap, movement is investigated from the aspects of play and game design, bodily experience and technology. For such inquiries, the Research through Design (RtD) methodology is chosen as it combines and draws on both practical design knowledge and theoretical knowledge in a mutually informing process. Concretely, a movement-based game was designed along with a set of derived theories through an RtD process. Thus, the process revealed both practical and theoretical contributions.

Because of the emphasis on technology and bodily experiences, the theoretical and epistemological background comprises a posthumanist orientation in a phenomenological and postphenomenological perspective.

The process led to the following contributions:

- Theoretical foundation of movement-based game design as different structures of “play” or game, and how bodily attitudes emerge as the doings; being playful or “gameful”, including derived design strategies.
- Restraints and paraphernalia as bodily preconditions and surrounding conditions; generic game mechanics supporting, facilitating and encouraging movement and bodily play, including definitions and design strategies.
- A movement-based game as a practical exemplar designed from the above theoretical contributions. In addition, the design comprises a modular structure adaptable to various situations as a response to technical and practical issues regarding appropriation of movement-based play and games in everyday living environments. Furthermore, the game is empirically evaluated and found constituting a pervasive interactive playground.
- The role of movement in digital play; how bodies are continuously constituting, (re)configuring and negotiating through movement. Furthermore, it is argued that movement pre-reflectively transcends the physical, technological and virtual worlds and delineates bodies as combinations thereof.

From these investigations, this thesis provides a perspective to movement as an underlying dynamic of play and game experiences in particular and how humans, non-humans, and technologies are enmeshed in general. Consequently, this thesis argues that all play and games are movement-based because movement does not pertain to humans only.

PREFACE

This thesis is submitted to the Norwegian University of Science and Technology (NTNU) in partial fulfillment of the requirements for the degree of Philosophiae Doctor.

The PhD work was carried out at the Department of Computer Science, NTNU, Trondheim. Professor Dag Svanæs was appointed main supervisor and Professor Alf Inge Wang, Associate Professor Hanna Wirman and Professor Beatrix Vereijken as co-supervisors. The work was conducted as part of the EXACT – Exergaming for active healthy ageing and rehabilitation – project.

ACKNOWLEDGMENTS

Most thesis' acknowledgements sections that I have read so far, start by thanking their supervisors. I will start by thanking my wife! And our two sons! They are amazing! They have supported and followed me through all the ups and downs that have passed in the time of my PhD writing, the Corona pandemic and beginning of the Ukraine war. Together we have cried, laughed, played and fought our ways through. The readers of this thesis will see my family throughout the papers and videos playing - sometimes in the foreground, sometimes in the background. Nevertheless, they have always been there, and I am forever grateful for their support and love.

A place that has helped me a lot is the IT University of Copenhagen. It has been like coming back to the lar where it all started when I graduated with my master's – at the IT University. Thank you to Lone Malmborg and Hanna Wirman for your empathy to help me and give me shelter at the IT University when I was lost somewhere over the Kattegat between Norway and Denmark. Moreover, a special thank you to Hanna Wirman for your supervision, talks, understanding and encouragement! Also, a big thank you to Dag Svanæs, who arranged my stay at the IT University in Copenhagen and the Exertion Games Lab in Melbourne. Your help in these matters has been paramount to my studies! Also, a thank you for employing me in the first place and our talks at the beginning of my studies. In this regard, I also want to thank Beatrix Vereijken, who has always helped when asked.

I want to thank Alf Inge Wang for help, guidance and understanding in the final phase and my Kappa writing. I am grateful that you took over and stood by me in this final hour of my PhD creation.

I also want to send a huge thanks to Florian Floyd Mueller and the Exertion Games Lab for inviting me into their lab and network. I experienced a Lab where people thrived, and mutual help and understanding was at the forefront – besides fascinating research, ideas and experiments! I have learned so much from my stay and afterwards being part of the network.

I want to thank my co-authors, Mads Hobye and Henrik Svarrer Larsen, for your help when I needed it. I also want to thank Terje Røsand for technical assistance and interest, Povl Eiland Olsen and Eva and Brian Jagd Mauritzen to stand up as test people even when the Corona crisis was lurking, Eva Matjeka for support and participation throughout the crises and achievements, and everybody else who has participated in tests, workshops, discussions and readthroughs. Lastly, a warm thank you to the rest of my caring and supporting family, Sanne (Mom), Niels, Mads, Christina and the boys.

Finally, I want to send a special thank you to Randi Holvik for listening and support through hard times.

You are all aces in my book!

I hope you enjoy reading the rest of this thesis.

TABLE OF CONTENTS

PART I

INTRODUCTORY SECTIONS

1 INTRODUCTION

Bodily play and games are documented as far back as the Greek gods' games at the Olymp (Welcome to the Ancient Olympic Games, 2020). However, as mammals also play, play and games are most likely older than the human race (and, thus, the Greek gods). With this introduction, I want to draw attention to how games have existed long before the digital era – and always have been bodily. In other words, when we investigate bodily play, we can draw from this vast tradition. Investigating this tradition, we can decipher the underlying dynamics of bodily play in these games and bridge the physical, digital, and technological domains to better understand and leverage the already existing knowledge into the present game and play design.

While research into bodily experiences in and of game and play design have driven much research in HCI and game design communities during the last decades (Bianchi-Berthouze, 2013; Höök, 2018; Höök et al., 2018; Keogh, 2018; Klevjer, 2006; Márquez Segura et al., 2013; Martin, 2012; Matjeka et al., 2021; Matjeka and Mueller, 2020; Mueller et al., 2018, 2019; Mueller et al., 2020; Mueller, Matjeka, et al., 2020; O'Brien, 2018; Rostami et al., 2017; schraefel et al., 2019; Svanæs, 2013; Svanæs and Barkhuus, 2020; Westecott, 2008), little attention has been given to movement as an experiential and constituting factor, with a few exceptions (Bianchi-Berthouze, 2013; Isbister, 2016). On the contrary, attention has been given to movement as a measurable element and for calculable rewards. This approach has been prevailing for several exergames and digital sports design (Bianchi-Berthouze, 2013; Kepplinger et al., 2020; Kunze and Lukosch, 2019), often addressing an underlying health purpose (Lyons, 2015; Ma et al., 2018; Staiano et al., 2016; Wiemeyer et al., 2015). Addressing this gap in the literature seems important considering that moves and movement are essential for the emergence of any game experience. For example, in chess, each game piece is defined and constituted by how it moves across the board, i.e., its unique movement repertoire. In addition, the players make moves to progress the game. Then, consider a chess game without moves or a chess piece without a specific movement behaviour.

While game pieces can be defined by their movement repertoire, players are also game pieces constituted through movement repertoires. In, for example, football (soccer), the players are not allowed to touch the ball with their hands (or arms). Also, in handball, the players are not allowed to, e.g. touch the ball with their feet or take more than three steps with the ball without dribbling. The limitations in their movement possibility spaces are essential for defining the activity as football or handball and the players like football or handball players. In these examples, movement – and the body – seem to be fundamental for the constitution of a game as an activity, its elements, and players. The compelling investigation is, thus, to unfold the role of movement, and the mechanics, and underlying dynamics for the constitution of bodily play and games. Thus, this thesis investigates the relationships between movement, play, game, players, and technology and the implications for the bodily play and game experience. These investigations aim to uncover the dynamics of and advance knowledge about movement-based game and play design.

Because the investigations presented in this thesis are of the experiential aspects of movement in conjunction with game and play, a phenomenological perspective is adopted. Besides the focus on experience, a core question of (transcendental) phenomenology (Husserl, 1982; Sokolowski, 2000; Van Manen, 2014; Zahavi, 2011, 2018) is how subjects transcend domains to understand and act in and with the world. As this thesis investigates experience in various domains, e.g. play, game, players, and technology, such perspectives seem adequate.

Phenomenology traditionally positions itself within the humanist philosophy of science (Holm, 2018), which as a basis for inquiries, has the human being and culture as the superior and dominant species. However, this thesis' emphasis on technology – and its pervasive and ubiquitous presence (visibly or invisibly) – calls for a rethinking of humans as superior (though perhaps still dominating). Therefore, I have chosen a posthumanist (Ferrando and Braidotti, 2020) direction to meet these challenges as this thesis's underlying epistemological foundation. Moreover, a posthumanist orientation has entered the field of HCI as part of a proposed new wave by Frauenberger (2019), while other studies from both game studies and HCI include posthumanist theories (see, e.g., (Bjørn and Markussen, 2013; Jochum, Demers, and Vlachos, 2018; Krzywinska and Brown, 2015)). This direction has allowed viewing technology as an agent acting at the same level as the human players and as both mediating and agential elements in the constitution of bodily play and game experiences. Thereby, the way is paved to pinpoint the underlying dynamics and interrelations of all agents, human and no-human, involved in an activity.

As stated above, the overall aim of this thesis is to derive design knowledge, and it does so both practically and theoretically grounded in a Research through Design (RtD) process (Zimmerman and Forlizzi, 2014; Zimmerman, Stolterman, and Forlizzi, 2010). As this thesis is concerned with and contains design, the RtD methodology was found to be the most suitable as it offers the researcher a possibility for getting hands-on knowledge about a particular problem and reciprocally derive theoretical knowledge. As such, the investigations conducted in this thesis led to *design knowledge* on several levels:

- A practical level in terms of a playable game design.
- A theoretical level in terms of mechanics, design strategies and implications applicable in the design process.
- A meta-level addressing bodily play and game experiences as interrelations between players and technology emerging through movement.

While knowledge at the meta-level can be applied to design processes, it also addresses profound knowledge of the fields in question by addressing essential perspectives epistemologically. The guiding research questions for this research are listed in the next section.

2 RESEARCH QUESTIONS

As stated in the previous section, the research questions include practical and theoretical orientations as part of the RtD Methodology. Therefore, the research questions concern designs as artefact, design knowledge, and the role of movement in the designs. The research questions are answered in Part II in the Research Contributions Section 6.

RQ1-3 concern design knowledge by investigating generic mechanics, specific design challenges and solutions to leverage in the practical design of movement-based play and games and address the practical level. Together with RQ4, they also address the theoretical level in that theoretical design knowledge is derived from answering these research questions – as prescribed by the RtD methodology. Finally, RQ4-5 concern the meta-level to the practical design work and provides knowledge to understand better the underlying dynamics of bodily play and game experiences.

The research questions of this thesis are:

RQ1. *How can we describe generic mechanics facilitating and supporting playful bodily movement in theory and practice?*
RQ2. *What are some practical and technical challenges and subsequent solutions in designing movement-based play and games?*
RQ3. *How can the design support variations in bodily movements and gameplay as the activities progress and develop?*
RQ4. *How can we describe (digital) bodily play from a phenomenological perspective?*
RQ5. *What is the role of movement in digital play?*

The foundation for answering these research questions are the included papers listed in the following section. The papers lay the foundation for deriving the Research Contributions as answers to the above research questions and following conclusion.

3 INCLUDED PAPERS

This thesis is built on the following papers listed below. To provide an overview of the papers, these are listed below as ACM references.

In addition, during the thesis process, this author has participated in the writing of other papers that have influenced and provided adjacent information to this thesis' topic. While these are not included in this thesis, they are supporting papers for the final outcome. These are listed below the included papers and will not be explained further.

3.1 LIST OF INCLUDED PAPERS, ABSTRACTS, AND PUBLICATION PROCESS

This thesis is based on the following papers:

1. Louise Petersen Matjeka and Florian 'Floyd' Mueller. 2020. *Designing for Bodily Play Experiences Based on Danish Linguistic Connotations of "Playing a Game".* In CHI PLAY '20: 2020 Annual Symposium on Computer-Human Interaction in Play Proceedings, *ACM, New York, NY, USA, 13 pages.* https://doi.org/10.1145/3410404.3414264

   Best Paper Award

   Abstract:

Designing for bodily play in HCI is increasingly gaining attraction, including research on the experiential dynamics leading to that. Within this research, however, there has been little investigation into the differences between bodily playing and bodily gaming and associated implications for design. This paper investigates such differences and proposes an understanding derived from the Danish linguistic connotations of the four different combinations of bodily "playing/gaming" a "play/game". We exemplify these through four different examples and extract four strategies for designers to implement in their future bodily designs. With our work, we hope we are able to expand the range of diverse bodily play and game experiences within HCI.

Louise Petersen Matjeka initiated the paper during her research stay at Exertion Games Lab at Royal Melbourne Institute of Technology (RMIT) (at the time – now Monash University) in Melbourne, Australia. Co-author is Florian 'Floyd' Mueller, who contributed with discussion, reviews, and comments. The paper was led by Louise Petersen Matjeka. The presentation video was made by Louise Petersen Matjeka.

Link to presentation video: https://youtu.be/UJHZiZVJGpE

2. Louise Petersen Matjeka, Mads Hobye, and Henrik Svarrer Larsen. 2021. *Restraints as a Mechanic for Bodily Play*. In CHI '21: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems, ACM Press, Online. DOI: https://doi.org/10.1145/3411764.3445622

Abstract:

This paper presents restraints -directly imposed restrictions on players' bodily movements, as a mechanic for bodily play in HCI. While this is a familiar mechanic in non-digital movement-based games, its potential in designing bodily play experiences in HCI has been scarcely explored. Three types of restraints observed in non-digital movement-based games, are explored here: fixating body parts, excluding body parts and depriving/manipulating bodily senses. Then, we investigate the experiential dynamics of restraints as a bodily play mechanic bridging a phenomenological perspective on bodily movement with theories on play. These investigations form the theoretical framework for the subsequent analysis of five digital body game examples. Building on this analysis and theoretical framework, we formulate five design strategies for implementing restraints as a mechanic for bodily play in HCI. We propose restraints as a generative resource for researchers and designers interested in understanding and designing bodily play experiences in HCI.

The paper was initiated and led by Louise Petersen Matjeka in 2017 for the CHI Play'18 conference, Creativity & Cognition 2019, CHI2020, DIS'20, NordiCHI2020 and CHI2021. Mads Hobye joined the paper submissions for the CHI2020, DIS'20 and NordiCHI2020 submissions with discussions, comments and reviews. The paper was substantially reworked for the CHI2021 by Louise Petersen Matjeka. Henrik Svarrer Larsen joined the final submission for CHI2021 with comments and review. The paper was revised after acceptance by Louise Petersen Matjeka. The presentation video was made by Louise Petersen Matjeka.

Link to presentation video: https://youtu.be/VBvmCAHM5Ng

3. Louise Petersen Matjeka and Alf Inge Wang. 2022. *Paraphernalia – Game Mechanics Facilitating Bodily Movement and Play*. In the Proceedings of the 2022 CHI Conference Extended Abstracts on Human Factors in Computing Systems, *ACM,* New Orleans, USA, https://doi.org/10.1145/3491101.3519702

Abstract:

This paper complements "Restraints as a Mechanic for Bodily Play" by presenting the paraphernalia of games as different mechanics that address the surrounding and contextual factors of movement-based game and play activities, while restraints address the players' bodily preconditions. Based on an analysis of a collection of traditional games combined as bridging concepts, the mechanics are derived and exemplified in traditional and digital game exemplars and explained using theoretical concepts from phenomenology and postphenomenology. The presented mechanics provide a roadmap to design for and encourage bodily play by drawing on the historical development of (i.e., traditional) play and game activities and leveraging this knowledge into the domain of digital and technology-supported games and play activities.

The paper was initiated and led by Louise Petersen Matjeka. Alf Inge Wang reviewed and commented the final draft before submission. The revision after acceptance, presentation video and poster was made by Louise Petersen Matjeka.

Link to the presentation video: http://www.louisepmatjeka.com/wp-content/uploads/2022/03/presentation_Paraphernalia.mp4 (at the time of submitting this thesis, the video was not, yet, published through CHI's YouTube channel)

4. Louise Petersen Matjeka, 2020. *The Move Maker – Exploring Bodily Preconditions and Surrounding Conditions for Bodily Interactive Play*. In the Proceedings of the 2020 CHI Conference Extended Abstracts on Human Factors in Computing Systems, *ACM, New York, NY, USA, 6 pages*. https://doi.org/10.1145/3334480.3381652
    - **Winner of the CHI 2020 Student Game Competition; Transgressive and Transformative Play.**

    Abstract:

    Interest in interactive bodily play and game design has increased during the last decade, often fueled by the medical industry's focus on exergames and a need for basic movement training. By dividing bodily interactions into bodily preconditions and surrounding conditions for interaction, Move Maker systematically explores basic bodily play dynamics in combination with digital interactive devices. This way, Move Maker offers a movement-based game system challenging basic movement abilities through bodily play explorations.

The paper and accompanying video were initiated, led, filmed, edited and created by Louise Petersen Matjeka.

Link to the game video (part of the submission): https://youtu.be/5xQt7s5xNp0

5. Louise Petersen Matjeka, Dag Svanæs and Alf Inge Wang, accepted for publication. *Turning People's Homes into Interactive Pervasive Playgrounds during a Pandemic Lockdown*. In (eds) schrabel, Murnane and Andres. *Inbodied interaction*. Human-Media Interaction, Frontiers.

    Abstract:

    This paper presents an evaluation study of how eighth families adopted, played and experienced a movement-based game system of analogue and digital technologies in their homes during a pandemic lockdown. The COVID-19 pandemic locked down many countries and grounded people in their homes with social and physical implications. A game system consisting of simple, tangible technologies with modular components was designed to meet these needs. The game system was developed for the players to set up in their homes easily and, therefore, should not depend on screens or extensive physical installations. The game system comprises simple, tangible technologies such as light and music cubes, a simple mobile

robot, card game challenges, and a suite of mini-games combining the elements in a variety of playful experiences. Using the technology probes methodology, the game system was packed into a suitcase and evaluated by eight families that played the game in their homes, video-recorded their sessions, wrote a final report and were (informally) interviewed afterwards. The data set presents how the families turned their ordinary everyday spaces into interactive, pervasive playgrounds encouraging social and bodily exploration and play.

Furthermore, the study shows how bodily movement and social play can be promoted through different technologies that stimulate various bodily senses and incorporate them through the different game and play structures into their everyday living environments. The findings resulted in four design implications to aid designers and researchers in future work on movement-based game systems and interactive, pervasive playground design. These design implications accommodate social and bodily activities in ordinary places otherwise not pre-allocated for play or game activities.

The paper was initiated and led by Louise Petersen Matjeka and has been submitted to CHI2021, TEI'22 and Frontiers in Computer Science, Journal of Human-Media Interaction, Special Issue on Inbodied Interaction. Dag Svanæs helped finalize and tighten the submission for CHI2021. The submissions for TEI'22 and Human-Media Interaction Journal were reworked based on reviewer feedback from the previous submissions and led by Louise Petersen Matjeka – herein particularly the methodology. Alf Inge Wang helped finalize the final submission and revision of the paper for the Frontiers in Computer Science, Human-Media Interaction Journal.

6. Louise Petersen Matjeka, Hanna Wirman and Beatrix Vereijken. *The Role of Movement in Digital Play*. In review. Human-Computer Interaction, Taylor & Francis.

Abstract:

While movement is central to human development and our (bodily) understanding of the world, investigations of movement in relation to play and game experiences in both game studies and HCI research tend to focus on movement measurement for health benefits, engagement, or motivation. Here, we argue that bodily play and game experiences emerge through movement, and in that process, the boundaries between our physical and technological bodies are blurred, and the technology co-constitutes the bodily play experience. These arguments are based on a posthumanist view on technology and a phenomenological perspective to bodily experiences. This article aims to illuminate and uncover some of the underlying dynamics of how physical players and technologies intertwine through movement and how bodily play and game experiences emerge in this intra-action. Such dynamics are investigated in seven games through an autoethnographic approach, leading to three theory constructs of how we bodily incorporate technologies through movement and how the distribution and mapping of movement sequences across agents lead to bodily play. Raising the question, 'What is the role of movement for interactive bodily play and game experiences?', we view movement as constituting for the experience of any human and nonhuman agent in intra-action.

This paper was initiated and led by Louise Petersen Matjeka and submitted to toCHI. Hanna joined with reviews and comments and Beatrix joined with final comments for the two versions submitted to Journal of Human-Computer Interaction.

Before proceeding, Table 1 lists the correlations between research questions and papers.

Paper 1 presents the play and game theoretical foundation for the design process as well as basic argument for making the game into a system that could support a broad range of different game and play approaches.

Paper 2 presents a core mechanic for bodily play: Restraints.

Paper 3 is a complement to paper 2 and presents a set of game mechanics complementing restraints for bodily play.

Paper 4 presents the game design. Included in the submission was also an accompanying video.

Paper 5 presents the evaluation of the game as it was appropriated during the Covid-19 crisis and lockdown in Copenhagen.

Paper 6 is a meta-perspective to bodily experiences in and of technology centered on movement as the foundation for bodily play and game experiences.

TABLE 1 CORRELATIONS BETWEEN RESEARCH QUESTIONS AND PAPERS

Research Question/Paper	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
RQ1		X	X	X		
RQ2	X	X	X		X	
RQ3	X			X	X	
RQ4	X					X
RQ5						X

3.2 LIST OF SUPPORTING PAPERS

The following papers are also written during the thesis work and thereby influence the final work presented here. However, this thesis is not based on these papers. They are related to – and have supported - the work presented here but are not included as part of this thesis' core contributions for the following reasons: Works initiated, conceptualized and led by me are prioritized. However, some of the supporting papers also fit this description. Nevertheless, they were not included because of the following reason. They only fit at the fringes to the overall thesis's contribution and, thus, work to support and delineate my work but do not form a core part of it.

7. Buruk, O. 'Oz', Matjeka, L.P. and Mueller, F. 'Floyd', In review. *Designing Playful Bodily Extensions*,CHI PLAY '22: 2022 Annual Symposium on Computer-Human Interaction in Play.

Abstract

Emerging technologies offer novel opportunities for "physically extending our bodies." However, most systems appear to focus on instrumental benefits, missing out on the opportunity to utilize bodily extensions for play and its associated benefits (including a lower adoption barrier and the potential to reveal a broader understanding of such technologies by going beyond instrumental purposes). To begin understanding the design of playful bodily extensions, we interviewed five designers of bodily extensions. We explore this design space based on their insights and examination of prior work on how to design playful bodily extensions through thematic analysis. We present our findings in the form of design themes and actionable design implications suggesting that playful body extensions can be designed social, bodily interactive, , Our work aims to support the design of playful bodily extensions while promoting the experiential qualities of bodily extension design, and ultimately better understand such technologies and bring more playful experiences to people's lives.

This paper was initiated by all three authors. The paper was led by Oz. Louise Petersen Matjeka contributed with scoping the contributions, leading and writing the parts on phenomenology and play theories, besides contributing with reviews, comments and revisions of the rest of the paper. Louise also contributed in the second workshop and assisted with deriving the design strategies.

8. Mueller, F. F., Semertzidis, N., Andres, J., Marshall, J., Benford, S., Li, X., Mehta, Y & Matjeka, L. *Towards understanding the design of intertwined human-computer integrations*. in review, Transaction on Computer-Human Interaction (toCHI).

Abstract

Human-computer integration describes an HCI trend away from a classic command-execution paradigm and toward situations in which the computational machine can have agency, i.e. take control. Our work focuses on integrations in which the user and the computational machine simultaneously share agency, that is, can both have control over the user's body. We call the resulting experiences "intertwined integration". Due to the recency of technologies enabling intertwined integration designs, we find that little understanding and documented design knowledge exist for these systems. To begin constructing such an understanding, we use three design case studies to propose two key dimensions ("awareness of machine's agency" and "alignment of machine's agency") to articulate a design space for intertwined systems. We differentiate four unique roles that computational machines can assume in this design space (angel, butler, influencer, and adversary) along with their user experiences. Based on our craft knowledge gained through designing the case studies, we

discuss a set of strategies to help designers create future intertwined integration systems. Our work aims to advance the HCI field's emerging understanding of human-computer integration through contributing knowledge about how human and computational machine can share agency.

The paper as initiated and conceptualized by Florian 'Floyd' Mueller. Louise Petersen Matjeka contributed with comments and parts of the related work section.

9. Florian "Floyd" Mueller, Louise Matjeka, Yan Wang, Josh Andres, Zhuying Li, Jonathan Marquez, Bob Jarvis, Sebastiaan Pijnappel, Rakesh Patibanda, and Rohit Ashok Khot. 2020. *"Erfahrung & Erlebnis": Understanding the Bodily Play Experience through German Lexicon*. In Proceedings of the Fourteenth International Conference on Tangible, Embedded, and Embodied Interaction, ACM, Sydney NSW Australia, 337–347. DOI:https://doi.org/10.1145/3374920.3374926

Abstract

Bodily play systems are becoming increasingly prevalent, with research aiming to understand the associated player experience. We argue that a more nuanced lexicon describing "bodily play experience" can be beneficial to drive the field forward. We provide game designers with two German words to communicate two different aspects of experience: "Erfahrung", referring to experience where one is actively engaged in and gains knowledge from; and "Erlebnis", referring to a tacit experience often translated as "lived experience". We use these words to articulate a suite of design strategies for bodily play experiences by referring to past design work. We conclude by discussing these two aspects of experience in conjunction with two previously established perspectives on the human body. We believe this more nuanced lexicon can provide a clearer understanding for designers about bodily play allowing them to guide players in gaining the many benefits from such experiences.

This paper was initiated and led by Florian 'Floyd' Mueller during my research stay at the Exertion Games Lab. I contributed with writing and leading the section on phenomenology as well as initial discussions of the topic.

10. Louise Petersen Matjeka and Dag Svanæs. 2018. *Gamifying an Exergame Co-DesignWorkshop — Playful involvement of experts in the design process of balance training exergames*. In 2018 IEEE 6th International Conference on Serious Games and Applications for Health (SeGAH), IEEE, Vienna, 1–8. DOI:https://doi.org/10.1109/SeGAH.2018.8401343

Abstract

Exergames combine physical exercises and games. Thorough knowledge about the physical exercises is crucial in designing efficient exergames. Expert involvement in the design process, in this case with physiotherapists, is an efficient way to gather and retain domain specific knowledge for the design team. However, experts rarely have experience exploring design alternatives in a playful way, which is important when participating on the co-design of serious games like exergames. We explored the question: How can we involve experts to share and professionally explore their domain specific knowledge in a play-centric game design process? We present two codesign exergame workshops with physiotherapists. Based on lessons learned from the first workshop, we explored in the second workshop framing the entire workshop process as a game. We found that gamifying the workshop process into a design game provided a way to change the experts' effective-oriented mindset into a playful mindset. This article demonstrates some lessons learned from this process of creating and using such a method and proposes some directions for future research and applications.

The paper was led, written and revised by Louise Petersen Matjeka. Dag Svanæs contributed in conceptualizing the scope of the paper.

11. Louise Petersen Matjeka, *An Exergame Generator*. Abstract presented at the Games for Health Europe Conference, 2018. https://www.gamesforhealtheurope.org/speaker/louise-matjeka/

Abstract

Games benefit from at least a grain of play. So does the design process of games. And because expert knowledge is important when designing (serious) games with a purpose, I designed a game for designing exergames with experts.

I will be presenting a board game designed to design exergames while iteratively exploring the playful qualities of a set of specific physical exercises. It is structured in a way that specific physical exercises are exploited and developed into game elements in combination with digital objects. The game elements are in turn deployed in the (in-game) "game development".

While working their way around the path on the board, the players are faced with different challenges and must be careful to keep all limps of their avatar save. Only complete avatar bodies can finish the game.

The initial purpose of the game was as a creative tool to include physiotherapists as experts in the design process of designing a balance training exergame. The game served to explore physical movements in a playful setting as a way of working creatively with specific physical exercises for balance training in order to create a fun and engaging exergame. The game objective became to design an exergame.
Reasoning that a design game is also a game in itself and should be as fun to play as any other game, the game is now being further developed into a proper exergame. This presentation presents the gameplay, the game mechanics and elements as well as the theory behind.

12. Louise Petersen Matjeka. 2018. *Curiosity in Bodily Play Experiences*. In Foundations of Digital Games 2018, workshop paper for the Curiosity in Games Workshop.

Abstract

This paper investigates perspectives on designing for curiosity as a driving factor in bodycentric game design. It does so from an emotional perspective to (bodily) play experiences in digital game designs in combination with theories of play, curiosity and bodycentric design. Through the emotional sequence of fun exhilaration-gratification, the role of curiosity in the design for (bodily) play experiences is examined. The relationship between curiosity and bodily play is explored and demonstrated through theoretical exploration and analysis of several game designs. The paper ends with a remark on play as a bodily act of questioning and evoking curiosity.

4 THEORY AND RELATED WORK

This thesis bridges and manoeuvres between the research and design domains of human-computer interaction (called HCI) and interaction design, game studies and play and game design, and phenomenology and postphenomenology set in a posthumanist perspective (Figure 1). It does so to investigate bodily play experiences and the design therefore in a technological context. Much of the background literature is already included in the papers. Thus, this section primarily presents the additional theory and related work not included in the papers or provides further details of already presented theories. However, summaries of already presented theoretical aspects are included to provide necessary contextual information for presenting adjacent fields working on fleshing out this thesis's contribution in the relevant research landscape, as illustrated in Figure 1. This thesis's inquiries focus on the intersection of these fields comprising and interweaving bodily experiences, play and game experiences, and technologies. The following sections review research contributions from these fields, their correlations and boundaries to emphasise their specific combinations and correlations related to this thesis.

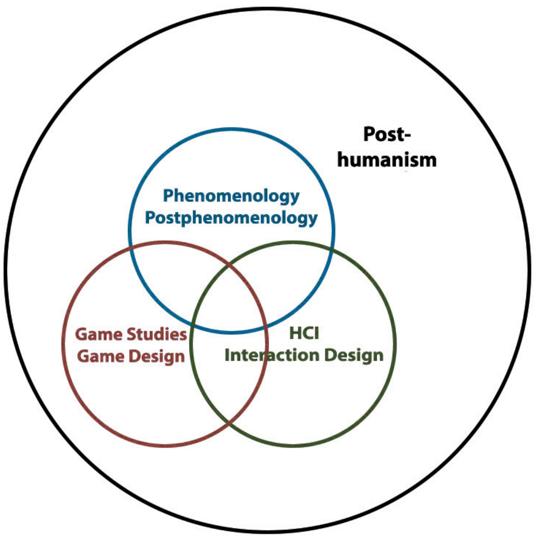

FIGURE 1 RESEARCH FIELDS AND THEIR CORRELATIONS FOR THIS THESIS.

4.1 POSTHUMANISM

Posthumanism developed from a critique of Humanism and the belief that the Human is sovereign, autonomous and self-contained (Nayar, 2014). The understanding of the Human (which is always used with the definite article) is considered exclusive and posits the Human as superior to other species. A stance which, for instance, feminist theories critique as the Human has historically been described from a (white) male perspective (Braidotti, 2007; Keeling and Lehman, 2018; Nayar, 2014). Posthumanism, on the contrary, seeks to resolve the dichotomies of human/nonhuman, nature/culture, and subject/object as it "*sees the uniquely human abilities, qualities, consciousness and features as evolving in conjunction with other life forms, technology and ecosystems*" (Nayar, 2014, p. 5). Posthumanism proposes humans as a hybrid form that is not self-contained and sovereign but constituted as part of its environment and pertaining discourses thereof. Ferrando (2020) also explains it in her translation of Marchesini's (2009) (translated from Italian) statement: "*the human is no longer the expression of man, because 'man' as a universal concept, has been deconstructed. It is only through such a deconstruction that the human can be accessed as a process of hybridization with the nonhuman"* (p. 58). This way, agents (human and nonhuman) are not seen as beings – but *becomings* as Haraway (1998) puts it. In other words, posthumanism posits the human body at the level of any other agent in a web of actions that are mutually constituting.

Haraway also positions her work in feminist critique of Humanism and breaks down the idea of binary genders and discursive identities dismantled by the cyborg – as technology embedded in our daily lives (co)constitute our embodiment. While this position of technology as a 'degendering' has been counterargued by, e.g., Harding (1986)[1], feminist theory is closely linked to posthumanism. So Barad (2007) also states: "*To presume a given distinction between humans and nonhumans is to cement and recirculate the nature-culture dualism into the foundations of feminist theory, foreclosing a genealogy of how nature and culture, human and nonhuman, are formed*" (p. 183).

As posthumanism seeks to resolve the dichotomies of Humanism, embodiment and the body become central – particularly in relation to technology. This is evidenced in how the posthumanist perspective has gained interest in technoscience studies in that; "*posthumanism sees embodiment as essential to the construction of the environment (the world is what we perceive it through our senses) in which any organ system (the human body is such a system) exists. But this embodiment is* ***embedded*** *embodiment, in which the human body is located in an environment that consists of plants, animals and machines*" (Nayar 2014, p. 9). As such, posthumanism also argues for an ontological view where human subjectivity is "*in-formed by lived (biological, embodied) experiences in an environment and the lived experiences as shaped by the subjectivity in a reciprocal relationship. Both biological living and subjectivity are 'emergent' conditions, the result of dynamical interactions"* (Nayar, 2014, p. 10). These thoughts were also presented by Haraway (1998) and include technology. In her classical piece Cyborg Manifesto, she points to how the body is a site for a technological merger, as she presents the cyborg as neither human nor machine but both.

As embodiment in posthumanism presents an ontology, following Barad (2007), posthumanism also proposes an epistemology, as it describes perspectives not only of ways of being – or becoming – but also ways of knowing. Barad (2007) suggests this

[1] Harding (1986) argues that science and technology have been drivers for a 'degendering' of women to 'more like men', but the same has not happened for men.

combination as an onto-epistemology. Our being in the world[2] is also a knowing about the world. The onto-epistemological idea of a merger between being in the world and knowing about the world is central to posthumanism. Ferrando (2020) explains this idea as: "*the processes embedded in revealing knowledge, production, and action are intrinsically and extrinsically cohabiting each other*" (p. 59). Unfolding this notion by linking it to phenomenological theories, I briefly turn to Sheets-Johnstone's (1981; 1990, 2017) epistemology of movement, as she points to how movement is a way of knowing (the theories of movement are covered in the papers P2, P3, and P7; hence, I will not unfold these in full here). While Sheets-Johnstone (1981;1990, 2017) does not describe her ideas as onto-epistemological, she argues how movement is our mother tongue and precedes language. As such, to Sheets-Johnstone (1981;1990, 2017), our conceptualization of and knowing about the world stems from movement, our ability to move, the way we move (as bipedal beings) in concert with the environment and other moving beings. Sheets-Johnstone's philosophical stance is within Phenomenology (she draws heavily on Husserl's ideas (Husserl 1973a, 1973b, 1982; Husserl and Moran 2001a, 2001b)), and, while she does distinguish humans as defined by their bipedality as opposed to quadrupeds, her theories comply with a posthumanist perspective. Sheets-Johnstone (1990) is concerned with bodily understandings of the world as the basis for knowing about the world, and similar to Barad's (2003; 2007) posthumanist onto-epistemology, Sheets-Johnstone (1981; 1990, 2017), posits her work as pre-lingual. To Sheets-Johnstone (1990), movement is our primary way of thinking, knowing and understanding the world.

4.2 PHENOMENOLOGY OF MOVEMENT

As much of the relevant literature on movement is covered in the papers included in this thesis – extensively in P6 – this section briefly provides contextual understanding and additional theoretical insights not covered in the papers.

Continuing Sheets-Johnstone's (1990) argument above of movement as our pre-lingual mother tongue, we learn to speak and understand and explore basic concepts like near/far, up/down, hard/soft, fast/slow, etc. through movement. Other movement theorists argue that movement is the foundation for decision making (Moore, 2005) and cognitive abilities (Damasio, 2000, 2006). While Sheets-Johnstone (2003) is here cited for linking movement and thinking, philosophers such as Kirkegaard[3] (Kirkegaard, 2022) have long before emphasised how moving yields cognitive thinking (Kirkegaard

[2] This version of being in the world refers to the ontological meaning of being in the world. Similarly, knowing about the world refers to an epistemological understanding of the world. As such, the phrase being in the world as it is used here does not refer specifically to Heidegger's (1996) Dasein.

[3] Kirkegaard wrote in a letter to his Sister-in-law who had been ill: "Tab for Alt ikke Lysten til at gaae: jeg Gaaer mig hver Dag det daglige Velbefindende til og gaar fra enhver Sygdom: jeg har gaaet mig mine bedste Tanker til, og jeg kjender ingen Tanke saa tung, at man ikke kan gaa fra den" (Rosenbeck 2021) My English translation; "Never lose the joy of wandering. I wander every day – for my wellbeing and from diseases. I had my best thoughts wandering, and I know of no thought so heavy that one cannot leave it behind wandering." Moreover, wandering has been central not just for Kirkegaard but for several other philosophers such as Nietzche, Kant and Rosseau (Andreasen 2015).

was known for wandering the streets of Copenhagen to think (Rosenbeck, 2021)). This link between movement and thought is also evidenced in movement studies of students' performance levels related to physical activity (see, e.g., (Beck et al., 2016; Have et al., 2018)). However, Sheets-Johnstone (1990) emphasises movement ia our fundamental way of thinking and not just a way to improve our cognitive skills but that we think in movement as our primary understanding of the world. Thinking in movement is, for instance, when players solve the bodily puzzles in *The Move Maker* (see papers P3, P5, and P6). Bodily puzzles are bodily challenges that require the players to solve by exploring different movement possibilities and options, i.e., thinking in movement.

The term pre-reflective is vital, as thinking in movement is pre-reflective. The term pre-reflective was introduced by Merleau-Ponty (2002). In his circumscription of the Cartesian statement, "I think, therefore, I am" (Cogito, ergo sum), to be "I can, therefore, I am", he stresses the idea that before a thought becomes a thought, the body has already thought, i.e., interpreted the experience (Kirkeby, 2006). In other words, the body pre-reflectively thinks in movement before the consciousness turns it into conscious thought. Solving bodily puzzles in *The Move Maker* (paper P5) can practically reveal some of these dynamics.

4.2.1 MOVEMENT AND INTERCORPOREALITY

Intercorporeality is a term introduced by Merleau-Ponty (1968) and is grounded in the Husserlian notion of intersubjectivity (Moran, 2017; Zahavi, 2014). While these notions are covered in more depth in paper P6, they are briefly summarized here to clarify the argument. Intercorporeality (or intercorporeity) seeks to explain the experiential aspects of how we as bodies communicate and relate. Intersubjectivity, on which intercorporeality builds, was introduced by Husserl (Zahavi, 2011) to explain how subjects recognize other subjects and communicate. As a term, it has been linked to empathy (Zahavi, 2014) and the discovery of mirror neurons in neuroscience (Rizzolatti and Craighero, 2004). While Merleau-Ponty (1968) argues that intersubjectivity is grounded in our corporeality, hence, intercorporeality (a statement that, according to Zahavi (2011), Husserl also implies in his notion of intersubjectivity), Sheets-Johnstone (2017) argues that intercorporeality is grounded in movement.

Continuing the track from the previous section and the understanding that movement is fundamental for our understanding and conception of the world, Sheets-Johnstone (2017) further argues that we are inherently intercorporeal as causally connected to our foundation as moving beings. She refers to the fetus in the womb and argues that communication between mother and fetus is grounded in movement as the fetus and the mother communicates through movements. Furthermore, the fetus is constantly moving as the mother moves around, and both mutually respond to those movements. From these arguments, Sheets-Johnstone (2017) argues that we, as a species, are fundamentally intercorporeal moving beings. We understand the world as we move, it moves and moves us. Through movement, we make sense of the world. In this sense, movement is causal and relational. We constantly move in relation to, with and through other people, technologies, animals, plants, etc. Our understanding of the world emerges through the related movements. These ideas are further developed in paper P6. Here, they represent the theoretical background for the subsequent arguments.

In line with the arguments above that we are inherently intercorporeal moving beings, Weiss (1999) has proposed an understanding of embodiment as intercorporeal. Grounded in Feminist studies, she argues that we, as embodied beings, form and are formed through our body images, because we are inherently intercorporeal beings. She builds her term body image on Merleau-Ponty's (Merleau-Ponty, 2012) notion of the same and Schilder's (2014) theory of body image intercourse.

Before continuing with Weiss' (1999) theory, it is essential to review the use of the term body image as there has been confusion about the term. Merleau-Ponty's French *schéma corporel* has been translated into both body schema and body image (Gallagher and Zahavi, 2012)(see, e.g., (Merleau-Ponty 2012) & (Merleau-Ponty 2002)) despite he did not have such a distinction. Nevertheless, this confusion led to a need to distinguish the two, to which Gallagher (1986) and de Vignemont (2010, 2011) each contribute with a definition. While these are covered in paper P6[4], the difference to Weiss' (1999) version of body image(s) is not explained.

While Gallagher (1986) and de Vignemont (2010, 2011), in each their ways, argue the difference between body image and body schema roughly as linked to a pre-reflective and reflective idea of the body, Weiss (1999) understand the term as encompassing both as one. However, for the arguments of Weiss (1999) that we have multiple body images and that they are created in intercorporeal exchange with other body images, it makes sense not to distinguish between pre-reflective and reflective bodily understanding as these are intertwined in such understanding. Weiss' (1999) understanding of body images covers our bodies' conscious and unconscious image as identities, appearance, perception, understanding, and being.

Weiss (1999) argues that we create our body images intercorporeally through exchanging and incorporating other body images – including technological. She further asserts that such exchange and incorporation is dominated by bodily imperatives and emphasises to "*recognize the corporeal within the cultural*" and "*to do equal justice to the physiological, social, and psychical dimensions of our body images*" (Weiss, 1999, p. 169). Like Sheets-Johnstone (2017), Weiss (1999) also highlights intercorporeality as fundamental to our existence and argues that we are formed as body images in intercorporeality. Referring to Schilder's (2014) body image intercourse, she argues that we are formed intercorporeally through exchanging and incorporating body images – as races, genders, classes, ethnicity and 'natural' abilities. Other theorists, prominently Foucault (1984) and Butler (2011), have stressed the social and cultural dynamics governing our relation to bodies. Weiss (1999) stresses that it is culturally formed but also grounded in our physiology, not as, e.g., a sex or race but our body images as sites for inscription and cultural upbringing, which she argues are intercorporeal practices.

[4] In paper P6, the differences pinpointed between the two notions by referring to Gallagher (1986) and de Vignemont (2010, 2011) emphasise the pre-reflective level that movement is part of most of the time. For the arguments in P6, it is helpful to make such a distinction. However, the stance of this thesis is that both represent aspects of the body as one.

And, as was argued above, intercorporeality is grounded in movement. Hence, movement is central to such practices. As such, every movement sequence is incorporated in intercorporeality and bears a natural-cultural trait of the process. While Weiss (1999) does not focus on or emphasise movement, this thesis argues that the intercorporeal dynamics that Weiss (1999) refers to are grounded in movement. While she does not promote a posthumanist understanding, nevertheless, in a posthumanist understanding, there is no division between nature-culture as these are seen as profoundly interrelated and inseparable (Nayar, 2014). A stance that this thesis also takes. The above theories are explained and discussed to form this thesis's initial theoretical backdrop.

So far, I have presented this thesis's posthumanist view that we are always already embodied as an embedded embodiment and that humans and non-humans are connected and interrelated at the same level therein. In other words, humans and technology are co-constituted as Haraway (Haraway, 1998) also states.

From phenomenology, I presented the view that movement is our mother tongue, as our primary and universal language, and through movement, we are inherently intercorporeal. Through our intercorporeality, we exchange and express body images and form our identities reflectively and pre-reflectively as our intercorporeality is grounded in movement. This latter argument ties into an emerging area within HCI that links experience design and performativity studies. The following section presents this area and links it to movement and intercorporeality. Doing so serves to position this thesis in relation to these fields.

4.2.2 PERFORMATIVITY

Adjacent to the field of intercorporeality and movement described above is performativity starting to gain traction in HCI and interaction design studies (Spence 2016). Spence (2016) argues that interactions can be seen as performances by referring to Butler's (2006, 2011) theory that genders are performed and inscribed by cultural norms and prohibitions and not a consequence of biology. However, she refers to performance in a broader context as performativity, a discursive practice that forms our beliefs and understandings of bodies and gender (as well as race, class, ethnicity, etc.) (Butler, 2011; Spence, 2016). By calling, e.g., gender performed, performativity seeks to dissolve any notion that gender should be naturally grounded in a person's sex (Butler, 2006). Butler (2011) argues performativity (in contrast to performance) to be a "*reiteration of norms, which precede, constrain, and exceed the performer and in that sense cannot be taken as the fabrication of the performer's 'will' or 'choice'*" (p. 178). She argues that identifications are manufactured fabrications of identities through "*corporeal signs and other discursive means*" (p. 178). She explains "*, acts, gestures, and desire produce the effect of an internal core or substance but produce this* ***on the surface*** *of the body, through the play of signifying absences that suggest, but never reveal, the organizing identity as a cause*" (Butler, 2006, p.185). An understanding that is not far from Weiss' (1999) understanding above of how body images are created and formed – into reproduced bodily imperatives. Where Butler's theories explain these dynamics as processual and performed, Weiss (1999) stresses the connection to intercorporeality and exchange of body images, i.e., bodily inscribed beliefs. Weiss (1999) also refers to

Butler's (2011) theory and emphasises that any such exchange and formation of body images (herein also gender) is grounded in both natural and cultural dynamics. This view aligns with the posthumanist understanding of the nature-culture connection as one and mutually constituting (Ferrando and Braidotti, 2020; Nayar, 2014).

Returning to the field of HCI, Spence (2016) introduces the Performative Experience Design methodology. She defines performativity as: "*Performativity refers to a contextualized, durational, heightened, and meaningful interaction among people – sometimes mediated or influenced by digital technologies*" (Spence, 2016, p. 31). Despite the paramount humanist stance in this quote where people are the centre, and digital technologies are positioned as utilities for the people, there is no mention of movement in Spence's conception. She, too, uses the notions of action and engagement - concepts that entail movement but movement in specific forms.

Drawing on earlier theories, we can draw a parallel between performativity and body image exchanges. While we can perform our gender and intercorporeally exchange body images, to do so entails movement. As such, performativity is based on movement. Thus, investigating the role of movement for bodily experiences provides a brick to the puzzle of understanding experience designs.

The brief review above of performativity regarding experience design, served to delineate the scope of this thesis. Despite that this thesis mainly focuses on movement and less on societal and cultural interrelations, it does acknowledge the causal connection and interdependence as performativity and bodily imperatives constitute through movement. Therefore the necessity for this brief review of performativity and movement.

Because technology is central for this thesis, which builds on ideas from posthumanism and phenomenology, a relevant field of study in this regard is postphenomenology.

4.3 POSTPHENOMENOLOGY AND A RETURN TO PHENOMENOLOGY

Postphenomenology, building on phenomenology, focuses on human-technology relations and technology entanglement (Frauenberger 2019; Ihde 2009). Like posthumanism, postphenomenology argues that we are always and already entangled with technology. Thus, our experience and constitution of the world revolve around how we are so. Ihde (1990) introduced four kinds of human-technology relations: Embodied; how we bodily interact with the technology. Hermeneutic; the informative level of technology. Background; how the technology works in the background of our conscious experience. Alterity; how we infer human characteristics into technology. While Ihde (1990) also explains these relations not as separately occurring but ongoing in parallel, the four relations provide different perspectives to the relations between humans and technology. Based on the perspectives presented in paper P6, this thesis argues for viewing these four relations from a movement perspective. This argument is elaborated in the Discussion because paper P6 has not yet been presented.

Also, as part of postphenomenology, Verbeek (2005) introduces technology, i.e., "things" as doings. In his book *What Things Do* (Verbeek, 2005), Verbeek dives into how things should be seen as their doing instead of what they are intended to be, called, or named. Elaborating on this assumption, let us return to phenomenology, where the enactive approach argues that perception is enacted (Thomson, 2010; Wilson and Foglia, 2011).

The enactive approach links neuroscience and phenomenology and argues that perception is enacted (Noë, 2006; Thomson, 2007). An example is Noë's (2006) explanation of the perception of a cube: "*The* ***visual potential*** *of a cube (at least with respect to its shape) is the way its aspect changes as a result of movement (of the cube itself, or of the perceiver around the cube). Any movement determines a set of changes in perceived aspect; any set of changes in perceived aspects determines equivalence classes of possible movements*" (p.77). He further explains that "*to experience the figure as a cube, on the basis of how it looks, is to understand* ***how*** *its look changes as you move*" (p.77)[5]. In other words, we recognize a cube as a cube through movement. Noë (2006) further argues that the (movement) possibilities are interpreted, i.e., bodily perceived (movement) potentialities. While the above example is based on the visual sense, Noë (2006) argues that the same dynamic is going on with other senses. Continuing this understanding, the perception of sound is enacted in the same way. *Space Agent* (papers P2 and P6) demonstrates this point, where the enemies are fought and located through sound and movement. From a movement perspective, we can perceive "things" only by distinguishing between near and far, one or the other side, up or down. These spatial differences, which, for instance, determine a relation between player and enemy, are based on our bodily knowledge as it is conceptualized through movement (Sheets-Johnstone 1990). In other words, "things" are enacted and, thus, emerge as a doing rather than a presupposed function. While "things" refer to technologies, i.e., non-human agents, I argue that also human agents are enacted. A statement that is further elaborated in paper P6.

Furthermore, seeing "things" as what they do also marks "things" as agents (Verbeek, 2005) at an equal level as any other human or nonhuman agent. Thus, this view also bears a posthumanist stance.

4.4 GAME STUDIES AND GAME DESIGN

As this thesis focuses on the design of play and games, one of the main areas of study is game studies including theories about play and game design. The centre of the

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[5] de Vignement (2011) has brought a counterargument to this understanding exemplified by a mosquito's sting that she argues is perceived passively without action, so how can perception be enacted? Regarding the difference between body image and body schema, she concludes that the body schema is "for action (that is, information about the body necessary for movements, such as posture, limb size, and strength)", while the "body image is for perception (that is, the judgement of one's own bodily properties)". de Vignemont expresses a strong humanist stance where the human body is superior and an encapsulated entity with clear borders at the skin. Such perspective ignores that we are intercorporeal moving beings with porous borders exchanging body images – through movement. Furthermore, perception is an interpretation of sensations, so the logical argument follows that we perceive the movements of the mosquito (often in combination with its sound) to interpret the sensation like a mosquito bite because how else would we know that it is a mosquito and not a needle in our clothes? Often we do not sense the bite – and never get to know that we were stung, or we see afterwards that we were stung but do not know what stung us.

investigations has been a bodily play perspective, why theories emphasizing this perspective are prevailing.

Paper P6 provides a thorough review of the related work within the game studies with the focus on bodily experience and phenomenological theories thereto. These contributions are briefly summarized here for contextual reasons. The contributions mentioned in paper P6 include Klevjer (2006), who argues that the avatar constitutes the player's vicarious body and the controller provides the prosthetic bridge thereto. Klevjer (2006) only regards third-person perspective avatars to constitute vicarious bodies as he argues that first-person perspective avatars as found in, e.g. virtual reality, rely on a natural embodiment schema and, thus, do not constitute a vicarious embodiment. Martin (2012) and O'Brien (2018) also provide a dualist idea of the connection to the avatars though slightly different. Martin (2012) argues that an avatar is a tool in a Heideggerian (1996) understanding (as a bodily extension) and the connection between the physical player and the avatar is established through the visual perception of the avatar in conjunction with the game controller. O'Brien (2018) critiques that this view is reductive. Instead, he distinguishes between absent and present avatars, i.e., visible or invisible avatars. In doing so, O'Brien (2018), too, emphasises the avatar as an image, i.e., (static) visual perception and not as a moving agent. Furthermore, they (Martin, 2012; O'Brien, 2018) have little regard for movement of the avatar as constituting the bodily play experience.

As a side note, they all explain the bodily play experience in relation to the avatar. In this thesis, the preferred term is in-game character. While *avatar* is denoted with ideas of personal, social and cultural identification, the notion of *in-game character* is less denoted in this regard (acknowledging that denotations are impossible to avoid entirely as following the arguments in the previous sections about bodily imperatives and body images).

Of the reviewed contributions in paper P6, only Keogh (2018) and Westecott (2008) states a relationship between the players' bodily experience and movement in the virtual world. Where Westecott (2008), describes bodily movement as a (neglected) bi-product of playing computer games as the players react to in-game events by twisting and turning, Keogh (2018) examines the movement of the thumbs moving on a smartphone as connected to the mind (he calls it "thumbs in mind") and, thus, the body image. As such, he refers to the culturally produced body images (as explained by Weiss, (1999)) where movement is not the issue but rather the exchange of body images. While such correlations are important and also highly influential on the bodily play experience, as also reviewed earlier, such experiences rely on movement, which is a neglected aspect in those explanations. Furthermore, as movement is experienced as a whole (Sheets-Johnstone, 1990) , what happens to the rest of the body's movements beside the thumbs, eyes and ears? This argument is elaborated on in paper P6. However, as Westecott (2008) describes there is a parallel and detached experience going on for the body parts that are not directly included in the activity. This aspect is treated in paper P6.

A theory not treated in paper P6 but relevant to the concept of incorporation and game experiences is Calleja's (2011) idea of incorporation. While the concept in paper

P6 is explained from Leder's (1990) phenomenology of the Absent Body. In paper P6 the concept is explained as the process of intercorporeal exchange of movements, Calleja (2011) builds his concept on Lakoff and Johnson's (2003) theory about linguistic metaphors that the virtual presence is a metaphor. This view is similar to Spiel and Gerling's (2019) idea of how player and avatar connect – through metaphor. While their notion is treated in paper P6, I return to Calleja (2011). Calleja explains incorporation as: "*the absorption of a virtual environment into consciousness, yielding a sense of habitation, which is supported by the systemically upheld embodiment of the player in a single location, as represented by the avatar*" (2011, p. 169). Like Martin (2012) and O'Brien (2018) above, he emphasises this relationship as twofold: "*incorporation as a sense of assimilation to mind, and as embodiment*" (Calleja, 2011, p. 169). While he does not explain why (and how) the mind is separate of the player's embodiment, the latter statement returns the understanding of the body to a Cartesian mind/body division. Furthermore, consciousness and linguistic understandings of the world (as metaphors) are dominating in his explanation, which leaves out any notion of movement, prelingual or pre-reflective experiences. Such a view is in contrast to Sheets-Johnstone's (1990), and Barad's (2007) prelingual stance explained earlier. According to Calleja's (2011) incorporation, the connection between avatar and player happens as a conscious process, while the system deals with the embodiment. This understanding is emphasised in the last paragraph of the chapter where he writes; "*with the concept of incorporation, we no longer need to draw a strict line of demarcation between stimuli emerging from the virtual environment and stimuli emerging from the physical world, for the emphasis is placed on the internally constructed consciousness of the individual*" (Calleja, 2011, p. 179). This conclusion ignores the body as anything else but a container for consciousness (the mind), easy to confuse with a dualist view of the body that many scholars have rejected (Gallagher and Zahavi, 2012; Merleau-Ponty, 2012; Noë, 2010; Sheets-Johnstone, 1990). Furthermore, it promotes an idea of the body as passively receiving stimuli and emphasises a view that all action is conscious. I disagree with this concept of incorporation because of its promotion of a Cartesian dualist mind/body division that has been counterargued throughout the previous sections. Furthermore, Calleja (2011) ignores the importance of pre-reflective experiences and including movement as profound for any action or experience to emerge in the first place. We take far more decisions on the pre-reflective level, i.e., through movement (Moore, 2005), than we do on the reflective level, i.e., consciously (Sahakian and LaBuzetta 2013). As has been argued earlier, before a though becomes conscious it has already been pre-reflectively incorporated (Kirkeby, 2006).

To Calleja's (2011) defence, he argues that we should move beyond the separation of virtual and physical environments experientially and, instead, treat them as "*domains continuous with the media-saturated reality of everyday life*" (Calleja, 2011, p. 179). While this thesis does not agree with parts of Calleja's (2011) theory, this thesis agrees that the virtual and physical environments are experienced as one. However, this thesis further argues that they are *pre-reflectively* experienced as one while the separation of domains is conscious, i.e., reflective. Calleja (2011) does not distinguish between the two, and, thus, any connection remains neglected. Furthermore, this thesis focus on technologies in a broader sense and not only media.

4.4.1 PLAY

While this thesis focus on games, play is also central, which paper P1 describes as it deals with the differences between play and game as connoted in the Danish language. While these perspectives are covered in paper P1, I briefly mention other related contributions here.

Møller (2010) defined play as different from work in the formula: P/R > 1 = play P/R < 1 = Work, where P = process and R = result. Meaning that if the process is greater than the results, it is play, and if the result is more important than the process, the activity is regarded as work. While Møller (2010) contrasted play with work emphasizing the difference as the outcome, Juul (2005) has treated play in his description of classic games. While Juul focuses on a definition of classic games, he, too, refers to play as less focused on the outcome of the activity, however, in contrast to games. Also, Sicart (2014) mentions the difference between play and game. However, because Sicart's version is further expanded in paper P5, it is not explained here.

Eichberg (2016), building on Møller (2010), describes the differences between play, game and display, where play and game are linked to Caillois' (2001) paidia and ludus. However, he develops the idea of display as a contrast to the two former and explains: "*In theatrical and musical performances, play as display is an imitative show-off of certain given forms*" (Eichberg 2016, p. 154). In this quote, Eichberg (2016) refers to display as the development of play, a show-off. If we recall the discussion of performativity as linked to experiences, with Eichberg's (2016) understanding of play as display, we can further link performativity to play. Eichberg's (2016) continues by linking play as display to Caillois's (2001) mimicry as role-playing exerted in, e.g., carnivals, further connotes a connection. While, for instance, Juul (2005) also describes the difference in the Danish connotations of the words, Eichberg (2016) expertly points out that Danish is not the only language emphasizing different aspects of play and game. He also mentions Korean and Chinese languages to include several different conceptions of play (Eichberg, 2016). While I will not review these here, I found it relevant to mention as a perspective to the contributions in paper P1.

Furthermore, the discussion of play as display points to bodily play as mimicry (Caillois, 2001) and role-playing, that is less covered in paper P1. While paper P6 explains how we pre-reflectively incorporate movement and exchange bodily imperatives, movement and play as display and role-playing provides an outspoken example of these processes. Through role-playing, players can explore and experiment with identities as is prominent in, e.g., carnivals and costume balls (Eichberg, 2016; Skovbjerg, 2021). Role-play is a popular genre with many sub-genres. While these will not be reviewed here, the critical aspect is the connection to movement. As has also been pointed out by Isbister (2016) and Bianchi-Berthouze (2013), movement is connected to role-playing. This thesis argues that movement is central to all play and games.

This section also points to a link between play as display and performativity, as Eichberg (2016, p. 154) states the connection to theatrical and musical performances. That said, entering such a discussion will diverge the focus of this thesis out of its main track and, therefore, belongs as possible future work, however, very closely related. Lastly, these perspectives are also brought here to show that while paper P1 examines play and game from the Danish connotation related to bodily experiences and movement, there are other ways to describe and view play from linguistic connotations.

The following section reviews gamification as a subset of game design and the relation to this thesis.

4.4.2 GAMIFICATION

Gamification is a way to turn goals and tasks into playful experiences – in the form of games - to motivate and engage people in their endeavours to reach external purposes such as changing habits, learning new things, being more productive, or physical and mental training (Fuchs et al., 2014). Gamification seeks to draw on games and play as inherently motivating in their nature of being autotelic activities (Csikszentmihalyi, 1975) by exploiting elements as design resources in instances where using a product or obtaining a desired goal needs further motivation (Sailer et al., 2017; Seaborn and Fels, 2015). A much-cited way to describe gamification is; *using game design elements in non-gaming contexts* (Deterding et al., 2011, p. 2425). While game design elements are manifold, a common approach has been to apply PBLs; points, badges, and leaderboards (Fuchs et al., 2014; Lyons, 2015; Sailer et al., 2017). This approach has been critiqued in recent years by some gamification scholars. Deterding (2014) compares these approaches to being reduced to a stimuli-response understanding of games, and yet other scholars claim that gamification is marketing "bullshit" (Bogost, 2015). Gamification is mentioned here to position the content of this thesis in relation to that.

Gamification scholars (Friederichs et al., 2015; McGonigal, 2011, 2015; Peng et al., 2012) have drawn extensively on theories from psychology, particularly positive psychology (Deci and Ryan, 2011; Ryan, Deci, and Huta, 2008). In this regard, Deterding (2014) promotes a turn from gamification strategies as reward systems for external motivation and proposes an understanding of gamification as eudaimonic design (Deterding 2014). Eudaimonia is Aristotle's philosophy of the good life, motivated by personal and societal growth. Within positive psychology, Eudaimonia as motivation has been contrasted by hedonic motivation (Ryan, Deci, and Huta, 2008; Waterman and Schwartz, 2008), referred to as the need for immediate satisfaction and comparable to the stimuli-response motivation that Deterding (2014) critiques. In addition, an extensive body of literature on serious game design has been informed by positive psychology studies (Friederichs et al., 2015; McCallum, 2012; Peng et al., 2012).

As a way to meet the challenges pointed to by Deterding (2014) above, approaches to exergames have turned to other strategies such as either modulating the game controller into, for instance, a bicycle (Hagen et al., 2016; Playpulse, 2018) or trampoline (Exergame Europe, 2020; UNIS Technology, 2020). Other approaches have been to adapt existing game concepts like an endless runner (Ioannou et al., 2019) or The Floor is Made of Lava (Jessen, 2016) to add physical activity (by the player) in the activity. The modulation of the game controllers to add physical exercise lies within the Interaction Design field of study.

No matter if gamification is seen as "bullshit" (Bogost, 2015) or simple stimuli-response mechanisms (Deterding, 2014), as gamification is defined as *using game design elements in non-gaming contexts* (Deterding et al., 2011, p. 2425), any design task in this regard revolves around the use of game design elements – and, thus, profound knowledge and skills in that regard is preferable. From a design perspective, practical gamification design starts with a basic knowledge of game design. Therefore, the results presented in this thesis comprising game design elements apply equally to game design as gamification – or exergame design – but are not limited to those domains.

4.5 HCI AND INTERACTION DESIGN

As this thesis contributes to the HCI and Interaction Design fields by emphasising bodily experiences and game design, I review some of these fields' primary contributions. Herein also rests a discussion of embodiment and embodied interaction, as Dourish (2001) promoted in his book *Where the action is: The Foundations of Embodied Interaction*. The title is mentioned because it describes the problems this thesis treats. First, it mentions *action*. Action entails movement with a purpose. Second, it mentions *embodied interaction*, where this thesis's stance is borrowing from posthumanism that we are always already embodied. While Dourish (2001) is not promoting the view that we can be "unembodied", the notion ties into a much-debated term in HCI which is also dealt with here. Finally, as a development from the thoughts initiated by Dourish's (2001) book, this thesis emphasises movement and how bodies constitute and delineate through movement. This thesis posits movement as the constituting factor for any experience and not the means with which we achieve something, as the words *action* and *embodied interaction* denote. This section reviews related contributions within HCI and Interaction Design with this statement.

Within the discussion on embodiment, van Dijk and Hummels (2017) introduce a framework for embodiment. Their "*intention is to design for Embodied Being-in-the-World, which concerns skills, social coordination and action-based reflection*" (p. 54). They want to break with previous understandings of embodiment as either "anything physical" or "external representations" and refer to Heidegger's (1996) term and Dreyfus' (1991) interpretation to emphasise a deeper understanding of embodiment as our being-in-the-world. While they emphasise skills, social coordination, and action-based reflection, this thesis takes these notions further and argues that they are all grounded in movement. As was covered in earlier sections, skills are our bodily "I cans" (Sheets-Johnstone 1981) as movement sequences, while social coordination as intercorporeality is grounded in movement. Furthermore, action-based reflection once again uses the word action, as if there is a purpose, a goal or an outcome of one's movements. This thesis argues that we move to act. Any action entails movement, but movement does not necessarily foster action. Instead, it fosters experiences and is, according to Sheets-Johnstone (1990), our mother tongue with which we understand the world – what she also refers to as our being-in the world (Sheets-Johnstone, 2003, 1990, 2011). Thus, following the posthumanist understanding (Nayar, 2014), we are always already embodied. An aspect van Dijk and Hummels (2017) also emphasise.

While Dourish (2001) introduced phenomenology to understand embodiment for interaction design, Svanæs (2013) extends Dourish's (2001) framework in the lens of Merleau-Ponty's (Merleau-Ponty 2012) Phenomenology of Perception and introduces *embodied perception*. Svanæs (2013) explains the elements of embodied perception from

Merleau-Ponty's theoretical concepts: *Phenomenal field,* that perception is shaped by the *phenomenal field* drawing on previous and present experiences as context. Perception has *directedness* – a "preobjective" intentionality where the object presents itself. Perception is *active* – requires action, and it involves *the whole body*. However, in his explanation, Svanæs (2013) does not include the whole body but only visual perception, an arm and a hand. What happened to the rest of the physical body? One of the main arguments in paper P6 is that we should be aware of what happens to the rest of the physical body that is not directly involved in, i.e., has a direct influence on, the activity in focus. When scrutinizing the arguments further, *action* is used instead of movement, and I point to the same issue above that action entails a purpose, an outcome building on movement as the constituent. Furthermore, Svanæs (2013) talks about the directedness, which we can link to action, as the purpose of an action. While directness can be understood as the phenomenological concept *intentionality*, that actions are pre-reflectively intentional toward an object (Merleau-Ponty, 2012), it also presupposes that an object exists before the intention. Let us unfold the notion of directness in terms of movement and play. As elaborated in paper P6, Barad's (2007) concept of intra-action connotes that phenomena emerge in intra-action, i.e., movement. From this argument it is argued that digital games and play experiences emerge in intra-action, i.e., movement. For example, in children's play, the to-and-fro movement is prevailing as an exploratory behaviour without a purpose other than being (Eichberg, 2016). The directness of their movements emerge and consolidate as they move through the environment. In continuing this argument, the to-and-fro movement has also been linked to the situationist's flanêur (Coverley, 2010) which has also been linked to play (de Souza e Silva and Hjorth, 2009). The Flâneur, similar to how Kirkegaard as mentioned above, wanders the city to explore and observe without a predefined purpose. In those cases, the experience emerges in intra-action (Barad, 2007). The city unfolds as the flanêur (Coverley, 2010) wanders about, and the play activity evolves as the children move about in to-and-fro movements (Eichberg, 2016). Directness evolve in movement.

From the above argument, in play, meaning emerges as part of the activity. This argument is not arguing that Svanæs (2013) is wrong, but elaborate on how directedness emerges in intra-action – causally connected to movement. Following Barad's (2007) notion of intra-action, none is before the other but constitute and (re)configure as the activity progresses. This is particular for digital designs as they comprise a set of rules and devices that will only emerge and constitute a "thing" in intra-action. Likewise, a user becomes a user in the activity. As this thesis argues, both the user, player, game, design or artefact emerge as such as they are mapped by movement in intra-action. These arguments are further explained in paper P6.

While it is clear that the theories above want to break with a dualist thought dominance by emphasizing embodiment – and not in the sense that we can be "disembodied" – but that we are bodily beings. Nevertheless, an argument in this regard that perception is embodied leads to the rhetorical question: What else would perception be? In this light, this thesis advocates moving the discussion beyond embodiment to accept that we are always already embodied and discuss bodily experiences based on movement as our mother tongue (Sheets-Johnstone, 1990).

Also, Segura (2016) uses the term *embodied* to derive the concept of embodied core mechanics. However, she stresses and refers to Höök et al.'s (2016) similar argument that using the word does not connote an idea of disembodiment. She presents core embodied mechanics as building on Dourish's (2001) embodiment. Segura (2016) develops her term from a combination of Dourish's (2001) embodiment and Salen and Zimmerman's (2004) core mechanics. Core mechanics refer to the mechanics central to a specific game experience. For instance, in football, the core mechanic is kicking the ball. She explains embodied core mechanics as desirable and repeatable embodied phenomena that are *physically realized* and *socially situated* and implemented via rules and devices. While Segura's (2016) perspective to the body resembles a Humanist stance with an encapsulated predefined Human body, this thesis disagrees that mechanics are necessarily physically realised. While they can be physically manifested, they can just as well be virtually realised. Furthermore, this thesis presents a perspective that we do not have to be co-located to be socially situated as socially situated phenomena are intercorporeally constituted across physical, technological and virtual domains. This perspective is described in-depth in paper P6. Additionally, this thesis presents a set of generic mechanics defined by their doing in relation to movement. These are presented in papers P2 and P3.

In her book *Designing with the Body*, Höök (2018) focuses on the physical human body as a design resource and target. By also introducing the body as a design resource, she emphasises the importance that designers should also know – bodily – what they are developing. Therefore, designers should work with their bodies to gain "bodily knowledge" and advance their designs. She draws on pragmatism and Somaesthetics (Shusterman, 2008) for such work to advocate an aesthetic approach to the body and movement. While she also draws on Sheets-Johnstone (2011) for information about movement, her focus is on the inner experience as an aesthetic experience. In this combination, Höök (2018) argues that movement has an essential role in shaping the experience and the reciprocal exchange between a system and a user. She argues; "*Because our designs (art and everyday tools) are part of our lifeworlds, shaping us as much as we shape them, interaction designers have a responsibility to pay attention to the movements, rhythms, postures, or kinaesthetic-tactile experiences we build into our systems*" (p. 62). Höök (2018) further addresses this discussion in the chapter on the politics of the body.

In the chapter on Politics of the Body, Höök (2018) again stresses that the designs have an impact and that designers should be aware of the impact. Her focus is on the physical human body as an encapsulated entity that can be communicated with and manipulated. Furthermore, she argues that emotion and movement are tightly connected. This thesis argues that they are inextricably linked because, without movement, there is no sensation and, thus, emotion. While Humanism (Nayar, 2014), with its view on Humans as sovereign and encapsulated entities, tend to promote a view that perception can be passive, posthumanism's argument that we are always embodied in the world (Nayar, 2014) opens up an understanding that we perceive the movements of 'others' and incorporate them as part of our perception. We understand the world as intercorporeal moving beings (Sheets-Johnstone, 2017). As such, perception is not just active as Svanæs (2013) argued above, but also intercorporeal as Weiss (1999) argues.

Furthermore, Höök (2018) addresses male/female, able/disabled as juxtapositions. While I agree that designers should be aware of the impact their designs have and that the design practice is a reflective practice (Löwgren, 2004), This thesis disagrees to juxtapose these in the first place as it runs the risk of ignoring the juxtapositions' agency which is one of Feminism's (Nayar 2014) core issues. Instead, we should seek to dissolve such dichotomic listings and work with fluidity (Tacikowski, Fust, and Ehrsson, 2020) and technology as co-constituting bodily knowledge (Haraway, 1998).

In this regard, Höök (2018) also argues that designers should pay attention to bodily logos as embedded bodily knowledge (Sheets-Johnstone, 2011). However, bodily logos refer to bodily knowledge as neutral. Instead, this thesis advocates the view put forth by Weiss (1999) that we exchange bodily imperatives and that embodiment is intercorporeal. Bodily imperatives encompass the cultural dimension that posthumanism argues is inseparable from the natural dimension and that Barad (2007) stresses to be natural-cultural practices. These are essential aspects if we want to break the gender bias that Höök (2018) also talks about. To do so, we should state the bodily practices as natural-cultural practices and not neutral. This latter argumentation also ties into the above discussion on gender performativity as promoted by Butler (2006, 2011) and introduced into HCI by Spence (2016). Identities are performed (Butler, 2006, 2011) as exchanged body images constructed through natural-cultural practices (Weiss, 1999). Designs and technology are construed as part of such practices. From this discussion, the scope is narrowed to be about bodily play experiences and movement-based games within HCI.

Within HCI research on the bodily (play) experience, the focus lies on how interaction with technology can stimulate bodily senses and perception. For instance, Mueller et al. (2018) examine the implications of connections between sensations and perceptions in their unpacking of German words for the body as *Körper* (the carnal body having sensations) versus *Leib* (as the living perceiving body) to highlight how bodily sense stimulation can lead to the experience of play. Additionally, they point to how specific bodily postures can trigger bodily sensations. They refer to an example of how keeping the arms stretched up in the air fires sensations of victory (also called power-posing Carney and Cuddy 2010). Also, Isbister (2016) addresses how designers can design for power poses, which she explains as specific physical positions that trigger specific emotions. However, these ideas of universally inherent power poses are debatable (Jansen and Hornbæk, 2018) as these can just as well be culturally learned as bodily imperatives (Weiss, 1999) as part of our lived body (Merleau-Ponty, 2012). The lived body, as introduced by Merleau-Ponty (2012), refers to the sum of our individual bodily experiences. As argued previously, bodily experiences are grounded in intercorporeal movement through natural-cultural practices (Barad, 2007) into bodily imperatives (Weiss, 1999). As a bodily imperative, the question is whether we learn the emotional feeling of such postures by practising them throughout our lives as part of our cultural understanding, i.e., performance of, in this case, victory/defeat, just as, e.g., the meaning of nodding is learned differently in different cultures[6] (Kirk, 2017). In other words, as a

[6] Kirk (2017) refers to how nodding in Bulgaria means no, which is different from many other western cultures.

performance or bodily imperative, movement is the underlying dynamic enforcing, creating or undermining power poses as bodily sensations. Furthermore, by understanding power poses as bodily imperatives and, thus, grounded in natural-cultural practices, we can further see our designs as part of natural-cultural practices – as grounded in movement.

Movement in HCI has been treated differently by different scholars. While contributions on this topic are reviewed throughout the papers (P1-6), I also elaborate on some of these contributions. Mueller and Isbister (2014) focus on the design of movement-based games and introduce a set of guidelines based on designers' best practices. The authors promote a view on movement as diverse and self-expressive and argue to embrace players' differences in skills, preferences, and challenge levels. Furthermore, the authors introduce bodily challenges, which is an aspect developed in paper P2 into the notion of bodily puzzles. Mueller and Isbister (2014) also touch on how different mappings of movements can lead to play. This is an aspect that is unfolded extensively in paper P6. The work presented in this thesis extends and expands on these guidelines introduced by Mueller and Isbister (2014).

Also, Isbister et al. (2011), Isbister (2016), and Bianchi-Berthouze (2013) have focused on movement and games. While Bianchi-Berthouze (2013) investigated a connection between movement and engagement, Isbister (2011) contested such an argument. As these are reviewed further in paper P6, they are only mentioned here because the aspects of movement and role-playing that they also touch upon were left out. Therefore, these are included below.

Both Isbister (2016) and Bianchi-Berthouze (2013) point to the connection between movement and role-playing. While the connection between movement, role-playing and play as display was previously highlighted, Isbister (2016) and Bianchi-Berthouze (2013) provide examples of this connection and demonstrate how specific movement behaviour lead to identity play, e.g. imitating the movements of playing the guitar. As Eichberg (Eichberg 2016) also pointed to, play as display links to theatrical and musical performances. Thus, such perspectives link back to the performativity discussion earlier in Section 4.2.2. Furthermore, identity play as movement behaviour ties into the discussion on bodily imperatives and exchanges of body images and connotes games as natural-cultural practices. To conclude the circle, movement is fundamental for creating our identities – an aspect that also Höök (2018) points to – whether through games, play, role-play or our entanglement with technologies. This thesis provides insight into the dynamics and mechanics underlying these practices – in theory, and practice.

5 RESEARCH METHODOLOGIES AND ACTIVITIES

The overall methodology for the entire project is Research through Design (RtD) (Zimmerman and Forlizzi, 2014). As illustrated in Figure 2, the RtD methodology relies on a reciprocal process between research and practical design activities. Therefore, a design process ran parallel to the research process resulting in a range of design activities in a reciprocal process with research activities. An overview of these activities is listed below. Their different correlations to the papers are listed in Table 2. The methods and methodologies used for the activities are listed in Table 3 and 4 as correlated to the activities and papers. The theoretical review and reasoning for the choices are further explained in the subsequent sections starting with the RtD methodology.

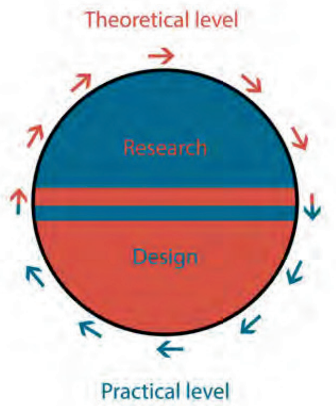

FIGURE 2 PROCESS OF RESEARCH THROUGH DESIGN.

5.1 RESEARCH AND DESIGN ACTIVITIES

To provide an overview of the research design, the practical activities and their correlations to the included papers (P1-P6) are listed in Table 2. The activities are presented and described in the following section, followed by the methodologies and methods used in this thesis in the subsequent sections. Before explaining the methodologies and methods, the activities are further presented in Table 3, showing their correlations to the methodologies and methods. To link the methodologies and methods to the papers, Table 4 demonstrates these correlations. First, this thesis's activities are described.

List of research activities conducted as part of my work:

- A1: Two Co-design workshops with physiotherapists (P4)
- A2: Development of a Design Game (P4)
- A3: Physical training session and interview with a physiotherapist to learn a balance training program developed for elderly people (P4, P5)
- A4: Analysis of a collection of traditional games (P2, P3)

- A5: Playtesting of Crazy Soccer Physics on Trampolines (P1)
- A6: (Anonymous) interviews of participants at the Inferno event at MetaMorf festival in Trondheim (P1, P2)
- A7: Design of Move Maker (P4, P5)
- A8: Evaluation of Move Maker (P5)
- A9: Extract and development of design theories (P1-P6)
- A10: Playing, watching and participating in many game and play sessions (P1-P6)

The activities are described below. Note, that the theoretical methods for the activities are described later in the document.

TABLE 2 CORRELATIONS BETWEEN RESEARCH ACTIVITIES AND RESEARCH PAPERS

Activities / Papers	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
A1				X		
A2				X		
A3				X	X	
A4		X	X			
A5	X					
A6	X	X				X
A7				X	X	
A8					X	
A9	X	X	X	X	X	X
A10	X	X	X	X	X	X

TABLE 3 CORRELATIONS BETWEEN RESEARCH METHODS AND ACTIVITIES

Research Methods/ Activities	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**
Co-design workshops	X						X			
Interviews	X		X			X		X		
Written report/Questionnaire					X			X		
Observation	X				X					
Ethnographic and Auto-ethnographic Methods				X		X				X
Video recordings	X		X		X		X	X		

Technology Probes		X						X		
Coding data	X	X	X	X	X	X	X	X	X	
Practical Design Methods	X	X					X			
Annotated portfolios				X					X	
Strong Concepts									X	
Bridging Concepts									X	

TABLE 4 LIST OF METHODS AS CORRESPONDING TO THE PAPERS

Research Methods/ Papers	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
Co-design workshops				X		
Interviews					X	
Written report/Questionnaire					X	
Observation					X	
Ethnographic and Auto-ethnographic Methods						X
Videorecordings				X	X	X
Technology Probes					X	
Coding data					X	X
Practical Design Methods				X		
Annotated portfolios		X	X			
Strong Concepts	X					
Bridging Concepts	X	X	X			X

5.1.1 A1: TWO CO-DESIGN WORKSHOPS WITH PHYSIOTHERAPISTS

Two co-design (Sanders and Stappers, 2008) workshops with physiotherapists were held to initiate the design work. The workshops were held to get an initial idea of exploring playful movement and working with movement and play in an exergame context. In addition, the workshops focused on exploring balance training exercises as "fun". The two workshops are described in detail in supporting paper P10. The workshops were designed, conducted and facilitated by me and supervised by Dag Svanæs with the attendance of co-supervisor Beatrix Verijken.

The two workshops were structured differently. The first workshop started with social warm-up exercises followed by an assignment structured from the topic of balance training ending in a presentation of the assignment.

The second workshop (Figure 3) was structured like a board game as a design game (Vaajakallio and Mattelmäki, 2014) to keep the activities within a playful frame throughout the entire workshop.

The workshops were facilitated, organized, structured and led by me and built on my prior work experience as a music and movement teacher.

The two workshops (A1) led to the development of The Exergame Generator (A2)(supporting paper P11), presented at Games for Health Conference 2018 (Matjeka, 2018).

FIGURE 3 SET UP AFTER THE SECOND WORKSHOP.

5.1.2 A2: DEVELOPMENT OF A DESIGN GAME

As mentioned above, a design game (Vaajakallio and Mattelmäki, 2014) (see Figure 4) was developed for the second co-design workshop. While the game was initially developed for the second co-design workshop, the creative play of exploring and experimenting with movement (as "leg" – see paper P1 and RC1 for explanation) that the game fostered inspired me to develop the game further. Furthermore, the observation was that, despite the game being a board game, the players naturally moved because it was focused on designing exergames. Hence, it was an exergame in itself. From these assumptions, the game was further developed into the *Exergame Generator* (Matjeka, 2018) (supporting paper P11) and presented at the Games for Health Conference 2018. This work was initiated, designed, conducted and led by me.

While *The Move Maker* is not a direct development from this game, the "design game" principle was carried on into the work of *The Move Maker*. Thus, one of the minigames included in *The Move Maker* is a "design your own game".

Link to the game video: https://www.louisepmatjeka.com/design-game/

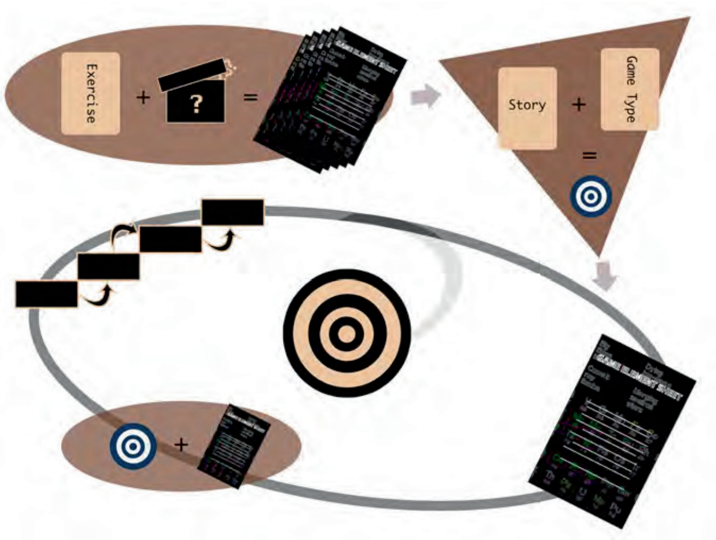

FIGURE 4 THE BOARD OF THE DESIGN GAME

5.1.3 A3: TRAINING SESSION AND INTERVIEW WITH A PHYSIOTHERAPIST

To get insight into balance training exercises and practice for my design work, I had a session with one of the physiotherapists from the workshops. The session included a training session with balance training exercises and an interview focusing on challenges and solutions to training balance. Furthermore, the background for a need to train balance was the topic for the interview. The session was initiated, conducted, facilitated and analyzed by me.

The session was part of the initial research on the topic of movement and balance training as initial knowledge and insight into the design field (Löwgren, 2004).

5.1.4 A4: ANALYSIS OF A COLLECTION OF TRADITIONAL GAMES

As stated in the introduction, games were not invented with digital media, and, therefore, I turned to research traditional games and play forms. This was done from the assumption that there is a large pool of un-scavenged knowledge about movement and play to uncover in traditional games and play forms. The study was designed, conducted, and led by me.

The basis for this analysis was the collection of 140 games from Møller's (2000) research combined with a collection of Danish singing games (Riis, 1989). The analysis focused on movement and how movement was employed in these games. The analysis was carried out in the bridging concepts (Dalsgaard and Dindler, 2014) methodology by bridging concepts derived from the games with theoretical concepts from phenomenology (Sheets-Johnstone, 2003, 2013) and postphenomenology (Verbeek, 2005) described earlier. The results of the analysis are presented in papers P2 and P3.

5.1.5 A5: PLAYTESTING CRAZY SOCCER PHYSICS ON TRAMPOLINES

Twelve sessions were held of testing a set-up of the game *Crazy Soccer Physics* by Ojala (2013) connected to two trampolines (see Figure 5). Inspiration for doing so was the W00t game festival 2014 in Copenhagen, where students from Vallekilde Højskole in Denmark had connected two trampolines to Ojala's game.

Crazy Soccer Physics is a version of a football (soccer) game with two teams consisting of either one or two players each. The game can be played alone or with up to four players. The version that was tried out was the two-player version. While the game draws on traditional football, the in-game characters move in unfamiliar ways as the physics in the game are programmed to do so. Meaning that the in-game characters move on their heads, fly around, kick "randomly", and at times end up in the other team's goal.

The game was tested as a trampoline version against the keyboard version of pressing the X and [arrow up] keys (see Figure 5). The sessions were video-recorded (Heath, Hindmarsh, and Luff, 2010). Furthermore, the players were asked to fill out a questionnaire (Kvale, 2007) together with informal interviews (Spradley, 1979) at the beginning and end of each session. The sessions were designed, conducted and led by Louise Petersen Matjeka. The technical set-up was led by Dag Svanæs and assembled and supported by Terje Røsand.

FIGURE 5 SET-UP OF CRAZY SOCCER PHYSICS ON TRAMPOLINES

5.1.6 A6: INTERVIEWS OF PARTICIPANTS AT THE INFERNO EVENT

Because the focus for this thesis is on bodily experiences and movement, I found it compelling to investigate the experiences of the Inferno event at the MetaMorf Festival in Trondheim, 2017 (metamorf, 2017). The Inferno event by Demers (Demers, 2015) and Vorn (Vorn, 2015) is an exoskeleton "performance" where the audience can participate by wearing an exoskeleton and dancing to the music. Set in a dystopian electro atmosphere, the "dance floor" consist of "dancing" exoskeletons externally controlled by a choreographer (Figure 6) while the two musicians perform the music. I interviewed 9 participants as anonymous interviews (Spradley, 1979) inspired by ethnography (Blomberg and Burrell, 2012) about their bodily experience of the event. This study was designed, conducted and led by me. The Inferno event is used as an example in papers P1 and P2.

FIGURE 6 THE CHOREOGRAPHER CONTROLLING THE EXOSKELETONS ON THE DANCE FLOOR

5.1.7 A7: DESIGN OF *THE MOVE MAKER*

As mentioned previously, *The Move Maker* is inspired by but not directly developed from the *Exergame Generator*. The design was conducted and assembled in a reciprocal process with the theories presented in papers P1, P2 and P3 and the subjective experiences from the activities mentioned above (Fullerton, 2008; Löwgren, 2004). Family members assisted in the design experiments carried out in our home as a direct consequence of the Covid-19 pandemic lockdown. The design has been formed through an iterative and dialectical process with the elements, players and the design (Schön, 1995). This work was designed, conducted, and led by Louise Petersen Matjeka. It was supported by my family and our friend, Povl Eiland Olsen. Figure 7 shows a set-up of the minigame, "Get the robot through the maze of light cubes". Laser lines are set up on the chairs and tables. While steering the robot around and turning the light cubes red, the players had to avoid "breaking" the lines.

FIGURE 7 A SET UP OF THE MOVE MAKER WITH THE LIGHT CUBES DISTRIBUTED ACROSS THE ROOM, LASER LINES POSITIONED ON THE CHAIRS AND THE ROBOT AT THE BACK.

As a consequence of the circumstances posed by the Covid-19 lockdown, the target group for the game moved from balance training for older adults (65+) to encouraging movement diversity among families.

5.1.8 A8: EVALUATION OF *THE MOVE MAKER*

Because of the Covid-19 pandemic lockdown, lab tests of *The Move Maker* were not possible. Instead, families were bound to their homes. As the game was developed for balance training for older adults (65+), it had qualities also suitable for indoor family activities. Therefore, the game was packed in a suitcase and delivered to eight families to play. While there were heavy restrictions on social distancing and an assembly ban, I was not allowed to enter the families' homes. Therefore, the Technology Probes (Fitton et al., 2004; Hutchinson et al., 2003) methodology was chosen, and the families were asked to record their game sessions while also filling out a questionnaire. However, there were minor opportunities for brief and informal interviews (Holstein 1995) upon delivery and pick-up. This study was initiated, designed, conducted, and led by me.

5.1.9 A9: EXTRACT AND DEVELOPMENT OF DESIGN THEORIES

The theories presented in this thesis and the included papers P1-P6 are derived and extracted from the activities described earlier. The methodologies for doing so are Strong Concepts (Höök and Löwgren, 2012), Bridging Concepts (Dalsgaard and Dindler, 2014), Annotated portfolios (Bowers, 2012; Gaver and Bowers, 2012) and Autoethnography (Blomberg and Burrell, 2012; Rapp 2018). The theories together form this thesis' contribution on Designing for Movement-Based Play and Games - in Theory and Practice. This work has been initiated and led by me with support from the co-authors.

5.1.10 A10: PLAYING, WATCHING, AND PARTICIPATING IN GAME AND PLAY SESSIONS

Building on the posthumanist idea that humans are inseparable from the environment (Ferrando and Braidotti, 2020; Nayar, 2014) and the postphenomenological (Verbeek, 2005) understanding of technology's agency, I found it necessary to include and acknowledge that the games I have played throughout the process (and before) have influenced my work. Games and play experiences have been an inspiration, background research and part of the other activities as an ongoing autoethnographic investigation (Duncan, 2004; Rapp, 2018). It is understood as an autoethnographic investigation because game and play experiences are subjective experiences, and to access the experiences, they need to be treated as such; subjective experiences. As was stated in the introduction, games without movement are just a bunch of rules and devices. Thus, to emerge and be experienced as games, the bunch of rules and devices needed to be played. While there are several ways to research experiences, autoethnography provides a helpful way to access these as subjective experiences and derive further design knowledge and understanding (Rapp, 2018). This work has been initiated, led and conducted by me.

5.2 CORRELATIONS BETWEEN ACTIVITIES, METHODS, AND METHODOLOGIES

While the above sections describe the activities leading to this thesis, below are described the methods and methodologies used to design the activities, gather and process the data and derive theories. Because RtD processes are naturally reciprocal between theory and practice, and a design practice includes researching and defining the scope of the design field (Löwgren, 2004), some methods used for design activities overlap with those of the theory construction. Table 3 lists the methods used for each activity, while their relation to the papers are shown in Table 4.

Furthermore, and within the frame of RtD (Zimmerman and Forlizzi, 2014), other methodologies were applied throughout the study. These comprise ethnographic (Blomberg et al., 1993; J Blomberg, Burrell, and Guest, 2003), autoethnographic (Duncan, 2004; Rapp, 2018) and the technology probes (Fitton et al., 2004; Hutchinson et al., 2003) methodologies. These methodologies are described further down the section. Despite being methodologies, they are listed at the same level as methods because they are used within the framework of RtD. However, they are addressed and used as methodologies in the studies.

The main difference between a methodology and a method is that a method provides a practical way of doing things, while a methodology comprises an epistemological direction and range of practical methods. While RtD's epistemology lies within the reciprocal process of practically designing artefacts and deriving theories, each strand can contain other methodologies. Examples are how ethnography and autoethnography has been appropriated to suit design research and work (Blomberg and Burrell, 2012; Buur et al., 2010; Duncan, 2004; Rapp, 2018). These approaches are further elaborated upon in the following sections.

The following sections describe the methods and methodologies listed in Tables 3 and 4 and how they were used and appropriated for this thesis. These are subdivided into sections of Research through Design (Section 5.3), Theory Construction (Section 5.4), Data Collection Methods (Section 5.5), Coding and Analyzing the Data (Section 5.6), and ending with Practical Design Methods (Section 5.7).

5.3 RESEARCH THROUGH DESIGN

"*All designers engage in creative exploration in the process of designing, but the difference between design that is simply design and design that serves as research has to do with the goals and outcome of each. Designers who are conducting research through their creative practice crate work that is intended to address both a particular design brief and a larger set of questions at the same time*" (Burdick, 2003, p. 82).

This opening statement from Burdick describes the initial rationale of Research through Design (RtD). However, RtD as a scientific discipline has been refined, revised and critiqued in several ways since Burdick put forth her introductory description almost a couple of decades ago. While the basic idea of RtD as the process of interconnecting design practice and theory to both be feeding on and off each other (see Figure 2) remains a common idea (Burdick, 2003; Dalsgaard and Dindler, 2014; Gaver and Bowers, 2012; Gaver, 2012; Höök and Löwgren, 2012; Zimmerman and Forlizzi, 2014), one of the main issues that has been raised is how to leverage practical artefact-based knowledge/solution to the level of design theory. Furthermore, such discussion often includes questioning design theory and how it is science? The critique details that because designers create their own conceptual understanding of their endeavours to articulate and communicate their design solutions and features to colleagues and other relevant people (customers, clients, etc.), this knowledge is not necessarily design research or theory (Höök and Löwgren, 2012). In such discussion, design scholars agree that design theory comprises theoretical arguments or concepts that are generative, evaluative and relevant to a range of design situations – and not just of a specific design artefact (Bowers, 2012; Dalsgaard and Dindler, 2014; Gaver, 2012; Höök and Löwgren, 2012). Furthermore, design research should also provide designers and researchers with a more profound knowledge of a particular design area or field as designers often engage in "wicked problems" (Rittel and Webber, 1973), for which solutions often demand a thorough knowledge about the field (Stolterman, 2008). Moreover, design research should also be evaluative and enable an analysis of designs and design proposals (Höök and Löwgren, 2012).

The rationale behind RtD is that for design work to be research, it needs a methodology and methods so that the process and results are clear and transparent for other people to follow (Gaver, 2012; Höök and Löwgren, 2012). Because design is inherently interventional and changes a current state to another by offering a solution to or information about a problem (either as a critical art piece or point to some current problems), it cannot be proved right or wrong - as it is impossible to revert the situation and test a prior state (Gaver, 2012). Instead, design science borrows from methodologies from the science of humanities, where scientific results are validated on their arguments and reasoning – adhering to a transparent and documented methodology.

Whereas, in the natural sciences, results are often measured and validated by their replicability and falsification (Gaver, 2012; Holm, 2018). As such, producing design knowledge does not provide results that can be scientifically falsifiable in a Popperian (Holm 2018) understanding. In comparison, design research methodologies argue that results should be based on thorough knowledge about the "problem field" (Höök and Löwgren, 2012) in addition to a reflective practice (Löwgren, 2004). RtD contains both practical design activities and academic research activities (Zimmerman and Forlizzi, 2014; Zimmerman, Stolterman, and Forlizzi, 2010). Furthermore, the design process should be thoroughly documented for outsiders to follow the rationale, and the theoretical contributions should be generative and evaluative to other design situations (Bowers, 2012; Höök and Löwgren, 2012; Zimmerman and Forlizzi ,2014; Zimmerman, Stolterman, and Forlizzi, 2010).

Thus, a researching designer – or designing researcher – inform themselves at different levels: The *practical level* about design processes containing the creative methods as well as how to conduct tests and evaluations to develop their designs, and the *theoretical level* concerned about leveraging these experiences into generative and evaluative design research, from which the design and research community can benefit. These two levels have guided this thesis's activities toward the research contributions. As demonstrated above, the activities have supported the practical design endeavours of designing movement-based play and game artefacts while also informing the theoretical level to derive theories and design knowledge as generative and evaluative knowledge for the design community. Furthermore, while other methodologies have been applied in the process, RtD has been the overarching methodology in which the other methodologies and methods have had a supporting role.

The twofold approach of RtD raises some science-theoretical questions; How can we assess the rigour and validity of such contributions? Moreover, any solution, i.e., scientific result, is to some extent based on the person's subjective understanding as they are connected to their design practice and experience – as researching designer, designing researcher, audience and user/player (Benford et al., 2009; Bowers, 2012; Dalsgaard and Dindler ,2014; Frauenberger, 2019; Gaver and Bowers, 2012; Gaver, 2012; Höök and Löwgren, 2012). These issues are also known from methodologies like ethnography and autoethnography, which are also methodologies often applied in design research (Blomberg and Burrell, 2012; Duncan, 2004)). Consequently, different researchers have treated these problems in conducting design research differently. Among these – relevant for this thesis – are Gaver (2012), Bower (2012), Höök & Löwgren (2012), Dalsgaard and Dindler (2014) as well as Frauenberger (2019). While such discussion is often grounded in natural science approaches of objectivity, it has been questioned whether we can talk about such objectivity in design research (Gaver, 2012). Instead, scholars argue that we should make the process transparent for other scholars to follow rationality and conclusions (Duncan, 2004). In the following, I will dive into this discussion while reviewing the design methodologies applied in this thesis for theory construction.

5.4 THEORY CONSTRUCTION

As mentioned above, the reciprocal process of practical design and academic research activities can work in synergy as we might learn and discover aspects of the design problem that are not otherwise accessible. However, there are also downsides to this approach. Gaver and Bowers (2012) are concerned about the risk of possibly losing creative and practical design results because of the documentation and verification requirements that proper validity assessment (often) demands. Nevertheless, as Löwgren and Stolterman (2004) emphasise about the reflective practitioner, while methodological frameworks benefit from a critical evaluation, the researcher and designer should reflectively adapt and adjust their methods and methodologies to the specificity of any current design situation. While there is not one general solution to this problem, one must be aware of this trade-off and adapt and combine methods where needed. In the following section, I dive into the three, in the literature, dominating ways of producing theoretical design knowledge with rigour and validity – as related to this thesis' methodological choices. Herein are not included ethnographic and autoethnographic approaches. Because they are not part of an "intermediate-level knowledge approach", they are reviewed later. The individual papers further detail how these are adapted and adjusted to the specific design situation, while these are also visually demonstrated in Table 3 as correlations between methods and research activities above.

5.4.1 ANNOTATED PORTFOLIOS

Individually and together, Gaver (2012) and Bowers (2012) approach these issues in the form of Annotated Portfolios (Gaver and Bowers, 2012). They argue to include the design artefact as embedding valuable knowledge that any textual account cannot convey. While they argue how design research can be produced by annotating designs, that is adding textual accounts of the design, they also argue a way to provide rigor as the textual accounts should be based on a portfolio of design, hence, annotated portfolio, i.e., collections of designed artefacts. By designed artefacts, the authors refer to instances that do not need to be interactive products, designed artefacts can be illustrations, scientific papers, exhibitions (Bowers, 2012) - or games/play forms. Basically these comprise of instances brought together as "*a systematic body of work*" (p. 71) that "*capture family resemblances*" (p. 71) according to a specific purpose or interest. As such, a specific annotated portfolio can be annotated differently depending on the topic and design knowledge (i.e., "concept") that the annotator wants to convey. This way, annotations serve the purposes of conveying topics and themes that illuminate a specific meaning and features across a collection of instances and can take the characteristics of being generative, suggestive, provisional, aspirational and annotative (Gaver and Bowers, 2012). While the authors do not state it explicitly, I would add to this list that annotations in nature, too, must be evaluative as they, in the process of creating the textual accounts of the entity also evaluate it within the given theme or topic.

Bowers (2012) further explains the reciprocal exchange in information between artefact and theory: "*Artefacts are illuminated by annotations. Annotations are* *illustrated by artefacts*." (Bowers, 2012, p. 71) Because of the authors' reservation toward rigid methodologies, they are reluctant to provide a precise method for annotating designs and explain: "*The notion of annotated portfolios is not a formal one. What is defining to the concept is not how materials are presented, but that a balance is achieved between descriptions of specific, detailed examples of design practice, and articulations of the issues, values and themes which characterize the relations among the collection and to which the examples suggest answers*." (Gaver, 2012, p. 944) As such, annotated portfolios can consist of many different entities as long as a theme or topic binds them together.

In addition, Gaver (2012) and Bowers (Bowers, 2012)(Gaver and Bowers, 2012) explain little of the role of empirical data from users or user evaluations, tests or studies. If they understatedly do, these are embedded in the designer's account of a given design or implicitly interpreted into the textual accounts. In contrast to this approach, Höök and Löwgren (2012) emphasise empirical data as vital to creating "Strong Concepts" as their contribution to design knowledge formation.

5.4.2 STRONG CONCEPTS

Strong concepts are characterized by being generative and are "*design elements abstracted beyond particular instances which have the potential to be appropriated by designers and researchers to extend their repertoires and enable new particulars' instantiations*" (Höök and Löwgren, 2012, p. 5). While Gaver (2012) and Bowers (2012) (Gaver and Bowers, 2012) are reluctant to provide methodological details, Höök and Löwgren (2012) state how strong concepts are based on interactive - i.e., not static[7], instances residing between technology and people, and "*speaks of a use practice and behavior unfolding over time*" (Höök and Löwgren, 2012, p. 5). In other words, the designs that strong concepts spring from deal with people and their lives – as opposed to, e.g. a technical term. Furthermore, it is based on a core design idea that can be generally applied and understood in many situations and application domains and, as such, can be realised in many different ways similar to a topic or theme developed from the textual accounts of an annotated portfolio.

The authors Höök and Löwgren (2012) further list the following criteria for validating a strong concept as an academic contribution: A strong concept is *contestable* (inventive and novel), *defensible* (presented through beyond-reasonable argumentation) and *substantive* (relevance to the research community, e.g., generative or valuable for further development) (Höök and Löwgren, 2012). Furthermore, strong concepts are grounded empirically in the following two ways: Analytically - in the form of horizontal grounding and theoretically – in the form of vertical grounding. Horizontal grounding means that the concept should also be found in other designs, similar to how an annotated portfolio is a collection of several designs connected through their textual accounts. Theoretical grounding refers to the theories used to explain the

[7] The use of the term to explain interactive technologies is how it is used in the theory of Strong Concepts. Paper 7 of this thesis uses the term static to describe non-moving technologies from moving technologies.

concept. For instance, in this thesis, some of these are Sheets-Johnstone's (2003, 2013) kinetic joy rides and Merleau-Ponty's (2002, 2006) body schema.

Höök and Löwgren's (2012) strong concepts differ from annotated portfolios, explained above, and bridging concepts explained below, in that they emphasise the design process and the empirical data derived from such. A strong concept emerges from the design instance in this process as an element or principle understood and explained on a more general level than the single instance (thus intermediary level knowledge) used in other designs. Once a core design idea is derived, the researcher then contests it against other designs (horizontal grounding) and whether it can be defended and explained through theoretical aspects (theoretical grounding). The concept is further validated as a generative resource, i.e., its generality for and applicability to other design situations and practices. While Höök and Löwgren (2012) use theories (often from other research domains than design, e.g., philosophy sociology or anthropology) to ground a core design idea derived from a design process, Dalsgaard and Dindler (2014) explain how a design concept, a core design idea, can emerge from theoretical concepts and feed a design process.

5.4.3 BRIDGING CONCEPTS

Bridging concepts (Dalsgaard and Dindler 2014) are concepts that origin in theoretical concepts and further confirmed in design artefacts. As such, the methodology bridges theoretical concepts from other domains such as philosophy and branches therein like pragmatism as the authors demonstrated or phenomenology as is the case in this thesis. The design concepts are further validated by explaining exemplars and the textual accounts thereof, which the authors explain as articulations. The articulations explain the characteristics of the practical concept. As they write: "*Its purpose is to bridge and span the gap between theory and practice and thereby unveiling and articulating untried design opportunities and potential theoretical advancements*" (Dalsgaard and Dindler, 2014, p. 1637). Compared to strong concepts derived from the practical design process and validated through design artefacts and theories, bridging concepts aims to inform and inspire the practical design work from theoretical understandings. Bridging concepts are validated by practical design artefacts as exemplars illuminating both the core as well as the limits of the concept.

5.4.4 SUMMARY OF THEORY CONSTRUCTION

Following the three design theory methodologies above, design theories are derived from a reciprocal process and dialogue between existing theoretical understandings of the world and the artefacts residing in this world. The theories are validated as research contributions from a triangulation assessment process of existing theories, artefacts and design generation in the aforementioned reciprocal process (Figure 2). Whether the derived theories originate in theoretical concepts (as the Bridging Concepts (Dalsgaard and Dindler, 2014)), artefacts (annotated portfolios (Bowers, 2012; Gaver and Bowers, 2012)) or practical design ideas (Strong Concepts (Höök and Löwgren, 2012)), they can be characterized as generative, illuminating, aspiring, explicating and general. Most of the contributions of this thesis reside within this understanding. Furthermore, the methodologies presented here for design concepts are equally applicable when working with game and play design. Play and game design also resides between *technology and people*, and "*speaks of a use practice and behavior unfolding over time*" (Höök and Löwgren, 2012, p. 5). Furthermore, designing play and games also undergo a design process and mutual exchange of practical concepts – as mechanics – and theories, just as in any other design domain.

Because of its emphasis on bridging theoretical concepts with practical design knowledge, the methodology of the bridging concept has dominated the papers of the three methodologies. However, any theoretical understanding derived in an RtD process stems from the reciprocal process of design ideas and theoretical concepts. Therefore, the solid concepts and annotated portfolios methodologies have influenced the theory constructions despite not explicitly stating as such in the papers.

While the above methodologies revolve around driving theory from practice, the following sections describe the methods used for collecting data.

5.5 DATA COLLECTION METHODS

Data in RtD processes are collected for two reasons: 1. As empirical data for theory construction and 2. for the practical design work. In the latter, the data serves two functions: 1. As inspiration, 2. As documented argumentation (Buxton, 2007; Celikoglu, Ogut, and Krippendorff, 2017; Löwgren, 2004). The inspirational part is highly individual for each designer (Schön, 1995). Nevertheless, documented argumentation works as a convenient way of documenting the design process; the designer designs on an informed basis and can go back and forth in the process and change or explore different paths and directions before settling on a course (Buxton, 2007; Löwgren, 2004). While the rationale behind creative leaps (Löwgren, 2004) is difficult to document, however, what is documentable is the data collection and analysis processes. As part of the entire RtD process, the collected data also serve as research data as we know from, e.g., traditional research, i.e. non-design research.

While researching the design field and problem, this thesis has benefitted from several methods to collect data about the design situation and design evaluation by involving players and experts in different ways. As such, this thesis positions itself within the user/player-centered design tradition.

5.5.1 CO-DESIGN WORKSHOPS

The user-centred design tradition is rooted in the participatory design (PD) tradition formed in the 1960s and '70s in Scandinavia, along with a US branch stemming from the more product development-oriented focus in the US tradition (Lee 2008; Sanders and Stappers, 2008). Users are central in all these approaches, however, on different levels often defined by the end-goal and scope of the design project. For instance, PD is often used for significant organizational transformations where the users' (who also often are the experts) empowerment and feeling of ownership of the process and end-result is crucial for the project's final success. On the other hand, it is a product development process[8] of mass-market products. It is up to the philosophy of the company and the designers when and how much to involve users.

In design workshops, designers and users work (often together) on developing new designs and concepts as co-design or co-creation methods. The term co-design or co-creation has been defined differently by many scholars, but I rely on the definition from Sanders and Stappers (2008): "*We use co-design in a broader sense to refer to the creativity of the designers and people not trained in design working together in the design development process*" (p. 6). Thus, the term co-design entails *people not trained in design* to have an active role in the process, and co-design workshops are structured gatherings in which *people not trained in design* and designers meet, collaborate and develop new concepts, knowledge and skills.

The term *people not trained in design* (Sanders and Stappers, 2008, p. 6) needs further clarification because users are more than just users. In this regard, the user's role in a user-centred design process has been largely debated. Some scholars argue that users are not creative and thus should not participate actively in the design activities and even less the design decisions (Allen et al., 1993; Patil, 2017). Others argue that given the right conditions (design methods and facilitation), users are the experts (Robertson and Breen, 2014), and yet again, others believe that only lead users[9] are creative and should participate in the design activities (Sanders and Stappers, 2008). I argue that the user's role depends on which design goal, field and problem is in focus. While this thesis focuses on designing movement-based games, experts on movement and the players were in focus – however, at different levels and, thus, should be involved in the process at different stages. From this reasoning, experts on movement were involved in the initial exploration stage and gathering knowledge about the design problems and domain. Players were involved later in the evaluation and test of prototypes and games. I also benefitted from my previous experiences as a music and movement practitioner and performer and my expertise as a skilled game designer and entrepreneur. I used the methods described in the following sections to involve and learn from the experts and players.

Vaajakallio and Mattelmäki (2014) examined using design games as co-design practices and highlighted how these work as a tool, mindset, and structure. Design games work as a tool for the designer to involve users or experts, a mindset as was also a finding in P1 where the involved people adopt a playful mindset where failure is accepted because exploration and play are prioritized, and then design games also provide a clear structure to follow. While games can be used as part of a workshop, in this thesis, it was the entire workshop with introduction, warm-up and conclusion, that was structured into a game.

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[8] In product development or innovation of products, there is a distinction between the levels of innovation from incremental to transformative. Incremental innovation is when an existing product is being made better, e.g. a faster chip. An example of transformative innovation (today part of the whole disruption paradigm) is the mobile (cell) phone.

[9] Lead users have already explored innovative ways to get things done and are willing to share their approaches with others (Stappers & Sanders, 2008).

Design games primary purpose is to establish a common language for all stakeholders to understand each other better and create a common language (Brandt 2006; Brandt, Messeter, and Binder 2008; Pedersen and Buur 2000). Firmly rooted in the co-design approach, the assumption is that the best result is obtained by joining all project forces. Design games, then, are co-design methods developed to explore and evaluate design ideas and concepts and foster a dialogue between users/experts to exchange ideas, problems, experiences, etc.

Brandt, Messeter, and Binder (2008) further compared the methods of design games vs enactment – in the form of body-storming. They concluded that design games provide a birds-eye view, while people engaged in body-storming or full-scale enacting scenarios are immersed in the design situation (Brandt, Messeter, and Binder, 2008): "*To sum up, we see the exploratory design games as a venue for designers working with participation. Design games can facilitate design dialogues for mutual learning. These design games go well beyond mapping information of use context as they invite co-discovery and the creation of new and shared design representations.*" (p. 63). This thesis's use of design games gave the physiotherapists a frame for exploration in a broader sense than concretely developing new exercises, as was the case for the first workshop. The mindset of playing a game and the exploratory nature of design games provided a helpful method. To quote and concur with Brandt (Brandt, 2006): "*Game playing creates an informal atmosphere, which is the most productive in creative work*" (p. 65) As can be read in supporting paper P10, the use of a design game as frame for creative work helped encourage a playful mindset. The developed design games (see supporting papers P10 and 11) functioned as initial research into the field of movement-based games. Furthermore, and in addition to Brandt, Messeter, and Binder's (2008) comparison above of design games versus enactment, I want to add that when design games are developed to explore bodily movement, they are also enacted. In other words, design games can be designed to include enactment and not exclude enactment as was the case in the process of this thesis.

5.5.2 TECHNOLOGY PROBES

Hutchinson et al. (2003) introduced Technology Probes (Fitton et al. 2004; Hutchinson et al. 2003), to, "*combine the social science goal of collecting information about the use and the users of the technology in a real-world setting, the engineering goal of field-testing the technology, and the design goal of inspiring user and designers to think of new kinds of technology to support their needs and desires*" (p. 18). As such, technology probes provide a methodology that facilitates unobtrusive data collection in a real-world setting and the means to field-test a design leading to improvements and insights about the specific design while allowing the designer to keep their artistic approach in a structured, research adapted way.

Technology probes are rooted in Cultural Probes introduced by Gaver and Dunne (1999) as an untraditional way of getting user data for design research. Untraditional in the sense that it does not use traditional methods of inquiry and is developed from inspiration by the 1960s' avant-garde movement of the Situationists. Cultural probes are meant to fuel the designer's inspiration by researching people's culture, thoughts, preferences and values based on the people's inputs (Gaver and Dunne, 1999). "*Traditional ethnographic methods require researchers to spend long periods living in a culture to study it, whereas cultural probes offer a less obtrusive way of gathering information by asking participants to generate their own visual and narrative data.*" (Celikoglu, Ogut, and Krippendorff, 2017, p. 86).

In Gaver and Dunne's (1999) version, probes were intended to explore a design space and foster dialogues between the users and researchers (Boehner et al., 2007; Gaver and Dunne, 1999; Wallace et al., 2013). However, probes can also be used for information rather than inspiration (Boehner et al., 2007). As such, probes are good at minimizing the consequences of the researcher's presence, and because of that advantage, they are good at capturing user narratives of their experiences and emotions about a specific topic. This advantage is particular for experiences based in the domestic context in which the representation of a researcher would be considered obtrusive (Celikoglu, Ogut, and Krippendorff, 2017).

As the Covid-19 pandemic hit the world just when *The Move Maker* was ready for player evaluation, the methods for doing so needed changing as traditional lab-test was out of the question. The technology probes methodology provided a way to test the game as it does not require the researcher to be present. Furthermore, the probes approach was found suitable as the game also required to be played in people's everyday living environments. The technology probes methodology provides for an adaptation to fill such needs, and, therefore, it seemed the most feasible and appropriate solution considering the restrictions of the pandemic and the benefits of testing in people's everyday living environments.

However, while probes can seem to be an (almost) unobtrusive[10] way to collect data from the real world, the specific methods for data collection might be obtrusive in themselves. For instance, a camera to record actions might affect people's behaviour (Penn-Edwards 2012), and so will the written reports also reflect what the users/players want to reveal to the researchers (Celikoglu, Ogut, and Krippendorff, 2017). In other words, the users/players tell the researcher what they want to tell (consciously and unconsciously). Therefore, embracing any probes methodology needs to consider this premise as a dialogue between the informants (users/players) and the researcher (Boehner et al., 2007) and that the data and subsequent results are consequences thereof. In this regard, such inquiries cannot provide data for generalization. Nevertheless, they provide an insight into people's use and everyday application of technologies that are different from any other method because of the embedded user/player autonomy in the revealed information. Such inquiries work well for cases where researchers want to explore use cases and appropriation and explore a possible design space. The choice of the technology probes methodology was also based on these assumptions.

[10] Making people report on their use or preferences of technologies is obtrusive in itself and makes people conscious about their use of technologies. However, this method is unobtrusive in that the researcher is not present to occlude the experience more than it already is.

5.5.3 INTERVIEWS

Interviews were part of the research activities; A1 (workshops), A3 (physical training session), A6 (Inferno event) and A8 (the evaluation). Interviews are tightly connected to ethnographic methods, and, thus, references to ethnography occur in the following sections. Furthermore, and because interviews can be used for various – and different – situations, which require different approaches, the approaches described below are narrowed to concern the inquiries for this thesis.

While interviews can be highly different and depend on the context, study and people involved, some approaches can be generally applied. For instance, interviews can be conducted as either unstructured or semi-structured interviews (Kvale, 2007) where the latter is prepared as either themes to cover or specific details need clarification but not as formally structured as a questionnaire or quantitative survey. The lack or incompleteness of structure in semi-structured and unstructured interviews can provide an informal level intended to be conversations as a process of give-and-take and exchange of experiences (Holstein, 1995; Lagesen, 2010). As such, a researcher also uses her personality when interviewing (Rapley, 2004). While such approach comes with a clear bias, it is important to be aware of personal bias – also for the analysis part. However, these issues are further dealt with later.

In line with the above explanation, the guiding principle for interviews was ethnographer Spradley's (1979) friendly conversation in an ethnographic setting, where the interviewer strives for a casual atmosphere and lets the interview take a form of a conversation guided by the emerging themes and stories (Spradley, 1979). The principles of the friendly conversation were also found helpful and suitable for situations with traits of ethnographically inspired studies. These were the Inferno event (A6) situated in the field and the delivery and pick-up situations in the evaluation study (A8). While a researcher should always be friendly, this principle of letting the emerging themes and stories guide the conversation was used throughout all interviews, including the sporadic conversations during the workshops.

The last remark is that the interviews in the Inferno event were kept anonymous. There was no apparent reason for making the interviewees known, so it was easier to keep them anonymous. These interviews were audio-recorded together with my note jotting.

The interviews during the workshops were video-recorded, and I jotted notes down during and after the sessions. The interviews at the pick-up and delivery stages of the evaluation study were noted down afterwards.

5.5.4 ETHNOGRAPHIC AND AUTOETHNOGRAPHIC METHODS

The methods adapted from ethnography to accommodate design research (Blomberg et al., 1993; Blomberg and Burrell, 2012; Sharp, 2007) for this thesis were in A1; the observation parts of the workshops, A6; Inferno performance, A10; the game sessions throughout the study.

As design research is much about understanding users and players in various ways, ethnography provides a suitable methodology for doing so (Blomberg et al. 1993;

Blomberg and Burrell, 2012). However, ethnography is also a methodology with its epistemological reasoning and principles (Emerson and Fretz, 1995; Emerson, Fretz, and Shaw, 2011). Therefore, while the methods belonging to and developed as part of ethnography are helpful for design research, to fully take advantage of their qualities, it is essential to understand some of the fundamental principles. Therefore, the following will explain the principles relevant to this study, while the methods and practical application are explained afterwards.

Ethnography is traditionally used in social science studies that describe and uncover cultural and social practices as a qualitative methodology (Gubrium, 1997). Ethnography seeks to report their findings as thick descriptions – often written afterwards from notes and jottings done during an observation. Ethnographic methods include observation (also as a participant), interviews (explained above) and autoethnographic studies, which are explained below. As such, ethnographic studies and adapted ethnographic design methods differ in their scope and purpose. The designer doing ethnography focuses on issues relevant to the design situation, i.e., problem and purpose. On the other hand, the ethnographer aims for thick descriptions of human activities, e.g. specific cultures or small-scale societies. (Blomberg et al., 1993; Blomberg, Burrell, and Guest, 2003).

The designer's challenge when applying ethnographic methods for learning about a design field or artefact is not to be biased (for instance, anticipating solutions) but keep an open mind aiming for thick descriptions (Blomberg et al., 1993). These descriptions function to uncover use cases and scenarios to inform design decisions on levels ranging from initial inspiration and understanding of a design field or problem to the specific disclosure of use applications and problems to inform concrete design decisions. Therefore, I applied ethnographic methods and approaches throughout the studies, took notes, and did jottings along with other activities. As such, an ethnographic mindset of paying attention to details and biases as well as power structures between researcher and the study participants, i.e., players and workshop participants, was luring in the back of my head throughout the data collection and analysis process (Blomberg, Burrell, and Guest, 2003; Nardi, 1997).

However, while biases in the form of assumptions or anticipations are essential to pay attention to, bias, particularly personality and lived experiences, cannot be avoided. Instead, they should be embraced and explained as part of the data inquiry and analysis (Duncan 2004). This idea is particular for design work as Benford et al. (2009) argue that the designer's craft knowledge has a vital role in theory construction besides, of course, the design work. It is relevant to mention my background as former music and movement professional and game designer, which has influenced my studies in various ways. For example, as a facilitator of the movement workshops, my understanding and bodily training within movement practices and the games and subsequent game designs being played and developed throughout the studies.

Lastly, in ethnography and autoethnography, data analysis is done ongoingly to guide the inquiry. Differently than, for instance, a quantitative survey where all questionees must answer the same questions for comparison, ethnography often deals with open and exploratory research questions where the researcher constantly learns and gains new ground. Therefore, it is paramount that the methodology considers methods and approaches that allow for such processes. Design inquiries are often exploratory and developing as new ideas and understandings emerge (Buxton, 2007; Schön, 1995). Such approaches suit design processes well. Design processes also undergo a similar learning process as data are gathered and analysed. Therefore, ethnographic and autoethnographic methods were applied throughout the studies.

Ethnography provides a set of methods for the researcher to participate and observe in study activities. The researcher can be a participating observer or an observing participant. While the boundaries and understandings of the two are porous and overlapping, an excellent example of the former is how the researcher in, e.g., design workshops (as described above), can take part as a participating observer while also being the facilitator and thereby also gather data from a first-person perspective in the activity. Because the researcher in this instance is a facilitator – and researcher, the researcher cannot observe unobtrusively. However, the role of the facilitator can be shielding to some extent in this regard.

Furthermore, as a participating observer (and facilitator), the researcher can take a proactive approach toward getting information and data by asking questions and being a central part of the design work and discussions (Blomberg et al., 1993). However, as the researcher participates in the activity, the challenge can be to document the data. Data are often collected as notes and jottings whenever possible (Emerson, Fretz, and Shaw, 2011), and video recording is also possible (Blomberg et al. 1993; Blomberg, Burrell, and Guest, 2003). Furthermore, the researcher can make notes and jottings afterwards, thereby recalling and reflecting on the events and observations (Blomberg, Burrell, and Guest, 2003). For example, I was a participating observer – and facilitator – in the workshops (A1). While I was also the facilitator, notes and jottings were made afterwards.

The researcher can also participate in events as regular participants as part of an audience or team and collect data as an observing participant. In this thesis, this was the approach to observe the sessions of Inferno (A10). As a regular (though observing) participant, the researcher can observe unobtrusively (as opposed to the example above of participating observer) following the guidelines by ethnographers Emerson, Fretz and Shaw (2011), where the observer is known to (also) observe the activities. Documentation in such instances can be varied, similar to the above (Emerson, Fretz, and Shaw, 2011).

5.5.4.1 AUTOETHNOGRAPHY

Autoethnography was the dominant methodology for paper P6, while it has been an approach underlying the understanding of the games and play activities engaged in throughout the entire process (A10).

Autoethnography is a branch of ethnography where the researcher's lived experience is the primary data source and object of study (Duncan, 2004; Ellis, Adams, and Bochner, 2011). While ethnographic methods help shed light on use practices and applications, autoethnographic accounts help to shed light on subjective and pre-reflective experiences and use applications that are not otherwise accessible. Such an approach has been applied for social science studies of, e.g., race, gender or minority experiences (Ellis, Adams, and Bochner, 2011).

Designers can use this method to illuminate the experience of a design – and design process – that is only accessible through a reflective and analytical process that we know from research (Duncan 2004; Rapp, 2018). When designers try out designs – be it their own or those of other designers – these experiences become part of their knowledge base from which they base their assumptions and decisions, hence, an unarticulated autoethnographic approach. As Duncan (2004) also points out, designers are already familiar with such processes as what Schön (1995) calls – knowing-in-action, how designers subjectively explore possibilities through sketching and prototyping. As mentioned above, Benford et al. (2009) refer to using their craft knowledge as designers and researchers when deriving design knowledge regarding artefacts.

Following the above argument, applying an autoethnographic approach in qualitative research, in general, is also an acknowledgement of the innumerable ways that personal experience and bias can influence the research process and outcome (Ellis, Adams, and Bochner 2011). Autoethnography springs from realizing that the researcher will always influence the research and process subjectively (Duncan 2004; Ellis, Adams, and Bochner 2011).

The reason for choosing this methodology is that the experience is central to understanding games, gameplay and play activities as these are procedurally determined by the players' choices and the rules and conditions of the activity. In this regard, autoethnography allows for the researcher's subjective and emotional experience as part of the research data (Duncan, 2004). Furthermore, these subjective and emotional experiences can work in synergy with the researcher's craft knowledge (Benford et al., 2009) in accessing and processing the data as design knowledge. Thereby, the researcher can anchor their relationship to the data in multiple ways and add a deeper understanding of the experience (Douglas and Carless, 2020).

In this thesis, I have been used autoethnography as a methodology for understanding and accessing subjective and pre-reflective experiences, concretely those in the game and play contexts. These reflections have provided the data set with an extra layer for the situations where I have been present (I was not present in A8; hence I have no subjective experience of the situation – only of the situation as mediated by the video recordings). This approach has supplied a way to reflect and bring into the analysis my words, thoughts, and feelings, e.g., knowledge, motivation, responses and influence on the processes. It is also common – and anticipated – that autoethnographic (and ethnographic) studies are complemented by other sources like interviews, pictures, and reports of various kinds (magazine articles, commercials, etc.), maintaining the subjective experience as the focal point (Duncan 2004). These methodologies are not brought forth in all the papers. However, all the game and play descriptions rely on such processes of reflection and analysis.

The subjective experiences were documented mainly as notes and jottings and sometimes as minor drawings.

5.5.5 VIDEO RECORDINGS

Video recording was used as a data collection method in the workshops (A1), the physical training session (A3), the playtest of Crazy Soccer Physics on Trampolines (A5) and the families' home video recordings (A8). The videos recordings of the workshops and the playtests differed from the physical training session and the families' videos. The former was recorded in the lab, while the latter was recorded by themselves "in the wild". However, some aspects are the same; the position of the camera, what it captures and the obtrusiveness of being recorded (Heath, Hindmarsh, and Luff, 2010; Penn-Edwards, 2012). As such, it is essential to ensure that the camera records the actions (Sharp, 2007) and be aware that events take place outside the camera angle, as well as these are aspects that can lead to validity issues (Lomax and Casey, 1998). In order to accommodate such issues, the video recordings were accompanied by other data sources (interviews, written reports and questionnaires) to provide for triangulation.

5.5.6 WRITTEN REPORTS/QUESTIONNAIRES

The written reports and questionnaire used a fixed set of structured questions (Kvale, 2007) instead of the less structured conversational forms in interviews explained above. This approach was used in two instances; for the families to fill out written reports in the evaluation study (A8) and the questionnaire accompanying the playtest of Crazy Soccer Physics on Trampolines (A5). While the questions were structured, they were kept open (as opposed to closed) for reflection, avoiding any yes/no questions (Kvale, 2007). While interviews provide the option for a conversation pursuing any emerging topics, in a written report, people are given a chance to reflect on their feedback before replying. The downside is that it takes more effort from the participants (Sharp, 2007). Nevertheless, having both interviews and written reports can provide data for triangulation.

5.6 CODING AND ANALYZING THE DATA

In general, data were first run through an open coding process where recurrent themes and topics were spotted (Sharp, 2007; Williams and Moser, 2019). Then, the initial codes were further refined and aligned through axial coding, establishing relationships among the themes. The emerging findings were further developed into theory constructs in an inductive process while also contested against existing and related theories in a deductive process (Williams and Moser, 2019). These were finally processed into a higher level of "story" or meaning (Flick, 2018). In design research, this meaning is often an understanding of a use case or user/player experience from which the researcher or designer extracts design knowledge. Design knowledge is demonstrated and validated through the methodologies presented at the beginning of this section. This approach to the coding of empirical data has been applied throughout all data; interviews, video recordings, notes and design artefacts.

However, as the data also comprise ethnographic and autoethnographic approaches, these data have undergone initial analysis as the study progressed. This procedure is usual for such approaches as the continuous analysis help guide the inquiry and focus of the study (Duncan, 2004; Ellis, Adams, and Bochner, 2011; Spradley ,1979). Often such studies are exploratory and, thus, the focus develops over time as insights emerge throughout the activities (Duncan, 2004; Ellis, Adams, and Bochner, 2011; Spradley, 1979).

An important aspect when doing qualitative research is that open coding of qualitative data – as well as the data collection process – as the foundation for the analysis process "*can be more art than science*" as the way and reasoning behind determining what is a recurrent theme or topic is also subjectively grounded in the researcher (Williams and Moser, 2019). In addition, because the data sources were of different characteristics and, thus, revealed a different kind of data, I had also to use my own understanding and interpretation of the situations. For instance, bodily action in video recordings yields pre-reflective experiences (Rizzolatti and Craighero, 2004), while written reports reveal the reflective parts (Schön, 1995). These collection methods reveal different kind of data that is not necessarily comparable. To accommodate these challenges, I turned to Svanæs and Barkhuus' (2020) second person and third perspective in which I used my own bodily, i.e., pre-reflective, understanding and interpretation of the situation. While this method has some validity issues because it is – like auto-ethnographic studies – entirely subjective, I found that comparing these experiences with the other data sources helped reveal the bodily experience in ways that would not otherwise be accessible. As such, my professional (and personal to some extent) background as a music and movement teacher, professional musician, and experienced game designer also played a role in reaching the results – theories and designs – presented in this thesis.

5.7 PRACTICAL DESIGN METHODS

Turning the knowledge gained from the data collection and analysis processes into a practical design requires the designer to work practically with the data and sometimes make creative leaps (Löwgren, 2004). As Schön (1995) explained in his studies on creativity, a creative leap is the sum of the data at hand, the designer's lived experiences and competencies, and a range of methods to foster these processes. While a designer uses both formal and informal methods for design work, i.e., her own cognitive and bodily processes (Svanæs and Barkhuus, 2020), most designers engage in sketching and prototyping to explore and stabilize design ideas (Buxton, 2007; Fullerton, 2008; Schön, 1995). For the design of *The Move Maker*, I used hand drawing and digital image creation tools like Photoshop and Illustrator to sketch out ideas. I used digital tools like Arduino and matching peripherals to prototype interactive processes. I also used enactment – acting out ideas (Höök, 2018) – to experiment with and try different game mechanics.

PART II

RESEARCH CONTRIBUTIONS, DISCUSSION, AND CONCLUSION

6 RESEARCH CONTRIBUTIONS (RCS) AND THEIR CORRELATIONS

The following Research Contributions answer the research questions posed in Section 2. As an RtD project, included are both a game design artefact and accompanying design theories. As such, the game design works as an exemplar for the design theories.

The first paper presented here as Research Contribution 1 (RC1) describes the theoretical understanding of play and games, grounding this thesis' investigations into bodily play and game experiences. Furthermore, RC1 presents practical design strategies for movement-based play and game design based on the presented theoretical grounding.

Following the theoretical grounding outlined in RC1, Research Contribution 2 (RC2) presents generic mechanics supporting movement-based games and play forms. While these are presented as theories, they form the basis for the practical design work presented in Research Contribution 3 (RC3). RC3 presents the practical game design and the evaluation thereof. The final Research Contribution 4 (RC4) addresses a meta-perspective of movement-based games and play forms by offering a phenomenology of the role of movement in digital play. The research contributions are consolidated below.

- **RC1:** Theoretical Foundations for Movement-based Game and Play Design: Correlations between player attitude and a design's structure and how these influence the bodily play experience in reciprocity (P1).
- **RC2:** Generic Mechanics for Bodily Play (P2 and P3)
- **RC3:** A game artefact developed as a practical exemplar and demonstration of the previous RC's; RC1 and RC2 – and an evaluation of these. (P4 and P5)
- **RC4:** A Phenomenological Perspective on Bodily Play (P6)

6.1 RC1: THEORETICAL FOUNDATION FOR MOVEMENT-BASED PLAY AND GAME DESIGN

RC1 highlights how game design comprises different structures, and bodily attitudes emerge as doings therein. RC1 provides the theoretical foundation for designing the structure of *The Move Maker* in Section 6.3 as a modular system.

6.1.1 PAPER 1 (P1): PLAY VS GAME AS FOUNDATION FOR MOVEMENT-BASED PLAY AND GAME DESIGN

P1 examines play and game as these are nuanced in the Danish language and connected to bodily play experiences. It investigates the Danish connotations of the English concept of *playing a game* from a phenomenological perspective. It provides four different "*playing a game*" variations as combinations of two different structures and doings and answers RQ4; *How can we describe (digital) bodily play from a phenomenological perspective*? Moreover, P1 provides design strategies to leverage in practical design work and, thereby, also answers RQ3; *How can the design support variations in bodily movements and gameplay as the activities progress and develop*?

Best Paper Award

Presentation video: https://youtu.be/UJHZiZVJGpE

Louise Petersen Matjeka and Florian 'Floyd' Mueller. 2020. *Designing for Bodily Play Experiences Based on Danish Linguistic Connotations of "Playing a Game".* In CHI PLAY '20: 2020 Annual Symposium on Computer-Human Interaction in Play Proceedings, *ACM, New York, NY, USA, 13 pages.* https://doi.org/10.1145/3410404.3414264

Designing for Bodily Play Experiences Based on Danish Linguistic Connotations of "Playing a Game"

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ABSTRACT
Designing for bodily play in HCI is increasingly gaining attraction, including research on the experiential dynamics leading to that. Within this research, however, there has been little investigation into the differences between bodily playing and bodily gaming and associated implications for design. This paper investigates such differences and proposes an understanding derived from the Danish linguistic connotations of the four different combinations of bodily "playing/gaming" a "play/game". We exemplify these through four different examples and extract four strategies for designers to implement in their future bodily designs. With our work, we hope we are able to expand the range of diverse bodily play and game experiences within HCI.

CCS CONCEPTS
• Human-centered computing ~ Human Computer Interaction (HCI) ~ HCI theory, concepts and models • Human-centered computing ~ Interaction Design ~ Interaction Design Theory, Concepts and Paradigms

KEYWORDS
Bodily play, movement-based game, play design, game design, embodiment, design methods

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1 Introduction
There is a growing interest in HCI around designing for bodily play (e.g. [7,34,43,46,49,59,63–65,88]), together with the development of guidelines, lenses, tactics and frameworks for such experiences, often described under the terms body-centric games, movement-based games, exertion games, or exergames (e.g. [46,47,60,61:10,67–70,72]). Alongside this development, there is a growing interest within the game culture literature on the phenomenon called play and the relation to game experiences and design (e.g. [14,44,78,83,84]). While several scholars [8,12,19,54,75,83,86] have proposed an account of the experiential differences between the two phenomena of play and game, little such focus has yet been given to the implications for bodily play in HCI. We believe that such investigations can bring novel perspectives on the experiential dynamics in bodily play and game experiences and subsequently further our design knowledge. Concretely, we are interested in bodily play, in particular, bodily play experiences, and how to design for it.

In this article, we build on the fact that it is an established practice in HCI to draw on other languages to understand technologically-augmented experiences, e.g. [44,62,66]. Here, we look at the Danish language to understand the difference between four different combinations of "playing/game-ing" a bodily "play/game". The phrase "playing a game" translates in Danish into two different versions; *at lege en leg* and *at spille et spil.* Where the English language only has play as verb (except "the play" for theatric performances) and game as noun (except "to game the system", but this is a different context). The Danish language, in contrast, has play and game as both verbs - *at lege* (to be "playful") or *at spille* (to be "gameful") - and nouns - *en leg* (a "play" [1]) or *et spil* (a game). We believe

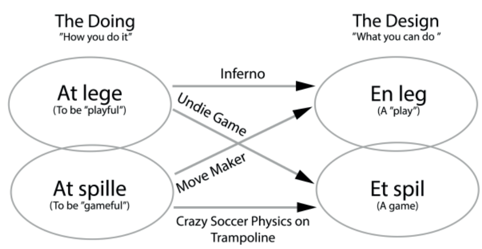

Figure 1: The different combinations of play and game as both verbs and nouns forming different bodily play and game experiences.

[1] This is not similar to the English "theatre play", but the noun correlating to "being playful".

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that this offers some valuable nuances in the conception of play and game that are different from the English use of the words. This is important to highlight, we find, as although bodily play is played across the world, English is the predominant language of scientific papers within HCI and hence can influence our understanding of bodily play from a narrow perspective.

The Danish connotations of playing a game reveal two ways of playing and two types of games – making up four different correlations (figure 1): The commonly understood correlations of playing a game; *at lege en leg* (to be "playful" in a "play") and *at spille et spil* (to be "gameful" in a game). When we switch the verbs and nouns, we reveal two additional correlations; *at lege et spil* (to be "playful" in a game) and *at spille en leg* (to be "gameful" in a "play"). This allows us to ask the questions: What can these four linguistic correlations of playing a game (in a bodily experiential perspective) tell us about bodily play and game experiences? Moreover, how can we address these when we design for bodily play and game experiences?

To answer these questions, and in order to be able to construct the four perspectives of "playing a game", we first investigate the differences between the two verbs as a doing; *at lege* (to be "playful") and *at spille* (to be "gameful"). We then investigate the two nouns; *en leg* (a "play") and *et spil* (a game) - in the form of designable structures. From these investigations, we explain the four perspectives and demonstrate them through examples. We use these to draw out four strategies for designers to implement in their designs. As our focus is on bodily play experiences, we conduct our investigations from a bodily experiential perspective informed by phenomenological [21,30,51,94,95] and postphenomenological [31,32,77] theories of perception, bodily movement [81,82] and action [71,89] in combination with play and game theories [8,19,27,84,86].

We use the Danish connotations of "playing a game" in combination with theoretical ideas of bodily perception and movement to build the four perspectives of bodily play and game experiences. We regard the results as residing within the methodology of the bridging concept [11].

We intend this paper for game design scholars interested in bodily play and game experiences either in the form of practical design guidance or to use for analysis of such experiences and the corresponding designs.

In the next section, we go through prior contributions of bodily (play) experiences within HCI and how our work is related to those. In order to do so, we turn to different areas; experiential perspectives on bodily play, bodily interaction design, and play versus game within the HCI community, as well as experiential perspectives on computer games.

2 Previous Investigations of Experiential Perspectives to Bodily Play and Interaction Design Within HCI

Within the field of experiential accounts of bodily play sits the work by Mueller at al. [53,54,55], who highlight in their work that it is essential to unpack the bodily play experience. We learn from this work that such unpacking is essential, and like them, we begin by unpacking it into two separate, but interconnected aspects. The authors unpacked the notion of the human body into two perspectives (Körper / Leib), which is useful to understand the overall experience but does not yet help us understand the difference between game-ing and playing in bodily play experiences. Berthouze [4] also investigates bodily play experiences by examining the role of body movement for player engagement and develops an engagement model. Berthouze provides essential knowledge of the bodily play experience from a physiological perspective on cognitive and emotional processes but does not cover the differences between game-ing and playing for the bodily play experience.

Within studies of the experiential account of interaction design, Svanæs [88] examines design implications through the lens of Merleau-Ponty's "Phenomenology of Perception" and demonstrates how technology can become an integral part of our body schema, while Loke and Robertson [43] contribute with the "moving" and "making strange" design methodology. While these contributions unpack experiential factors for action and interaction with technology, we still need to link such perspectives with experiential factors of game-ing and playing in order to get an understanding of the experiential factors to bodily play and game.

As one of the few contributions within HCI concerning the differences between play and game (but not specific to *bodily* play), Lucero et al. [44], examine playful versus gameful design. The notions of playful and gameful are the closest understanding to the Danish *at lege* (to be "playful") and *at spille* (to be "gameful"). They draw on Caillois' "paidia/ludus" dichotomy [8] for their work, while we extend these perspectives with a linguistic understanding to derive implications for design as structures.

Within play and game studies, Keogh examines the embodied player experience and develops two player characters: The hacker, who is in charge of the system, and the cyborg, who becomes one with the system across bodies and worlds [38]. Keogh refers to embodied experiences in general, while we refer to bodily experiences in particular. We look specifically at bodily play and game experiences in which bodily perception and movement are fundamental for the experience.

We turn to phenomenology and postphenomenology to understand how we create meaning in bodily play and game experiences through bodily perception and movement. In this understanding, perception is active [71], and so we perceive the world through movement [81]. We use the following understandings of bodily meaning-making in our analysis of examples of designs and also later in the presented design strategies. However, before explaining these theoretical concepts from which we draw our understanding of bodily meaning-making, we go through our methodology for doing so.

3 Our Knowledge Contribution as Bridging Concepts

As mentioned in the introduction, we regard the presented descriptions of the Danish correlations of "playing a game" as residing within the methodology of the bridging concept as introduced by Dalsgaard and Dindler [11]. Bridging Concepts, as intermediary knowledge contributions, serve as translations of existing theoretical ideas or perspectives into design concepts through accompanying examples. We use the Danish connotations of "playing a game" in combination with theoretical ideas of bodily perception and movement from phenomenology and postphenomenology to build the four perspectives to bodily play and game experiences.

From the accompanying examples, we extract design strategies. We chose the examples because of their specific design qualities to demonstrate our arguments. Also, we have personal experience with these as either designer, an audience, or players [17]. We present the design strategies as generative resources and, as such, these should be assessed on their generativity in combination with the designer's design practice [17].

4 Meaning-Making through Bodily Perception and Movement as our Basis for Understanding Bodily Play and Game Experiences

Within postphenomenology (building on phenomenology), Ihde explains how we bodily make sense of the world through micro- and macroperception: microperception deals with internal bodily perception as the basis for bodily meaning-making, whereas macroperception refers to how bodily meaning-making is influenced perceptually by the social and cultural dimensions of our lifeworld [32,77]. Bodily meaning-making is a process of both macroperception and microperception [32,77]. We explain these theoretical concepts in the following sections. We begin by discussing microperception in regards to bodily play and game:

A microperceptual perspective of bodily play and game experiences is that players create meaning from the designed bodily game mechanics in the form of *kinetic joy rides* (see below), these are sequences of movements [81] that the players are ready to do [71]. We argue that players are ready to do different movements when they *leger* (are "playful") or *spiller* (are "gameful") than they would do in other situations. The macroperceptual perspective of bodily play and game experiences are explained afterwards.

4.1 Microperception: Bodily Meaning-Making from Kinetic Joy Rides and Enacted Perception

Sheets-Johnstone links movement with play and points out how meaningful movement is not constituted by separate movements but as a sequence of movements in a kinetic dynamic – "*a sequence of sensations felt as a whole, a process, as an entire experience,*" which she terms a kinetic joy ride [81]. Sheets-Johnstone puts forth the idea that we perceive the world through movement as a repertoire of "I can's" [80,81] drawing on Husserl's idea of "I can's" as our bodily capabilities [30,94]. These arguments also build on theories of bodily perception as pre-reflective knowledge from Merleau-Ponty.

To Merleau-Ponty, bodily perception is the foundation for our understanding of the world as a pre-reflective consciousness; before thought becomes a thought, our body has already sensed and interpreted the action [50,51] into bodily knowledge. Moreover, we bodily perceive the world through our senses [51]. Continuing Merleau-Ponty's thoughts, Nöe explains bodily knowledge to entail action; perception is not passive, but enacted [71]: "*What we perceive,* is determined by *what we do*, (or what we know how to do); it is determined by what we are *ready* to do." [71]. Hence, we argue that in the pursuit of the kinetic joy rides offered in *en leg* (a "play") or *et spil* (a game), players are ready to do other sequences of movements than they would otherwise do in other situations. However, the kinetic joy rides that we are ready to pursue are also formed by whether we prefer *at lege* (to be "playful") or *at spille* (to be "gameful"). We further link these arguments to the examples and later design strategies in later sections.

While kinetic joy rides and enacted perception form part of our internal processes of bodily making sense of the world, bodily perception also involves social and cultural factors. Hence, we next explain how these factors influence bodily perception.

4.2 Macroperception: Bodily Meaning-making from Social and Cultural Perception

Our ability to *at lege* (to be "playful") or *at spille* (to be "gameful") is also based on social and cultural relations. As such, macroperception as the ability to perceive social and cultural contexts is concerned about external processes of bodily perception. Ihde explains this notion in terms of perceiving various dimensional perspectives in images [32]. He argues that in such images, we can decode cultural and social dimensions. As a further explanation of this, we turn to phenomenologists Moran [58] and Gallagher & Zahavi [21], who explains how we are social and cultural about something that joins us socially and culturally in our activities. Within our bodily play terminology, we further contrast this referring to Suits [86], who tells us that play is always relative to something. In the following section, we examine this something as the object for perception, which in this paper also refers to *en leg* (a "play") and *et spil* (a game).

4.2.1 The Design as Object for Perception

The structures of *en leg* (a "play") and *et spil* (a game) allows for certain kinetic joy rides that unfold as either *at lege* (to be "playful") or *at spille* (to be "gameful"). Bodily perception is always relative to something [15,21]. When we play, it is relative to play and game as objects – or objects constituted for play and game. As Suits argues, we always play with something, an excess resource be it food, time, nature, etc.:" *play is concerned with a use of resources for which those resources were not initially intended, where the original allocation was for instrumental activities and the new allocation is for autotelic activities*" [86]. Critical voices might say: "*but what about toys, then? Are toys not resources initially intended for play?*" The short answer is yes, with one explanation that toys are already excess resources initially designed for autotelic activities (play). What we are hinting at here is not a discussion of toys, but how "things" (toys, instruments, technologies, etc.) in play can be allocated very different roles: in a game of catch, an armchair (made for resting and sitting) is turned into a hindrance for the catcher and a rescue for the other players. In another situation, the armchair can be turned into a carousel. Depending on the objective of the players, a design's structure can encourage bodily movements as either "I can's" – get past the chair, or as perceptual stimulation – get dizzy from turning. Players' objective for these experiences is grounded in the doings; *at spille* (to be "gameful") or *at lege* (to be "playful").

In bodily play and game experiences, players create meaning through movements that we are *ready to do.* The bodily skills that we apply or seek to achieve in these experiences are our repertoire of *I can's.* While bodily play and game experiences are based on bodily perception, the designs as an object in the form of either *en leg* (a "play") or *et spil* (a game) connect us socially and culturally as the *object for perception.* Whether we *leger* (are "playful") or s*piller* (are "gameful") is connected to the object for perception – in our case, the structure of the design. These concepts form the basis for our further understanding and analysis of the Danish connotations of "playing a game".

We will, in the following sections, dive into the, for our arguments in this paper, main differences in play and game as a doing – the verbs *at spille* (to be "gameful") and *at lege* (to be "playful") and subsequently the structure between *et spil* (a game) and *en leg* (a "play") as they are understood in the Danish language.

5 The "Doings" of *at spille* (to be "gameful") and *at lege* (to be "playful")

We now investigate each of the verbs *at spille* (to be "gameful") and *at lege* (to be "playful") as a doing. We argue, that when we *spiller* (are "gameful") and *leger* (are "playful") from a bodily perspective, we are ready to do bodily actions that we would otherwise not do or find ridiculous, odd, unnecessary or inappropriate – and that this particular form of meaning arises in reciprocity to the design. We further argue that *at spille* (to be "gameful") is concerned with bodily achievements and challenges, *at lege* (to be "playful") is concerned with bodily perceptual stimuli and exploration. And, both are fueled by curiosity, however, in different ways.

5.1 *At spille* (to be "gameful")

In the Danish dictionary, *at spille* (to be "gameful"), refers to the action of doing something with the purpose of reaching a goal [96]. Therefore, when we *spiller* (are being "gameful") it is always with a purpose. The verb describes an achievement seeking behavior and covers activities like music, which is always *spillet* ("gamed"). In the case of *at spille musik* (to play music) the achievement is the music. Likewise, engaging in games of chance like lottery and gambling (which Caillois calls Alea [8]) can never be *leget* (played) in Danish. In such games there is always an outcome, a result, that is sought [19]. Table 1 illustrates some of the differences between English and Danish connotations of play and game as a doing in often used phrases.

Drawing on Caillois' notion of Ludus, *at spille* ("being gameful") can be seen as a quest for achievements with success or failure as the outcome. Caillois describes Ludus: "*Ludus inspires in the player the hope of succeeding*" [8]. This achievement-seeking behavior drives players to pursue unnecessary [86] and arbitrarily chosen [8] obstacles as ways of testing and improving abilities [33,36,42,54,55]. *Spiller* (are "gameful") leads to an irreversible outcome of victory or failure with the emotional states of fiero [42] or being flawed [36]. The latter, as Juul describes, *"has the double function of creating in us a feeling of being flawed and forcing us to reconsider our strategies in order to escape that feeling."* [36]. In this way failure is also linked to the very act of completing a game with an immanent opportunity for improvement [8,36].

5.1.1 Bodily Forms of *at spille* (to be "gameful")

From a bodily perspective, meaning is found in pursuing bodily achievements and skills. This is most notably in sports [19,55]; it is (almost) only the achievement that counts, and it is also evidenced in self-tracking where training apps and exergames are being developed to suit the desire for improved health, endurance, etc. (e.g. [20,45]). In the perspective from the previous section on bodily meaning-making in movements, these activities create bodily meaning for the players through the sequences of movements supporting a desired outcome in the form of e.g. quantifiable measurements. Often such measurements depend on technological resources, however, two *spillende* ("gameful") players can create a contest by using each other as comparing measurement. Any such possibilities occur in relation to the allocated resources, which we refer to as *en leg* (a "play") or *et spil* (a game), which we explain later, first, we look at *at lege* (to be "playful").

5.2 *At lege* (to be "playful")

The Danish dictionary describes *at lege* ("being playful") as being engaged in or occupied by *en leg* [97]. This description indicates that the process is important; being occupied by the activity. Furthermore the origin of the word is *leika* – dancing, doing sports, being physically active.

When we *leger* (are "playful"), the process of the activity becomes the locus for interactions with a design. Kerr and Apter explains how a particular form of sense-making in playing transforms the means to reach a goal into being the "goal" itself [2,39]: for example in "catch", the process of catching each other or avoiding being caught becomes the locus of the activity rather than the catch itself as a measurable result. Another example is when players (often parents), in a game of hide and seek, pretend that they cannot find the other players (often children) in order to keep the "play" going and even out skill levels to include all players.

Table 1: Examples of differences between English and Danish connotations of play and game as doings.

English	Danish
Play the lottery	*Spille* lotteri
Play (or make) music	*Spille* (eller lave) musik
Play a role (theatre)	*Spille* en rolle (teater)
Play "Family"	*Lege* "Familie"
Play "Doctor", "Police and Robbers" etc.	*Lege* "læge", "Politi og røvere", etc.

4.2.1 Bodily forms of *at lege* (to be "playful")

In our endeavors of investigating *at lege* ("being playful") from a bodily perspective, we turn to Caillois' *Paidia* [8]: "*the spontaneous manifestations of the play instinct*". Paidia is often referred to as the free and immediate form of playing [18,19,25–27,78] and to be "playful" [44]. We want to emphasize that while we draw on Caillois' Ludus/Paidia dichotomy, Caillois' version is more of a mindset, in contrast, we describe this dichotomy as a doing (visible in our actions) in relation to configurations of two different structures.

Caillois further links his Ilinx game classification (see *En leg* section) as an extension of Paidia. Ilinx is the play form of bodily perceptual stimuli such as children's whirling but also adults' preference for speed resulting in bodily perceptual stimuli [8]. Play and bodily perceptual stimuli are further linked by Paasonen in her book *Many Splendored Things – Thinking Sex and Play: "For the quest for bodily pleasure – the enchantment of the activity itself - can be seen as the key purpose of, motivation and rationale for both sex and play"* [74]. She further links sex and play to bodily exploration and experimentation. While she is not the first to connect play and exploration (see also [8,19,27]), she is linking these notions to bodily stimuli. Thus, when we *leger* ("being playful") in a bodily perspective, there might be a purpose or a goal but it is the process of the activity as a quest for enjoyable bodily perceptual stimuli that is the focus.

6 The Structures of *et spil* (a game) and *en leg* (a "play")

The following descriptions of *et spil* (a game) and *en leg* (a "play") describe how constitutional components form different structures. While the components are the same, we highlight that it is in the way designers configure these components that make up the structure of either *et spil* (a game) or *en leg* (a "play").

6.1 *Et spil* (A Game)

The Danish expression *et spil* (a game) is explained as an entertaining activity performed from fixed rules with varying requisites (cards, dice, balls, ropes etc.) [98]. We present two configurations for the constitution of *et spil* (a game): Firstly, an irreversible and comparable outcome, and secondly, fixed rules.

6.1.1 Irreversible and Comparable Outcome

In *et spil* (a game) the outcome has to be irreversible in the sense of either a winner/loser is determined, or an award or gain is achieved that is comparable across game rounds. An outcome is here understood as a focus on results achieved by the player. Both Juul [35] as well as Salen and Zimmerman [78] define the outcome of a game as a main feature of a game. If the results are not irreversible, it will be a different structure. This is constitutional for the doing of *at spille* (to be "gameful"). This configuration of irreversible and comparable results is imperative in sports [35] as the extreme version of bodily games [55,56]. Whether in sports or in *spil* (games), an irreversible outcome is closely linked to fixed (and unalterable) rules.

6.1.2 Fixed Rules

The use of rules in *spil* (games) is different from that in *leg* (play) [3,8,8,35,35,78,86]. To be able to provide comparable results, rules of games need to be rigid [18]. Salen and Zimmerman explain that game rules cannot be altered and must be explicit, unambiguous and fixed. Rules are binding and must be obeyed by all players involved [78]. If not, the results are not comparable or quantifiable across game rounds. However, game rules can be amended and agreed upon before a game session commences (if the technology allows), corresponding to Jesse Schell's notion of House Rules: Rules, which players negotiate beforehand [79]. An example of such amendments is the finishing scenario in Ludo: There are four spaces left for the player to get one of his pieces "home", but the die shows five pips? Must the die's pips match the exact number missing for the player to get his piece "home", or can there be excess pips? Nevertheless, once the game session starts, the agreements are bound, and the rules are not to be altered, once commonly established. In ***en leg*** (a "play") they are not. The difference is that rules in ***et spil*** support an irreversible and comparable outcome, while rules in *en leg* support the activity's progression. The next section explains how these elements of outcome and rules are configured differently in *en leg* (a play).

6.2 *En leg* (A "Play")

En leg is defined as a spontaneous, unhindered, and rule-based activity containing degrees of randomness and fantasy [99]. In line with this definition, Eichberg describes *en leg* (a "play") to "*hint in many directions at the same time*" [19]. Building on these definitions, we will, similar to the above explanation of *et spil* (a game), present two constitutional configurations of *en leg* (a "play"). Following the same structure as in the previous section, these are firstly, no irreversible or comparable outcome, and secondly, undefined or negotiable rules resulting in an ambiguous structure.

6.2.1 No Irreversible and Comparable Outcome

Møller emphasizes *en leg* (a "play") as a process without a determinant goal [56], similarly to how other play scholars have described play [16,19,27,29,86,87]. This does not mean that there is no goal, rather, that the outcome or result of any goal is not important and constitutional for *legen* (the play). The process, then, becomes the locus for the constitution of *en leg* (a play) [54]. An example of this is Caillois' Ilinx game form. Ilinx is Caillois' classification of bodily play forms; play forms almost deprived of any external goal with the only purpose of exploring the bodily senses in various settings until exhaustion [8].

6.2.2 Undefined and Negotiable Rules

Rules in *en leg* are flexible and depend on negotiation. Rules are made up as *legen* (play) progresses, and the purpose of the rules is not to accommodate a quantifiable outcome, but rather to form a common basis for the act of playing [55]: For example, we point to the illustrative phrase common among children when playing: "*Shouldn't we say that …*" [37].

Møller states an example of the alteration of rules in *en leg*: "In the simple *leg* (play) '*tagfat'* [equivalent to the English 'catch'], one person is the catcher, trying to catch the other players. In the instance where the catcher is the one all other players can outrun, *legen* (the play) would end. However, at this point *legen* enters another phase. If *legen* has to continue, the good runners will have to demonstrate a kind of solidarity that is not part of *et spil's* nature, but extends it and belongs to the structure of *en leg*: The good runners will have to instate new rules (like run dangerously close, crawl on their knees, or jump on one leg) for someone to end up being caught. It becomes their responsibility not to augment the pressure too much, but to ‘stop while everything is good’ in order to keep *legen* going” [55].

This enables *legen* (the “play”) to continuously adapt to the circumstances through alterations and additions of the rules [3,12,19,53,55–57,86]. This way, it does not adhere to any irreversible outcome as skill acquisition or other bodily measurements like being fastest or having most catches.

So far we have covered the Danish connotations of play and game as a doing and as design configurations. In the following, we describe an example for each of the four correlations.

7 Examples of the Four Correlations

We present four different examples, one for each combination and highlight how the configurations affect the doing and vice versa. The analyses of the examples are based on four different studies and as such are not meant as evidence but rather as empirically based explanations. The studies were originally conducted to investigate individual bodily play experiences and thus vary in methodology and approach.

7.1 *At spille et spil* (To be ”gameful” in a game) – in Crazy Soccer Physics on Trampolines

To exemplify the correlation *at spille et spil* (to be “gameful” in a game), we present a study of the bodily play experience in Crazy Soccer Physics on Trampoline [73] (figure 2). Crazy Soccer Physics is a traditional computer game [35] created by Otto Ojala [73] with trampolines added as interface. The game is called Crazy Soccer Physics because the physics applied to the avatars are “crazy” in the sense that the avatars respond almost randomly to player interactions; jump high, fly through the air, do somersaults, fall on their heads (and stay in the position), move in the opposite direction and so on. Basically, it is difficult to fully control the avatars. In addition, the size of the goals varies randomly as well as the size and quality of the balls (huge balls, “inflated” balls, etc.). Despite the "randomness", some control is possible. The trampoline jumps are divided into three categories based on weight and time length. The more intense the jump and the longer the time between jumps, the avatars fly higher and longer and start kicking. This allows the players to apply different jumping strategies; controlling their jumps in terms of light or heavy, fast or slow pace, or if they await the right moment to jump and make the avatars "do something" to save a goal and affect the outcome. In the following, we analyzed the empirical data using the extracted definitions above. We conducted 11 game sessions with 22 participants. The sessions were video recorded and complemented by structured individual interviews [76].

7.1.1 Analysis of the Experience in Crazy Soccer Physics on Trampolines

We consider this game *at spille et spil* (to be “gameful” in a game) because the configurations for bodily perception and movement in the design almost exclusively encourage bodily achievements. This is also reflected in the players’ statements: in the interviews, players were all quite focused on achieving

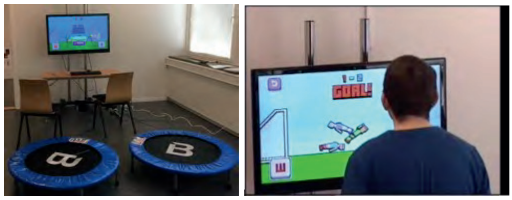

Figure 2: Crazy Soccer Physics. Left side: the set-up. Right side: the “crazy” physics of the avatars

the goal of winning as the main motivation. There were even two players who asked to play the game many times to compete expressing desire to reach fiero and failure experiences. None of the participants sought to jump just for the bodily stimulus (considered as “childish”).

The trampolines were the only bodily interaction option. Therefore, the players' jumping anticipated by the onscreen part of the game constituted the *kinetic joy ride* (see section 4.1). While the game progressed, the jumps became more intense either in the sense of being calculated (to trigger the avatar to move at just the right time), jumping a lot (as a “fire at random” kind of strategy) or jumping intensely. The players’ readiness to jump grew as they were getting closer to a result of either fiero or failure. We continue our presentation of practical examples by presenting an example of *at lege en leg*.

7.2 *At lege en leg* (To be “playful” in a “play”) – in Inferno

We use the example of Inferno [13,52,92] (figure 3) to describe *at lege en leg* (to be “playful” in a “play”). Inferno is an interactive performance with exoskeletons created by Demers [13] and Vorn [92]. We consider Inferno *en leg* (a “play”) because there are few rules and no irreversible outcome. In Inferno, the participants wore an exoskeleton on the upper body, which was controlled by a choreographer in real-time. The participants were able to twist their upper body and generally free to move their lower body around the room as far as the cables allowed. The event included a dystopian

Figure 3: “Inferno” participants’ upper bodies being controlled by exoskeletons.

atmosphere of loud electronic music, changing light settings and theatre smoke. Inspired by ethnographic methodology [22], we investigated the bodily play experience in Inferno in the form of self-reporting observation (as an audience), complemented by semi-structured, informal interviews [40] with 10 participants after the event asking about their bodily experience and motivation for participation. Just as with the Crazy Soccer Physics on Trampoline example, we here analyze the empirical data anew using the extracted definitions above. We do so to get an understanding of the bodily play experience in Inferno.

7.2.1 Analysis of the Experience in Inferno

The general reason for participation expressed by all participants was a curiosity of the unknown bodily experience. They wanted to feel what it was like to be controlled by another person through an exoskeleton. They all expressed exploration as the main driver. They said that it was fun to be thrown around and the tumultuous feeling from being partially controlled by external forces. Some found it both scary and fun at the same time. Furthermore, participants started experimenting with different bodily possibilities (twisting, bending, etc.) once they had overcome the initial adaptation to the new bodily situation.

In Inferno, the *kinetic joy rides* (see section 4.1) were formed by the imposed movements controlled by the exoskeleton, as was also expressed by the interviewees. The movements that were imposed on the participants from the exoskeleton together with the participants own movements created a sequence of movements that the participants experienced as almost "*ridiculous*", "*really surreal*", and "*fun to lose control*" with one participant even feeling dizzy at times. The (almost random) sequences of movements imposed by the exoskeleton stimulated the bodily perception with exploration to follow.

Figure 4: Move Maker elements: Proximity controlled mobile robot, laser lines, light cubes, music cubes and bodily precondition cards.

Thereby the participants' readiness to move around and do movements that they would not otherwise do, grew. Thus, we explain *at lege en leg* - to be "playful" in a "play" – pursuing bodily perceptual stimulation and exploration in a structure with few rules and no irreversible outcome (see section 5.2).

In the following section, we introduce how we interpret switching the verbs and nouns into *at lege et spil* (to be "playful" in a game) and *at spille en leg* (to be "gameful" in a "play").

7.3 *At lege et spil* (To be "playful" in a game) – in The Undie Game

This bears resemblance with the English "gaming the system". Besides that gaming, in general, entails an achievement, which *at lege* (to be "playful") does not, the English phrase is more about testing the system than bodily exploration and perceptual stimulation. In this perspective of *at lege et spil* (to be "playful" in a game), we describe the "Undie Game", a game in which the designers configured the controller to hint at bodily sense stimulation in, what we consider, a classical computer game. Because the game has a structure of "et spil" (a game), it already encourages *at spille* (to be "gameful") in the sense of achieving an irreversible outcome, while *at lege* in such a structure will entail focusing on bodily perceptual stimulation and exploration. We here describe how the designers reconfigured the controller to hint at bodily *at lege* (to be "playful") as a diversion of the game's core objective.

7.3.1 Analysis of the Experience in The Undie Game

The Undie Game [10,23] is a traditional computer game created by the Copenhagen Game Collective [10] using a traditional screen as visual feedback and a mouse as controller but with one significant modification: The mouse is built into the front of a pair of modified underpants, which the players wear (on top of their clothes) during the game (figure 5). It is a two-player game where the players feed a gigantic mouth with an unnaturally long tongue with food falling from above. We consider it *et spil* (a game) because it has fixed rules and an irreversible outcome; the player, who feeds the mouth the most within a given time frame, wins. However, maneuvering the dislocated mouse mimics sexual interaction with the vulva (the designers call this "queering" the mouse [23]). Referring to Loke and Robertson's "Moving and Making Strange" methodology [43] as covered in section 2, we argue that

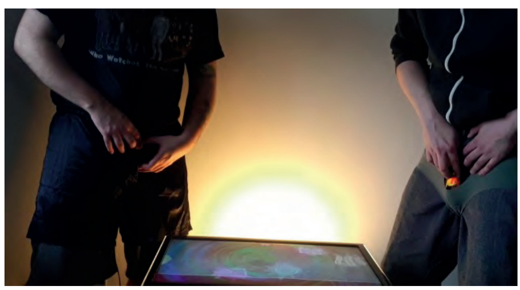

Figure 5: The dislocated mice mimicking interaction with the vulva in The Undie Game. Picture by Simon Nielsen.

because the mouse is dislocated onto the body to resemble, but not perform, a sexual act, players are presented with a new way of (bodily) interacting with the computer, which in turn encourages bodily awareness as a precursor to bodily exploration, e.g., men can explore the sexual act from a female perspective, and women can explore their genitals differently than during a sexual act. This way, the designers reconfigured the mouse to be a resource allocated from an instrumental activity to an autotelic activity [86].

While the gameplay is simply about feeding the mouth, the *kinetic joy ride* (see section 4.1) stems from stimulating bodily perception through the actions mimicking sexual interaction (as a sequence of movements) – and emphasized further by the long tongue onscreen. What enables the players (and audience) to perceive these actions as sexual is the macroperceptual (see section 4.2) dimension; besides perceiving the hint to bodily perceptual stimuli, we also perceive these actions to be of the specific social act, sex [74], and the culture thereof. This hint to experimentation with bodily perceptual stimuli made the audience respond with loud noise and great laughter at the presentation of the game at the conference [23]. While the structure of the game remains a game (*et spil*), the doing of *at lege* (to be "playful") is encouraged through the hints to bodily perceptual stimulation.

7.4 *At spille en leg* (To be "gameful" in a "play") - in The Move Maker

To demonstrate the perspective of *at spille en leg* (to be "gameful" in a "play"), we describe The Move Maker [48] (figure 6), a movement-based hybrid game system created by Matjeka [48]. While we consider The Move Maker *en leg* (a "play") – a structure of few rules and no irreversible outcome, the perspective of *at spille en leg* (to be "gameful" in a "play") is to focus on bodily achievements and skills in *en leg* (a "play"). In this example, participants will have to either determine an objective or goals or choose to follow suggested objectives and goals in a structure that is basically *en leg* (a "play").

Figure 6: *At spille en leg* (to be "gameful" in a "play") in Move Maker

7.4.1 Analysis of the Experience in Move Maker

The Move Maker is a system that players can play with as it is or they can use the included rulesets. The system consists of a set of elements (figure 4) containing sensors promoting bodily perception and exploration; light cubes, music cubes (with a fixed period of playing time) controlled by proximity sensors, laser lines ("lines" made from laser pointers connected to a brightness sensor), a mobile robot controlled by proximity sensors and a set of cards determining a bodily precondition as a temporary handicap (e.g. "your left foot cannot touch the ground" or "your right arm is glued to your back"). As such, there is no initial irreversible outcome and no rules to obey, but bodily perceptual stimulation – and room for exploration. To start an activity, players can choose to use any of the included rulesets: "get the robot through a maze of light cubes", in which the players collaborate to steer the robot around a self-created maze of light cubes, while adhering to a bodily precondition, or "get through the laser field" in which players have to climb and crawl to avoid the laser fields. Players can also choose to define the activity as they wish. Either way, they will have to create or follow objectives and possible outcomes. Hence, we consider Move Maker to be ***at spille en leg*** (to be "gameful" in a "play") because players are encouraged to create their own goals from a setting that initially is about bodily perceptual stimulation and exploration.

Players experience *kinetic joy rides* (see section 4.1) in Move Maker from movement sequences created by the applied bodily preconditions, a chosen objective, and how the players chose to allocate the different elements. In figure 5, the man and the boy are trying to get the robot through a maze of light cubes while avoiding the laser lines while the man's right foot cannot touch the ground, and the boy has the knee glued to the ground. This way, they test their bodily skills, and the design encourages achievements in a structure of *en leg* (a "play"). The open structure with no pre-defined outcome containing various sensory elements, invites players to define objectives and achievements. Whether the players *leger* (are "playful") or *spiller* (are "gameful") is up to the players. However, designers can apply strategies to design for each of these perspectives.

8 Strategies to Design for either of the Four Perspectives

In the following, we transfer our previous analyses of the four perspectives into design knowledge in the form of strategies for designers to apply in their design work. While the players individually apply their "doing" of *at lege* (to be "playful") or *at spille* (to be "gameful"), designers can support these or move a design in the desired direction through the design's structure and form elements. We explain these strategies by focusing on how the design's *structure* (objective and rules) and *elements* encourage bodily movement; as a way for *achievements and skills acquisition or testing*, or for *bodily perceptual stimulation and exploration.* These are addressed below for each correlation. While we draw on the examples described previously, we will, in this section, include other examples to underline our arguments.

8.1 Designing for *at lege en leg* (to be ”playful” in a ”play”)

When designing for a*t lege en leg* (to be “playful” in a “play”), the focus is on creating an open structure with objectives and design elements to stimulate bodily perception and exploration. In the following, we address such strategy.

8.1.1 Create Objectives Stimulating Bodily Perception and Exploration

A strategy to create *at lege en leg* (to be "playful" in a play") is to center the design's objective around sequences of bodily movements that require no or little skills but stimulates perception and exploration. The objective of the Inferno event was to be partially controlled by an exoskeleton, an objective that required few skills but was highly stimulating. Furthermore, there was no goal to achieve, and there were few rules to follow; the participants could leave whenever they wanted to. Bodily perceptual stimulation and exploration was further stimulated through the loud dystopian music, light show, and theatre smoke: Rhythmic music can function not only to stimulate the aesthetic and hearing sense, but also bodily movement [4,93]. The lightshow and theatre smoke helped facilitate the dystopian atmosphere through the visual and olfactory senses. Lastly, the exoskeleton was stimulating the kinesthetic and tactile senses and thus, encouraging *at lege* (to be “playful”).

8.2 Designing for *at spille et spil* (to be ”gameful” in a game)

In the following section, we describe our strategy to design for *at spille et spil* (to be ”gameful” in a game), in which the focus is on creating a structure with a clear objective to encourage bodily achievements and skill testing.

8.2.1 Create Objectives Based on Skills; Sequences of Movements for the Players to Master

Designers can design for this kind of experience by centering the design’s structure around an objective with a skill as a specific sequence of bodily movement to master. We demonstrated how players in the Crazy Soccer on Trampolines example were focused on winning as the irreversible outcome and applied different jumping strategies to achieve this. The skill to master was the trampoline jumping by applying the “right” strategy to control the avatars, and the irreversible outcome was winning – despite the avatars’ random feedback on their efforts.
However, the achievements as winning conditions in *at spille et spil* (to be “gameful” in a game) are adjusted to the individual player. An example of this is “Zombies, Run” (first edition) [1], a running game in which the players collect resources on their route based on different measurements related to their athletic performance. The players later use the resources to maintain their basecamp in the accompanying strategy game. The resources work as different kinds of feedback on achievements in the form of individual rewards instead of comparable results (to determine a winner). While running is the objective in Zombies, Run!, the resources support this objective in the form of elements providing feedback on achievements.
Another example of using technology to implement objectives for bodily mastery and skill acquisition is the WEARPG [6]. For this tabletop role-playing experience, wearables are used to implement bodily movement in the form of different minigames, with each corresponding to basic actions in the game such as swinging a sword or shooting an arrow. To play the minigames, the players use the Elemental Gauntlet, an arm-worn device to test their skills. This way of using physical movement to interact with a narrative-based tabletop role-playing game implements possibilities of bodily mastery and skill acquisition in an otherwise less movement-based game experience.
In the following, we describe the perspectives when switching the verbs and nouns opposite to the ones above.

8.3 Designing for *at lege et spil* (to be ”playful” in a game)

In *at lege et spil* (to be “playful”), the structure is that of *et spil* (a game), which basically encourages *at spille* (to be “gameful”). A*t lege* (to be “playful”) in *et spil* (a game) is then a kind of “going against” the structure. This bears resemblance with the English “gaming the system”. Besides that, gaming, in general, entails an achievement, which *at lege* (to be “playful”) does not. The English phrase is more about testing the system than bodily exploration and perceptual stimulation. In the following, we discuss how to design for this and argue that designers can facilitate this in the configuration of the elements in a design.

8.3.1 Implement Hints to Bodily Perceptual Stimulation and Exploration

Designers can use hints to different forms of bodily perceptual stimulation and exploration as we saw it in the Undie game to facilitate this bodily play perspective. In The Undie Game, the designers used the positioning of the computer mouse to the forefront of the underpants as a way to create different bodily perceptual stimulation in comparison to what regular usage would have done. In other words, they allocated the mouse from an instrumental activity to an autotelic activity. In this way, designers can use already implemented (or traditional) elements by either dislocating these or, in other ways, change their configuration to hint at perceptual stimulation.
The game Fortnite [85], which is a traditional computer game played using traditional controllers, also hints at bodily stimuli. The game does so in the dances that players achieve in the game. The players act these dances out in their physical lives as a way to communicate with other Fortnite players. We consider casual dancing to be *at lege* (to be “playful”) because the specific sequence in movements can facilitate *kinetic joy rides* (see section 4.1)[81], besides being stimulated kinesthetically by music [4,93]. Furthermore, in this case of Fortnite players’ dancing, the dancing functions as the “third” that socially and culturally connects the players [41,91].
Though the players do not physically exert the dance movements while playing Fortnite [85], we argue that when bodily exerting the dance moves outside the game, the players *leger* (being playful) Fortnite as a way of reproducing the avatar's movements. Calleja explains this phenomenon as

kinesthetic involvement [9]; players start to incorporate the game avatar's bodily movements as a consequence of their engagement in the game.

Another example of *at lege et spil* (to be playful in a game) is Beat Saber [28], a VR rhythm game where players slice boxes rhythmically to the music and get scores accordingly. While this game encourages bodily play by using music and rhythm to stimulate bodily perception, we consider it a game because of the fixed rules and the irreversible outcome of a final score. However, there is a twist incorporated in the score calculation: To score max points, the players must not only slice the boxes timely in rhythm, but must also exert excess body movements; they must continue the swing of the saber after slicing the box [24]. Because this feature is only perceivable through bodily exploration, this part of the game encourages *at lege* (being playful) once the players realize that there is more to the game than merely being timely. When players *leger et spil*, they perform actions in and from the game without any regard to the game's (*et spil*) irreversible and comparable outcome.

8.4 Designing for *at spille en leg* (to be ”gameful” in a ”play”)

To design for *at spille* (to be ”gameful”) in *en leg* (a ”play”) is to leave room for the players to achieve goals and test or acquire skills. As there are no predefined goals in *en leg* (a “play”), it thus encourages *at lege* (to be “playful”). Therefore, designers should leave room for the players to instate goals and possibilities to test or acquire bodily skills.

The structure in designing for *at spille en leg* (to be ”gameful” in a “play”) is an open structure leaving room for player definition of goals supporting that of *en leg* (a “play”). In this structure, the elements of the “design” support or encourage forms of bodily achievements or skills to test.

8.4.1 Include Possibilities for Bodily Achievements through Rulesets and Elements with Measuring Qualities

Designers can implement possibilities for bodily achievements and skills in a structure of *en leg* (a “play”) by either implementing various rulesets or elements containing qualities to measure time, distance, height etc.. In the Move Maker example, the included elements stimulated bodily perception; however, the system also contained several accompanying rulesets with irreversible outcomes. Also, players are encouraged to make rulesets of their own. In this way, the players choose how they want to experience Move Maker; as a straight *leg* (“play”) or for bodily skill testing and achievements. This perspective of *at spille* (to be “gameful”) can be further encouraged through elements with measuring qualities: In the Move Maker example, the music cube can function, for examples, as a kind of time measurement by only playing for a certain period, the laser lines can function as a boundary giving feedback when “broken,” the color of the light cubes can function as a collectible resource, e.g. collect all red cubes or turn a minimum five cubes blue.

Another example of using technology to encourage *at spille en leg* (to be “gameful” in a “play”) is Just Dance [90]. We consider the basic structure of casual dance to be *en leg* (a “play”) as there are few rules (except the socially and culturally defined) and no irreversible outcome, only the sequence of moving rhythmically to music. The game Just Dance [90] uses the interface of the console (specifications differ for each console) to measure the quality of each player’s movements against predefined dance movements. Thereby the game implements bodily achievements by focusing on dancing as a skill to master with feedback on the outcome.

9 Discussion: Transitioning Between the Different Experiences

Before concluding on this paper, we want to briefly discuss how players can transition between the experiences. We have explained how the two Danish versions of *at lege* (to be playful) and *at spille* (to be “gameful”), relate to the two different structures of “a game”, *et spil* (a game) and *en leg* (a “play”), resulting in four versions of "playing a game". Regardless of the structure, players can revert between *at lege* (to be playful) and *at spille* (to be “gameful”): some players *leger* (being playful) in the same game as other players *spiller* (being “gameful”), or players can revert between the two during a game. In Beat Saber [28] (section 8.3.1), players might start with a focus on bodily mastery wanting to achieve the highest score (*at spille* to be “gameful”) but end up being caught in bodily exploration of different rhythmic movements or only just moving to the music not caring about the outcome (*at lege* – to be playful). Likewise, participants in the Inferno event [13,92] (section 7.2) can start focusing on their bodily movements as a performance, which can be a measurable outcome (e.g. best performer), and compare these to the other participants' movements and thereby start to *at spille* (be “gameful”).

Contrary, the mere use of technology might encourage bodily exploration. In the example of WEARPG [6] (section 8.2.1), the use of technology combined with bodily movement can bring an awareness of the players’ bodily skills and abilities. This bodily awareness can temporarily lead to a new bodily perceptual stimulation and focus on bodily exploration when the players acquire the skills needed to gain mastery to win the minigames.

Finally, players can experience *at lege* (to be playful) and *at spille* (to be “gameful”) at different immersion levels: We exemplify this through Brown and Cairns’ Game Immersion model [5]; how players transition through three stages of immersion during gameplay (engagement, engrossment, total immersion). Regardless of whether the players *spiller* (being “gameful”) or *leger* (being playful), they can do so at each of the different levels. An athlete can be totally immersed and have no awareness of anything else when attempting to set a world record (*at spille*- focus on bodily skills and mastery). A player in Inferno is probably "only" at the engagement stage, being curious about what is going to happen when putting on the exoskeleton (*at lege* - focus on bodily exploration and stimulation) and then gets totally immersed once being moved to the loud music by the exoskeleton.

10 Limitations

The presented definitions of play and game in the form of the Danish connotations do not serve as exhaustive or mutually exclusive definitions but as guiding principles as we have interpreted these in the Danish language. As such, we have only dealt with a part of the differences in the Danish connotation. Therefore, the four perspectives are a first step towards understanding the relationship between bodily game and play experiences in terms of design construction and player "doing". Likewise, the presented design strategies represent a starting point for design and should be used in conjunction with other design tools. Lastly, many other aspects are not covered here. To name a few; other phenomenological perspectives such as computer game culture [38], or bodily perspectives; how body cultures affect bodily gameplay in different ways [17,18], as well as other linguistic connotations [19,29]. Nevertheless, we believe that our work contributes as a generative resource for future work of bodily play and game design within HCI.

11 Conclusion

In this paper, we investigated the Danish linguistic connotations of bodily "playing a game", because this phenomenon, differently from the English language, exists in Danish as two verbs and nouns, making up four different correlations. Through these investigations, we introduced the following four perspectives of bodily play and game experiences:

- *At lege en leg* (to be "playful" in. a"play"): Pursuing bodily perceptual stimulation and exploration supported by a structure with no irreversible outcome and few rules.
- *At spille et spil* (to be "gameful" in a game): Pursuing bodily achievements and skills supported by a structure of fixed rules accompanied by an irreversible outcome.
- *At lege et spil* (to be "playful" in a game): To "go against" a structure of fixed rules and an irreversible outcome and pursue bodily perceptual stimulation and exploration.
- *At spille en leg* (to be "gameful" in a "play"): To pursue bodily achievements and skills in an open structure with few rules and no pre-defined outcome.

From these definitions, we extracted a set of design strategies for designers to apply in their design work:

- *At lege en leg* (to be "playful" in a "play"): Create objectives stimulating bodily perception and exploration.
- *At spille et spil* (to be "gameful" in a game): Create objectives based on skills – sequences of movements for the players to master.
- *At lege et spil* (to be "playful" in a game): Implement hints to bodily perceptual stimulation.
- *At spille en leg* (to be "gameful" in a "play"): Include possibilities for achievements and skill testing through rulesets and elements with measuring qualities.

To arrive at these perspectives on bodily play and game experiences and subsequent design strategies, we examined the Danish connotations of the verbs; *at lege* (to be "playful") and *at spille* (to be "gameful") and their corresponding nouns; *en leg* (a "play") and *et spil* (a game). We did so by bridging the phenomenological and postphenomenological theories of bodily meaning-making as *kinetic joy rides* formed by *sequences of movements* that we are *ready to do* in *en leg* (a "play") and *et spil* (a game) as *objects for perception*, the something that connects us socially and culturally.

This paper is intended for researchers and designers with an interest in bodily play and game experiences. The descriptions and analysis presented in this paper serve as a step toward the understanding of the experiential dynamics in bodily play and game experiences and how to design for these in a design process. With this work, we hope we are able to expand the range of diverse bodily play and game experiences within HCI.

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CHI PLAY 2020

Best Paper Award

Presented to

Louise Petersen Matjeka and Florian 'Floyd' Mueller

For

Designing for Bodily Play Experiences Based on Danish Linguistic Connotations of "Playing a Game"

ACM SIGCHI Symposium on Computer-Human Interaction in Play

Virtual

2 - 5 November 2020

6.2 RC2: PRECONDITIONS AND CONDITIONS FOR MOVEMENT AS GENERIC MECHANICS CONSTITUTING BODILY PLAY EXPERIENCES

RC2 presents *Restraints* and *Paraphernalia*, generic mechanics supporting, facilitating and encouraging movement and bodily play, including definitions and design strategies. The design of *The Move Maker* is built from these mechanics. A game collection of 121 Euro games[11] (Møller 2000) was analyzed from the assumption that traditional games and play forms have been developed and refined throughout centuries (and millennia) and, therefore, contain valuable knowledge leverageable for digital game design. These mechanics were derived and refined in the reciprocal process of designing *The Move Maker* and concepts from phenomenology and game studies on movement, bodily experiences and play. As such, RC1 and RC2 present the theoretical backdrop upon which the design of *The Move Maker* rests.

RC2 comprise two papers, while RC1 comprised one. The two papers are described in each their section on the following pages.

11 The book's last edition is expanded to include 140 games.

6.2.1 PAPER 2 (P2): RESTRAINTS AS A MECHANIC FOR BODILY PLAY

P2 presents a basic mechanic for bodily play as it deals with the bodily preconditions for movement and, therefore, provides a theoretical answer to RQ1: *How can we describe generic mechanics facilitating and supporting playful bodily movement in theory and practice?* Furthermore, P2 also provides a range of design strategies for working with restraints and, therefore, provides answers to RQ3: *How can the design support variations in bodily movement and gameplay as the activities progress and develop?*

Presentation video: https://youtu.be/UJHZiZVJGpE

Louise Petersen Matjeka, Mads Hobye, and Henrik Svarrer Larsen. 2021. Restraints as a Mechanic for Bodily Play. In *CHI '21: Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, ACM Press, Online. DOI: https://doi.org/10.1145/3411764.3445622

This paper is not included due to copyright restrictions

6.2.2 PAPER 3 (P3): PARAPHERNALIA – THE SURROUNDING CONDITIONS AS GENERIC GAME MECHANICS FACILITATING BODILY MOVEMENT AND PLAY

P3 complements P2 by adding mechanics that facilitate and support bodily movement. As the paper states, a restraint in itself does not encourage or facilitate bodily movement. The two papers, P2 and P3, are derived from the same analysis, however, with different foci. P2 focuses on the player and their bodily preconditions, while P3 focuses on the surrounding conditions for bodily movement. Together, they present a range of mechanics that facilitate and encourage bodily movement in various combinations. Like P2, P3 provides a theoretical answer to RQ1: *How can we describe generic mechanics facilitating and supporting playful bodily movement in theory and practice?* Moreover, designers can draw from the content of P3 to design for and with paraphernalia. In this understanding, P3 also answers RQ3: *How can the design support variations in bodily movements and gameplay as the activities progress and develop?*

Link to the video:

Poster:

Louise Petersen Matjeka and Alf Inge Wang. 2022. Paraphernalia – Game Mechanics Facilitating Bodily Movement and Play. In In the Proceedings of the 2022 CHI Conference Extended Abstracts on Human Factors in Computing Systems, *ACM,* New Orleans, USA, https://doi.org/10.1145/3491101.3519702

6.3 RC3: THE DESIGN ARTEFACT AND ITS EVALUATION

RC3 presents the practical design work and its evaluation. The design of *The Move Maker* represents a practical exemplar of the theoretical foundations and mechanics explained in RC1 and RC2. In addition, the design comprises a modular structure adaptable to various situations as a response to technical and practical issues regarding appropriation of movement-based play and games in ordinary environments. Furthermore, the game is empirically evaluated and found constituting a pervasive interactive playground.

A note: While *The Move Maker* is designed from the mechanics previously described, the following papers' wordings might differ. Due to the different times of the papers' publications, these have been termed differently. To clarify any misunderstandings, the connections between these are listed here: *restrictions on bodily preconditions* refer to *restraints*, and *surrounding conditions* refer to *paraphernalia*.

6.3.1 PAPER 4 (P4): *THE MOVE MAKER* EXPLAINED

P4, including the accompanying video, answers RQ1 and RQ2 by providing a design artefact as a practical exemplar of the theories described in the previous sections. Specifically, it answers RQ1; *How can we describe generic mechanics facilitating and supporting playful bodily movement in theory and practice*? It does so by employing the mechanics and theories from RC1 and RC2 into practical – and playable – design. Furthermore, by providing a solution to the challenges, P4 partially answers RQ2; *What are some practical and technical challenges and subsequent solutions in designing movement-based play and games*? *The Move Maker* points toward a solution to such challenges in a configurable and modular system. The system is designed based on RC1 by supporting both goal-oriented and exploratory behaviour in different ways. Furthermore, the different game elements are chosen based on their qualities to infer restraints and paraphernalia. The practical and technological challenges for designing movement-based games are further described in P5.

Winner CHI 2020 Student Game Competition; Transgressive and Transformative Play

In addition, this submission includes a 4-minute video as part of the submission.

Link to the game video: https://youtu.be/5xQt7s5xNp0

Louise Petersen Matjeka, 2020. *The Move Maker – Exploring Bodily Preconditions and Surrounding Conditions for Bodily Interactive Play.* In the Proceedings of the 2020 CHI Conference Extended Abstracts on Human Factors in Computing Systems, *ACM, New York, NY, USA, 6 pages.* https://doi.org/10.1145/3334480.3381652

The Move Maker – Exploring Bodily Preconditions and Surrounding Conditions for Bodily Interactive Play

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Abstract
Interest in interactive bodily play and game design has increased during the last decade, often fueled by the medical industry's focus on exergames and a need for basic movement training. By dividing bodily interactions into bodily preconditions and surrounding conditions for interaction, Move Maker systematically explores basic bodily play dynamics in combination with digital interactive devices. This way, Move Maker offers a movement-based game system challenging basic movement abilities through bodily play explorations.

CHI 2020 Extended Abstracts, April 25–30, 2020, Honolulu, HI, USA.

ACM ISBN 978-1-4503-6819-3/20/04.
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Move Maker is designed for elderly people to play with their grandchildren (through a suite of ready to play minigames) and for designers and physiotherapists wanting to explore and develop novel bodily play constructions.

Author Keywords
Bodily play, movement based game design, embodiment, interaction design, exergame, game system, design game.

CSS Concepts
• **Human-centered computing~Interaction design~Systems and tools for interaction design**.

Introduction
Designing for bodily play in HCI is gaining traction [1,12] along the development of exergames in the field of serious games [9,11]. Also tools for innovating and developing novel bodily play experiences has been introduced to the field [13,14]. Move Maker, the game system presented here, is a contribution to this compound field of designing for bodily play and movement in HCI: A suite of movement-based games for elderly people to challenge their movement abilities, and a system for designers to systematically explore bodily play dynamics for digital game design.

Categories of Bodily Preconditions and Surrounding Conditions for Bodily Play

Preconditions:

1. *Fixation of body parts* (e.g. to a device (as in JSJ), the floor/walls, body part, other players etc.)

2. *Exclusion of body parts* (e.g. not to use feet to play the ball in handball and hands in football)

3. *Deprivation/manipulation of body senses* (e.g. the balance sense in BN, blindfolded, ears muffled etc.)

Surrounding Conditions:

1. *Designations or marking* of fields, zones, goals, mats etc.

2. *Objects* to avoid, collect, pass by, turn on/off, protect, get rid off etc.

3. Conditions affecting the *surrounding atmosphere* such as light, sound, smell, heat, outdoor/indoor, grass, etc..

In the effort of researching bodily play, Move Maker explores the bodily play dynamics arising from dividing interaction into *bodily preconditions* and *surrounding conditions* for interactions with a game system. It does so from the phenomenological understanding that bodily perception is active, meaning that bodily experience is not only affected by the thing with which we interact, but also by our bodily preconditions as the basis for our actions (before interaction) [15,18]. In a play perspective, bodily preconditions are instated bodily handicaps. These dynamics have not gained much attention in the field of bodily play and HCI yet, however, some significant work has been done.

Related Work with Playful Bodily Preconditions in HCI

Within the field of HCI and bodily play, Byrne [1] explored manipulating the balance sense (vertigo) in their Balance Ninja game [2]. Manipulating the balance sense is a way of altering the players' bodily preconditions for interaction in the game and thereby create bodily play. In the performance event Inferno, Demers and Vorn [4] explored controlling the participants' bodily preconditions for movement through an exoskeleton (on the upper body, the participants had full control over the lower body). The exoskeletons were externally controlled live by a choreographer. Die Gute Fabrik explored limiting players' bodily preconditions for movements in their game Johan Sebastian Joust (JSJ) [5]. In JSJ, players are to keep their move controllers "still" to the rhythm of J.S. Bach's Brandenburg Concertos music, while at the same time pushing or in other ways make the other players move their controllers beyond the allowed threshold. By narrowing down the allowed movement threshold of the move controllers, the players' bodily preconditions for actions in the game become limited and the bodily possibilities for interaction are altered. Such mechanics are also found in e.g. Twister [19].

Move Maker

Move Maker explores similar bodily play dynamics of limiting bodily preconditions for interaction and the emerging implications for bodily perception and subsequent perceived interaction possibilities. However, it does so systematically: It offers a system to apply any body part in question in combination with any of the categories of bodily preconditions (sidebar). From these categories any physical exercise can be analyzed and thus applied to the game (e.g. walking on forefeet = your heels are not allowed to touch the ground). Specifically, these are developed into a set of cards to be dealt during the game. Likewise, the things players interact with are categorized (*surrounding conditions* – sidebar). Through combining these elements with either a play-thing and/or a game objective, a system of (almost) infinite possibilities for bodily play is created. As such, Move Maker is both a suite of predefined movement-based games and a game system offering designers and physiotherapists a way to explore these bodily play dynamics systematically, separate and in combination designing for bodily play.

So far, five predefined minigames with a duration between 5-15 minutes are developed. Two of these are listed in the sidebar (p.5). Common for the minigames is that players end up in awkward bodily positions as a kind of bodily puzzles, where they have to solve how to move around anew while pursuing the game objectives.

Background and Purpose of Move Maker

The motivation for the design originates in the arising need to design balance training games for fall

Figure 1: Getting the robot through a maze while avoiding laser lines by collaborating.

Figure 2: Avoiding the laser lines and turning the light cubes red on the way.

Figure 3: The placement of the objects is variable to suit player abilities and preferences.

prevention. The target group is elderly people (60+), healthy but not used to regular physical exercise. Due to little bodily challenge in their daily lives, their movement repertoire narrows: Movement repertoire is a person's (individual) diverse set of movement abilities [16] e.g.; getting the head up and down, stand on one leg, stretching to the sides, etc.. Decreased movement repertoire leads to increased risk of falling because it leads to less confidence in own movement abilities and thus, less joy of movement with the consequence of less movement in general [Fuglem and Granbo, personal communication]. While the target group is (still) healthy, the main challenge then is to keep their movement repertoire active and diverse through joyful movement. A way to achieve this is by (gently) challenging the players' movement abilities. This is the goal for Move Maker; gently challenging the players' movement abilities through play and thereby maintaining their movement repertoire.

The Game Design Process

Move Maker was created in a Research through Design [7] process theoretically informed by phenomenology together with play and game theories along the practical design work.

The practical foundation for the game development is a set of exercises developed by physiotherapists especially for fall prevention [Fuglem, personal communication]. And, because most elderly want to play with their grandchildren, this was found to be a proper situation to design for.

Theoretical Grounding

A phenomenological perspective on bodily experience is that bodily perception is active [15]. In action and through our senses, we perceive the world and the elements of our equilibrium get reshuffled [10]. This creates a momentary disorientation onto a new orientation. In this process the body acquires new knowledge and skills [10].

From play and game studies, the game design of Move Maker has been informed by Suits definition of games as; "*unnecessary obstacles to overcome*" [17] and Caillois' similar definition of games constituted by "*arbitrarily chosen obstacles to overcome*" [3]. The viewpoint that play is driven by curiosity [6,8] has also guided the design process, as it is curiosity that bridges play and bodily perception: When the bodily equilibrium gets reshuffled by arbitrarily chosen and unnecessary obstacles, the body's curiosity is evoked in a kind of questioning like; "How can I overcome this?", "How will this feel?" "Can I do it?" [6].

Basic Bodily Play Dynamics in Ball Games

From the assumption that the ball is a very popular play technology yielding an infinite range of bodily play possibilities, ball games were found to be an ideal starting point to investigate basic bodily play dynamics. The guiding question was: What are the common denominators constituting this range of diverse (ball) games? With the sub-question: How can interaction with a ball yield so many different games?

From these investigations, three constituents emerged: 1. A plaything; the ball, 2. Players' bodily preconditions for action (often constituted by rules); bodily limitations such as in football (soccer), players are not allowed to interact with the ball using their hands (with some exceptions). This rule is reversed in handball. In tennis, the players use a racket for interacting with the ball,

Figure 4: Different precondition cards: left; *exclusion* of forefeet, middle; *deprivation* of sight, right; *fixation* of left knee.

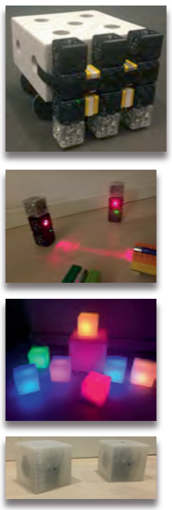

Figure 5: The play-thing and the surrounding objects: Laser lines, light cubes and music cubes.

similar to e.g. cricket, and 3. Surrounding conditions for interaction; markings of fields and zones, goals, grass lanes, indoor/outdoor etc. Both as single and combined elements these constituents create different obstacles to overcome and thereby constitute the defining part of a game's rules together with the objective of the game.

The Game System

The Move Maker system is made up of the three constituents as derived from ball games listed above; a plaything, bodily preconditions and surrounding conditions. The latter two elements are further divided into three categories each. These are listed in the sidebar (p. 2) and elaborated below.

Driving Robot as the Play-thing

The play-thing (figure 5) in Move Maker is a moving robot made of Cubelets from Modular Robotics and Modu® elements. Controlled by proximity sensors, the robot only drives forward and twists to the sides. The robot's functionality is deliberately kept simple just as the ball, albeit with digital interactive behavior. The play-thing can take on different functions; as a ball to score goals, a racing device, a thing to not be touched by or get through a maze, etc., or it can be left out.

Cards Instating Bodily Preconditions

The bodily preconditions are divided into three categories listed in the sidebar (p.2). These are developed into a set of cards (figure 4) in the following ways: To fixate a body part, the cards carry the phrase; "Your [body part] is glued to [??]", where the question marks are to be defined by the players (e.g. the floor, the cube, your leg etc.). Similarly, to exclude a body part; "Your [body part] is not allowed to [??]" (from touch the floor/play-thing, cubes or to control e.g. the play-thing etc.). To deprive a body sense, the cards carry phrases like; "You are blindfolded" or "Muffle your hearing". There are two levels of cards (figure 4); incomplete as in the previous examples and complete with full definitions (e.g. touch the ground). Lastly, "remove" cards are included for the players to be able to remove bodily preconditions as well.

Tangible Objects as Surrounding Conditions

Similar to the bodily preconditions, the surrounding conditions are divided into three categories (sidebar p.2). These are implemented in Move Maker by a set of interactive objects (figure 5). As argued below, these objects can take on functions from all categories, however, each group of objects is developed with the purpose of one category in mind. Objects included in Move Maker are: Laser lines, Light cubes, and Music cubes. The main idea behind these objects is that they are mobile to be distributed around the physical space.

Laser lines consist of laser lights in one end and a Cubelet brightness sensor connected to a Cubelet speaker (bipping) in the other end. When the line is broken, the speaker makes noise. These are designed to mark off the play space but can function as objects to avoid, jump over, limbo under or as collectable (break the line). The sound in the laser lines can also contain music affecting the surrounding atmosphere.

Light cubes (from Hippomini) are cubes that change color according to which side is down. These are initially implemented as objects to collect, avoid, change color etc. However, these can just as well mark off spaces or zones through their coloring; red or blue zone, or red = no entry, blue = only exit etc..

Minigame: The Maze

2+ players. Players collaborate to get the robot through the maze and change all light cubes' color to red. Make a maze by distributing the light cubes around the floor in different colors except red. Each player draws a precondition card (first card cannot be a remove card). For each light cube you pass draw a new card (remove cards apply).

Extra Rules
Use the laser lines as walls that neither you nor the robot can break.

Minigame: Get through the Laser Field

1+ players. Get through the laser field without breaking the lines. Create a field of laser lines in varying heights. Each player draws four cards. Apply a new for each line passed. Only one remove card is allowed to use at a time (each player has at least one bodily precondition).

Extra Rules
Place light cubes around and change colors on your way.

Music cubes add music to the game as a way to affect the surrounding atmosphere of the game while also being an object to interact with. The music is controlled by a proximity sensor that basically turns the music on for five seconds: one plays harmonics, the other the beat. So far, only music cubes are included in Move Maker, however, as objects affecting the games' surrounding atmosphere, cubes including smell (diffuser), or wireless light controllers can be added.

The Minigames' Gameplay
Players play the minigames just by following the rules. Each minigame has a set of extra rules to vary and advance the games. The extra rules also present alternatives as a way to kickstart the players own creativity and customize the minigames. It is the interplay between handicapping the players in arbitrary ways through bodily preconditions and the interaction with the arbitrarily distributed surrounding objects, that creates unforeseen bodily experiences. The randomness in the dealt cards together with different placements and characteristics of the objects combined with different game objectives, create infinite bodily challenges and thus bodily play possibilities.

Status of Move Maker
Currently, Move Maker is developed as a prototype and play-tested in the lab (figure 1,2,3). As an exergame, these playtests indicate a potential of fulfilling the criteria of challenging the players' movement abilities (head up and down, stretch to the sides, etc.). The long-term exercising qualities of developing and maintaining movement repertoire are yet to be tested.

Future Development
The suite of predefined minigames will be expanded, the cards will be further developed into difficulty levels accommodating different levels of bodily abilities, and the objects into single entities. Future development can include expanding the variety of objects or options to connect the various objects for more complex configuration (e.g. light cubes turn on/off laser lines).

Discussion and Conclusion

Analyzing Move Maker gameplay in the theoretical perspectives outlined earlier, the precondition cards create unnecessary and arbitrary obstacles to overcome encouraging player curiosity. The peculiar bodily positions created when the (bodily handicapped) players start to interact with the various kinds of objects in pursuing game objectives, creates a variety of different bodily puzzles to solve. In this situation the players' equilibrium gets reshuffled and creates possibilities for bodily play.

Move Maker is a suite of movement-based games with a potential of challenging the players' movement abilities while at the same time offering a system to explore and develop novel bodily play constructions.

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Move Maker Design Game:

Before playing, players agree on how to deal the cards, add objects, and the function of the play-thing or another objective to drive the game.

Dealing the Cards

The cards can be dealt in two ways: Either the dealt cards apply to all players, or to each player only. Maximum two cards can be applied at a time. Agree on when to deal the cards (on turn, on x achievement, etc.).

Adding Objects

The objects can either be added and replaced on turn, or the players can agree on setting up a playfield before playing.

Determine the function of the play-thing

As a scoring device (e.g. a ball), a final treasure to conquer (e.g. king in chess), or, leave the play-thing out and create challenges of only bodily preconditions in combination with objects.

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CHI 2020

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The Move Maker – Exploring Bodily Preconditions and Surrounding Conditions for Bodily Interactive Play

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6.3.2 PAPER 5 (P5): *THE MOVE MAKER* EVALUATED

P5 presents an evaluation of *The Move Maker* conducted during the first lockdown in Copenhagen caused by the Covid-19 pandemic. P5 contains a more wordy (as opposed to the video) description of the motivation and reflection behind *The Move Maker* design. Because *The Move Maker* was played in – and adapted to – people's everyday living environment without the presence of any researchers or designers, this paper provides a view into how the families appropriated *The Move Maker* to their homes and the activities unfolded. Moreover, P5 also describes a reflection and motivation for choosing the technologies used for *The Move Maker*. As such, P5 evaluates *The Move Maker* as a game system as well as the chosen technologies for the prototype and, thus, provides reflections of both challenges and solutions for such design. In doing so, P5 answers RQ2; *What are some practical and technical challenges and subsequent solutions in designing movement-based play and games*?

Louise Petersen Matjeka, Dag Svanæs and Alf Inge Wang, accepted for publication. Turning People's Homes into Interactive Pervasive Playgrounds during a Pandemic Lockdown. In (eds) Schrabel, Murnane and Andres *Inbodied interaction*. Human-Media Interaction, Frontiers

Turning Eight Family Homes into Interactive, Pervasive Playgrounds during the COVID-19 Pandemic Lockdown

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Word count: 13.089, 7 figures, 1 table

Keywords: Bodily Play$_1$, Movement-based Games$_2$, Social Play$_3$, Game Design$_4$, Pervasive Games$_5$, Interactive Playgrounds$_6$, COVID-19 Pandemic$_7$.

Abstract

This paper presents an evaluation study of how eighth families adopted, played and experienced a movement-based game system of analogue and digital technologies in their homes during a pandemic lockdown. The COVID-19 pandemic locked down many countries and grounded people in their homes with social and physical implications. A game system consisting of simple, tangible technologies with modular components was designed to meet these needs. The game system was developed for the players to set up in their homes easily and, therefore, should not depend on screens or extensive physical installations. The game system comprises simple, tangible technologies such as light and music cubes, a simple mobile robot, card game challenges, and a suite of mini-games combining the elements in a variety of playful experiences. Using the technology probes methodology, the game system was packed into a suitcase and evaluated by eight families that played the game in their homes, video-recorded their sessions, wrote a final report and were (informally) interviewed afterwards. The data set presents how the families turned their ordinary everyday spaces into interactive, pervasive playgrounds encouraging social and bodily exploration and play.

Furthermore, the study shows how bodily movement and social play can be promoted through different technologies that stimulate various bodily senses and incorporate them through the different game and play structures into their everyday living environments. The findings resulted in four design implications to aid designers and researchers in future work on movement-based game systems and interactive, pervasive playground design. These design implications accommodate social and bodily activities in ordinary places otherwise not pre-allocated for play or game activities.

1 Introduction

The design of movement-based games has increasingly attracted attention in the HCI community (Buruk and Özcan 2018; Byrne 2015; Höök 2018; Isbister et al. 2016; Matjeka 2020; F. 'Floyd' Mueller et al. 2018; Tennent et al. 2020). Different motivations exist for designing such games: exercising purposes (Matjeka and Svanas 2018; F. 'Floyd' Mueller et al. 2017; F. 'Floyd' Mueller and Young 2018; 2017), to augment player engagement in computer games (Bianchi-Berthouze

2013; Pasch et al. 2009) and to encourage joy and increase the amount of physical movement in our daily lives (Isbister et al. 2016; Márquez Segura et al. 2016). While movement-based games do not provide a solution to these problems, such games can provide a temporary frame for social and physical activities that permeate the boundaries of everyday life (Bateson 1972; Brown and Vaughan 2009; Caillois 2001; DeKoven 2013; Deterding 2009; Henricks 2015; Huizinga 2016; Stenros 2012) and thereby offer a different social and physical space in people's everyday lives (Deterding 2017; Eichberg 2010; 2016; Møller 2010)[1].

During the COVID-19 lockdown in Copenhagen, people were isolated and bound to their homes. These circumstances posed an immediate threat to public health in the form of lessened physical activity, leading to many lifestyle diseases and less social activity with consequences for mental health, as stated by WHO (WHO 2020). However, when the COVID-19 crisis hit the world, the development of a movement-based game provided a solution for promoting bodily movement while emphasizing social activities through bodily play and games designed to be played in people's homes. Furthermore, the qualities of promoting movement and social activities are also part of the inbodied interaction design area that focuses on these qualities in HCI design (schraefel 2019). As such, this study emphasizes a solution designed to make the players move (in little space), engage socially in new forms (play) and cogitate as the game challenges encourage not only physical movement but also the players' cognitive skills in solving unfamiliar challenges and the option to create their own games.

The ideal approach would be to intervene in people's own houses. However, due to the restrictions hindering researchers from entering homes and people leaving their homes, a technology probes approach was adopted (Hutchinson et al. 2003). Therefore, the game was boxed into a suitcase with manuals (see Figure 1) and a suite of five different minigames (Appendix) for people to play in their

Figure 1 Game elements; top left image: The moving robot, top middle: Restraint cards, top right: Laser lines, bottom left: Music Cubes, bottom right: Light cubes.

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[1] Movement-based games (and interaction) are games designed to promote physical activity by emphasizing the players' physical movement in the design (Pasch et al. 2009; Moen 2005; F. Mueller and Isbister 2014).

homes. The suitcases were delivered to eight families to play (in turn) in their homes during the lockdown.

This study focused on evaluating the game as a physical and social activity in people's everyday living environments (their homes), how the players adopted the system to their homes, and how the activities therein unfolded into bodily play experiences. There has been conducted (to our knowledge) few studies of adaptable interactive playgrounds and even fewer studies of how players play movement-based games in their homes. Thus, the results from this study can be valuable to designers and researchers interested in designing pervasive games systems for social and bodily play experiences.

Concretely, the following research questions were investigated:

RQ1: How did the players adopt the system to their homes?

RQ2: How do the activities unfold as bodily play activities – set out of the ordinary daily activities of the players' everyday living environment?

RQ3: What are the resulting game experiences as reported by the players?

RQ4: What can we learn about the design of the game system and its elements based on the answers to the above questions?

To answer these research questions, the families were asked to video-record their game sessions and, upon returning the game, to write a report answering a set of predefined questions. Furthermore, the informal conversations with the families when delivering and picking up the game provided additional data.

Methodologically, this study was conducted using a technology probes approach (Hutchinson et al. 2003) designed from the requirements mentioned above: adaptable to the players' homes while promoting bodily play and movement as a social activity, and then evaluated as such. For the design work, an experiential perspective to bodily movement, play and game activities (Gallagher and Zahavi 2012; Merleau-Ponty and Lefort 1968; M. Sheets-Johnstone 2003; 2013; 1981; Maxine Sheets-Johnstone 2014; Zahavi 2014) and a theoretical understanding of (interactive, pervasive) playgrounds as emerging spaces in which bodily and social play and game activities occur (Petersen 2014; Sicart 2014; Specht Petersen et al. 2018; Walther 2011) was adopted. For the evaluation part of this study, the empirical data consisted of video recordings (Buur, Binder, and BRandt 2000; Buur et al. 2010) with written reports and informal interviews (Holstein 1995; Kvale 2007; Lankoski and Bjork 2015) and analyzed as qualitative data drawing on, e.g., ethnographic methods for (game) design (Rooksby, Rouncefield, and Sommerville 2009), resulting in the discussion of four design implications leverageable for future designs.

The following section provides the theoretical background for the game design and previous research. The subsequent sections present the rationale behind the game system, the resulting game system, the research design, and findings, followed by a discussion of design implications, ending with a conclusion.

2 Background

This section looks at related work on interactive playgrounds and pervasive games to learn from these experiences and inform our game design. Specifically, this section describes theories on bodily movement and social interaction and how they relate to bodily play and game experiences and theories on playgrounds.

As this study focus on both technical and theoretical issues as two intertwining aspects of digital game design, this understanding is reflected in the composition of the sections throughout the paper – including this section. Hence, this section starts by reviewing previous work in the field and moves on to explaining the theoretical grounding of this paper.

2.1 Pervasive Games and Interactive Playgrounds in HCI and Digital Game Design

As movement is naturally embedded in the gameplay of pervasive games and interactive playgrounds, they are often tied to digital solutions to health benefits promoting physical movement and exercise (van Delden et al. 2017; Mattila and Väätänen 2006; Sturm et al. 2008; Tetteroo et al. 2014; de Valk, Bekker, and Eggen 2015). They also utilized pervasive and ubiquitous computing, including smart toys (technology-enhanced toys) and augmented table-top games (Magerkurth et al. 2005) and smartphones (Bell et al. 2006; Benford et al. 2006; Drozd et al. 2006; Peitz, Saarenpää, and Björk 2007) to accommodate play. While there are various definitions to pervasive games ranging from being explained by the technologies used (Björk et al. 2002; Magerkurth et al. 2005), to how these games differ from "traditional" computer games (Bell et al. 2006; Benford, Magerkurth, and Ljungstrand 2005; Montola 2009), there is less literature on interactive playgrounds. However, both terms are often described as bridging the digital and physical (Benford, Magerkurth, and Ljungstrand 2005; Mattila and Väätänen 2006; Tetteroo et al. 2014). The main difference between the two terms lies in that interactive playgrounds are often implemented by stationary technologies in large installations (van Delden et al. 2017; Mattila and Väätänen 2006; Specht Petersen et al. 2018), and thus define a specific space, while pervasive games utilize mobile and ubiquitous technologies and thus can be played anywhere, anytime (Benford et al. 2006; Benford, Magerkurth, and Ljungstrand 2005; Drozd et al. 2006; Magerkurth et al. 2005; Montola, Stenros, and Wærn 2009; Peitz, Saarenpää, and Björk 2007; Walther 2011).

Montola, Stenros and Waern (2009) define pervasive games as the magic circle. Further, pervasive games expand the magic circle in up to three dimensions; spatial, temporal, and/or social. The magic circle, a much-debated term in game theory (Rodriguez 2006; Salen and Zimmerman 2004; Stenros 2012), refers to the flexible boundary or invisible bubble emerging in play or game activities, allowing the players to make up the rules and define the activities as set out of the ordinary daily life.

Technology-supported games, coined by Waern, is a subcategory within pervasive games (Montola, Stenros, and Wærn 2009). Technology-supported games use technologies as part of the game world as a way to add "magic" and implement functions that "*superimpose the diegetic world on top of our everyday reality*" (Montola, Stenros, and Wærn 2009). In this regard, Van Delden et al. (2017) demonstrate how enticing – the use of non-functional rewards, e.g., aesthetic changes or additions, can promote physical movement and social interaction among children (van Delden et al. 2017). Moreover, technology-supported games are not defined by the technology but are either supported or experientially enhanced by it, i.e., often technology-supported games can be adapted to a version without the technology (Montola, Stenros, and Wærn 2009). Both pervasive and technology-supported games are different from interactive playgrounds as interactive playgrounds are often situated in pre-allocated spaces. Moreover, such systems are often sustained (rather than supported) by the technology, i.e., dependent on calculations, state changes, and other measurements to function and progress.

Within the development of interactive playgrounds, Mattila and Väätänen (2006), designed the programmable playground Ubiplay, for which the players can design their own games to play in the digital environment. In the area of design, Tettero et al. (2014) investigate traditional children's play to create a design taxonomy as the basis for their (stationary) playground design, while Sturm et al. (2008) highlight a set of general key issues (social interaction, simplicity, challenge, goals and feedback) for the design of interactive playgrounds (Sturm et al. 2008). While these contributions bring valuable knowledge to the field of interactive playground design, they tend to focus on predetermined stationary installations requiring advanced equipment (that the players would not be able to handle on their own) and a pre-allocated physical space (van Delden et al. 2017; Mattila and Väätänen 2006; Sturm et al. 2008; Tetteroo et al. 2014). In contrast to these constraints, our game system emphasizes the quality of pervasiveness as the ability to adapt to different physical places and expand the magic circle in various ways, primarily spatial and social – instead of complex technology-sustained systems designed for a pre-allocated place.

2.2 Social and Emergent Play in HCI

Within studies of social play, De Valk, Bekker, and Eggen (2015) demonstrate how social interaction is facilitated through three stages in open-ended environments – invitation, exploration, and immersion and how players transition between these stages throughout play (de Valk, Bekker, and Eggen 2015). Mueller et al. (2017) present the idea of bodily interplay (the players' social interaction) as parallel and interdependent play. *Parallel play* is activities that could be played alone but are played as a shared session. In contrast, *interdependent play* is activities where the players rely on each other either by playing against each other or collaborating. In the context of pervasive games and interactive playgrounds, where interactive playgrounds tend to be bound to a physical location, the activities therein are naturally co-located and, thus, encourage social play in either parallel or interdependent form. However, as pervasive games have the inherent quality of expanding the magic circle, pervasive games "invite" any person (or animal) who accidentally appears physically within the magic circle into the activity. In other words, a pervasive game has the advantage of "accidentally" inviting outsiders into the activity because it expands spatially and socially, i.e., moves around, which the interactive playground does not – because of the pre-allocated space.

Furthermore, in this study of creating play spaces in spaces initially allocated for other purposes, the concept of emergent play is relevant. Emergent play refers to the kind of immediate play (Pichlmair, Mech, and Sicart 2017) that emerges and develops from a situation – often in combination with the allocation or change in use of resources into the play activity that is initially intended for utility use – to use Suits (Suits 1978) understanding. Emergent play in HCI also refers to the appropriation or change of the technology to suit the play activity, as Desai et al. (2019) point out. Emergent play can be linked to coincident play (Wirman 2021) that provides an analytical frame to distinguish play activities in urban spaces from non-play activities, as well as the concept of bodily play as bodily exploratory and experimenting without a set goal as described by Matjeka and Mueller (2020) in the following section.

2.3 Bodily Play Experiences

Bodily play experiences are rooted in bodily movement, and perception and our ability to navigate these. Sheets-Johnstone (2013; 1981; 2014) explains how play and bodily movement connect into kinetic joy rides, as the synergy of sequences of movements perceived as one experience.

Furthermore, Sheets-Johnstone (2013; 1981; 2014) explains how the movement sequences are based on our movement repertoire as a repertoire of “I can’s” (a term she borrows from Husserl (1982)) as our bodily abilities (M. Sheets-Johnstone 2013; 1981; Maxine Sheets-Johnstone 2014). Bodily movement is our mother tongue, our first and universal language and primary way of understanding the world (M. Sheets-Johnstone 2003; Maxine Sheets-Johnstone 2007). Through our bodily understanding, we can understand and interact in the world, physically and socially, in what Merleau-Ponty (1968) introduced as inter-corporeality and further developed by other phenomenologists (Moran 2017; Weiss 1999).

Inter-corporeality seeks to explain how we, pre-reflectively, can bodily connect and behave with other people (Gallagher and Zahavi 2012; Merleau-Ponty and Lefort 1968; Whitehead 2005; 2010). Recent phenomenological theories rely on the neuroscientific discovery of mirror neurons to explain this phenomenon (Gallagher and Zahavi 2012; Moran 2017). Mirror neurons are activated in the sensorimotor parts of the brain[2] when we experience action and emotions in ourselves and others and is in recent phenomenology linked to the human ability to feel empathy (Gallagher and Zahavi 2012; Zahavi 2014). Inter-corporeality is grounded in our corporeality (explained above as bodily movement and perception). Through a process with the mirror neurons, it enables us to bodily perceive and understand (pre-reflectively) the corporeality and bodily intentions of the ‘other’ (Gallagher and Zahavi 2012; Zahavi 2014) and thus move together, bodily relate to one another and also collaborate (pre-lingually) on a common bodily goal. Hence, the inbodied interaction’s emphasis on *cogitate* as described by schraefel (2019): “[pre-reflectively] *move from novel to familiar*”.

In designing for bodily play experiences, Matjeka and Mueller (2020) unpack how playing a game, as conceived in the Danish language, entails two different attitudes with two corresponding game structures. The attitudes are a) *lege* (being bodily playful), referring to play as an attitude dominated by exploration, experimentation and bodily perceptual stimulation without regard to a specific outcome, and b) *spille* (being bodily “gameful”), which refers to the bodily stimulation caused by gaining results as either skill acquisition or tests of skills and bodily abilities. These two attitudes correspond to two different structures of a game respectively: *en leg* (a “play”) – which we know from open-ended play, and *et spil* (a game); a set structure with predefined rules and a clear and irreversible goal. Designing *en leg* is to design an open structure with no predetermined outcome for the players to continuously define and redefine by negotiating and collaborating throughout the activity. Designing *et spil* is to design a complete structure with a predefined outcome, not necessarily in the form of a winning condition, but as a determinant condition for the activity in either testing or developing bodily skills and achievements. To support this claim, Segura et al. (Márquez Segura et al. 2013) concluded that the role of the chosen technology in a design for bodily play experiences (as co-located play) is a central design issue in how designers can use technology; as a “referee” of determining a winner, or as giving “broken” feedback, which the players can interpret more loosely. Having the technology as a “referee” will, in Matjeka and Mueller’s (2020) view, be designing toward *et spil* (a goal-oriented activity), while emphasizing a design’s “broken feedback” seems to be up for negotiation and interpretation by the players, hence designing toward *en leg* (exploration in an open structure). Matjeka and Mueller (2020) highlight how players have different foci for engaging in bodily play experiences and how designers can facilitate such foci by incorporating both strategies (*et spil* and *en leg*) into the design. This division of and viewpoint on

[2] Mirror neurons are also activated in other parts of the brain, i.e., Broca’s area associated with language. For a fuller account, see, for example (Grèzes and Decety 2001)

how play can unfold into different experiences is found similarly in work on playgrounds and pervasive games (Sicart 2014; Walther 2011).

2.4 Defining the Notion of an Interactive, Pervasive Playground

In his book, Play Matters, Sicart (2014) distinguishes between play spaces and game spaces in the chapter on playgrounds. He explains: "*A play space is a location specifically created to accommodate play but does not impose any particular type of play, set of activities, purpose or goal or reward structure*." He goes on to explain his take on game spaces: "*A game space is a space specifically designed for a game activity. The size, measure, props, and even location are all created with the purpose of staging games.*" Game scholar Walther (2011) provides a similar take on the differences between play spaces and game spaces. However, in particular regard to pervasive gaming in game spaces, the player moves according to fulfil a task to get a result, whereas, in a play space, the player moves to explore the space and discover new stories. Both descriptions of play and game spaces are comparable to the terms of bodily play vs game proposed by Matjeka and Mueller (2020) above. Thus, we can say that the structure of *et spil* pertains to a game space as a designated space for an activity focused on achievements. In contrast, the structure of *en leg* pertains to a play space as an emergent space in which exploration and bodily stimulation are the dominating foci.

In line with these arguments, recent research investigating the design of playgrounds concerning play styles suggests that contrary to being one space, a (traditional) playground consists of several minor spaces. These minor spaces can be seen as an assembly of architectural elements, where each element constitutes its own space, e.g., a swing, a rollercoaster, climbing frame, etc. Like this, a playground can foster both play and game spaces, depending on whether the players *leger* (are being playful) or *spiller* (are being "gameful"). As such, we can say that a playground is a space constituted by minor play and/or game spaces fostering play and/or game activities fuelled by the elements present at the time. These elements can be designed for play (Petersen 2014) as we know it from traditional playground designs, or players can allocate other available elements to fit the activities (Suits 1978). Whether the elements are designed for play, like toys (Sicart 2014), playground elements (Specht Petersen et al. 2018), or they are initially intended for other purposes, in play, elements shift roles and purposes as the activities progress (Suits 1978). Therefore, we regard these as multi-stabilities (Ihde 1999; Rosenberger and Verbeek 2015).

Multi-stabilities is a theoretical concept from post-phenomenology referring to how the perception of technology can change depending on the context of use (Ihde 1999; Rosenberger and Verbeek 2015). In the area of play, Suits (1978) refers to how elements, which were initially intended for an instrumental activity, are allocated autotelic activities in playing (he uses the word resources, which also comprises, e.g., time). In this regard, anything can be allocated for play; an armchair can be perceived as a climbing frame or a brightness sensor in a sofa connected to a laser pointer on a bookshelf can be perceived as an alarm field to avoid while trying to move around it (see Figure 3).

To sum up: An interactive, pervasive playground is an assembly of allocated resources (i.e., multi-stabilities) that – alone or together – encourage and foster either game or play spaces – or both. While the choice of technology and design can support and enhance either type of space, these emerge from the players' attitudes of playing or gaming – as explained in the previous section.

3 Designing a Movement-based Game Adaptable to People's Everyday Living Environments

The final design originates in a Research through Design in HCI (RtD) process of exergames focusing on fall (Zimmerman and Forlizzi 2014) prevention[3] for elderly people (65+). It emphasizes autonomous play-at-home interventions as part of the EXACT project. The game system initially targeted social play between elderly people and their grandchildren. However, as the circumstances of the Covid-19 crisis banned the assembly of elderly people and their grandchildren and evaluation of the system, the focus changed to target families and indoor social and physical playing. While there were no overall changes to the design and choice of technologies or the system, the adjustments were mainly in designing and formulating the minigames. These were the least developed part as they were deliberately kept as open structures to be adjusted and changed during a lab test. Furthermore, the focus was on packing a suitcase to contain all necessary equipment for the families to run the game sessions alone.

The design process went through a chain of considerations for the choice of technologies and to settle on a flexible structure in terms of size, range, and fitting to people's varying housing and furnishing. Furthermore, the technology had to be easily configurable for all ages to operate and set up the game. While movement-based games can have different foci, ranging from rehabilitation purposes (Skjaeret et al. 2016; 2015) to optimizing physical training (Endomondo LLC Under Armour 2009), they are often not designed to be played at home by the entire family. This is either because they require assistance from a physician or physiotherapist (Tobaigy et al. 2018), or they are designed to be played outdoor (Alderman and Levene 2012; Benford et al. 2006; Endomondo LLC Under Armour 2009). However, the specific requirements for the design included that the game had to be autonomously playable by the players, adaptable to the various conditions of their homes, and at the same time promote physical and social activities.

One of the main requirements was for the game to promote physical activities that could be performed indoors and at the same time be sufficient to maintain physical health. For example, keeping a light physical activity level for approximately 30 minutes (preferably) a day can be sufficient to maintain physical health (WHO 2020). Light physical activities are, e.g., going for a walk (not strolling), house cleaning, or bicycling to and from work ('Sterk og Stodig -' 2020). Moreover, the kind of movement in the activities should include movement diversity (Whitehead 2005; 2010), e.g., stretching to the sides, moving up/down from the floor, and cross-coordination from one side to the other ('Sterk og Stodig -' 2020), basically doing movements that gently challenge our movement repertoire – our bodily abilities (M. Sheets-Johnstone 2003). Besides training and maintaining the basic muscular and skeletal systems ('Sterk og Stodig -' 2020), these diverse movements[4] also stimulate the nervous system and, thus, essential brain training (Bushman 2012). Thus, we chose to design for light physical activities and a significant degree of movement diversity.

As a family game (either of grandparents or parents and children), the final design facilitated multiplayer games from two or more players. Furthermore, to satisfy the different age groups and members in a family with children, the game had to facilitate play and game spaces by facilitating a wide variety of play forms (Matjeka and Mueller 2020). The game had to encourage bodily exploration and experimentation and options for bodily achievements and improvements while also

[3] Falls due bad balance (decreased physical movement) have been determined as one of the main factors to elderly people's health decline ('Sterk og Stodig -' 2020).

[4] Basic balance training movements, including cross-coordination, are also neuro-motor training, which is movements that stimulate the nervous system – and thus the functioning of the brain (Bushman 2012).

offering spatial flexibility and adaptation opportunities. Therefore, the choice was to design a technology-supported game system, taking advantage of such games' qualities. Furthermore, framing the design as a system of games and play qualities rather than one fixed game structure added options to accommodate the flexibility that the different indoor environments, age groups, and possible play and game preferences and situations required by facilitating different structures. This choice is further explained in the following section.

4 A Pervasive Game System in a Suitcase

The choice of designing a technology-supported game system and focusing on using pervasive, tangible technologies also helped to avoid the limitations of console games and interactive playgrounds (Mattila and Väätänen 2006; van Delden et al. 2017; Sturm et al. 2008). While these game forms promote physical and social activities in many instances, there are some limitations. For example, console games require accompanying controllers and a large screen with a designated physical space for movement in front of the screen. These requirements pose some immediate implications: The players are bound by the location and available space in front of the screen, implicating their physical movement possibilities; they have to face the screen to follow the game, a condition which limits physical movements like twisting and turning around, facing backwards, or moving up and down.

As indicated previously, designs of interactive playgrounds require advanced equipment like projectors and large screens (Mattila and Väätänen 2006) and a physical place of a specific size for a stationary installation (van Delden et al. 2017; Mattila and Väätänen 2006; Tetteroo et al. 2014). On the other hand, pervasive games promote physical and social activities (Tobaigy et al. 2018; Björk et al. 2002) with renowned games like Pokémon Go (Wang 2021) and Zombies, Run! (Alderman and Levene 2012). While these games do not bind the players to a specific place in their homes, such games are based on GPS tracking not being suitable for indoor playing. Doing so was not possible nor recommended during a pandemic lockdown. Thus, the choice was to focus on technology-supported play with simple, pervasive, and tangible technologies with no screen, GPS, or demand for extensive physical installations. The aim was a game system accommodating an interactive, pervasive playground that the players would be able to set up and adapt to their homes, no matter their technical skill level, the furnishing or room size of their homes.

4.1 The Suitcase

To meet the requirements outlined above, the result was a modular game system consisting of different elements (Ihde 1999; Rosenberger and Verbeek 2015). The elements and technologies were chosen to add magic (Montola, Stenros, and Wærn 2009) and aesthetic rewards (van Delden et al. 2017) by stimulating bodily senses. Furthermore, as bodily perceptual stimulation also encourages being playful (Matjeka and Mueller 2020), the elements were chosen to stimulate a range of different senses. Furthermore, the elements work as multi-stabilities in the game, i.e., each element can have different roles, e.g., the laser lines can be used to mark off a space. At the same time, they can also constitute gameplay as a laser field to pass through.

The following sections explain how the elements function as standalone devices, while the minigames define the elements as part of a system. The game system was packed into a suitcase containing the following elements (see Figure 1): ten light cubes, four laser lines (laser pointer + brightness sensor), two music cubes, a moving robot, three sets of restraint (Matjeka et al. 2021) cards and a camera.

4.1.1 Laser Lines, Light Cubes and Music Cubes

The *laser lines* consist of four laser pointers and four brightness sensors, each with a speaker. They form lines by pointing the laser into the brightness sensor. When this line is broken, the speaker plays a beeping sound. The laser lines are included because they stimulate the kinaesthetic sense in that the players must avoid breaking the lines with implications for the hearing sense.

The *light cubes* (see Figure 1) change colour according to which side is facing down. They have five different colours; red, blue, green, yellow, and purple. There are two sizes; 8 small cubes (diameter 7.5 cm) and two big cubes (diameter 15 cm). The light cubes stimulate the visual and tactile senses.

The two *music cubes* (see Figure 1) form a beat, with one playing the rhythmic part and the other a harmonic part. The harmonic part is designed to fit the beat part, ensuring that these two music parts always sound good together. The cubes are instantiated by a proximity sensor and play music for approximately 5 seconds (equivalent to two bars of a 4/4 beat in 100bpm) – then the players need to instantiate it again. The music cubes were developed to stimulate the hearing and kinaesthetic senses from the rhythmic pattern (Witek et al. 2017).

4.1.2 The Robot

A *robot* is included in the system as a moving entity as none of the other elements can move independently. Three individual proximity sensors connected to a motor/wheel unit control the moving robot (see Figure 1). Each pair of sensor and motor/wheel parts can only move forward. However, activating the left set will only move the left set as the sets are not connected. Because the other sensors are not activated, their corresponding wheels are not driving but instead "stopping" the forward movement - and consequentially twist the robot to the right. Activating only the right pair will twist the robot to the left while activating only the middle - or all - will move it forward at different speeds (see Figure 1). The robot does not move very fast and is included as the game's "plaything" like a ball in ball games (Matjeka 2020).

4.1.3 Restraint Cards

The *restraint cards* are based on the restraints (Matjeka et al.2021) mechanic inferring restrictions on the players' bodily preconditions for action as part of the game's obstacles to overcome (Caillois 2001; Suits 1978). There are three types of restraints: *exclusions* of body parts, *fixations* of body parts, and *deprivations/manipulation* of bodily senses. The cards are created from combining the three types of restraints with a body part; the two first types are combined with the body parts; legs, arms, feet, forefoot and heel, hands, elbows, shoulders, head, and the latter type is concerned with the bodily senses; vision and hearing. From these combinations, the cards formulate a restraint in combination with a body part for the players to adhere to while playing, e.g., "*Your right arm is glued to your back*" or "*Your right foot is not allowed to touch the ground*" (Matjeka et al. 2021). These cards help create the games' bodily challenges as bodily puzzles to solve, e.g., *move the robot when your feet cannot touch the ground*. The players draw cards upon beginning or during the activity, either by complementing or replacing a previous restraint. They can also choose to leave out the cards. The cards stimulate the kinetic and proprioceptive senses.

4.1.4 A Suite of Minigames - Rules

The suitcase also contained a *suite of minigames*. These were described in a booklet of rules. An example of a minigame: Collaborate to get the robot through the maze of light cubes. In this game, the players create a maze on the floor using the light cubes. Each player draws a restraint card. While adhering to the handicap, the players hold hands and collaborate to get the robot through the maze.

When the robot reaches a light cube, the player turns the light cube red. For every cube the robot passes, the players exchange their restraint card with a new card. Figures 4 and 6 illustrate instances of this game. For more games, see Appendix.

4.2 Combining Off-the-shelf and Tailor-made Devices

Most of the elements in the system are off-the-shelf products already available in existing products. Practically, these elements were more accessible and already thoroughly tested in terms of usability and durability. Only the music cubes are own production. The light cubes are sensory construction blocks from tts[5], developed for sense stimulating play for pre-school children. The moving robot consists of a Modu[6] element with a "motor" and sensors built from Cubelets[7]. Likewise, the laser lines are made from regular laser pointers in a mobile phone stand with a "receiving tower" assembled by a brightness sensor and speaker from Cubelets[8]. The cards are homemade cardboard cards.

5 Research Design

Our study was inspired by studies using a cultural probe approach (Mols, Hoven, and Eggen 2014; Ståhl et al. 2009; Zijlema, van den Hoven, and Eggen 2019). However, our study design differs from Gaver and Dunne´s (1999) original use of cultural probes in not only documenting people's everyday life and their use of technology they have but intervening by asking them to try out a game system in their home environment. While probes originally were intended to explore a design space and facilitate an open dialogue between the users and researchers (Boehner et al. 2007; Gaver and Dunne 1999; Wallace et al. 2013), our design was already stable and needed evaluation of ideas instead of exploring potentials. Thus, the probes as a method were adopted for data collection while not fully adopting the original methodology – which is to explore a design space and enter in dialogue with the users as a co-designing practice (Boehner et al. 2007; Wallace et al. 2013). The probes approach was used for information rather than inspiration (Boehner et al. 2007).

5.1 The Game System as a Technology Probe

Concretely, the Technology Probes (Fitton et al. 2004; Hutchinson et al. 2003) approach was adopted. As introduced by Hutchinson et al. (2003), technology probes "*combine the social science goal of collecting information about the use and the users of the technology in a real-world setting, the engineering goal of field-testing the technology, and the design goal of inspiring user and designers to think of new kinds of technology to support their needs and desires*". Our study fits this methodology in that we wanted to explore how movement-based play and games can lead to more joy and social togetherness to anticipate possible health-related complications in this regard. Similarly, Desai et al. (2020) applied off-the-shelf products as probes in their study of how people with dementia interacted with mixed reality technologies.

The "engineering goal" was to evaluate how the players adopted the system to their everyday living environments, i.e., their homes, and the design goal was to see how the system as a game system

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[5] (TTS 2019)

[6] ('Life-Size Buidling Toys for Active Play' 2020)

[7] ('Https://Www.Modrobotics.Com' 2020).

[8] ('Https://Www.Modrobotics.Com' 2020)

fostered different forms of play and game activities and to be inspired for “new games and play structures with the system”. However, our design emphasis was on evaluation rather than generation. With this adaptation, the research questions considered these three aspects: RQ1 is concerned with the engineering goal of field-testing the system, RQ2 and RQ3 are concerned with the social science part of the study. In contrast, RQ4 is concerned with the design aspects described as design implications.

5.2 The Resulting Research Design

The resulting research design was thus a qualitative study where data collection consisted of using technology probes (Hutchinson et al. 2003), in combination with ethnographic methods and approaches such as observation and video-recording (Blomberg and Burrell 2012; Buur et al. 2010), formal and informal interviews (Holstein 1995; Kvale 2007) (in the form of notes constructed afterwards) – inspired by ethnographic fieldwork methods (Blomberg and Burrell 2012; Nardi 1997)) and written reports (Mason 2017) as complementary methods. As such, this is a qualitative inquiry into how a specific game design was adopted, played, and experienced in a home setting.

5.3 Participants

Eight families were recruited via Facebook from personal and professional networks. All families lived in Copenhagen during the national lockdown due to the Covid-19 pandemic from April to June 2020. Seven of the families had two adults, and one had one adult. The adults were all in their thirties and forties. The average number of children per family was two, with ages ranging from five to sixteen. Due to the recruitment method, the level of education for the participants (the parents) was significantly higher than the average for Denmark.

5.4 Equipment and Probe

A video camera was included in the suitcase for the participants to make recordings of their use of the system and a paper form to fill out as a written report besides the game system and user manuals. The equipment in the suitcase was sufficient to run the game, including chargers to charge the game elements. The questions in the form covered both game use and game experiences.

5.5 Informal Interviews During Delivery and Pick-up

The game was brought to and picked up from the families’ homes. As this study was interested in knowing about the families’ adoption of the game system and the actual play activities with the system, the game system was brought to the families with no hard time limit. The families needed to have time to become familiar with the design and not only play the game once. Furthermore, we found this opportunity for the families to become familiar with the game to be one of the benefits of the probe’s methodology compared to, e.g. lab tests where players most often play the game once. The agreement was that the game would be picked up when the families had tried it out, however, within 2-3 weeks as there was only one instance of the game system. However, one family requested to have the game for four weeks, which was accommodated. Although some families expressed a desire to keep the system for longer, it was assured that they all had had time to adopt the game, become familiar with the elements and try the system in various set-ups. One family had even misplaced one of the laser lines in the children’s Lego box when they returned the suitcase.

Because there was only one instance of the game system (the suitcase), the evaluations were carried out in sequence. Although the pandemic put substantial restrictions on face-to-face contact, the national regulations allowed for short outdoor encounters as long as a two-meter social distance was kept. As we were not allowed to enter their homes, introductory information about the game and the content of the suitcase was given upon deliverance. Informative conversations with the families (both parents and children) about their game experiences took place upon pick-up. Furthermore, following the national pandemic recommendations, the game system and video camera were thoroughly disinfected between evaluations.

5.6 Gameplay Duration and Recorded Time

There was a significant difference in time spent playing the game and having the game at home between the families. While the average time with each family was four days, it spans two to fourteen days. One family had the game for two days and provided more than four hours of video. Another family had the game for fourteen days and never got to play the game but only played with the elements (and no video recorded). This latter case was a single parent, and the time also spanned the time that the child was at the other parent's place.

The recorded gameplay time was approximately 1,5 hours for each family with a range of no recorded data (one family) to more than four hours of data (two families). However, this does not include time to set up and to learn the game. The families reported the overall playing time (also the non-recorded playing time) to span between two hours and two days – where the latter covers the time the game had been set up in their home and ready to play – but not played all the time.

5.7 Analysis Process and Methods

While we appreciated the benefits of a probes approach, such as getting an insight into the practices of people's homes (though not everyday practices because of the unusual situation) and seeing their (almost) uninterrupted interpretations and appropriations of the game system, the drawback of the approach is that the quality, type and amount of data is uncontrollable and return as inconsistent, unclear and at times omitted (Boehner et al. 2007; Gaver and Dunne 1999). While this is a trade-off between the various study approaches, it also influences the analysis of the data, which will – eventually – also entail a degree of interpretation by the researchers. As Boehner et al. (2007) also states, probes is a relational methodology, comparable to ethnographic methods for design inquiries (Blomberg and Burrell 2012; Buur et al. 2010), where the analysis and thus assessment of the results is partly based on the researcher's subjective interpretation and experience as well (Dourish 2006).

When analyzing the videos as ethnographic data (Nardi 1997), we also used ourselves as instruments to make assumptions about the quality of the interaction between the participants and the resulting user experiences. Svanæs & Barkhuus (2020) pointed out how second person analysis of past interactions give added value to video analysis, although it introduces some validity issues. Nevertheless, as probes studies draw on ethnographic methods and entail some subjectivity (Boehner et al. 2007), we found this method informative. Thus, to analyze the data, we drew on ethnographic methods (Nardi 1997), a second person perspective to experiences (Svanæs and Barkhuus 2020), as well as open coding to assess recurring patterns and themes for later comparison across data sources (Sharp 2007).

5.8 Coding the Data

The data analysis process started with an open (inductive) coding looking for recurring patterns and themes (Sharp 2007) found in the videos, the written questionaries and notes of the interviews (see Table 1). The results were divided into affinities and compared across corresponding sources, i.e., videos, questionaries, and interviews for each family. The data was then compared across families to look for general themes – and individual instances as contrast and confirmation of general themes. However, the data was inconsistent and fragmented due to the trade-off in methods previously mentioned using technology probes. For instance, there were variations in the duration of gameplay and recording time for each family. In addition, the quality of the videos differed in terms of video recording angle not always covering the entire space of the activities, and the details provided in the written reports varied from family to family. However, this is a known disadvantage of the method and the corresponding complications for the analysis (Boehner et al. 2007; Gaver and Dunne 1999; Hutchinson et al. 2003; Wallace et al. 2013). Hence the qualitative nature (and inspiration from ethnographic methods) of the inquiries and subsequent use of various analysis methods to derive the findings from the data.

(A) Table 1 Themes, subthemes and codes with corresponding heuristics

Themes, subthemes and codes	*Heuristics*

• *Appropriation of the game set-up*
  ○ *Places*
    ▪ *Location*
    ▪ *utilities*
  ○ *Space*
    ▪ *Type (play/game)*
    ▪ *Prior use*
  ○ *Time*
  ○ *Duration*
	Game and play places and spaces (Sicart 2014; Walther 2011)
	
	Playgrounds as various spaces accommodating different kinds of play activities (Petersen 2014; Specht Petersen et al. 2018)
	
	The magic circle as socially, spatially and temporily expanded (Montola, Stenros, and Wærn 2009)
	
	The magic circle as a particular social space (Stenros 2012)

• *Gameplay*
  ○ *Collaboration*
    ▪ *Parallel*
    ▪ *Interdependent*
  ○ *Type*
    ▪ *Play (leg)*
    ▪ *Game (spil)*
	Being playful and "gameful" (Matjeka and Mueller 2020)
	
	Collaborative and social play (de Valk, Bekker, and Eggen 2015)
	
	Parallel and interdependent social play (Mueller et al. 2017)
	
	Play spaces and game spaces (Sicart, 2014; Walther 2011)
	
	Play versus game (Eichberg 2016)

• *The game system*
  ○ *The use of game elements*
    ▪ *Which*
    ▪ *Preferences*
	Toys as allocated resources for autotelic activities (Suits 1978)

o *Game rules* ▪ *Their own rules* ▪ *Used the included game rules* o *Creativity with the elements* ▪ *Use in the game set-up* ▪ *Individual use*	*Play and game as different activities* (Sicart 2014) *Human-technology relations* (Ihde 1990; Rosenberger and Verbeek 2015) *Using technologies for design of social play* (Márquez Segura et al. 2013) *Game rules in play and game structures* (Matjeka and Mueller 2020)
• *Subjective experience* o *Use of the game system* ▪ *Practically* ▪ *As an activity* o *The gameplay* ▪ *Play/game* ▪ *Development over time* ▪ *General bodily experience* ▪ *Movement Characteristics* ▪ *Applicability to their needs*	*Kinetic joy rides as synergies of movement sequences* (Sheets-Johnstone 2013; 2014) *Bodily perception* (Merleau-Ponty 1968) *Magnification/reduction structures* (Ihde 1990; Rosenberger and Verbeek 2015) *In5: Move and engage* (schraefel 2019) *Play and game as different structures* (Matjeka and Mueller 2020)

6 Findings

This section presents descriptions of the data structured according to the research questions; how the game was set up and adapted to the conditions of the players' homes (RQ1), the kinds of play that unfolded in the game sessions among the players as both bodily and social activities (RQ2), and the bodily play experiences (RQ3).

Concerning each research question, the results presented are those through the analysis to be the most critical emerging themes.

6.1 Setting up the Game System

The analysis describes how the families allocated different everyday ordinary places in their homes to set up the system.

6.1.1 Space: Large Parts of the Homes were Made into Playgrounds

The most common way to set up the game among our players was to allocate space on the floor, often in the living room, either in an "already free" space with no furniture or sometimes by moving any large piece of furniture to the sides, e.g., sofa tables, armchairs, floor lamps. The places were not already allocated for play, such as the children's room or designated play spaces for example building Lego or Brio train railways. Figure 2 shows an instance where the players involved their playroom in the setup. All the Lego builds are left untouched on the table to the right, while the piano and piano bench are included in the setup.

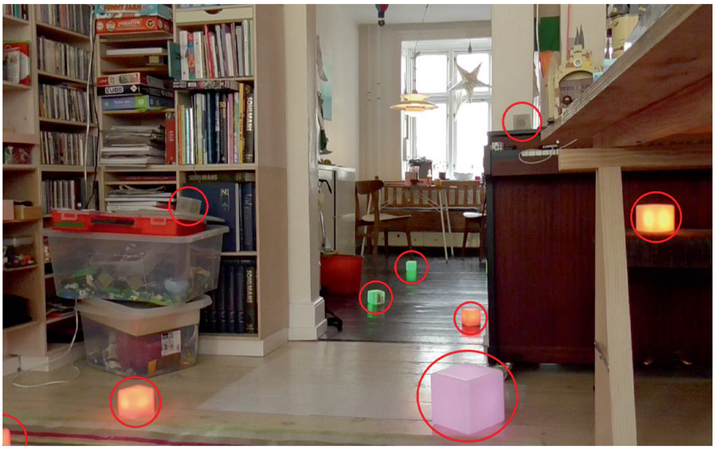

Figure 2 A game set-up using both kitchen and living room including piano, piano bench and plastic boxes.

Furthermore, it was observed that as the game sessions progressed, gradually, the players allocated more places by involving different furniture, like putting the laser pointer on the corner of the sofa (see Figure 3) or music cubes on a bookshelf. In an instance where the living room was connected to the kitchen (open kitchen/living room environment), the kitchen table was involved as a stand for the music cube (see Figure 3). In this particular family's house, the children's room was not involved in any of the eleven game sessions that the players had recorded.

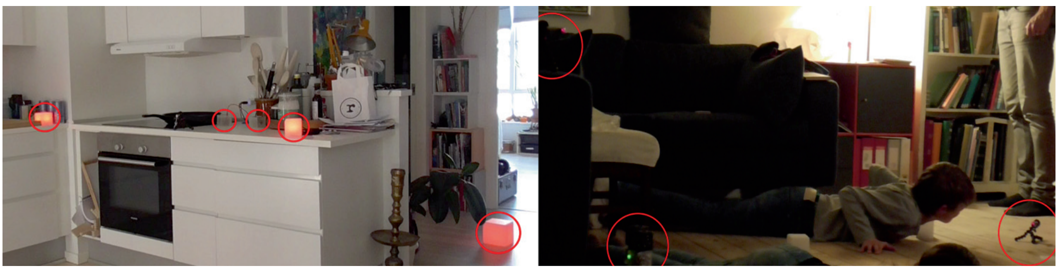

Figure 3 Two different set-ups: on the left; the light and music cubes involving the kitchen table, and to the right: the laser field involves the sofa in the living room.

6.2 Time: The Game Setup was not Fixed, but Changed over Time

A progression over time was observed in each family's game setups. Six families played with the game system for more than one session, and two families only played with it once. Several of the six families responded that they experienced increasing confidence with the game system. After some time, they felt confident enough to adjust and experiment with combinations and possibilities. The data analysis revealed that the players kept adapting the setup to their environment in different ways when they felt more confident with the game. Some liked to follow the rules and manual, while others did not like to follow a manual and instead "learn by doing". A family explained: "*Yes we changed it all the time when new challenges arose and made stable competition with music and colours! And obstacle course with handicaps!*" Two families explained that if they had been able to play the game more times (kept the game longer or owned one), they would have evolved other ways of playing and made their own games. Instead, they felt that they had only "scratched the surface" of playing with the game system.

6.2.1 Shared Spaces: The Game was Set Up to Foster Social Play

All game sessions were held in a shared room, e.g., living/dining room environment, involving different family members. It was, however, in general, a parent/child activity. One family had a pet (a cat) who also got involved in a game. Though it did not follow the same set of rules, it was included in the game – mainly because it had positioned itself in front of the robot (see Figure 4). Thus, the family included the cat in the game. Eventually, the cat bit the daughter and went away. One family had a visit from the grandparents. While the family was playing, the grandparents were having a debate in the background.

That the game sessions were held in shared rooms and could involve the people (and pets) who were present in the room either as participants - or watching the activity as bystanders indicates that the game system, in general, was perceived as a voluntary family activity for all members of the family to join and leave as wanted – even the pets.

Figure 4 Left image: Mom, daughter and cat playing together. Mom and daughter's hands are glued to each other, right image: Mom and daughter playing Keep the Music Going.

6.3 The Game in Use

This section reports on the characteristics and variations in the activities as bodily play experiences. The most prominent game form was bodily collaboration - as anticipated by the minigames. Moreover, the game was presented as a family game when recruiting players. Although one of the minigames included competition between the participants, none of the families reported having played this minigame.

6.3.1 Emergent Play with the Game Elements was Common

As mentioned earlier, the game system's elements were deliberately chosen because of their "commercial product" - quality as toys with different interactive behaviours, stimulating different bodily senses. The players also perceived this quality. However, it was discovered that outside the formal game sessions, the elements took on various functions as exploratory gadgets. The following quotes illustrate this phenomenon: "*Also because we decided just to explore the potential!*" "*It was a party to unpack the game, and we had to have some time to explore just this.*" Depending on the kind of activity, the elements were perceived differently. They took on different roles: In a gaming activity, i.e., *et spil* (Matjeka and Mueller 2020), the light cubes were used as a treasure to protect or a building block. In contrast, in bodily playing, i.e., e*n leg* (Matjeka and Mueller 2020), the light cubes stimulated the bodily senses as either delightful (the light cubes and the music cubes) or alarming noise as the brightness sensors in the laser lines. One family reports such differences: *"It was pretty cool with all the gadgets that could do something when you did something with them and between them."* One family even reported using the light cubes as a night light. All families reported that the "free" play sessions also yielded bodily play like crawling around with the robot, jumping over and under the laser lines, and using the laser pointers as a game of catch or avoiding the laser. The players also reported spontaneous reactions like dancing to the music and being fascinated by the changing light of the light cubes.

These instances of play were not part of the formal game sessions, and therefore not video-recorded by the families at first. However, we asked the remaining families to video-record these instances when aware of these instances. Because these instances were spontaneous, our assumptions are based primarily on the written reports and the informal interviews. Nevertheless, it was an important quality and a finding that contributes to the players' perception of the game system as a whole.

6.3.2 Some Restraint Cards Led to Interdependence while Others Led to Parallel Play

Figure 4 shows two instances where the players collaborated while being glued together. To the left, two brothers work back-to-back, getting ready to move the robot around. On the right, their parents are working ear-to-ear, reading their next restraint card. Both couples were giggling and, at times, laughing out loud while they were steering the robot around the maze adhering to the different handicaps. In the written feedback, players reported these instances as: "*Fun when you are glued to each other and have to cooperate in that way*" and" *Being glued to each other was fun*."

The images in Figure 5 illustrate siblings working together individually. To the left in Figure 5, the children work together to get the robot around the maze, each adhering to a restraint. Here, the boy's feet are not to touch the ground, and the girl's elbows are glued to her body. To the right in Figure 5, the child's (in the kitchen) right hand is not allowed to be used, and the other child's (in the playroom) elbows are glued to the body while playing the minigame *Keep the music playing*. Through these collaborative activities, the players explored their bodily capabilities – together: "*It was cool to move and invent together - the collaboration!*" Another family reported: "*[The mother] enjoyed that the pulse quickly rose on even a few square meters and that you suddenly experienced new angles and parts of your body and also the mutual dependence when we had to lean on each other's bodies and cooperate around it*."

Figure 5 Two examples of working together individually.

6.3.3 The Players Chose to Solve the Game Challenges through Close Cooperation

Some game challenges where bodily achievements were in focus were also present in the game sessions. These were activities such as passing the laser line with one foot not allowed to touch the ground as the mother is doing to the left in Figure 6. Another instance was succeeding in keeping the music playing while collaborating to turn all light cubes red, as the two players are doing in Figure 6. A quote from a family illustrates this kind of experience: ”*It was incredibly challenging and fun with the collaborative game - discovering what the other was doing and making a common strategy was both problematic and fun when it succeeded*.” Also, how to find a way together to be able to achieve an outcome or goal, e.g., moving the robot around the maze, was found in the videos. Furthermore, in the informal conversations, several families expressed a desire to set the time of the music cubes as this was perceived to be too short. As it was, they could not succeed in turning all light cubes and keeping the music playing simultaneously.

Figure 6 Getting through the laser field; on the left; a mom is forcing the laser field with one foot off the floor, and the two children, in the picture on the right side, are getting under a laser line glued together (the laser pointer and sensor are not in the picture).

6.4 Social and Bodily Play Experiences

The spaces that the players created through their different setups and kinds of bodily play also yielded experiences of different movement potentials and social play forms than what the players were used to doing in those particular places. As was revied in Section 2, a trait of bodily play is constituted in a reciprocal process of kinetic joy rides: Synergies of movement sequences that together form a whole and constitute its own meaning. Below, findings derived for meaningful kinetic joy rides are described, i.e., sequences of movements that formed a whole. These were, for instance, awkward movements (described below) that became meaningful in their own rights (and would not be outside the activity). The following sections describe findings regarding the players bodily as well as social play experiences.

Figure 7 Working together back to back, and ear to ear

6.4.1 The Players Experienced Physical Closeness

Section 6.2 described how the players, at times, were exploring the potential of their bodies together. These experiences are illustrated in Figure 7, where two boys are working back-to-back, trying to move around to control the robot, and their parents had been moving around ear-to-ear. The mother of the family further expressed her bodily experience: "*[The father], and I had to put our ears together, and I (re)experienced a kind of closeness that we may lack in our everyday, hectic daily life*." She explains how bodily interplay can be more than just a fun and entertaining way to move around and explore our bodies. The social and playful nature of bodily interplay can create a space for bodily and social experiences that are not part of everyday ordinary family life. This experience was also viewed in the videos, though not expressed in the same way as the quote above.

6.4.2 The Game System Places the Generations at the Same Level

Making the bodily challenges unfamiliar and unpredictable through the constant changing in unknown restraints (the cards) anticipate equal premises for play across generations. The following quote exemplifies this point while also giving us an insight into the bodily movement potential of the game: "*[Restraints] give you an insight into other people's lives because you have your own room for manoeuvre - short or long arms, short and long legs, and it makes us more equal. Adults and children are equally good/bad at it. Adults also need to do something new*." The videos showed that the variety of the restraint cards – and that they are changed either between games or between rounds in a game forces a constant change in bodily challenges. While it was apparent in the videos that this design feature yielded much laughter, the subsequent bodily puzzle-like challenges were positively commented on in most reports. No one expressed any concern or dislike of this feature, only that they were difficult at times. As such, the continuous change in restraints via the implementation of the restraint cards force continuous bodily challenges as opposed to the non-changing restraints as in sports (e.g., football where the players are not restricted from touching the ball with their hands

(Matjeka, Hobye, and Larsen 2021)) that force refinement in bodily skills and improvements. Thus, it was discovered that the unfamiliarity and shift in bodily challenges players experienced also made them experience each other in different ways and resolve gaps in (bodily) skill levels across generations.

6.4.3 The Game Allowed for Awkward Movements and Silly Positions

Another recurrent theme found in the videos was doing awkward movements and standing in silly positions, like the ones illustrated in figures 4 and 5. Though the design of the restraint cards anticipated this behaviour, it was also a choice that the players took; to do more or less awkward movements. A family reported that the children found it fun to "*watch your parents in silly positions.*" The quote in the above section also touches on this finding of unfamiliar, i.e., silly positions resolved the gaps between generations. This finding corresponds to what game scholar Deterding (2017) explains in his article about adult play; how adults, as a way of escaping embarrassment, refrain from playing without a proper setting for doing so. As such, the players, when appropriating and playing the game in their everyday living environments, created temporary spaces in which it was allowed to be silly and bodily playing together in ways the specific places would not naturally encourage.

7 Discussion

In the following discussion, the main findings are clustered into three overall themes and draw some design implications.

7.1 Configurable Interactive Playgrounds

Findings from the evaluation:

- Space: Large parts of the homes were made into playgrounds
- Time: The game setup was not fixed but changed over time
- Shared spaces: The game was set up to foster social play

From the findings listed above, it could be observed how the emerging game and play spaces (Sicart 2014; Walther 2011) were facilitated by the modular structure of the game system with distributable elements that allowed, and even forced, the players to allocate places and use the furniture creatively to create a working setup. This approach in the design of letting the players define different parts of the physical setup and, thus, conditions for play and game is the opposite of both the traditional playground idea and the interactive playgrounds reviewed in Section 2. Traditional and interactive playgrounds rely on pre-allocating specific places for specific activities (Petersen 2014; Svanæs and Barkhuus 2020; Mattila and Väätänen 2006; Tetteroo et al. 2014). The analysis of our study revealed spaces that contracted and expanded as the activities unfolded – socially, like the cat that accidentally entered the game and - spatially, illustrated in Figures 5 (left side image) and 3 (right side image). These images are from the same place, but the players' space with the elements is adjusted to the specific activity and time. While this phenomenon is known from children's play, e.g., creating train rails and landscapes, it is not a common way to think of interactive and traditional playground design.

When the players positioned the laser line in the sofa (see Figure 3), the light cube on the piano bench, or the music cubes on the kitchen table, the furniture became part of the emergent playground. Furthermore, when moving around while playing, the players had somehow to relate movement-wise to any physical object in the room, turning these into game elements. For instance, in the game *Get* *through the laser field* (Figure 3), the players were avoiding the laser lines and the rest of the "objects" (softa table and the other player) in the way. In a nutshell, all objects, game elements and furniture, in the allocated place became allocated resources for play (Suits 1978), as technological multi-stabilities (Ihde 1999; Rosenberger and Verbeek 2015). Moreover, because the players were playing, the resources were allocated from instrumental activities (kitchen table, piano bench, etc.) to autotelic, playful activities as part of a game system. In doing so, the players transformed their homes into interactive, pervasive playgrounds:

As the players set up the game system in their everyday living environment (homes), they created a temporary, physical space in which social and physical activities and norms were redefined and renegotiated during the activities. As a pervasive game, those allocated spaces temporarily and physically expanded and contracted to suit the activities - as well as socially, when the family included the cat in the activity or the grandparents watched a game session as bystanders (Montola, Stenros, and Wærn 2009). We view the game system presented in this paper as an interactive, pervasive playground because the players transform parts of their homes into spaces of play and game activities (Matjeka and Mueller 2020; Sicart 2014; Walther 2011). The game system is pervasive in that the game and play spaces expanded and contracted spatially and socially as the activities progressed (Montola, Stenros, and Wærn 2009). Sometimes it also expanded temporally, when the families kept the suitcase open for days and played with the elements as toys. As such, the game system is made up of many elements that are easy to configure and fit into any place, enabling the players to create temporary interactive pervasive playgrounds immediately.

Design implication: Movement-based game systems should be flexible and easily configurable by the players to allow them to transform their existing surroundings into an interactive playground. The game system should allow the players to change the setup during play and between play sessions dynamically.

7.2 Temporarily Redefine Social and Family Roles through Playful Bodily Togetherness

Findings from the evaluation:

- Some restraint cards led to interdependence, while others led to parallel play
- The players chose to solve the game challenges through close cooperation
- The players experienced closeness
- The game system places the generations at the same level
- The game allowed for awkward movements and silly positions

The most dominating and desired play experience that the players reported was the bodily collaboration encouraged by the unfamiliar bodily challenges caused by the restraints. Whether it was bodily collaborating in parallel or interdependent (Mueller et al. 2017), bodily playing in the form of intercorporeal exploring bodily possibilities and sensing the other player, or bodily gaming to find a common strategy to achieve a goal or reach an outcome (Matjeka and Mueller 2020), the players expressed experiencing bodily closeness and temporarily turning ordinary everyday family life into play. For example, one of the families expressed the challenges: "*Adults and children are equally good/bad at it*" (see Section 6.3). This way, the roles among the players were temporarily dissolved into a playful bodily togetherness in which they became equally skilled despite the age difference.

Note that the players found this kind of play highly amusing, judging from the videos - and their quotes.

The restraint cards present bodily challenges that are not drawing on ordinary bodily skills from any sport or daily activity. Thereby, these challenges encourage a significant degree of bodily creativity in the form of awkward movements and silly positions that force the players to find bodily solutions outside their standard movement repertoire, resulting in immediate play [56] - and a light physical activity level (WHO 2020). The cards were developed to challenge the players' basic movement repertoire by introducing unfamiliar and arbitrary restraints (e.g., "*close your right nasal with the pointing finger of your left hand*" – or "*your left knee is glued to the other player*"). Through their intercorporeality, the capacity to sense (bodily) empathy and work pre-reflectively together (Gallagher and Zahavi 2012; Merleau-Ponty and Lefort 1968; Moran 2017; Zahavi 2014), the players created a space for all players involved to be "*equally good at it*", where awkward movements and silly bodily positions were legitimate and anticipated. They even felt a "*closeness*" that they did not feel in ordinary everyday life, which the players explained as emerging in those spaces of legitimate awkward and silly movements being bodily equal and physically dependent on each other. We call this phenomenon the players' experience of a playful bodily togetherness caused by these intercorporeal experiences that temporarily transformed their ordinary space into spaces of bodily playing and gaming, constituting its own rules for bodily movement and togetherness (Matjeka and Mueller 2020; Sicart 2014; Walther 2011).

As such, the game subverted the limits of bodily movement in the players' everyday life places by encouraging awkward movements, silly bodily positions and physical closeness as legitimate and even in some instances needed for the activity, i.e., they were bodily playing (Matjeka and Mueller 2020; Sicart 2014; Walther 2011). Furthermore, the awkward movements and silly positions challenged the players’ basic movement repertoire – and thereby indirectly basic motor skills as a light (though not structured) neuromotor training. This was one of the requirements in designing for a light physical activity, level as listed in Section 3.

It is worth noting that the players were already confident with each other and had a high level of trust among them. We cannot say whether such a finding would also be prevalent had the game been played among less familiar players – or less familiar places.

Design implication: Experiences of playful bodily togetherness can be achieved in movement-based game systems by adding game challenges that require players to bodily collaborate and move in odd and unfamiliar ways.

7.3 Emergent Play

Findings from the evaluation:

- Emergent play with the game elements was common.

The elements in themselves had a kind of toy quality to them, which fostered playful explorations. While the elements initially were selected to take on various functions and stimulate a range of different body senses, the elements were perceived by the players to have many other roles other than anticipated through the design. This can be explained by almost all the elements individually being commercial products aimed at bodily stimulation or emergent play as also Desai et al. (2019) found in their study. As such, they were already tested and developed for bodily exploratory interaction and, thus, worked very well in doing so (which was no surprise). However, this quality of individual elements part of a more extensive system is often not exploited as a feature in itself. Most existing games and interactive playgrounds use technologies depending on mutual interconnections, e.g., consoles, controllers, projectors and screens, which do not embrace an individual function of their own. This quality was fundamental in our argument to include off-the-shelf elements in our prototype instead of reproducing these qualities in low-level prototypes.

This toy quality of physical game elements as part of a more extensive system is not a phenomenon emphasized in recent literature on designing movement-based games and bodily play experiences (see, e.g., (Desai, Blackler, and Popovic 2019)). However, our study revealed that when the players adopted the playful elements to their homes, they opened the possibility for bodily play and created an interactive, pervasive playground affording social and creative bodily possibilities and explorations. We argue that the toy quality of embedded elements as part of a more extensive game system can work as invitations for bodily play activities. Where de Valk et al. (2015) focused on facilitating social play in open-ended play environments, we argue how such understanding – invitations for [social play] can lead to further [social] engagement – also pertains to bodily play. This means that the design of the individual elements can work as an invitation for further bodily play with the game system.

> **Design implication:** Movement-based game systems should consist of tangible interactive elements that by themselves inspire bodily playful without having to be part of a game setup. In this way, the individual elements can work as invitations for engaging in and developing bodily play activities.

7.4 The Sensibility of the Probe and Game System Design

Finding from the evaluation:

- Significant amount of time was spent with the elements as single elements – and not as part of the system.

While probes are supposed to be tentative "probings" and sensible to changes (Hutchinson et al. 2003; Boehner et al. 2007), as also anticipated in the game design, the game system proved an inconsistent sensibility across the elements in this regard. The data from the study showed how a significant part of the time playing was spent with the elements as single play elements and not the game system (based on the videos and informal interviews upon pick-up, see Section 5). While such play can work as invitations to engage in bodily play, as discussed above, it was rarely working this way. The reason for this can be found in the differences in production stages. While the fully developed elements were easily accessed, the game system was only developed at the prototype stage was more complex to access and set up. This assumption is based on data that showed how playing with the system in all videos was mastered by a parent, who was also the creative part of developing and adjusting gameplay to the situation and setting up the system. Thus, the individual elements seemed to have had more substantial traction than the game system as a system. This tendency was further found in the case with the family of one parent and one child. Despite that this family had the game for fourteen days, they never got to play the entire game or set it up. The parent reported that the child (11 years old), together with a friend, had played with the elements. However, because of the game's complexity (and prototypic nature), they never got to play the game themselves – and the parent did not have the time to help in the situation. While arguing that this is a design implication of the probe, it can be an issue to be aware of when developing such systems further (possibly into commercial products).

Design Implication: When designing modular-based game systems, designers should be aware of the different levels of complexity in use between the individual elements, i.e., modules, their interrelations and how they affect the use complexity of the system as a whole.

8 Limitations

As is most often the case with studies based on probes, the data quality was inconsistent from family to family regarding the amount of gameplay time recorded, the quality of the recordings, the details provided in the diaries, what kind of games were played, and the game setup. These data provide different levels of insights. A proper lab test could have provided clearer and more consistent data for a clear and consistent analysis process with according results. However, the ecological nature of having people providing data from their everyday living environments with an insight into their use behaviour in everyday life will is not possible under lab conditions. To the best of our knowledge, such a trade-off is unavoidable.

The number of respondents was limited to eight families due to two circumstances: 1) The lockdown entered a reopening after two months, and the families returned to more normal lives. While we could have conducted more studies with the new situation – and even compared the data from the two situations, this was not done because 2) the differences in the sensibility of the various elements of the game system skewed the gameplay experiences to be more about the elements (which were already off-the-shelf products) than the system itself – which was "only" a prototype. Because we were primarily interested in the game system and not the elements individually, more tests would need a more thoroughly developed prototype for independent use "in the field". Therefore, the differences in "quality" between the elements and the game system compromised the experience of the game system as being "less interesting" than the elements as standalone devices. Thus, the collected data would be in this light. Furthermore, because we did not have the resources to develop the game system to reach the level of an off-the-shelf product like the elements, the sample size was limited to eight families – 28 players in total. Nevertheless, these findings provide valuable insights into researching pervasive and technology-supported games in people's homes during a pandemic.

Furthermore, the fact that the parents' educational level was higher than average (i.e., the majority of the parents have degrees from higher education) can have influenced their ability to understand and adopt the game system. However, because it is a qualitative study, the outcome serves as inspiration and knowledge for researchers and designers interested in designing movement-based games and does not, as such, make generalizations for the entire population.

Lastly, it was challenging to leverage the findings of people's behaviour during a pandemic lockdown to a post-pandemic situation. While we do not have a valid answer to this question, we should not refrain from doing empirical HCI research under changed circumstances. However, it is an essential question to discuss for future advancements in this regard. One potential added value, though, is that when looking back at the Covid-19 crisis, this study will add to the documentation of life during a very unusual time.

9 Conclusion

The COVID-19 pandemic lockdowns of 2020 posed an additional threat to public health in lessened physical and social activity. To meet these challenges, a hybrid movement-based game system was packed in a suitcase and delivered to eight different families for test and evaluation as a social and physical activity at home – during two months of the lockdown in Copenhagen. Our study evaluated how this game system was adapted, played, and experienced by the families. This study has presented the design results meeting the specific requirements of a game being adaptable to people's homes and promoting bodily and social play, the evaluation thereof and subsequent design implications.

To do so – and to meet the lockdown restrictions - the game was packed as a technology probe into a suitcase, including a video recorder that the participants used to record their game sessions. The game suitcase was further prepared with manuals, instructions, chargers, etc. Furthermore, the families were asked to write a report answering questions regarding their experience.

The adapted research design sought to enable us to answer the following research question:

RQ1: How did the players adopt the system to their homes?
RQ2: How do the activities unfold as (bodily) play activities set out of the ordinary daily activities of the players' everyday living environment?
RQ3: What are the resulting game experiences as reported by the players?
RQ4: What can we learn about the design of the game system and its elements based on the answers to the above questions?

We found that the players adopted the game system to their homes by incorporating kitchen tables, pianos, sofas, plastic boxes, bookshelves, etc., as elements to play the game (RQ1). They created different game and play spaces where social and physical activities and norms were temporarily redefined and renegotiated. The different activities emerging therein left room for new and different movement potentials and explorations, providing light physical activity and bodily challenges, often as awkward movements and silly positions (RQ2). Both children and adults much appreciated this feature. We call such emerging spaces supported by the appropriation of various interactive technologies interactive, pervasive playgrounds as the spaces they occupy are expandable with the activities both spatially (varying parts of the home is allocated for play) and socially; anyone near gets involved – even the pet.

A recurrent theme throughout all gameplay was the awkward and silly movements that the players were employing – forced by the restraint card challenges. The players experienced 'being playful' as they reported how they were encouraged to explore their bodily possibilities in new ways. These explorations led to sensory stimulation and novel bodily positions that challenged their movement repertoire. An example was how two parents felt a closeness they were missing in their everyday lives when they were glued ear-to-ear. Furthermore, and because of the bodily puzzles emerging from the use of the restraint cards, the players experienced a different focus on skills, i.e., being "gameful". In these instances, the bodily skill levels between generations were altered so that the children were "just as good" bodily skill-wise as the adults (RQ3).

While interactive playgrounds tend to be designed for fixed spaces using complex technological setups, this study demonstrates how interactive playgrounds - as technology-supported game systems – can, when adopted by the players' to their everyday living environments, constitute emerging game or play spaces in any place using simple technologies. To accommodate such design, we have suggested four design implications, of which three were concerning the specific game design of the system as a playable interactive pervasive playground and the last concerning the design of the game as a technology probe (RQ4):

- Movement-based game systems should be flexible and easily configurable by the players to transform their existing surroundings into an interactive playground. Furthermore, the game system should allow players to dynamically change the setup during play and between play sessions.
- Experiences of playful bodily togetherness can be achieved in movement-based game systems by adding game challenges that require players to bodily collaborate and move in odd ways.
- Movement-based game systems should consist of tangible interactive elements that by themselves inspire playful interaction without having to be part of a game setup.
- Implications of using probes consisting of elements of mixed production levels:
    - Be aware of the level in the development of the products; prototype or commercial product – and how these are interrelated.
    - Also, be aware of the complexity in use between the individual elements and the use complexity of the system as a whole.

This study aims at researchers and designers interested in bodily play experiences and the design of movement-based games. While this study gives the readers an insight into how an interactive movement-based game was incorporated to and changed the players' perception of their everyday living environment and the kinds of bodily play the game system yielded. The study also indicated that playing the game provided the players with physical and social activity as a legitimate space to explore awkward movements and bodily interplay that would typically not be allowed in the ordinary daily routines of everyday family life. Thus, evaluating the design as an inbodied interaction design shows how interactive, pervasive playgrounds demonstrate a potential to promote physical movement and social activities that challenges the players in unfamiliar ways to maintain or improve physical and mental health.

With this work, we hope to have inspired designers and researchers to advance their work in the field of designing interactive, pervasive playgrounds and the appropriation of technology-supported "play at home" systems.

10 Conflict of Interest

The authors declare that the research was conducted without of any commercial or financial relationships that could be construed as a potential conflict of interest.

11 Author Contributions

LPM – first author

DS and AIW share senior authorship

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Figures:

1 Elements; top left image: The moving robot, top middle: Restraint cards, top right: Laser lines, bottom left: Music Cubes, bottom right: Light cubes.

2 A game set-up using both kitchen and living room including piano, piano bench and plastic boxes.

3 Two different set-ups: on the left; the light and music cubes involving the kitchen table, and to the right: the laser field involves the sofa in the living room.

4 Left image: Mom, daughter and cat playing together. Mom and daughter's hands are glued to each other, right image: Mom and daughter playing Keep the Music Going.

5 Two examples of working together individually.

6 Getting through the laser field; on the left; a mom is forcing the laser field with one foot off the floor, and the two children, in the picture on the right side, are getting under a laser line glued together (the laser pointer and sensor are not in the picture).

7 Working together back to back, and ear to ear.

15 Appendix

15.1 Minigames:

This is a set of predefined minigames to play in the game. Choose any game of your liking – or get inspired to start making your own games. Amount of players, objectives, preparation and rules are listed below. Optional extra rules are added for variation and advancement of the minigames. You are welcome to add your own rules. Apply any restraint card set. We recommend starting with the Beginner's Silly and ending with the Designer's Challenge.

15.1.1 Get the Robot to the Other End

2+ players.

Score points by getting the robot to the other player's baseline.

Preparation

- Use the laser lines to create a play field with a baseline for each player.
- Draw five cards each.
- The players administer their own cards by applying a different card on each turn.
- Remove cards do not apply.
- Only one restraint per turn.

Rules

Players start at their own baseline. On turn, the players can change position only once while adhering to their handicaps. Each time the robot has reached a baseline the players change their cards and start again at their own baseline (remove cards are allowed).

Extra Rules

To advance the difficulty level, players can choose to place light cubes or music cubes in the field between the two baselines. These can be placed at various heights as well as locations on the floor. Score points by counting how many cubes each player has turned.

15.1.2 Around the Maze

2+ players.

Players collaborate to get the robot through the maze and change all light cubes' color to red.

Preparation

- Make a maze by distributing the light cubes around the floor in different colors except red.

Rules

For each light cube you pass draw a new card (remove cards apply).

Extra Rules

If you want to make it more difficult place laser lines around the maze and avoid these while moving the robot around the maze. To vary or adjust the game, you can set the laser lines in different heights. You can also choose to move the robot forth and back again through the maze – and change the colors to e.g. blue on the way back.

15.1.3 Going through the Laser Field

1+ players.

Going through the laser field without breaking the lines.

Preparation

Create a field of laser lines in varying heights.

Rules

Each player draws four cards and. Only one remove is allowed to use (each player must have at least one bodily handicap).

Extra Rules

Additional objectives can be instated; reach the other end first, move the robot to the other end while forcing the laser field, place light cubes for the other players to collect while forcing the field. You can also add scores; when a line is broken the other players get a point. Instead of applying cards to oneself, cards can be applied to the player on their right.

15.1.4 Game of Catch

3+ players.

Don't get caught by the robot! All players are catchers and all players can get caught.

Rules

Each player draws two cards to work as their own handicaps (remove cards are not allowed in this game). All players have their right foot locked to the floor (they cannot change location). On turn, players can move their locked foot once (change location) while adhering to their handicaps and move the robot. After a turn, the players freeze in their positions. Each time a player is caught by the robot, the players can change their handicaps by drawing a new card and exchange one of their existing handicaps.

Extra Rules

All players can move once on every turn (but are still locked by the right foot). Objects can be placed around the field and function as refuge. Objects can also function as obstacles to avoid touching.

15.1.5 Keep the Music Playing

1-2 players.

Keep the music playing and change the colors before the music piece ends. 1 cube plays a beat, the other plays (almost) "beat-less" harmonics.

Preparation

- Place the light cubes around the room in various colors.
- Place the music cubes in the middle of the room.
- Both cubes are to be placed at different heights (up, middle or down).

Rules

The music plays when the proximity sensor of the cube is triggered and plays for 2 bars – to keep the music playing the cube needs to be triggered every 2 bars. Change all light cubes to the same color while keeping the music playing.

Extra Rules

In this game cards are optional. To advance the difficulty level, cards can be instated and changed for each turned light cube – or keep the same restraint card during the game. A further advancement of the gameplay is to set up a square with the laser lines (vary the height) and distribute the light cubes inside and outside the square.

15.1.6 Design Your Own Game:

Before playing, players agree on:

- How to deal the cards.
- How to add objects.
- The function of the play-thing or another objective to drive the game.

The cards can be dealt in two ways:

1. Either the dealt cards apply globally (to all players)
2. Or the dealt cards apply locally (to each player).

A suggestion is to apply maximum two cards at a time for each player. Agree on when to deal the cards (on turn, on x achievement, etc.).

Adding objects (music cubes, laser lines or light cubes):

The objects can either be added and replaced on turn (e.g. together with the cards), or players can agree on setting up a playfield before playing.

Determine the function of the play-thing or another objective (feel free to add whatever object you like):

Here are some suggestions on functions to assign a play-thing: A scoring device (e.g. a ball) or a final treasure to conquer (e.g. king in chess). Or, create challenges using only bodily handicaps in combination with the objects (e.g. use the objects to create an obstacle course to force without applying bodily restraint cards, or make a racing game only applying bodily restraint cards).

- Or combine (and add) elements in whatever way you imagine.

6.4 RC4: A PHENOMENOLOGICAL PERSPECTIVE ON BODILY PLAY

RC4 presents a phenomenological perspective on bodily play. In conjunction with P1's phenomenological understanding of the Danish connotations of "playing a game", RC4 answers RQ4: *How can we describe (digital) bodily play from a phenomenological perspective?* and RQ5: *What is the role of movement in digital play?*

While P1 provided a theoretical understanding of bodily play unfolding in correlations between structures and players' bodily attitudes, P6 adds to this understanding of how the correlations unfold through movement. It examines the role of movement in digital play; how bodies are continuously constituting, (re)configuring and negotiating through movement. Furthermore, it is argued that movement pre-reflectively transcends the physical, technological and virtual worlds and delineates bodies as combinations thereof.

RC4 emphasises how movement is essential for bodily play in that any action – and thus perception, entails movement of something. We either move around, are moved around or perceive others moving around.

The posthumanist view allows for seeing anything – not just humans – as moving bodies with equal influence on the experience. As is emphasised in P6, it is through movement that we constitute ourselves – as humans, technology, animals or combinations thereof.

Furthermore, as the players constitute through movement, so do play and games – be it the players, the technology, or the rules. As such, meaning – and play – emerges in movement. The structures and doings described in P1 emerge as such through movement. While the first phenomenological understanding of this connection is presented in P1, P6 explains the role of movement for such constitutions.

6.4.1 PAPER 6 (P6): A META-PERSPECTIVE TO HOW WE INCORPORATE TECHNOLOGY: THE ROLE OF MOVEMENT IN DIGITAL PLAY

P6 provides a meta-perspective to how digital technologies blur and emphasise the boundaries of our bodies and thereby experientially become inseparable of and enmeshed with each other. The paper investigates how movement transcends domains, delineates and dissolves bodily constitutions and demonstrates how players and technology constitute emerging bodies by mutually incorporating movement. In the mutual incorporation of movement, different movement sequences emerge and can manifest as kinetic joy rides resulting in bodily play. Thereby, P6 answer RQ4: *How can we describe (digital) bodily play from a phenomenological perspective?* Additionally, P6 researches and answers RQ5: *What is the role of movement in digital play?*

Louise Petersen Matjeka, Hanna Wirman and Beatrix Vereijken. *The Role of Movement in Digital Play*. Under review in Journal of Human-Computer Interaction, Taylor & Francis

This paper is under review for publication and is therefore not included.

6.5 CONCLUSION OF RESEARCH CONTRIBUTIONS

The research contributions led to the following conclusion:

Movement-based play and games can be understood as different structures encouraging different bodily behaviour that, in intra-action, influence each other to emerge as particular experiences. The structures and doings are mutually dependent and range from fixed, rule-bound structures to emerging and continuously negotiated activities wherein players experience sensory stimulation and bodily achievements.

Bodies and bodily behaviour emerge in intra-action and are delineated, negotiated and dissolved through movement as the mapping practice. Thus, through movement, players and technologies - as human and non-human - are co-constituted. Furthermore, as pre-reflective, movement transcends domains, and because bodies are delineated through movement, the division between virtual, technological and physical domains does not dominate the pre-reflective experience. This way, the physical player as a technological merger extends into other domains. Such understanding includes any technology also non-digital, like using a stick for the player to reach the King in Kubb or for the blind man to feel the pavement.

Practically, movement in games can be encouraged, supported and facilitated in various ways. While movement is the constituting factor without which there would be no play or game, the mechanics affecting movement can be divided into two different categories; bodily preconditions and surrounding conditions. The bodily preconditions as mechanics are referred to as restraints and concern a body's preconditions for movement. A body in this regard is not limited to the physical body but is the co-constituted and (re)configured body as delineated through movement across domains. Restraints form part of this configuration by defining preconditions to that.

The second category is paraphernalia as the surrounding conditioning elements. These comprise collectables, demarcations, environmental conditions, and action enablers, encouraging and facilitating movement differently. While restraints concern a body's preconditions, paraphernalia concern the surrounding conditions for movement. For a close description of each element, see paper P3. Like restraints, paraphernalia emerges in intra-action mapped by movement. *The Move Maker* functions as an exemplar of the above-described phenomena and mechanics and is presented in papers P1, P2, P4, P5, and P6.

As movement transcends domains, so does the constitution of restraints and paraphernalia. Thus, any of these elements emerging in one domain affects other domains, e.g., mechanics emerging in the virtual domain affect movements in the physical domain and vice versa. Likewise, movement can be distributed and mapped across any represented domains. Furthermore, these principles regard any constituted body, physical, technological, virtual, human, non-human or hybrid. An example is the hybrid body of the physical player and their in-game character.

Restraints and paraphernalia were derived and explained as mechanics for bodily play from observing movement as arising from preconditions and surrounding conditions for movement. While the perspective for the observation was how humans moved, the view of movement as preconditioned and conditioned in various ways is valid for any moving body. Movement delineates a body and how a body moves is shaped by it's preconditions and surrounding conditions. Bodies and their movement repertoires are formed through these dynamics. Thus, any moving body and its movement repertoire can be understood and analyzed through these a well. Finally, while any precondition and surrounding condition emerge in intra-action, they are constituted in movement. An example is a ball rolling downhill. It can do so because it is round (preconditions), and gravity (environmental condition) pulls it. Any obstacles emerging on its way will constitute surrounding conditions that form its movements either by enabling or limiting it.

Bodies manifest through their movement repertoire as formed by their preconditions and surrounding conditions. In this regard, bodies do not discriminate between technological, virtual or physical domains. As the boundaries of bodies are negotiated and delineated through movement, bodies manifest equally as virtual without a physicality as they can manifest as combinations of virtual and physical or entirely physical. Examples are non-playable characters as purely digital bodies, the constitution of the physical player together with their in-game character as a hybrid form, whereas a tennis player with their racket manifest physically as one.

As is evident, the core of this thesis is arguing that play, games and their elements, be it restraints, paraphernalia or players, emerge through movement. We might design the collectables, demarcations, restraints, and action enablers while also considering the environmental conditions, but without movement, none of these elements constitutes as such. A ball that is not thrown, kicked, rolled, or moving in other ways does not constitute a ball, nor do two poles constitute a goal if they are not enacted. In this view, all games are movement-based because we cannot be playing without something to be moving.

Finally, movement is an underlying dynamic in natural-cultural practices. By moving, we are intercorporeally, constituting and exchanging body images and forming bodily imperatives. Play and games in this regard are no exceptions. They, too, emerge as the involved agents move and intra-act in natural-cultural practices. When we design games, we draw on and contribute to our natural-cultural practices. By paying attention to movement as the mapping practice and underlying dynamic for the constitution of bodies in our designs, we have yet another brick to the puzzle of understanding and designing for bodily play and game experiences and their impact. This thesis has also provided a set of mechanics and strategies for practical design work and analysis of the composition and emergence of movement sequences. Bodily play is grounded in these intercorporeal exchanges and (re)configurations and manifests as kinetic joy rides – synergies of performed and perceived movement sequences.

7 DISCUSSION

Several HCI and game studies contributions have used phenomenological perspectives to explain how sense-making of the experiences is a bodily process (Dourish, 2001; Klevjer, 2006; Martin, 2012; Svanæs, 2013). As already argued, only a few have focused on movement as a phenomenon. In those contributions, movement has been treated differently and at times confused as a less quantifiable version of physical activity (Bianchi-Berthouze, 2013), a mechanic (Isbister, 2016) or bodily aesthetics (Höök, 2018). Other contributions of bodily sense-making in HCI and game studies have focused on the notion of embodiment with debates about how we are embodied. Such debates have run the risk of arguing embodiment as opposed to "disembodiment" that we can be not-embodied (van Dijk and Hummels, 2017; Höök et al., 2016). This thesis has treated movement as to how we make sense of the world (Sheets-Johnstone, 1990) instead of how we are embodied or aesthetic. The idea of embodiment from posthumanism of an embedded embodiment (Nayar, 2014) was adopted to emphasise this thesis stance in this debate that we are already always embodied.

As part of the contributions on embodiment, this discussion section starts by discussing Segura's (2016) embodied core mechanics with the generic mechanics of restraints and paraphernalia presented in papers P2 and P3 of this thesis. Core mechanics describe the central mechanics in a game (Salen and Zimmerman, 2004). For example, in football, kicking the ball is a core mechanic. Segura's (2016) addition of *embodied* to this concept refers to how core mechanics are embodied in the form of being physically realised and socially situated. On the other hand, the generic mechanics presented in this thesis describe the characteristics of general mechanics by their qualities, attributes and forms – in relation to movement. As such, generic mechanics describe general mechanics conceptually and indicate how they can be adjusted to create a game's core mechanics. Thus, core mechanics are created from generic mechanics.

In her conceptualization, Segura (2016) emphasises how embodied core mechanics are physically realised and socially situated. However, as argued in paper P3, mechanics constitute through movement. Additionally, as argued in paper P6, movement delineates bodies and bodies do not have to be physical to be constituted bodies. This argument details that because mechanics are realised through movement and movement transcends domains, so can mechanics. Thus, instead of describing mechanics as physically realised, they are bodily realised and, thus, include virtual realisation.

In addition to the above argument, this thesis also argues that we can be socially situated across domains. Intercorporeality, which is our foundation for being social, is grounded in movement (Sheets-Johnstone, 2017; Zahavi, 2014), and as argued in paper P6, movement transcends domains. Therefore, we can intercorporeally, i.e., socially, transcend domains. In this regard, mechanics, whether core, generic or minor, are bodily realised through movement encompassing both physical realisation and social situatedness.

As part of the embodiment discussion, paper P6 discussed Klevjer's (2006) notion of natural embodiment. "Natural embodiment" refers to the idea of a 1:1 mapping of movements between the physical player and in-game character. However, paper P6 argued that such an idea is unrealistic and perhaps not desirable in a play context. While the mapping of movements and body parts might resemble "standard" in terms of "standard" bodies, i.e., two arms, two legs, a torso and a head and "standard" movement repertoires, in the form of punching, walking, running, etc. there are subtle differences in the mapping that the pre-reflective body perceives. For instance, pressing the game controller's buttons in *Superhot VR* (Superhot (VR), 2016) is mapped as a fist as was explained in paper P6.

Furthermore, while movement transcends domains, the mapping of movement across domains does not. Because of the differences in movement caused by the mapping of movements between the physical player and their in-game character, the in-game character constitutes its own movement repertoire. To constitute one body, they mutually incorporate each other's movement repertoires into one as an intercorporeal exchange (Weiss, 1999).

While a close mapping of movements across domains is desirable in some contexts, in a play context, it is not necessarily the case. In several of the game examples in paper P6, the mapping was not resembling "standard" bodies or movements. It was, thus, argued that parts of the bodily play experience is the mapping. This is similar to Mueller and Isbister's (2014) guideline of considering different mappings of movement to create novel game and bodily play experiences. In addition to the mapping of movements, paper P6 also argued that movement sequences can be distributed across domains. It was further argued that together the mapping and distribution of movements across domains is a significant part of the bodily experience in digital play.

Paper P6 also pointed to some ontological inconsistencies in related work on bodily experiences in games studies. These were primarily concerned with the physical players' connection to and with their in-game character (avatar). While this connection was described as incorporeal (O'Brien, 2018), metaphorical (Spiel and Gerling, 2019) or an audience (Martin, 2012), it was unclear how these constituted acting, i.e., moving bodies. While referring to paper P6 for a deeper explanation, the discussion highlighted how the connection between the physical player and their in-game character is bodily established through movement – and not as metaphor, incorporeal or an audience. Because the in-game character's movements reflect the player's movements as causally connected and, thus, inextricably linked, the player perceives the movements as belonging to them. By constituting one coherent movement repertoire, the player and their in-game character constitute one body. These are pre-reflective dynamics (Kirkeby, 2006; Merleau-Ponty, 2012).

The bodily pre-reflective experience has been emphasised throughout the papers and this thesis. However, any conscious account of pre-reflective experiences entails a reflective process. As has been argued, there are significant differences to be aware of between the two levels. For instance, the conceptualization of physical, technological and virtual domains[12] is a result of a reflective process. As was argued in paper P6, the pre-reflective body does not discriminate similarly. While the two levels are

[12] While the virtual domain is most often technological, technologies can also be physical, and physical can be non-technological. Therefore, these are mentioned separately.

interconnected, they have been confused in many theories. For instance, in Calleja's (2011) conceptualization of incorporation, he confuses the conscious mind and embodiment. He writes: "*the absorption of a virtual environment into consciousness, yielding a sense of habitation, which is supported by the systemically upheld embodiment of the player in a single location, as represented by the avatar*" (2011, p. 169). First of all, this thesis does not agree that the player is systemically upheld in a single location as the player is bodily constituted across domains. Moreover, the absorption of the virtual environment into consciousness is only a minor part of the experience as most of an experience is constituted at the pre-reflective level (Sahakian and LaBuzetta, 2013). However, we might consciously recall more significant parts of the experience afterwards, as is explained in the supporting paper P9. Nevertheless, these experiences have been processed pre-reflectively to be entering consciousness (Kirkeby, 2006). Thus, when we talk about the virtual domain, it is a reflective distinction of domains that the pre-reflective body does not make. Understanding the connection between pre-reflective and reflective experiences is crucial as it denotes how we perceptually extend into the virtual world. If we realise that the virtual world is a reflective concept and accept bodies as pre-reflectively co-constituted movement repertoires, we can better understand how we perceptually extend into the virtual world – and connect to the avatar.

With the above argument in mind, let us return briefly to the discussion on embodied perception (Svanæs, 2013) and how perception is enacted (Noë 2006; Thomson 2010). As such, the argument above indicates that because we can perceptually extend into the virtual world through movement, perception also works cross-domain, i.e., is not just active and embodied. Through the co-constituted conjoined movement repertoire, the player can perceive and act in the virtual world.

Furthermore, in the account of bodily experiences in both HCI and game studies, embodiment has been reduced to encompass only parts of the body, like Keogh (2018) mentioned only thumbs, eyes and ears as the bodily experience in games, and Svanæs (2013) mentioned only visual perception, an arm and a hand in his example. In continuation of these examples, the following question was asked; What about the rest of the player's or user's physical body? While this was answered in paper P6, it is relevant to recall.

To answer the above question in paper P6, Leder's (1990) notion of the absent body was a recurrent theoretical concept. As part of the absent body, Leder (1990) refers to how body parts can perceptually "disappear" in the background when they are left inactive. It was subsequently argued that they "reappear" when they were active. However, as Westecott (2008) also pointed out, body parts that are not part of the primary activity can also have a significant role in the bodily experience. While Westecott (2008) described these instances as "*physical slippages*" (p. 1), paper P6 argued that the "not-included" body parts still was part of the pre-reflective experience as the pre-reflective experience is not discriminated by reflectively constituted domains. Furthermore, it was argued that "not-included" body parts could influence perceptions of, e.g., danger or safety. The importance here is that body parts appear and disappear perceptually through movement and the absence of movement. Sometimes, the movements are directly caused by events in the design. Other times, they manifest as "*physical slippages*" (Westecott, 2008, p. 1). However, because we perceive movements as a whole, any movement in relation to the constituted body is part of the pre-reflective experience.

Moreover, "disappeared" body parts also refer to body parts that have never appeared, such as our eyes and ears. We can only see them as images – they are part of our absent body (Leder, 1990). Thus, we perceive a large part of our body as absent and therefore, through the consequences of our movements. For instance, when driving a car, we do not look at our feet to be able to speed up or break. This dynamic of the absent body allows us to accept different mappings and distributions of body parts and movements across domains because we realise they are causally connected to ours. Thus, to answer the question of what happens to the body parts not included in the main activity: They are not "disembodied" but appear and disappear perceptually as we move or not, disregarding any mapping, distribution or reflective connection to any domain. Based on these arguments, this thesis seeks to diverge such discussions and notions about embodied as how we are bodily in relation to the world and embodiment as either "natural" or an opposite of disembodiment to be about movement. Discussing movement as our onto-epistemology, constituting bodies and technologies, and intercorporeally transcending domains allows us to talk about dynamic bodily processes and exchanges, instead of how we are embodied as if it is a static condition.

Following the above argument, the notion of power poses (Carney and Cuddy, 2010) as inherently universal "trickers" of emotions can be seen as such an instance. Several scholars have introduced power poses into game design in HCI literature (Isbister, 2016; Mueller et al., 2018) but the use has also been contested (Jansen and Hornbæk, 2018). However, as we are intercorporeal beings through movement, we dynamically exchange body images and create bodily imperatives (Weiss, 1999). While there might exist universal power poses, nevertheless, power poses can be created, incorporated and manipulated as a bodily imperative through these practices as part of the game activity. For instance, nodding has two opposite meanings depending on different movement cultures (Kirk 2017). These perspectives arise when we look at movement dynamics instead of discussing how we are embodied.

As has been pointed to throughout this thesis, a Humanist stance of the player/user as an encapsulated sovereign body has been dominant in HCI and game studies. However, exceptions include Giddings and Kennedy's (2008) study of the player as part of a cybernetic circuit and Frauenberger's (2019) prediction of the next wave in HCI as grounded in entanglement theories including posthumanist views of, e.g., Barad (2007). Breaking with the dominating humanist stance and introducing a posthumanist orientation has allowed this thesis to view the player/user as embedded in a web of other bodies. This view also paved the way to understanding movement as the way we understand and are in the world, our onto-epistemology (Barad, 2007; Sheets-Johnstone, 1990). Introducing these views has allowed to see movement beyond a human activity and investigate movement as profound for the constitution of any human and non-human body. This view has led to understanding how humans and technologies are enmeshed and constantly constitute various bodily configurations. In movement, we think and are a body (Sheets-Johnstone, 1990) intra-acting (Barad, 2007) as part of the world, an embedded embodiment (Nayar, 2014). Thus, and to conclude the discussion on embodiment, this thesis proposes using the idea from posthumanism of an embedded embodiment (Nayar, 2014) as a web of bodies ongoingly constituting and (re)configuring through movement.

An emerging trend within HCI is investigating experiences through the lens of performativity (Spence 2016). While performativity can help shed light on the enactment of bodily imperatives, bodily imperatives and performed acts emerge through movement. Because movement transcends domains and delineates bodies, examining these constitutions from a movement perspective and performative acts as compositions of movement sequences provides (one more) key to understanding the various constitutions of humans and non-humans and the experience thereof.

Furthermore, the focus on movement also adds a perspective to Ihde's (1990) postphenomenological human-technology relations. Starting with alterity relations; how technology is perceived to have human qualities. A movement perspective adds to this relation an understanding that the human qualities perceived in technology stem from incorporation of movement, either as an "other" or as the mutual constitution as one body. Furthermore, the pre-reflective body does not distinguish between humans and non-humans but bodies as manifested by their movement repertoire. Thereby any constituted body is perceived as a body disregarding the domain of perception. This was evidenced in the merger of the physical player and their in-game character as described in paper P6, and also how the non-playable characters emerged and were recognized as bodies because they constituted movement repertoires.

In the same way, we can understand how technology works in the background when we do other things by looking at how we move with and about it. Recalling the example of the Oculus safety zone in paper P6 and how it emerged when the player stepped outside the set zone. The zone worked in the background when the player was moving according to it. However, when the player moved to its boundaries, i.e., not in mutual accordance, the zone emerged. When the player moved through the boundaries, the game dissolved, and the player was standing in the living room.

Ihde's hermeneutic relation concerns informative level of technology. As movement is our onto-epistemology of the world, any movement and exchange thereof is in itself knowledge and information, however, pre-reflective knowledge. In this case, understanding the dynamic between pre-reflective and reflective levels of knowledge is paramount as we are knowledgeable on both levels, though, differently. Lastly, this thesis also adds a perspective to the embodied relations by focusing on bodily movement as fundamental for any relation. However, the notion of embodiment in HCI was discussed above, and the embodied relation belongs there.

By focusing on movement of both humans and non-humans, this thesis has drawn attention from the Human as the centre to encompass any moving body. Thereby, we can add a new angle to understanding human-technology relations. These latter perspectives are not attempts to replace Ihde's (1990) theory. Instead, they are perspectives building on and expanding our understanding of those theories.

Returning to the main topic of this thesis, bodily play and games. While paper P1 discussed the difference between play and game in-depth, it did so from the perspective of bodily play and movement. As was reviewed, this topic has been explained from various angles (Eichberg, 2016; Møller, 2010; Sicart, 2014; Walther, 2011). However, the focus in paper P1 differs from these in that it relates the topic directly to bodily play and movement. The contributions in paper P1 highlight how structure and doings as bodily attitudes influence and depend on each other and illuminate how these emerge in intra-action (Barad, 2007) as mutually constituting. Whether the player's bodily attitude is interpreted as a performance or doing, it is grounded in movement and movement sequences. This way, the player's bodily attitude is causally connected to the structure, while the definition of the structure is causally connected and contingent on the player's bodily attitude. A game as *et spil* only emerges as *et spil* if the player is being "gameful" (*spiller*). Meanwhile, if the player *leger* (is being playful), the structure of *et spil* – a game – changes, while an activity as *en leg* will emerge as causal to the bodily attitude. In this regard, rules might be pre-defined but are negotiated as part of the activity. This aspect is also discussed in-depth in papers P1 and P2.

Lastly, these differences were also highlighted and discussed in paper P5 in relation to play and game spaces (Sicart, 2014; Walther, 2011) and interactive pervasive playgrounds. Based on the dynamics of the players bodily attitudes as either being playful or "gameful", their everyday living environments became interactive, pervasive playgrounds and the activities evolves in this intra-action (Barad, 2007).

To conclude, this section has discussed this thesis's contributions in relation to related work in HCI, interaction design, game studies and game design. Among related topics were embodiment, core versus generic mechanics, the role of movement for bodily experiences in and with technology, pre-reflective versus reflective experiences and how a posthumanist orientation to these topics and contributions changes the understanding of embodiment and bodily constitutions. Lastly, postphenomenology's human-technology relations were discussed in the light of this thesis's contributions, ending the section looking at play and game as mutually incorporated and constituted structures and doings. The next topic to discuss is revisiting the chosen methodologies of this thesis.

7.1 METHODOLOGIES REVISITED

This thesis's research questions have been investigated from a practical and theoretical perspective as is core to the Research through Design methodology. While the methodology of each paper is described in the respective papers, RtD as the overarching methodology for the entire process is revisited here. A Research through Design approach provides an opportunity for researching designers (or designing researchers) to exploit and create synergies between their practical and theoretical skills and knowledge. As the author of this thesis is as much a practitioner as a researcher, the reciprocally informing process core to the RtD methodology provided the means to draw on both skill sets. Schön (1995) explains how, for a practitioner, a design functions as the practical expression and exploration of different issues, herein, for example, theoretical issues as was the case in this thesis. Furthermore, in ethnographic and autoethnographic inquiries, the researcher as a subject is also present, and personality is an articulated part of the results (Douglas and Carless, 2020; Duncan,

2004) – like a design is for the designer. The practical design can, thus, work as an articulated presentation of the design knowledge.

As argued in Section 5.3, RtD as a pure methodology has been contested by several scholars, and therefore it was complemented by more recently developed methodologies within HCI, strong concepts, bridging concepts and annotated portfolios. These methodologies contribute with knowledge of how to bridge existing theories with practical design as either springing from a core design idea (Höök and Löwgren, 2012), emerging from philosophical theories (Dalsgaard and Dindler 2014) or by describing a design's attributes (Bowers 2012; Gaver and Bowers 2012). However, they agree on certain criteria. Design research should be generative and relevant to a range of situations and not just the specific designed artefact, and it should be evaluative and enable an analysis of designs and design proposals. Furthermore, it should present a more profound knowledge of a design field.

The mechanics, design strategies and implications presented in papers P1-P5 are generative and relevant to a range of design situations as they do not explain a specific entity. Instead, they describe phenomena found in language, traditional play and games and an empirical study of a modular game system. They are also evaluated through the theoretical concepts they build on as the prevailing methodology in the papers was bridging concepts.

Furthermore, they are evaluative in that they provide descriptions of phenomena with the terminology of specific attributes and specifications that are equally generative as evaluative. For instance, the mechanics can be used to analyze a game, as was done in the papers. Finally, they are generative in that to design a game, designers can add and modify collectables, demarcations, environmental conditions, action enablers and restraints by following the descriptions in the papers.

While papers P1-P5 present design knowledge as generative and evaluative, paper P6 provide more profound knowledge as it presents a meta-level to understanding how movement is an underlying dynamic of (bodily) play and game experiences – for which we design play and games as technologies. As such, the research contributions of this thesis present design knowledge on three levels; *practical* as a design expression, *theoretical* as generative and evaluative design knowledge, and a *meta-level* providing foundational knowledge for understanding the design field and premise.

Lastly, together the papers presented in this thesis can be viewed as representing an annotated portfolio as they present a collection of design knowledge annotated with brief textual accounts. Together they form this thesis research contributions and meet the above mentioned criteria for being so.

Before reviewing the validity, reliability and generalizability of this thesis's contributions, proposals to possible other methods and methodological approaches are reviewed.

Instead of designing one game, several games could have been designed to explore different aspects of movement in an annotated portfolio. This was done by, for instance, Hobye (2014). Such a process would have emphasised the designs and left the theoretical parts contingent on them, though not necessarily less important.

Nevertheless, designing several designs takes time and focus. As this thesis's research questions RQ4 and RQ5 are theoretically oriented together with the chosen phenomenological perspective, this thesis is grounded in a theoretical approach. The design functions as an exemplar for these approaches. As mentioned in Section 5, there are several approaches to deriving design knowledge, from which the bridging concepts emphasises an approach grounded in theoretical concepts illuminated by design exemplars. Therefore, this methodology has been dominating throughout the thesis work.

Furthermore, the autoethnographic study could have been conducted in the lab with players. Although the Covid-19 pandemic posed significant restrictions to such activities, the autoethnographic approach allowed for deeper access to the subjective experiences over a more extended period. On the contrary, a lab study would have revealed shorter and different experiences of many players.

Similarly, the evaluation of *The Move Maker* could have been conducted in the lab. However, this was impossible because of the Covid-19 restrictions, including an assembly ban and distance requirements. However, future work in this regard can include such investigations.

Also, the theoretical investigations could have been conducted as empirical studies in the lab, for instance, lab tests of the game examples presented in the studies. However, the Covid-19 pandemic could have presented issues for such studies. Nevertheless, lab tests of the game examples as complementary data sets could have provided further data for triangulation and comparison. However, design knowledge aims to produce generative and evaluative knowledge that is contestable and grounded horizontally and vertically in existing theory and designs (Höök and Löwgren, 2012). It is not the aim to produce any falsifiable or verifiable results as it is in natural sciences because designs are interventional and subjective by nature (Gaver, 2012).

7.2 VALIDITY, RELIABILITY, AND GENERALIZABILITY

As reviewed in the Research Methodologies and Activities section, design knowledge's validity, reliability, and generalizability as scientific contributions are debated issues. While Höök and Löwgren (2012) argue these to be grounded horizontally, vertically, and the knowledge to be generative for new designs, Dalsgaard and Dindler (2014) argue these to be grounded in theoretical concepts from other domains and practical exemplars to delineate the contribution as such. Finally, Gaver (2012), Bowers (2012) and Gaver and Bowers together (2012) refer to the argumentation of the contributions in close connection with the presented design portfolio.

Several methods – and pertaining methodologies – in design research are borrowed from Humanities. Therefore, criteria for validity, reliability, and generalizability from these domains can also be applied to this thesis' design inquiries. From Humanities, this thesis has drawn on ethnography and autoethnography, including observation, interviews and focus group-like inquiries adapted into workshops. Validity in autoethnography (and ethnography) is judged from how the described seems lifelike, believable, possible and could be true (Duncan, 2004). Furthermore, the story – or reported "result" – should be coherent in this regard. The autoethnographic study complies with these criteria.

Reliability in ethnography and autoethnography relies on the researcher's credibility (Ellis, Adams, and Bochner, 2011). While in autoethnography such issue is tightly related to the reported and whether what the researcher experienced is grounded available "factual evidence", that is, do other researchers and people, in general, perceive these instances as faithful – or possibly true. Thus, for the reliability of the reported subjective experiences derived through ethnographically and autoethnographically inspired methods, this kind of data was in all instances compared to and contrasted with data from other sources accompanied by theories as vertical (theories) and horizontal (other data sources) groundings (Höök and Löwgren, 2012).

Additionally, the researcher is central in ethnographic and autoethnographic studies, and, thus, the researcher's personality influences the studies (Duncan, 2004; Emerson, Fretz, and Shaw, 2011). In ethnography and mainly autoethnography, these influences are often an articulated part of the inquiry, which is also portrayed in how the results are conveyed. As such, results can be presented as stories, essays, films or artwork (see, e.g., (Carless, 2022; Douglas, 2022)). For RtD processes, the results of the inquiries are presented in the design – and accompanying theories. In that regard, ethnographic and autoethnographic inquiries fit well with such processes.

Using video recordings as data can lead to some validity issues if these are used as the only source, as mentioned previously. Thus, in the studies where video recordings were used as a data collection method, they were followed by a set of other data as well; the workshops (A1), the training session (A3), and playtest of Crazy Soccer Physics on Trampolines (A5) also produced other data such as the games that the participants made as well as my presence and observation of the situation. Furthermore, data from the evaluation study (A8) also comprised the interviews and written reports. These data combinations ensured triangulation between data sources, accommodating validity issues of using video recordings.

However, the data from the evaluation study (A8 and paper P5) comprised a small sample size. Furthermore, the probes methodology (Hutchinson et al., 2003) has issues regarding generalizability as the studies are qualitative and the data set often of varying quality (Mattelmäki, 2005). This was the case for the evaluation study (A8). While a degree of triangulation was attempted as the data set comprised interviews, videos and questionnaires, the data were too diverse and scarce to be reliable and, thus, the results generalizable. Instead, such studies can provide a valid exploration of a design field to guide future studies (Boehner et al., 2007), as is the primary result from the evaluation study (A8).

Furthermore, the collected data from the various sources has been processed as part of a more extensive data set of several different kinds of sources. Generalizability is assured in this process of vertical and horizontal grounding in theories, other design artefacts and related work as well as the empirical data from different sources. See Table 3 for correlations between the research activities and corresponding methods. The generalizability of the reported results can, thus, also be accredited the design-specific methodologies from Höök and Löwgren (2012), Dalsgaard and Dindler (2014), Gaver (2012), Bowers (2012) and Gaver and Bowers (2012).

From the above arguments, this thesis's results, including theoretical and practical, were found to meet the criteria for validity, reliability and generalizability for each activity and applied methodology, respectively.

8 CONCLUSION

This thesis has presented a set of generic mechanics and design strategies for practical work grounded in a Research through Design process. Theoretically, this thesis has presented contributions explaining how different bodily play attitudes as doings emerge and correlate in different structures. Furthermore, a basic understanding of the role of movement in digital play was presented. Finally, it was argued that movement is fundamental for the emergence of any play and game by demonstrating how movement constitutes play, games, and the bodies in play.

In a posthumanist orientation, the investigations were conducted from a phenomenological and postphenomenological perspective. The posthumanist orientation allowed viewing movement as not limited to the physical player but humans and non-humans, e.g., technologies – virtual or physical. From a phenomenological perspective, the bodily play experience emerges as the sum of all movement, and the pre-reflective body knows how to relate to and incorporate these. To advance our field, we, as designers, need to comprehend how. This thesis aims at doing that by providing design knowledge on three levels, practical, theoretical and meta-level. It does so by answering the research questions posed in Section 2. They are revisited below.

RQ1. How can we describe generic mechanics facilitating and supporting playful bodily movement in theory and practice?

This research question was answered by analyzing how movement is encouraged, facilitated and supported in traditional play and games and presented as RC2. The derived mechanics concern bodily preconditions and surrounding conditions and are presented as restraints in paper P2 and paraphernalia in paper P3.

As was demonstrated in RC2, we can design mechanics to facilitate movement behaviours. However, while the mechanics can encourage specific movement behaviour, any specific movement emerges in intra-action. Therefore, we cannot design the players' movements, only the preconditions and conditions as presented in RC2.

The mechanics are practically elaborated upon in the game design in RC3, *The Move Maker*.

RQ2. What are some practical and technical challenges and subsequent solutions in designing movement-based play and games?

This research question is answered in RC3. Through the design of *The Move Maker* presented in paper P4, these challenges and solutions were investigated and evaluated in paper P5.

A challenge of physically active games is that they often demand expensive and physically large technologies for playing. Moreover, the players are often physically bound by the physical installations. As a solution to such challenges, the game was designed as a modular game system including mechanics of restraints and paraphernalia comprising structures to suit the bodily behaviours of *being playful* and *being "gameful"*, as presented in paper P1.

RQ3. How can the design support variations in bodily movement and gameplay as the activities progress and develop?

This research question is answered in RC1, RC2, and RC3. Paper P5 demonstrated how the modular structure of *The Move Maker* as customizable allowed the players to appropriate the system to their homes, which opened up for the players to adjust the game to their preferences. Furthermore, paper P1 provided theoretical design strategies to encourage different bodily attitudes and support variation and progression in the activities. The design strategies were implemented in *The Move Maker* design and evaluated in paper P5.

RQ4. How can we describe (digital) bodily play from a phenomenological perspective?

This research question is answered in RC1 and RC4 and connects to the following research question. Briefly stated, a phenomenological perspective to bodily play was found by expanding and investigating the concept of kinetic joy rides as the synergy of movement sequences and manifested in the players' bodily doings. These were explained in paper P1. In addition, paper P6 explained how bodily play is the sum of all performed and perceived movement sequences. These are mapped and distributed across domains and bodies, including the physical players, their in-game characters and other moving technologies in relation to the perceived movement possibilities of movable and non-movable technologies.

RQ5. What is the role of movement in digital play?

Paper P6 deals with this research question in-depth. In short, the activity and bodies constitute in intra-action through movement. The characteristics of their doing and the activity are defined by how the bodies move, their interrelations and the mapping and distribution of movement across domains. Play and games constitute through movement.

The answers to the research questions were presented in Section 6 and present three levels of research contribution; *Practical,* in the form of a design and its empirical evaluation. *Theoretical,* in the form of a set of mechanics and design strategies as generative and evaluative design knowledge. Finally, a *meta-level* on the role of movement in play and games and a phenomenological perspective on bodily play.

Finally, a disclaimer is needed. The above argument that all play and games are inherently movement-based break down this thesis's consistent use of movement-based play and games as a category. Because play and games are inherently movement-based as they constitute in movement, it renders the term obsolete. As was argued in paper

P6, there is a distinction between *movement* and *physical activity*. Therefore, this thesis proposes to rename the game category (formerly known as) *movement-based*, to be named *physically-active* play and games. Nevertheless, this thesis's theories, mechanics, and design strategies are still concerned with movement – and not physical activity. In such regard, it is worth noting that also virtual (i.e., non-physical) bodies constitute through movement. The use of movement-based in this thesis's title connotes this emphasis and not a category of play and games.

8.1 POSTLUDIUM

Returning to the argument from the Introduction that chess pieces are defined by their movement pattern. It might be argued that chess is about logic, which it also is. Nevertheless, as has been argued throughout this thesis, such logic stems from our bodily knowledge, our thinking in movement – as incorporated and perceived movement repertoires. Recalling how renowned phenomenologists have argued that movement is our mother tongue, and through movement, we are formed as beings. Movement is our pre-lingual onto-epistemology. To demonstrate these arguments and continue using chess as an example, any spatial understanding of diagonally moving across the board is because we can move (or be moved) so. How else would we be able to understand the movement pattern of the bishop? Or, the springer's movement repertoire – two steps in one direction (not diagonally) and one to either side (or the other way around)?

On the other hand, this thesis's heavy focus on movement might be interpreted as an ableist stance. However, it is not the intention or purpose to discriminate abilities (or discriminate at all). Instead, this thesis acknowledges that we are all differently-abled (and shaped), and, therefore, we cannot predefine or predict behaviour or understandings of "things" as these emerge in intra-action formed by preconditions and surrounding conditions. Bodies emerge in this intra-action as incorporated – and incorporating – movements co-constituted by technology. In this view, a body's abilities and movement repertoire emerge as causal from such intra-action. In other words, once we design for specific movement sequences and repertoires, we discriminate movements. While it might not be possible to avoid, it might be helpful to consider which movement sequences and, thus, bodily imperatives are promoted and discriminated against when we design technologies. Thereby, we can open up for designing more diverse movement behaviours and work toward less sedentary, repetitive and static movement repertoires, creating more kinetic joy rides, more advanced bodily constitutions of humans and technologies – or whatever we desire. As stated in the Introduction, our brains are organs for movement, which means that we develop our brains through movement, albeit diverse and challenging movement sequences. For such development, kinetic joy rides play a significant role. That games and other (digital) technologies reflect and manufacture body images, and bodily imperatives is unavoidable, but awareness of *how* they do and *how* they are constituted through the emerging movement sequences and their composition can lead to more thoughtful choices and innovative designs.

8.2 FUTURE WORK

Several of this thesis's contributions are theoretical contributions and, thus, provide good cases for further empirical exploration and experimentation. For instance, the correlations between the structures and bodily attitudes presented in paper P1 can lay the ground for future empirical tests of different designs and how they are experienced.

Future experiments can also include the development of different restraints and paraphernalia. Concretely, the elements of *The Move Maker* can be developed and evaluated further.

Furthermore, future work can benefit from conducting more tests and experiments of the appropriation of *The Move Maker* or similar modular systems - in the lab and the field.

Also, developing the notion of interactive, pervasive playgrounds and their applicability to different environments is a topic for future work. Such projects can focus on interactive, pervasive playgrounds for leisure as well as an appropriation for basic neuromotor training, as diverse movement in the form of bodily puzzles is encouraged.

Additionally, restraints as a mechanic for bodily play and games can also be investigated as a more profound understanding of how bodies, including virtual and hybrid body configurations, are restrained by their constellation. In a posthumanist understanding, constellation refers to humans, non-humans and hybrids as any body can be restrained.

Future work should include investigations of the limits of bodily co-constitution. For instance, the co-constitution of the player and in-game character, where does the co-constitution end – and start? When are boundaries dissolved, and when are they (re)configured? Now that we know that movement is key to such investigations, we need to understand these (re)configurations better. Such knowledge is valid for games and play, human-technology constitutions and understanding of the connection between virtual and physical domains.

Future studies should also include experiments and empirical exploration of the results revealed in the autoethnographic study.

On the methodological level, work with auto-ethnography for design work and knowledge creation is an underexploited methodology that has proved helpful to access knowledge that is otherwise not accessible. While contributions have been made in using first-person perspectives in HCI, the approach from auto-ethnography is still less investigated as more than a "quick fix".

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