Theoretical Underpinnings of Embodied Design Theories

MeCaMInD - Internal report

Edited by Annika Waern & Laia Turmo Vidal

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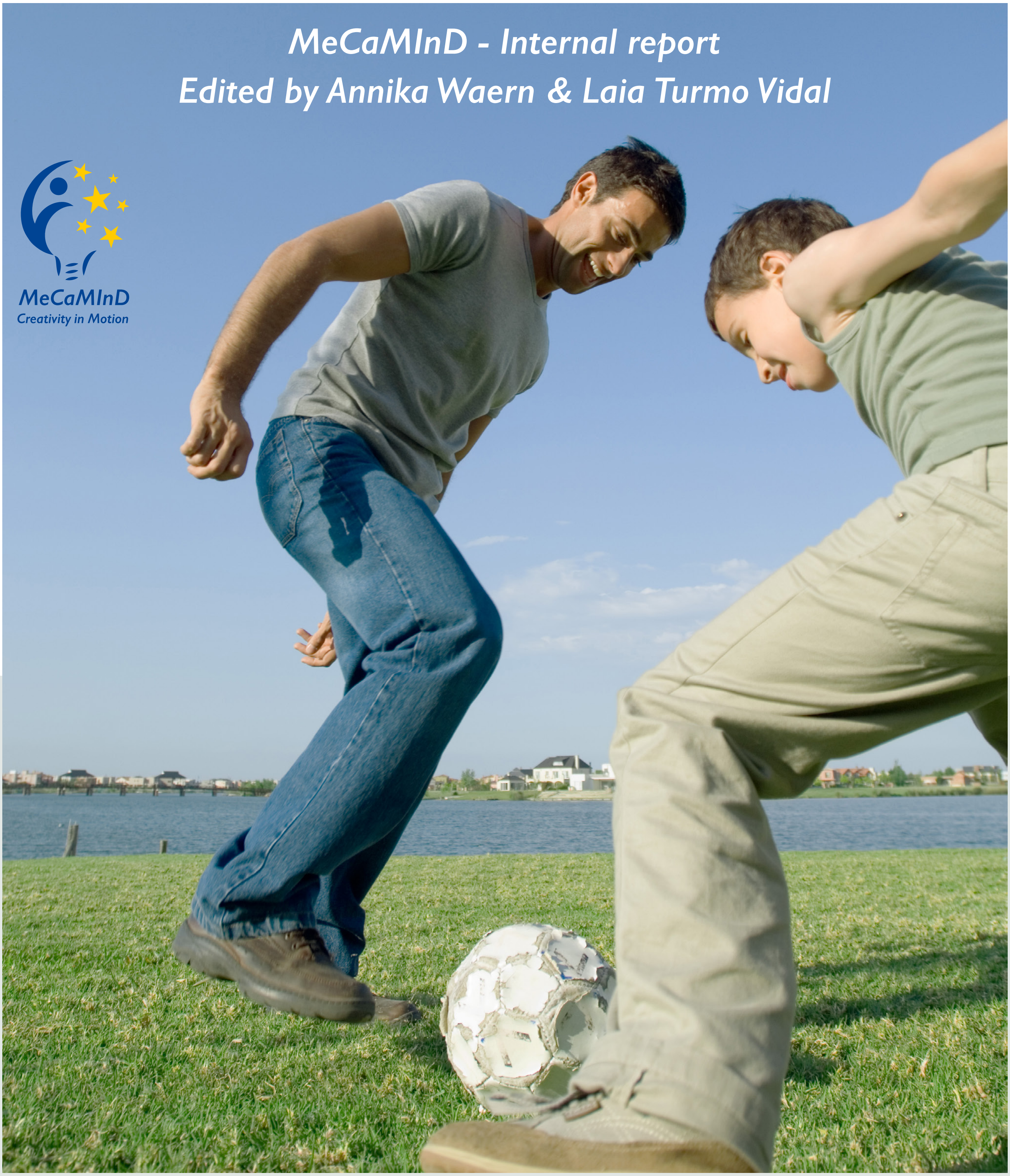

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ABSTRACT

This document summarises the main concepts and theories underpinning the Mecamind project. It is intended as an internal report within the project, underpinning the later work on gathering and classifying movement-based design methods and providing a base for outreach activities in the Multiplayer Event context.

The report is based on a qualitative survey within the project, asking its experts to supply short descriptions of their main theory base and how it has impacted their practical work. The outcome is a brief overview of relevant theories, providing some links between them. The report also suggests a few different ways to sort and classify key concepts from the theories, according to their relevance in different application domains and different stages of design.

Embodied design theories

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I. Overview of the Project and Partners

The MecaMind project's goal is to gather and document knowledge about movement-based design methods, suitable for the development of technology as well as training practices in health and sports domains. These design methods help foreground the importance of bodily engagement in design. The project is looking for ways to encourage designers, and everyone else involved in a design process, to not just engage intellectually but also to themselves move while carrying out design activities.

The outcomes of the project will be a structured collection of method cards documenting practical methods of designing with the body and for and of movement, and an accompanying toolbox which provides further insight into why, how, and when these methods are useful. Movement-based design methods are in use in multiple fields and for very different reasons.

The Mecamind project gathers experts from a range of fields, who all have deep insights into designing for and with their bodies; but with sometimes very different theoretical and methodological approaches to their work.

This report documents the diverse theoretical underpinnings for their work, to make clear in what ways these support particular design strategies and methods. It is intended to serve as a theoretical foundation for the ways in which design methods will be collected, categorised, documented, and made shareable in the MecaMind project

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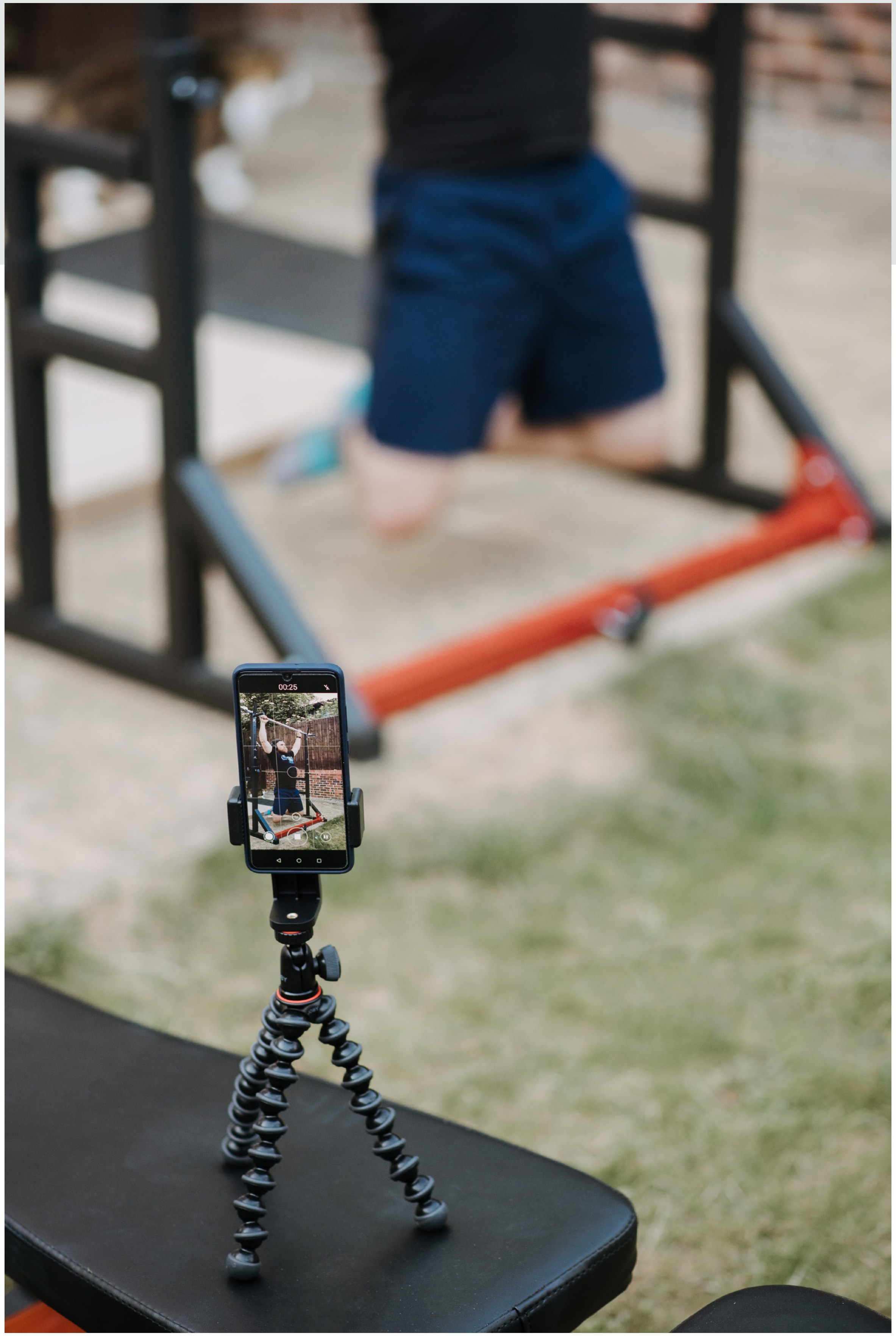

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2. Method

A key methodological choice for the production of this report was to focus on theories and methods that have been meaningful for the participating experts in practice. While each field encompasses its own theoretical and epistemological stance, we wanted to elicit the theoretical underpinnings that had been productive of practical engagement, inspiring methods and influencing design processes. For this reason we decided to not perform any widely scoped literature review. Instead, the participating experts contributed with their own, brief, descriptions of theories and methodologies that had been influential in their research or practical work, and also exemplified with a specific project or method where and how this particular theoretical underpinning had become central.

In line with Blumer's ideas of sensitising concepts [13,14] as a suitable level of abstraction for sharing knowledge between experts from different fields, focus was placed on eliciting concepts that are practically useful: for engaging in discussion, for analysing existing design methods and designs, or for informing design processes and solutions. The form used to collect relevant theoretical underpinnings is enclosed in Appendix 2. After an initial analysis and categorisation of these responses by the Uppsala partners, we ended up with 24 different theoretical framings, of which some were represented in multiple answers.
These theoretical framings were then extensively discussed in a five hour, online workshop with the members of the project. In this workshop, the main goal was to organise the concepts and theories according to similarities as well as their use, add important perspectives that had been overlooked, and create a deeper shared understanding of each other's ontological and epistemological grounding.

COLOURBOX

3. Preliminaries

A first, and important, observation is that not everyone means the same thing when they talk about theory. Movement practices and practices of design are situated, framed by practicalities, and shaped by experience in ways that most of the time lie very far from any specific theoretical grounding. Both need to pull on many resources to create a wide enough grounding for critical choices, and this includes theoretical knowledge. The theories in our collection are as diverse as taking a phenomenological stance to knowledge production, specific models of perception, and algorithmic approaches such as reinforcement learning.

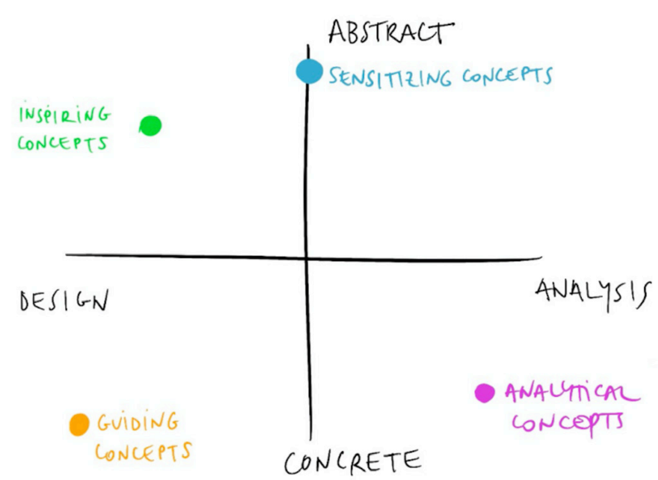
Below, these are briefly summarised, roughly grouped into methodologically coherent bodies of theory in separate sections. Of course, any such grouping can be challenged. When describing the relevant bodies of theory, the report strives to stay close to the experts own words, which allows us to retain a focus on their practical usefulness.
At the end of each summary section, we have put a small table which provides a selection of key concepts from each theory complex. The identification of key concepts provides a joint language, e.g. for discussing the theories, for referring to them in method descriptions, and for motivating key aspects of methods.

It should be noted that the selection of key concepts has deliberately been kept as small as possible and does not reflect the full complexity of the underlying theories.
Blumer [11] identified the importance of joint language as analytical lenses in social science research. This idea has also been adopted in design research, but with a greater emphasis on how concepts inform design.

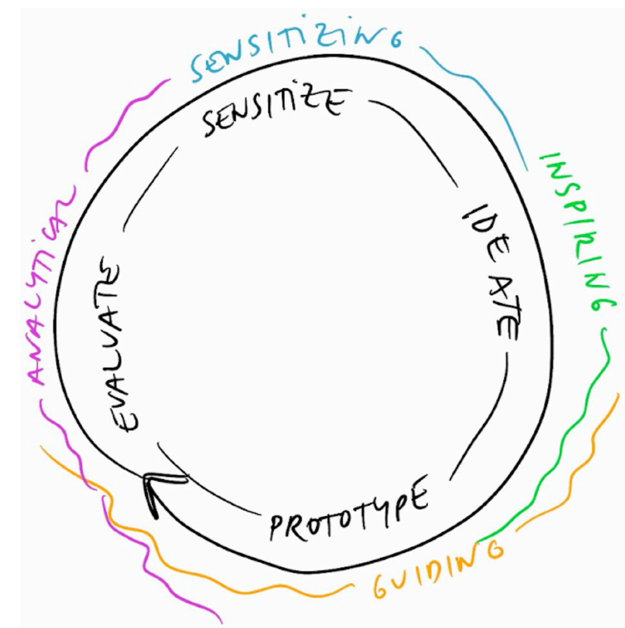
In this report, we make an attempt to both ground our concepts in relevant theories, and distinguish between concepts at different levels of specificity. The selected concepts are classified according to the following broad categorisations:

- Sensitising concepts - concepts that primarily highlight a particular perspective in analysing a phenomenon and support communication between experts with different backgrounds.
- Inspirational concepts - provides the same basic function, but are also inspirational of creativity and design through highlighting unusual options.
- Analytic concepts - more precise concepts that support the analysis of a phenomenon, sometimes through coming with measurements or evaluation tools, sometimes through providing categorisations that can be established empirically through observation.
- Guiding concepts – are analytical concepts that also support design directly, through offering specific methods or guidelines for designing, or at the very least a range of selectable options for how to approach design.

This categorization forms a rough scale, from broadly applicable but rather vague concepts towards those that have more clearly defined uses, potentially offering more support in design and evaluation but at the same time typically having more narrow applicability and use.
The categorisations also differ in relation to how applicable they are in design; some provide direct inspiration or guidance for design exercises whereas others are better geared towards analysing a phenomenon or evaluating the results of a design intervention.



This can be illustrated as a two-axis figure.



This also means that the categories of concepts differ in relation to when, in a design process, they become most relevant. This is illustrated by the figure above.

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4. Philosophical Stances

At the highest level of abstraction we find theories that influence our perspective on knowledge production as such; what do we consider knowledge, what are key values in life and therefore design, and what is the role of technology in human life.

It should be noted that at this level of abstraction, neither researchers nor practitioners will always make explicit what their stance is. Hence, some highly relevant perspectives remain unarticulated (such as positivism) in this overview, as they are ubiquitous to the experts' work practices. As such, they become less of a tool that we use to better understand something specifically, or tools to inspire new design decisions in specific situations. For example, the theories that were articulated in our collection may have been so in opposition to more common assumptions, e.g. in physical training or in technology development.

Postphenomenological philosophy has recently begun to influence a range of research in the domain of technology design. Postphenomenology has brought about an open stance to the role of technology that can be used to analyze technology-use instances [124] and how they transform certain behavior, give rise to some behavior, and disencouraging others. Central to postphenomenology is the realisation that technology is not neutral, but emphasises certain aspects (such as possible actions or interpretations) while diminishing or inhibiting others, what Ihde calls Technological intentionality [66]. For example, this concept has be illustrated by how a word processor triggers a different way of writing than a dip ink pen [168].

Postphenomenology is rooted in Husserls' underlying idea of "phenomena", but goes beyond it by stating that the object and subject `cos-hape one another', to argue that they can't be analyzed a priori nor on their own. This general stance is shared with the neighbouring theory Actor-Network Theory (ANT); an influential technology-oriented framework of constructivism [76]. ANT presents an analytical stance towards phenomena in which "things and artifacts, too, can become actors and thus deserve to be studied on a par with humans." [168:102]. Underlying such an analysis is the premise that nothing can be viewed just as an actant (something that acts, human or not) nor an artifact, and even its description and measurement is part of the same network. In ANT, it is only the network of objects-actants that can be an element of investigation.

Postphenomenology has also been influential through the conceptualisation of what must be considered a small range of possible technology relations. In the context of movement-based interaction, the embodied relation (in which we act through technology) and the hermeneutical

PostPhenomenology

relation (which captures the realization that technology colours our interpretation of what we see as reality) are particularly relevant. Don Idhe [65], and later Verbeek [168], have conceptualised these as laying on a scale from the immediate integration with the self, over intermediate forms including the hermeneutical (technology as tools for perception and interpretation) and alterior (technology as an active counterpart) relations, to relations where the technology is integrated with the environment. The technology relations are productive of design in that they offer a choice, direction, or even ideals to designers related to which relation they want to design for.

However, it should be noted that Idhe emphasises that we seldom have just one relation with technology, but that technology relations are multistable, and shift between users as well as for the same user over time.

While postphenomenology provides some tools for deconstructive analysis, it favours a holistic form of analysis with a dynamic interrelation where technology and use shape each other over time. Latour [77] discusses processes of

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Philosophical Stances

convergence in terms of programs (action facilitating targeted behavior) and anti-programs (measures circumventing this), with a non-constant outcome. In his well-known key-chain example of a hotel manager limiting hotel key losses, this takes shape as follows. The hotel manager adds a heavy keychain to get the customer to leave the key at the desk, whereas the guest might then separate the hotel key removing the weight from the key, where subsequently an anti-anti-program would be soldering the ring of the chain tight, removing the opportunity for removal.

In design, the postphenomenology focus on technology and humans co-shaping each other and their activities calls for working iteratively, and including interrelations between humans-in-action with acting things. It also leads to foregrounding a turn to "experiencing it yourself at location", as that back and forth between action and tech plays a role and can inform what actions the technology could facilitate and initiate. In studies and evaluations, it foregrounds the need to go beyond planned dependent variables to emphasise the importance of holistic accounts of what happened, as valuable elements to record. Finally, since the technology-in-use aspect is difficult to capture under experimental conditions, it emphasises the need for measuring bodily interactions e.g. proxemics in an unobtrusive way and over a longer term.

Concepts	Use in Design	Neighbouring theories
Technological intentionality: emphasising and diminishing	Guiding	Affordance (Norman version) Distantly related to Somaesthetics (subtle guidance, change, interest)
ANT	Analytical	
Program and Anti-program	Sensitising	
Technology relations	Guiding	

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Philosophical Stances

Existential Theories on Aesthetics and Ethics

Ethical and aesthetical perspectives on movement practices influence our experts in multiple ways. If we are to see users as more than machines and as social and physical moving human beings, we need to consider what value stances may enhance the design of sustainable movement-centric experiences. In this context, the philosophy articulated by Søren Kierkegaard has been brought in to help framing such embracing virtues, values, logics or lenses, that influence innovation in movement practices and sport.

According to the Danish existentialist philosopher Søren Kierkegaard, human existence has three main dimensions: the aesthetic, the ethical, and the religious. The aesthetic dimension denotes the human aspiration to have a life with pleasurable experiences. The ethical dimension refers to the human endeavour to do well in relation to certain normative standards of social co-existence. According to Kierkegaard, the aesthetic dimension of a human being is that which does not extend beyond the self but is in and of the self. It is human desires and preferences as they actually exist. The aesthete as a personality is determined by the strongest preferences of the individual at any given time. Kierkegaard argues that an equilibrium between aesthetics and ethics in personality building is worth striving for [15].

An ethical choice presupposes that one can distinguish between choosing right and wrong, and this requires a basic normativity. We as humans presuppose a normative value difference between good and bad reasons, to be able to judge reasons for action.
As an example, whether one feels "I am doing well as a tennis player" is not (just) determined by winning and/or subjective well-being in playing tennis, but also by whether I practice fair play and develop my play for the better, which is determined by the normative standards of the game.

Value Stances in Sports Practices
The concepts of ethics and aesthetics become relevant in movement-based design as there exist a fairly consistent set of value stances in sports practices [34,99]. Uncovering these can provide a basis for understanding how aesthetics and ethics shape the interplay between the personal and the interpersonal dimensions in sports and other movement-centric domains. In a study at University of Southern Denmark [34], a text analysis from a range of sources was used to map out commonalities in values and their interrelations (see Figure 1).
An interesting aspect of this map is that some values seem to integrate the ethical and aesthetical; concepts of play, competition, and fun & happiness incorporate both ethical and aesthetic dimensions due to the ways in which playing, competing, and fun & happiness in action combine social practice with individual experiences of pleasure and satisfaction.
Besides these ten value stances, the authors emphasise the "the purposefulness of no purpose". The mission of human "movement" is not only to assist people in their effort to survive – but also to (co-)live – in an ethical sense to do good for each other.

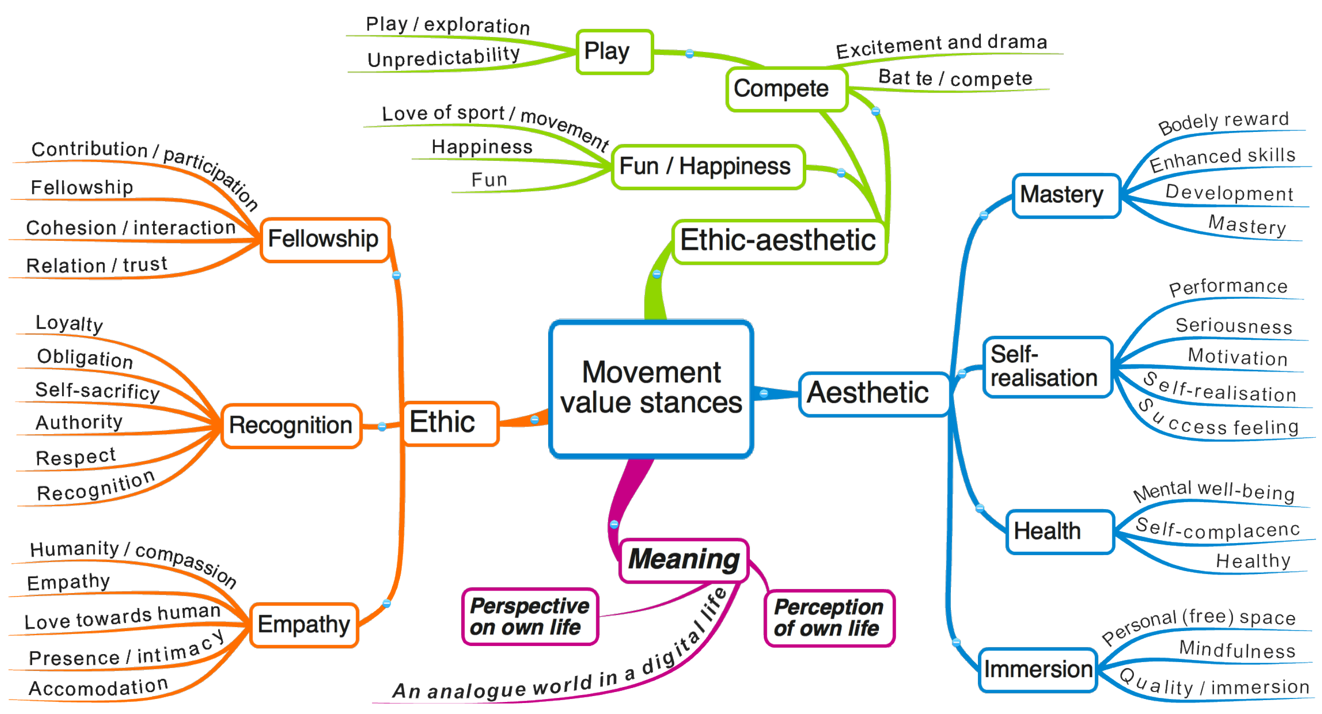

Figure 1. Value stances in sports and movement-based social activities

Philosophical Stances

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Concepts	Use in Design	Neighbouring theories
Fellowship	Inspirational	Self-Determination Theory
Recognition	Inspirational	
Empathy	Inspirational	
Play	Guiding	Game Design Knowledge
Competition / battle	Guiding	Game Design Knowledge
Mastery	Analytical	Self-Determination Theory
Self-Realisation	Inspirational	Self-Determination Theory
Health	Guiding	Self-Determination Theory
Immersion	Analytical	Game Design Knowledge
Meaning	Inspirational	

5. Understanding Humans

In designing for body and movement, one must build on solid knowledge about human psychology and physiology. In this category, we find theories that are brought in from adjacent fields, most notably psychology, to inform the design of technologies, activities, and movement-based design methods. There is no strong consensus among our experts concerning which theories are most productive, but neither is that expected. The purpose or type of artefact that one is designing for may determine which theories are the most productive.

These theories are thus at a different level than the philosophical stances discussed above, and the concepts derived from these theories provide at the same time more specific guidance and have more narrow applicability than those chartered above.

Ecological Psychology

Ecological Psychology was articulated as a metaphysical stance towards understanding perception. It is fundamentally concerned with the relation between the perceiving agent and its environment, a relation that takes the form of affordances, a relation that is actively explored through perception.

"The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or for ill." [49:127].

Which action possibilities manifest in any given situation depend on the relationship between the (behaviorally relevant) properties of the agent's action system on the one hand, and the properties of the environment on the other hand [173]. A ball affords catching to a player whose abilities (e.g. maximal running speed and acceleration) are such that the demands imposed by the flight-characteristics of the ball (e.g. flight time and projection distance) can be met [113]. Ecological psychology is anti-representational, in that it is concerned with how actors investigate and make sense of affordances through constant interaction with the world, but rejects any discussion of how affordances may be represented in the minds of actors, or in language or culture. Framing motion, behavior, action and interaction in terms of affordances helps designers to appre-

ciate that action possibilities are codetermined by the (unique) bodily characteristics of an agent and the (unique) environment in which the agent is situated. This realization helps to see that not only every user and every environment is unique, but also every interaction between user and environment. Tweaking the agent's action system, their environment or both might lead to unique new perspectives and interventions. Action possibilities change with the introduction of novel elements. This plays an important role in triggering certain levels of creativity or divergent thinking. We see this for instance in interaction relabelling [32], using the capabilities of one device to inspire an action in another domain e.g. from loading a revolver to making appointments; and also using tinkering and capabilities of toys as inspiration (cf Schell's brainstorm tip (#4) [135]).

The concept of affordances has also long been influential in the area of interaction design, albeit in a slightly different meaning [104]. In interaction design, the concept has been used to describe properties of objects which show their users which actions they can take. While this is a creative misreading of the original concept and produces a semiotic rather than an ecological perspective, it is a productive one and models integrating the two have been proposed [45].

Concepts	Use in Design	Neighbouring theories
Affordance (Gibson)	Analytical	
Affordance (Norman)	Guiding	Technological intentionality: emphasising and diminishing

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Understanding Humans

Embodied and Situated Cognition

Embodied (or sometimes Embedded) Cognition is closely related to Ecological Psychology, and can be seen as a generalisation of the same ontological stance towards sensemaking. The main premise of embodied cognition is that perception, action and cognition are necessarily embodied phenomena [23]. Perception is not without action, action is not without cognition, and cognition not without perception. Colloquial examples of embodied cognition include gesturing while speaking, fidgeting while thinking, and manipulating puzzle pieces while laying a jigsaw. On a more fundamental level, our bodies can themselves be construed as well-designed tools (relating back to the post phenomenological understanding of technology) that enable certain actions and behaviors while restricting others.

Embodied cognition is closely related to the concept of situated cognition [125], i.e.: not only is the body pivotal to cognition, so too is the (social) environment in which the body is situated. In their most radical form, both are based on antirepresentationalism: a rejection of the premise that the main involvement of cognition is in the construction of mental models that represent the world - cognition is instead seen as emerging from and in action, and agent and environment form a nonlinearly coupled dynamical system, that cannot be explained by its separate parts. Theories of embodied cognition have inspired our experts e.g. to use methods from improvisation theatre and puppeteering for sensitizing designers in Robotic Interaction Design.

Theories of situated and embodied cognition provide a theoretical grounding for a couple of common methodological principles in design, integral to both research and practice. Iterative design can be motivated by how the agent-environment system forms a nonlinearly coupled dynamical system, so that changes imposed on the system cannot be predicted, only observed. This requires the state of the system to be closely monitored, and design requires changes to be made iteratively, to maximize control over the system's response. Several Mecamind partners also subscribe to the need to do "In the wild"-testing. Since cognition is embodied and situated, the real effect of (design) interventions can only be observed with an agent in their authentic environment. For instance, it cannot be assumed that user experiences in VR translate to the physical word, or vice versa.

1 See e.g. https://www.interaction-design.org/literature/topics/affordances (visited 2020-08-29)

Concepts	Use in Design	Neighbouring theories
Embodiment	Inspirational	Postphenomenology, Ecological psychology
Situatedness	Analytical	Ecological psychology
Anti-representationalism	Inspirational	
Iterative design	Guiding	Research through Design
In-the wild testing	Guiding	

COLOURBOX

Understanding Humans

Sensorimotor Body Perception

Mental Body Representations (MBR) can be understood as cognitive adaptable representations of the body's characteristics. The way we perceive our body, its appearance, configuration and motor abilities shapes our movement and how we interact with objects and with others [40]. Think about walking through a door opening, or reaching for a glass of wine. To perform these actions efficiently, one needs to access mental information on the location, size and shape of one's body parts relative to external objects [71,89,167]. Neuroscience research has shown that these mental body representations (MBR) are continuously being updated in response to the sensory inputs about the body received from the environment [12,157,159]. MBR allows us to keep track of the configuration and position of our different body parts in space, and of the continuously changing appearance and dimensions of our body [57]. Emotionally, they are tightly linked to self-esteem [20], forming a basis of self-identity [85]. The theoretical grounding for MBR largely overlaps with that of embodied cognition, but MBR has its empirical grounding in a range of studies experimenting with sensory alteration.

As a psychological concept, MBR can be understood as an adaptable representation of the body's characteristics. MBR conscious representations of body appearance, e.g., its shape, size, configuration, are known as body image [27,40,84] and encompass perceptual, cognitive and affective attitudes towards one's body, which are also at the basis of self-identity. MBR subconscious representations of body motor capabilities, e.g., body parts position and kinematics, are known as body schema [80,89,167] on which people rely whenever they reach for objects, walk or manipulate tools. The boundaries of MBR can eventually extend into the space closely surrounding the body – known as "peripersonal space" [117,120,155] – enabling fast adaptation when using tools [139] or when interacting with others [155].

Experiments conducted with tools [19,89], a "rubber-hand" [12], the face of another person [154,156] or virtual bodies [73,110,152] have shown that feedback conflicts between multisensory inputs, or between sensory and motor inputs, induce changes in MBR. These changes in MBR lead to perceived changes in the appearance and configuration of one's body, as well as of the body in relation to the bodies of other people with whom it interacts. Some studies described changes in behaviour, emotional and social functioning (self-identity) associated with MBR [36,153,167].

Neuroscientific knowledge can be used to design paradigms/experiences in which sensory feedback is used to provide information about the actual body, complementing other sorts of bodily information (e.g. proprioceptive information), for instance to enhance body awareness/coordination, increasing motivation, reducing anxiety related to physical performance and enhancing the emotional state related to one's body. For instance, sound feedback informing on the distance to a target posture can guide movement and facilitate sensorimotor learning [10] and increase self-efficacy [144]. For dance, interactive sound feedback position and movement has been shown to increase dancers' physical awareness of their body and the stage space [169], and feedback on movement qualities has been shown to trigger reflection on movement learning and to change behavior by inducing movement exploration [38]. But it can also be used as a source of sensory alteration of body perception. It is only recently that this possibility has been considered in the context of HCI. Designing multisensorial embodied experiences taking into account these bottom-up sensorimotor processes, e.g. by altering the perceived physical appearance and the physical capabilities of one's own body through sensory feedback, provides unique opportunities for changing people's motor and social behaviour [36,88,96,139], emotional state [73,153,167], body satisfaction [116] and self-identity [151,154,156]. These can bear a high-gain impact on sports and health applications, but also for the embodiment of wearable/remote robotic devices and virtual avatars [133], and new art forms.

The neuroscientific studies also provide a number of measures that allow us to assess body perception and its effects on motor, social and emotional functioning. These include a) self-report [85], b) behavioural measures ranging from explicit to more implicit measures, such as estimation of length of body parts [82], visualization of one's body [153], estimation of object size [167], proprioceptive drift [80], changes in movement patterns [71,153], changes in interpersonal distance [155], changes in implicit cognition of self- and self-other attributes [52,152] etc; and c) physiological measures, such as changes in emotional response/state [110,153,156] or changes in activation of brain areas related to self-body processing [4].

Understanding Humans

Concepts	Use in Design	Neighbouring theories
Mental Body Representations (MBR)	Analytical	Embodied and situated cognition, Newell's theory of constraints
Body image	Analytical	
Body schema	Analytical	
Peripersonal space	Guiding	proxemics
Body configuration	Guiding	
Sensory alteration	Guiding	

Polar HR monitor

Understanding Humans

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Understanding Humans

Proxemics

The field of proxemics studies the culturally dependent ways in which people use the space (distance, orientations in it) to mediate their interactions. This usage of the space is influenced by and influences actions and interactions, activities and practices, but also the spaces are designed (e.g. interior design, urban design…) and how space design facilitates particular kinds of actions and activities. The field was introduced by cultural anthropologist Hall in the 60s [53–55], and has been introduced to HCI by Marquardt and Greenberg [90], compiling knowledge by Hall and others and clarifying the implications of such knowledge to the design and study of interactive systems (in particular, ubicomp technologies).

Proxemics discusses how individuals relate to the space around themselves as dividied into different zones, that vary in shape and size: The intimate (0-50cm); personal (0.5-1.2m); social (1.2-3.5m); and public (<3.5m) zones. The personal space is that which an individual feel is theirs in a social situation. Actions that happen in that space influence how people act towards others. It is often described as a bubble – it has been described having a circular/spherical shape, but also an hourglass shape, or an elliptical shape (summary in Marquardt and Greenberg). Many scholars show how it changes contingent on the environment (e.g. room size, spatial layout, lighting conditions….), culture (some cultures have smaller personal spaces), gender and age (e.g. increases with age), relationship, and personality.

Proxemics is also concerned with the bodily orientations of groups of people in a social setting. People orient themselves to be able to interact well with one another in facing formations, and to share a transactional space [25,72] that hosts the elements relevant to the joint action, such as objects. F-formations [25,72] describe the spaces formed by how people orient themselves towards each other. For instance, people talking and interacting with a shared object tend to favor side-by-side (I-formation) or face-to-face (H-formation) arrangements [72], so that their transactional segments overlap and include that object. The orientation of a group of people can furthermore be directed towards one another or away from one another, often determined by elements in a space such as furniture, and this influences how these facilitate joint action and communication [106].

Proxemics is a key consideration in the design of ubicomp systems [90] and has been used to design human-robot interaction [58]. Proxemics has also been used to inspire bodystorming methods [112] and embodied sketching [93]. In general, the design of proxemic interactions involve designers and users physically exploring and testing particular actions, movements, trajectories, gestures etcetera, in the space.

Concepts	Use in Design	Neighbouring theories
Personal space	Analytical	Embodied and situated cognition
Sociofugal / sociopetal orientations	Guiding, Analytical	
Distance zones	Guiding, Analytical	
F-formations and other social formations	Guiding, Analytical	
Transactional space	Guiding, Analytical	Sensorimotor Body Perception

Understanding Humans

Self Determination Theory and Basic Psychological Needs

Being motivated means being moved to do something [126]. Motivations can be divided into intrinsic and extrinsic [126,127]: Extrinsic motivation originates from outside an organism e.g., in the form of game score or salary bonus. Theories of intrinsic motivation try to explain autotelic behavior such as play, which can be highly motivating even in the absence of extrinsic rewards or punishments. Intrinsic motivation is crucial for exercise adherence [105,128].

Intrinsic motivation is elicited by basic psychological needs but can also include internalised external motivations. The basic needs have been classified as the need to feel competence, the need to feel social connectedness, and the sense of autonomy [126], which makes us like activities we are good at, or the craving for novel stimuli, and which manifests as curiosity towards the new or surprising [140,142,143].

Intrinsic motivation measures based on need satisfaction correlate with enjoyment in games and exercise [21,98,129,134]. Physical activity enjoyment can be defined as a positive affective response described with vocabulary such as pleasurable, gratifying, invigorating, or exhilarating [101,134]. Considering the above, one can at least roughly equate "motivating and enjoyable" with a high degree of intrinsic motivation, operationalized as need satisfaction. Within the SDT framework, researchers have developed a range of survey schemas that can be used to acquire experiences of need satisfaction in various domains including physical training.

In designing for enjoyable embodied experiences and joy of movement, understanding of basic psychological needs provides practical ways to analyze a design (e.g., "Does this experience support the user's needs for competence and does it invoke their curiosity?") and quantify the impacts of design changes on the experience using validated questionnaires. One example was the evaluation of a multiplayer trampoline game, which showed that the game supported needs for competence, autonomy, and social relatedness [79].

Concepts	Use in Design	Neighbouring theories
Intrinsic and Extrinsic motivation	Guiding	Computational Modelling
Autonomy, Competence, Relatedness	Inspirational, Analytical	
Need satisfaction	Analytical	

COLOURBOX

6. Motor Learning and Physical Training

Motor Learning and Physical Training

Several of the participating experts are active in domains where learning motor skills is either an important factor, or the ultimate goal. This includes work on exertion games, the development of physical controls for VR games [79] as well as work on technology support for training [161,162] and smart sports exercises [30,114,132]. General theories of learning and more specific knowledge about motor skills, as well as a theory-level conceptualisation of motor learning practices, influence this work.

Constraint-led Approach to Learning

The constraint-led approach [103] is a conceptual framework often used in Physical Education to promote motor learning. The basic premise of the Constraint-Led Approach is that motor behavior and skill acquisition arises from the complex and dynamic interplay between constraints related to the agent, the environment, and the task. Muscle architecture, genetic make-up, heart rate, and state of mind, are all examples of agent constraints. Ambient light, and the structuring of the environment and the elements in it, are examples of the environment constraints, while task-goals, rules, customs, and norms, are task-related factors. The interplay between these constraints shapes the emergent (motor) behavior. The various constraints (agent-environment-task) can be considered “dials” that can be adjusted in order to influence behavior (and cognition). Introducing additional constraints or altering existing constraints might lead to the emergence of unique behaviors.

The constraint-led approach to learning relates in several ways to embodied design methods.

- A designers’ action system can be altered to match the users’ action system. This helps the designer in empathizing with their users. For example, a designer could choose to wear weighted clothing to facilitate empathizing with people who have a different strength or stamina.
- The constraint-led approach views agent, environment and task as a nonlinearly coupled dynamical system that shapes emergent behavior. As such, changes induced to the system state should be iteratively and continuously monitored to maximize control.

As with many other theoretical frameworks employed by our experts, the perspective strongly suggests an iterative approach to design. Embodied design methods such as the hands-only scenario method [16] fit well with the constraint-led approach to learning.

In van Delden [166] this was the basis for something he called ‘acting out movements as a generative technique’ which included repetitively acting out movements that needed to be trained, also actively integrating the use of objects from the direct surroundings.

See https://www.interaction-design.org/literature/article/design-thinking-getting-started-with-empathy (accessed 2021-09-01)

Concepts	Use in Design	Neighbouring theories
Agent-constraints, environment constraints, task constraints	Analytical, Guiding	Ecological psychology

COLOURBOX

Motor Learning and Physical Training

Motor Learning and Skill Acquisition

Several experts also rely on more specific knowledge about motor learning and skill acquisition, as this is one of the major areas where movement-based technology can have a meaningful impact. Here, we collect some major insights within this area.

- The 85% rule of optimal learning: in designing difficulty progressions, tutorials etc., it is good to know that maintaining an 85% success rate leads to optimal learning and skill acquisition [174].

- Empirical findings on designing optimal skill/challenge progressions [81], factors affecting difficulty of decision making such as complexity & time pressure and how they can be manipulated [3,56].

- A basic understanding of motor skills and embodied experiences include an understanding of e.g. Fitt's law [87], limits of attention and multitasking, stimulus-response compatibility (foundational to designing intuitive controls), motor control as nested feedback loops and the tradeoff between conscious slow control and automated/non-conscious fast control, and how real-time/low-latency feedback can be both beneficial and detrimental to skill acquisition [67,137,141].

- Gentile's taxonomy [46,47] can be used to assess the skill level of users, and subsequently to design optimally challenging experiences.

- Empirical findings on augmented feedback (e.g. [141]) is used to inform feedback design (see e.g. [30]). This includes principles on timing, modality, frequency and content of feedback.

- Literature on distribution of practice, scheduling of practice, variability of practice and skill partitioning (e.g. [33,136]).

- Another relevant design sensitivity is transfer and retention of learning. Both concepts are of crucial importance to ensure effectiveness in learning.

These are just examples. These theories and empirically verified principles provide quite concrete and specific lenses and heuristics for guiding design choices, analyzing and critiquing designs, and some may even be encoded in implemented systems.

Concepts	Use in Design	Neighbouring theories
Optimal learning, Stimulus-Response Compatibility, guidance effect, limits of attention and multitasking	Analytical, Guiding	Play Theory

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7. Games and Play

Movement-based Design Methods often capitalize on the cultural conditions of play, to foster creativity and social connectedness [2]. Multiple knowledge sources related to play behaviour and game design thus become relevant in creating and analysing such methods.
Researchers have not come to an agreement for defining play, though it is often described as unproductive, free and voluntary, uncertain, separate, make-believe and governed by rules. Play tends to be intrinsically motivated and present participants with agency to explore and create new forms of agency. Play relates our bodies to things around us, abstract ideas, feelings or whatever we chose to play with. It appropriates the environment where it takes place, leading to reimagining, creation, and destruction [28]. Games are a legitimate social interaction that can be conductive of trust formation [31]. Several bodies of theory and design knowledge related to on game design and play behaviour are brought up by our experts.

Social Play

Social play is a phenomenon rather than a theory, defined as the active engagement with a game by more than one person. Social games and social play also have a direct connection to bodily play. The intersection between digital interactive technology for entertainment and the human body has fascinated both game researchers and the game development industry. There have been countless frameworks proposed by the HCI community to design around body interaction and movement. At the same time the entertainment industry has produced countless games and hardware peripherals, for example arcade games such as Dance Dance Revolution, or PS Move, Nintendo Switch, Wii fit, Wii-motes, Kinect, etc. Existing research has analyzed the effects of playing the same games with or without different sorts of embodied interfaces [18,39,121], concluding that embodied versions enhance social interaction, enjoyment, affection, and provide an overall better experience.
Social play has been explored for its potential of building mutual trust. Trust is most defined as a "willingness to be vulnerable based on positive expectations about the actions of others" [31]. Results show that games are an optimal environment for trust formation because they can simulate both risk and interdependence. Gameplay interactions engender genuine social bonds. The results clearly indicate that a game has the power to facilitate interpersonal trust between players [31] and fostering intimate connections [130]. Games centred on social play thus present a good framework for icebreaking activities. Groups accept games as a viable team building exercise, even in a business context. Playing an icebreaking game has positive effects on group communication in terms of talking activity, and group member participation [31], as well as potential benefits of in subsequent face-to face collaborations [102].
Hence, social play offers both a rich domain for movement-based design, and a common element in movement-based design methods. For example, social play is prominent in sport practices, even if mostly in team-based competitive forms. An exception to this is Parkour, a training practice with less emphasis on correct performance and more emphasis on creative exploration than more traditional sports. Designing for Parkour requires close engagement with the community to adhere to inherent values such as creativity, inclusivity, and non-competitiveness [171]. The capabilities of social play to foster trust and foster intimate connections have for example been capitalised upon in MESMER [1], an Ouija-board inspired tangible conversation tool for playful design.

Concepts	Use in Design	Neighbouring theories
Gameplay interactions	Guiding	
Interpersonal trust and trust building	Inspirational, Analytical	

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Games and Play

Play Moods

Skovbjerg [70] suggests to define play as a relation between the triad play media, play practices, and play moods. Where play media form the locus of play, the play practices are the ways of doing with the play media(s), and the play moods is the way of being in these play practices – the player motivation and goal for playing. In this understanding play becomes a practice of mood, where different ways of doing with play media modulate different ways of being in play.

Play moods describe the special state of being, and are a precondition for play as well as a goal for playing. Skovbjerg adopts Heidegger's conceptualisation of moods to understand play moods. Heidegger argues that we are always in a mood, as an constitutive aspect of our being in the world. An individual may move from one mood to another, but never to be outside a mood. Skovbjerg lists as possible moods those of devotion, intensity, tension, and euphoria.

The understanding of play moods can be a way to address the challenges of how to get designers into a bodily creative "bodily"-state [body-setting] and sustain them in this mood when being in a generative phase of a design process. The mood of euphoria and its characterizing of silliness is a way to get people into being open towards new ideas and ready to play. Shifting between play moods is a characteristic of play, and a way to sustain a playful practice. Shifting between different play moods within a bodily design practice stimulates different design ideas and perspectives.
When facilitating a movement-based design workshop, aspects of Ludic and Paideia [17] can be valuable. A Paideia approach is a very open-ended process [7] where the autonomy of the participants and the playful and spontaneous parts of the process is in focus. The approach of Ludic on the other hand, is a rule-based controlled activity, which will give a better control of the design process and outcome. More rules like e.g., social regulation by turn-taking or spatial social organization of the participants represents a more rule-based ludic approach to the generative aspects of the movement-based design. A reflection of the balance between regulating or controlling (Ludic) or letting the participants be free and be spontaneous (Paideia) is an important reflection that the designer must consider before using movement-based design methods or creating a movement-based design process.

Concepts	Use in Design	Neighbouring theories
Devotion, intensity, tension, and euphoria	Guiding, Analytical	
Play media, Play practice, Play mood	Analytical	
Ludus, Paideia	Guiding	

PlayAlive

Games and Play

Game Design Knowledge

Game Design knowledge consists of concepts and gudelines that are largely process-oriented. The typical goal is to make the process of playing as interesting as possible for the participants.

Game design knowledge approaches play as "free movement within a more rigid structure" [131]. Game design elements constitute that rigid structure, which support and invite that relatively free movement around that structure.

Game design knowledge is practical and mostly both concrete and specific. Play design scholars however prioritise designing for open-ended play, where the activity of playing is creative of itself, changing and fluctuating over time. Our experts have been more influenced by this latter trend, than by traditional game design knowledge In this section, we restrict the discussion to game design knowledge and concepts that our experts have found relevant to movement-based design.

- Core mechanics, also known as core gameplay or game mechanics or interaction mechanism, refers to essential game actions that are repeated over and over in the game [131]. This can be simple actions, e.g. throwing dice to advance in the game snakes and ladders; or more complex "suites of action." As all games are restricted in what they allow players to do, the core mechanics present the major action possibilities of the game, which resonates with the concept of affordances [49,104]. Marquez Segura [91] has proposed embodied core mechanics as the focus of design and drivers of design processes in the application domain of collocated physical and social play, and developed design methods based on this concept [93].
- The concept of self-effacing play was introduced by Bill Gaver as part of his "ludic design" program [41,42], referring to the openness, ambiguity and at times strangeness of certain designs which encourage exploration, engagement and appropriation. These designs are described as "open-ended and personal" and said to "encourage us to play – seriously – with experiences, ideas and other people." The concept underlies a range of design approaches in the HCI field [44,163].
- The concepts of the well played game and coliberation were both developed by Bernie DeKoven, a proponent and designer in the tradition of the New Games movement. The well-played game is used to refer to a game that "becomes excellent because of the way it's being played" [29]. This concept foregrounds that players may appropriate a game, and adapt it so that they can have the most out of it as a group/team. It involves players knowing their possibilities and what works for themselves and for one another, trusting each other, and jointly working towards that goal. Coliberation [28] refers to the feeling of working together towards the common goal of feeling great playing together, feeling free, released, and at your best, while still potentially competing. Both concepts have been used in movement-based learning [94].

Concepts	Use in Design	Neighbouring theories
Core mechanics, embodied core mechanics	Guiding	
Self-effacing play	Analytical	Play moods
Well-played game, coliberation	Guiding	Play moods
Open-ended play, transformative play	Guiding	

Games and Play

Larp Design Knowledge

In contrast with Game Design knowledge, Larp Design knowledge [74] tends to be people-oriented, centering on making groups of players engage in creative improvisation together . In larp, players take on characters separate from themselves and enact them, typically in an embodied way, in a fictive setting. Larp values co-created narratives and emotional experiences over e.g. challenge and competitiveness. It prioritizes ease of access over e.g. preciseness in instruction. Larp are seen as co-constructed by designers and players, but it is also very common for designers to maintain a role in their execution as game masters or organisers [68,69]. A significant portion of larp design knowledge relates to the design and construction of props and costumes. An important consideration in larp design is the selection of meta techniques - a few rules that guide and regulate the improvisational activity or represent aspects that are difficult to enact. Larp can offer very strong experiences and also bleed-over experiences between fiction and reality [176], which is why some of the meta techniques are focussed on regulating player safety. The design of characters is also an important consideration, although some of the character development by necessity always will be up to the player.

Brainstorming is sometimes done as larp or using larp-like formats [2]. A number of scholars have begun to tap into larp design knowledge to create design activities: as methods for sensitizing designers [172], to develop methods for exploring innovative uses of technology [92], and to explore future societies [35,115].

Concepts	Use in Design	Neighbouring theories
Character	Guiding	
Game master	Guiding	
Bleed	Inspirational, Analytical	
Meta technique	Guiding	Game design
Safety technique	Guiding	Game design

8. Design Research and Method

Many of the methods chartered in MeCaMInD are used in design processes. Hence, design theory and design methods are considered relevant theoretical knowledge by our experts. Some of this body of knowledge conceptualises the design process in itself, other is concerned with overarching approaches to design, or specific methods relevant for design research and design practice.

Research through Design

Research through Design (RtD) has been articulated as an overarching approach towards researching design by doing design. While sharing some of its methodology with design science, the two approaches do not share epistemological assumptions and knowledge contribution goals. Within our group of experts, some but not all subscribe to RtD.

The difference between design and science is often perceived as a gap between theory and practice. Design science is positioned as an intermediate bridging this gap, through 'theorising' design by producing generic or semi-generic knowledge applicable in design. In contrast, the principles of Research through Design have been articulated as a way of looking at design as a legitimate form of knowing in itself, and consequently also a legitimate form of research. Informed by Schön's study of design practitioners [138], RtD puts emphasis on the design process itself and the cyclic process of engaging in and reflecting upon design. Material aspects are often foregrounded [164,165] and practical expertise and artistic practices are considered valid to inform research [9]. Interviewing practitioners about their expertise can be a valid method of inquiry.

RtD is rather radical in its hesitance towards drawing a clear line between design and science. In a strong warning against scientising design, Gaver [43] argues that design knowledge never is generic, and unlikely to be falsifiable as it builds on the fact that something was constructed.
Design knowledge, they argue, does not strive to converge towards universal truths but instead tends to diverge, as new knowledge is added through the way design strives to constantly look for new opportunities and expansions to what is considered 'possible'.
This affects how knowledge is formulated. Where Design Science [59] prioritises definite and clearly delimited formulations of knowledge (e.g. in the form of clear design guidelines, frameworks, and design patterns), RtD favours articulating knowledge in more vague and open forms, e.g. as sensitising concepts [13,26,63,100] or methods [5,148].

Design Research and Method

For design to be academically contestable, RtD researchers will still put emphasis on rigor in the design and evaluation process [63], and the production of intermediate-level knowledge [86] together with the design exemplars [111]. Redström [119] has proposed that more advanced knowledge contributions resulting from RtD are not its theories or concepts, but instead the creation of consistent design programs, encompassing all of design concepts and theories, aesthetic commitments, methods and exemplars.

Concepts	Use in Design	Neighbouring theories
Reflection in Action	Inspirational	
The Ultimate Particular	Sensitising	
Design Knowledge as Generative rather than Generalised	Sensitising	
The Ultimate Particular	Generative	Postphenomenology

Design Research and Method

Activity (-Centric) Design

Activity Design is an analytical lens towards conceptualising such designerly practices that, fully or partially, aim to design what people do. There exist numerous examples of activities that we enter into, sometimes just once and sometimes more regularly, that have been (or are continuously in the process of being) deliberately designed.

- Paying your ticket in the front of the bus.
- The ride of an amusement park.
- A panel debate. A traffic light.
- An online game.
- A physical training class.
- A theatre performance.
- A larp (live roleplaying game).

Activity design can be seen as a generalisation of service design [61], but without the latter's emphasis on servicing a customer. It builds upon practice theory [118], theories of social schemata [50], and practice-based design [147], but rather than arguing that design should adapt to practices, it emphasises how activity design can be done to circumvent established patterns and norms, and to establish entirely new activities or change existing practices. It is also influenced by theories of Situated Action, in its emphasis on in-the-moment action and how it is shaped by contingencies of the situation [146], and Distributed Cognition in its focus on how different objects support understanding and action [60]. Within HCI, it stands in contrast to a more traditional technology-centric design stance. While both ultimately target the experience of users' engagement, traditional HCI center on the design of the technology/object/artefact itself.
Game Design is very influential in this approach. In general, games are a great example of activity-centered design. As [131] put it: "[…] Game designers don't just create content for players, they create activities for players, patterns of actions enacted by players in the course of game play." Just as Game design, activity design is second order design [170], and emphasises the rich plethora of materials available for its design [95].
An example of an activity-centric approach to embodied design is Márquez Segura's work on embodied core mechanics [91], which suggests a work process for designing embodied activity through focusing on key actions at the core of that activity, the embodied core mechanics, and identifying and developing material and immaterial elements that support those actions. The latter includes technology, but also non-digital artefacts as well as spatial and social elements shaping action, such as the physical layout of the room, or rules of interaction. These are considered resources for design.

Concepts	Use in Design	Neighbouring theories
Activity Design	Sensitising	Game Design, Larp Design
Embodied Core Mechanics	Guiding	Game Design
Resources for Design	Guiding	Game Design

PlayAlive

Soma Design

Soma Design [62,75] as been articulated as a design programme [119] and belongs to the Research through Design tradition. It is an approach to the design of computational artefacts that considers and foregrounds the felt, first-person perspective on the body to be central during the design, deployment and evaluation of interactive body experiences. It seeks to enhance the somatic awareness and sensory appreciation of both designers (during the design process) and end-users. It foregrounds designing as the orchestration of an array of bodily, material, social and computational resources.

Four interactive qualities are key [62]:

- Subtle guidance: The interactions that guide and direct a person's focus and attention, for example towards specific bodily or sensory sensations, need to be very subtle.
- Temporal, interactive and spatial places for reflection; slowing down the pace of life and actively disrupting everyday habitual routines and making space for feeling safe, enclosed, taken care of.
- Intimate correspondence – providing feedback that follows the rhythm of the body.
- Providing means to articulate the experienced bodily sensations.

Soma design provides a context for a multitude of designing with and for the body. It foregrounds sensitizing methods as ways to help bring designers to the right mindset and bodyset. Methodological examples are Feldenkrais sessions, in which a facilitator verbally guides designers to attune their attention inwards, to their body; or slow walks, to encourage designers to reflect on their experience. Participants often fill up a body map before and after each of these activities, to help their reflection [160]. Soma design also foregrounds a rich and nuanced engagement with design materials, and a deep sensory exploration of them. Examples are sensory lab workshops, in which designers in pairs explore objects with different material properties - one sense at a time (e.g. visual, auditory, olfactory, gustatory, touch) [160,175].

Design Research and Method

Concepts	Use in Design	Neighbouring theories
Subtle guidance	Guiding	post-phenomenology
Reflective space	Guiding	
Intimate correspondence	Guiding	post-phenomenology, perceptual-bodily relations
Experience articulation	Guiding	

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Design Research and Method

Computational Modeling and Machine Learning

The current wave of computational modeling and design research, empowered by recent advances in AI and machine learning, utilizes and extends the theoretical frameworks of computational rationality and Intrinsically Motivated Reinforcement Learning (IMRL) [24,48].

The basic assumption is that user movement and behavior can be modeled as (approximate) utility optimization, limited by the computational capabilities of the human brain. Hence, human-like behavior can emerge from machine learning and AI techniques such as Reinforcement Learning (RL) where an AI agent discovers and uses behaviors that maximize some utility metric.

A fundamental problem in designing interactive software and systems is that predicting user experience and behavior is difficult. The problem is particularly severe for embodied interaction such as Virtual Reality (VR) games, as such experiences are not supported by low-cost online user testing services such as UserTesting.com. The promise of computational modeling and design is that sufficiently realistic user models can allow designers to rapidly evaluate design ideas without users, and even allow optimization methods to automatically improve and/or discover designs [22,37,107,108,122].

RL is a classic AI paradigm for optimizing action utility, i.e., the expected cumulative future rewards [149]. An RL agent implements a policy (e.g., a neural network) that maps observed state to an action. As illustrated in the figure above, executing the action causes the agent to observe a new state and receive a scalar reward. RL algorithms optimize the policy parameters—e.g., neural network weights—so that the policy outputs high-utility actions. RL utilizing modern deep neural networks can solve highly complex tasks like game playing based on visual observations and full-body biomechanical movement control [78,122].
Unlike classic user modeling tools, computational rationality does not need a detailed breakdown of the interaction task [108]. Instead, all that is needed is defining the utility optimization problem. This comprises the policy network architecture, action and state representation, and a reward function. Simulated behavior then emerges from the optimized policy. IMRL extends RL by considering both extrinsic rewards (e.g., game score) and intrinsic rewards that originate from inside the agent [24,123]. For example, reaching movements can be modeled using an extrinsic reward for target acquisition, and an embodied intrinsic reward for minimizing movement effort or discomfort [22]. The same can be applied to psychological phenomena, e.g., implementing curiosity through rewarding the agent for rare or unpredictable observations [8,109]. This can be also interpreted as using the satisfaction of basic psychological needs as a reward signal, in this case the need for novelty-variety [6].

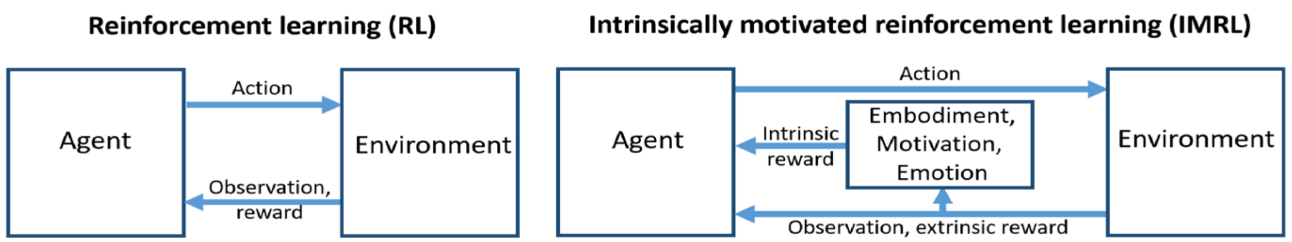


Figure: Reinforcement learning (RL) and intrinsically motivated reinforcement learning (IMRL). RL agents learn optimal actions that maximize utility, i.e., expected cumulative future rewards. IMRL extends this by modifying or augmenting the extrinsic reward (e.g., game score) with components modeling, e.g., motivation and emotion.

Concepts	Use in Design	Neighbouring theories
Computational Modelling of User	Guiding	Theories and sciences the models are based on: Ergonomics, Psychology of motivation and emotion, Fitts law, Self-Determination Theory, Basic psychological needs theory
Reinforcement Learning (in AI&ML), Intrinsically Motivated Reinforcement Learning	Analytical (tools)	Reinforcement learning (in psychology), Behavioural psychology, Psychology of motivation

Design Research and Method

Point of View and Tense

The term point-of-view describes the use of three distinct perspectives on the body: 1st-, 2nd- and 3rd person [145,150,158].

The 1st person perspective is the person-as-me: Described as the body that is me, living my life through my perspective [158]. This perspective is drawn from the term The Lived body, coined by the French phenomenological philosopher Merleau-Ponty (2014). Simply put, the body I experience as being me [150].
The 1st person perspective is observed when the users focus on themselves and their own work. In the 1st person perspective users explore their own space without being disturbed by others and/or without (knowingly) sharing their knowledge with other users in the design process. In utilising the 1st person perspective, the users independently develop movements or ideas by themselves.

The 2nd person perspective is an interpersonal, empathic, body relation. Svanæs and Barkhuus [150] describes this as when you feel another person's movements as your own, utilising your empathic sense. "In creating an awareness of another bodily self, you also create the same awareness in my body" [97]. In the 2nd person perspective, the body is seen as a social phenomenon interacting with other bodies displaying an innate bodily empathy [150,158]. The 2nd person perspective is observed when users perform or observe an action with the intention of sharing knowledge with each other or to be inspired. Sharing knowledge can be done by either mirroring others, mimicking or by sharing an artifact, a movement or an idea. The primary focus is the intention directed towards others rather than oneself.

The 3rd person perspective is the body seen as an object. Utilising 3rd person perspective is creating a distance to the field, in which you are to gain insights [158]. The 3rd person perspective is possible with the own body as well. as those of others, as with the body I see in the mirror [150]. This perspective is also seen when the user is looking at other users and analysing the movement for improvement. The 3rd person perspective is described as being an analytical approach as opposed to the empathic approach seen in the 2nd person perspective and allows for tweaking and tinkering as well as verbal reference and discussion.

Tense allows us to refer to body and movement in the present, past or future [150]. Body-centred design methods differ in both point-of-view (1st, 2nd and 3rd person) and in tenses, in that a particular method can be intended to create insights from what has happened in the past, what is happening now, or what might happen in the future [150].
Working in Past tense activates the users' memory by looking reflective on past experiences to gain insights. In e.g., doing an interview the interviewer is taking the interviewee back to previous encounters with movement and sport experiences.
Present tense is used to create insights by increasing awareness of the feel of here and now.
Working in Future tense is focusing on potential and possible outcomes, e.g., by enacting a future scenario using by Svanæs & Barkhuus Somatic facilitated phenomenological inquiry through movement. The future tense can be exemplified by enactment taking place in the present, the work is then projected into possible imagined future scenarios.

COLOURBOX

Concepts	Use in Design	Neighbouring theories
1st, 2nd and 3rd person perspectives	Guiding	Somaesthetics
Past, Present, Future tense	Guiding	

9. Relevant Mappings of Concepts

As stated already in the introduction, design is a highly eclectic activity that needs to pull resources from a variety of fields and theoretical frameworks to support a myriad of design decisions. In this process, the theories themselves tend to shrink from view, being invoked through such concepts that have been identified above in ways that are not always entirely faithful to the underlying theory.

A well-known example of this is the way in which Interaction Design has appropriated the concept of affordances from Ecological Psychology, without taking into account how the underlying theory is radically anti-representational. What is being retained are concepts – or appropriations of concepts - that are inherently useful in a design (research) process: they enhance communication, inspire design, and or come with methods, guidelines or tools that scaffold and guide the process.

In the overview above, we have ended each summary with the extraction of relevant concepts, suggested some associations between concepts from different theories, and begun to identify their potential role in designing a movement-based method or understanding its results.
We now leave the theories behind, to instead uncover ways to uncover meaningful relations between the concepts.

The overview already suggests one such sorting, related to how widely applicable or precise the concepts are. The sorting of concepts as 'sensitising/ inspirational/ analytical/ guiding' was included in the tables at the end of each subsection. This sorting provides a first understanding of why the theories have become relevant for the project experts, but it does not present the only way that theory becomes relevant in MeCaMInD. Below, we propose additional sortings of concepts, that provide additional support for their usage. The first subsection presents a typology.

Relevant Mappings of Concepts

Classifying Movement-Based Design Methods

The research group at Syddansk University has already developed a typology of movement-based design methods [2]. The typology is already a way to categorize different design methods and provides a structured overview for designers, facilitators and students wishing to use movement-based/embodied design methods in their work. This model will support later work on organising the methods collected and chartered in the project.

Although differences exist between different embodied/ movement approaches, they share the commonality of conceptualizing physical movement as a material in the design process [64,83].

Loke and Robertson [83] define the conceptualizing of movement in design as:
"In conceptualizing movement as a design material, the moving body is viewed as a creative material that requires physical exploration and can generate unexpected responses and insights [p. 7:3].

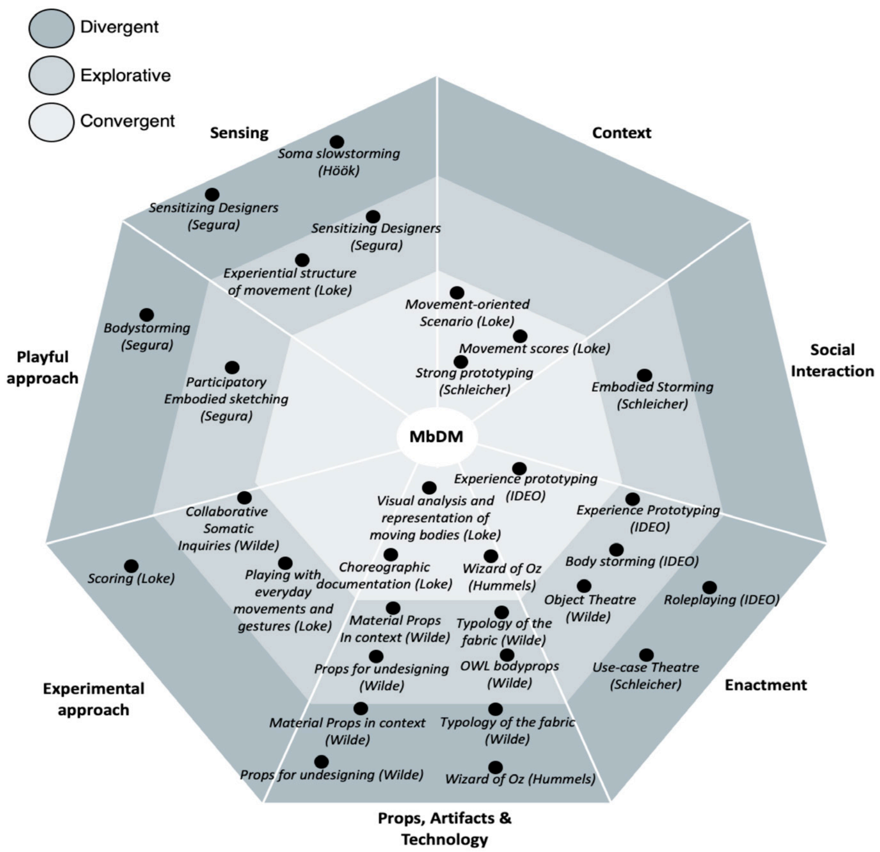
Its relevance to this theory overview is related to how it foregrounds specific aspects of movement-based design methods.

Firstly, the typology provides a structured overview of the type of insight the individual methods can give, categorized as either divergent, explorative, or convergent. This relates closely to the categorization above, where concepts were categorized according to their preciseness and scope. The typology further builds on the three stages in design activities suggested by Gray, Brown & Macanufo [51] and help guide their appropriate use in a design/development process, independent of the overarching specific design goal. From a movement perspective, the typology contributes with differentiation between methods based on how movement is stimulated, formed, or catalysed. The typology uses a very wide concept of medium, including moods, tools, indicating the vast array of materials that come into play in design methods (see also activity design).

Relevant Mappings of Concepts

Relevant Mappings of Concepts

Concepts	Use in Design	Neighbouring theories
Divergence, Exploration, Convergence	Guiding	
Medium	Guiding	Activity design



The typology consists of two dimensions to categorise Movement-based Design Methods´s; 1) The seven sub-mediums, each with its own 1/7 slice of the model; Sensing, Playful approach, Experimental approach, Context, Social Interaction, Enactment & Props, Artifacts and Technology, that stimulates, form og catalyses movement and 2) The type of design stage for what the movement will help gain insights into, each divided by colortones (Divergent, Explorative, and Convergent).

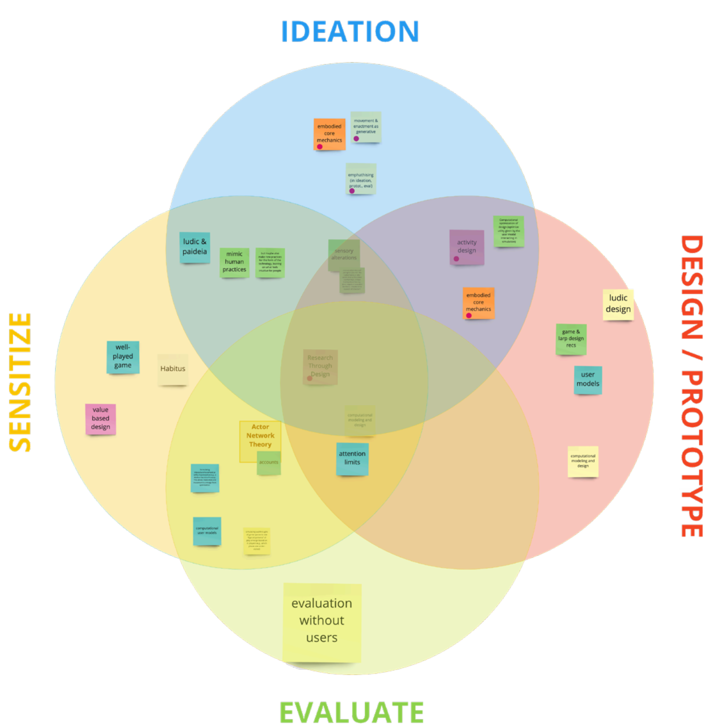
COLOURBOX

Relevant Mappings of Concepts

Concepts Sorted Related to Their Relevance During a Design Process

The graph in the next page was generated in the concept sorting workshop, by the group of experts working together to uncover meaningful relations between key concepts from the various underpinning theories. The graph was generated as an experiment and is not complete, nor necessarily covers the same concepts as are identified in this report.

This graph explores sorting concepts according to their relevance during the different stages of a design project. This approach mirrors one of the more important categorisations of methods suggested in the movement method taxonomy discussed above [2], but uses a more classical model appropriated from iterative design. The reason for the difference might be that the iterative design model is both well known to the experts, and one that several use to describe their own research approach. The graph was drawn as a Venn diagram, since some concepts are relevant in multiple, or all phases of design.



Concepts Sorted Related to Their Relevance During a Design Process

shutterstock

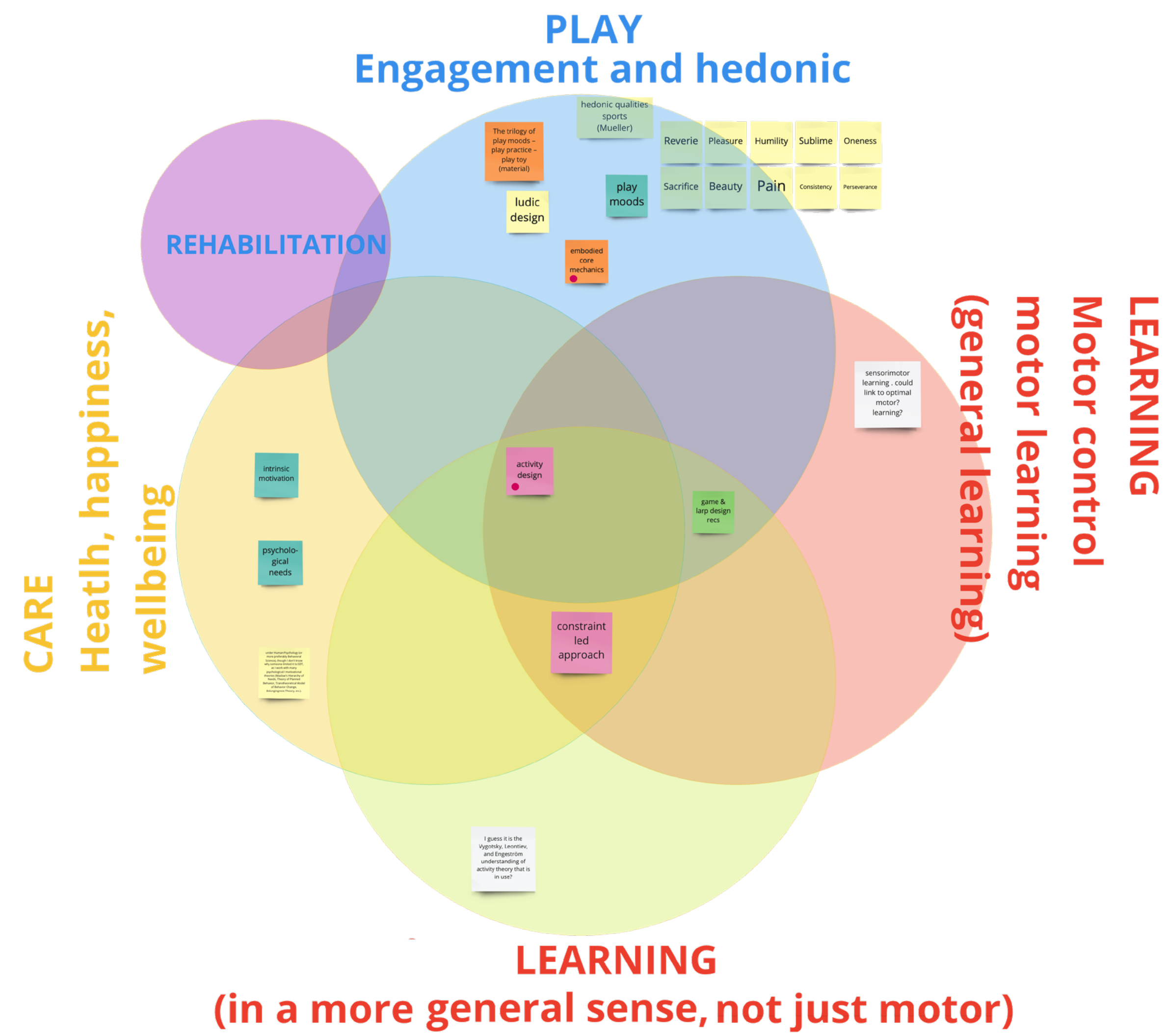
Relevant Mappings of Concepts

Relevant Mappings of Concepts

Concepts Sorted Related to Their Relevance for MeCaMInD Application Domains

The graph in Figure Y was generated in the same workshop, and relates to how the MeCaMInD project has identified four application domains, in which movement-based design methods are particularly useful. These concern; 1) health and rehabilitation, 2) teaching and learning in general, 3) movement learning in particular, and 4) hedonic play. An attempt at sorting the concepts according to the domain was made, identifying some concepts that were tightly associated to only one of the domains. This overview primarily uncovered a lack of supporting theories and concepts for general learning, most likely a result of very few of the partners working in this area. Even more surprising was the lack of concepts relevant for movement learning and training; this may however been an oversight since many such concepts are discussed in the sections above and that there is an obvious overlap between the domains of health and rehabilitation, and motor learning practices.

PlayAlive



Concepts Sorted Related to Their Relevance for MeCaMInD Application Domains

10. Discussion

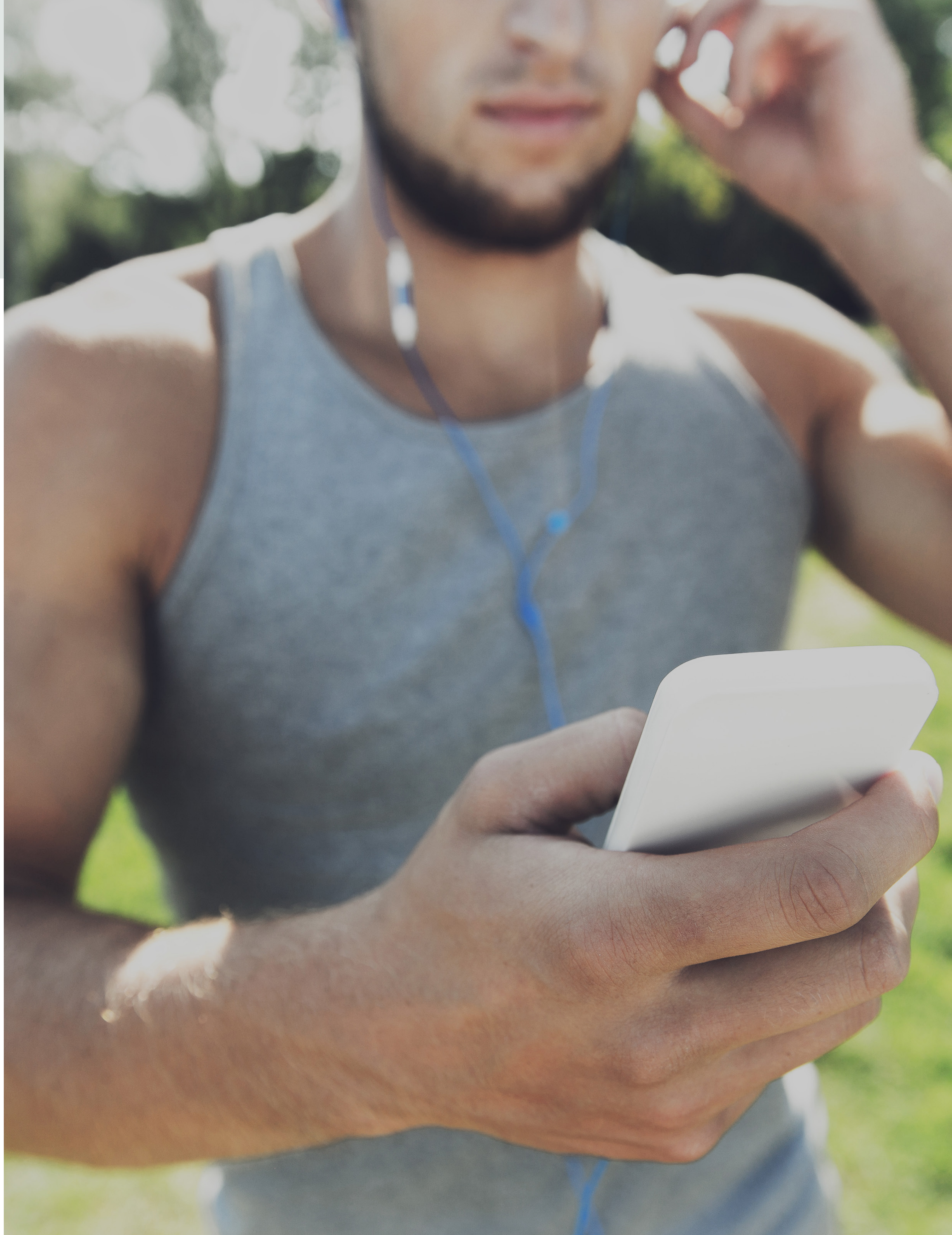
This internal Mecamind report has multiple uses within the project. Firstly, the report provides a go-to guide for project members, to get easy access to the various theoretical perspectives that underpin the work of project members, and thereby also the project. The summary section above is intended for this purpose.

It can also be used as a theoretical resource when writing future papers. To this purpose, Appendix 2 contains the full contributions from partners, including their complete descriptions of usages, and reference lists. We see this report e.g. working as an introductory guide for (bsc/msc/phd thesis) students working on related topics to familiarize themselves in an efficient manner to the existing theoretic backgrounds/views in the field. This is why the chapters can also be read on their own, facilitating educators to select their set of chapters relevant for their course or topic.

Most methods collected in the project will have some theoretical grounding, or at least rely on concepts such as those elicited in this document. This means that the concepts, or the theories themselves, can be used to organise and classify the collected methods, and potentially to explain why/how they work. This will support the educational activities in the project. In line with this purpose, the report provides a condensed version of the variety of perspectives underlying our methods collection. Although this potentially leads to losing important nuances for the specialists in the field, it makes it more fitting for non-academic purposes, e.g. for reaching out to commercial partners working in the field.

The work presented here must however be seen more as a starting point for discussion, than its end result. In particular, we need to do further work on identifying both synergies and clashes between the different perspectives taken – while there are large synergies between the perspectives, not all theories are compatible. Secondly, this report has only completed one sorting of the concepts and more work is needed on finding alternative ways of sorting and classifying both concepts and methods, to see how they impact each other. This work will continue as part of later work packages.

MeCaMInD
Creativity in Motion



COLOURBOX

BIBLIOGRAPHY

[1] Ferran Altarriba Bertran, Ahmet Börütecene, Oguz'Oz' Buruk, Mattia Thibault, and Katherine Isbister. 2020. MESMER: Towards a Playful Tangible Tool for Non-Verbal Multi-Stakeholder Conversations. In Extended Abstracts of the 2020 Annual Symposium on Computer-Human Interaction in Play, 168–172.

[2] Rasmus Vestergaard Andersen, Søren Lekbo, René Engelhardt Hansen, and Lars Elbæk. 2020. Movement-Based Design Methods: A Typology for Designers. In European Conference on Games Based Learning, Academic Conferences International Limited, 637–XVI.

[3] Ashton Anderson, Jon Kleinberg, and Sendhil Mullainathan. 2017. Assessing human error against a benchmark of perfection. ACM Transactions on Knowledge Discovery from Data (TKDD) 11, 4 (2017), 1–25.

[4] Matthew AJ Apps, Ana Tajadura-Jiménez, Marty Sereno, Olaf Blanke, and Manos Tsakiris. 2015. Plasticity in unimodal and multimodal brain areas reflects multisensory changes in self-face identification. Cerebral Cortex 25, 1 (2015), 46–55.

[5] Jon Back and Annika Waern. 2015. Experimental Game Design. In Game Research Methods: An Overview, Petri Lankoski and Staffan Björk (eds.). ETC Press.

[6] Leyla Bagheri and Marina Milyavskaya. 2020. Novelty–variety as a candidate basic psychological need: New evidence across three studies. Motivation and Emotion 44, 1 (2020), 32–53.

[7] MM Bekker, Ben AM Schouten, and LCT de Valk. 2020. Designing play solutions with the lenses of play card tool. In Framing Play Design: A Hands-on Guide for Designers, Learners and Innovators. BIS Publishers, 75–87.

[8] Marc Bellemare, Sriram Srinivasan, Georg Ostrovski, Tom Schaul, David Saxton, and Remi Munos. 2016. Unifying count-based exploration and intrinsic motivation. Advances in neural information processing systems 29, (2016), 1471–1479.

[9] Steve Benford, Chris Greenhalgh, Andy Crabtree, Martin Flintham, Brendan Walker, Joe Marshall, Boriana Koleva, Stefan Rennick Egglestone, Gabriella Giannachi, Matt Adams, and others. 2013. Performance-led research in the wild. ACM Transactions on Computer-Human Interaction (TOCHI) 20, 3 (2013), 14.

[10] Frédéric Bevilacqua, Eric O Boyer, Jules Françoise, Olivier Houix, Patrick Susini, Agnès Roby-Brami, and Sylvain Hanneton. 2016. Sensori-motor learning with movement sonification: perspectives from recent interdisciplinary studies. Frontiers in neuroscience 10, (2016), 385.

[11] Herbert Blumer. 1954. What is Wrong With Social Theory? American sociological review 19, 1 (1954), 3–10.

[12] Matthew Botvinick and Jonathan Cohen. 1998. Rubber hands 'feel'touch that eyes see. Nature 391, 6669 (1998), 756–756.

[13] Glenn A Bowen. 2006. Grounded theory and sensitizing concepts. International journal of qualitative methods 5, 3 (2006), 12–23.

[14] Glenn A Bowen. 2020. Sensitizing concepts. SAGE Publications Limited.

[15] Svend Brinkmann. 2005. Tilværelsens æstetik og etik. Psyke & Logos 26, 2 (2005), 20–20.

[16] Jacob Buur, Mads Vedel Jensen, and Tom Djajadiningrat. 2004. Hands-only scenarios and video action walls: novel methods for tangible user interaction design. In Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques, 185–192.

[17] Roger Caillois. 2001. Man, Play and Games. University of Illinois Press, Champaign, IL.

[18] Alessandro Canossa, Ahmad Azadvar, and Erik Kjaer Andersen. 2020. Hold My Hand: Impact of Intimate Controllers on Player Experience. In 2020 IEEE Conference on Games (CoG), IEEE, 261–266.

[19] Lucilla Cardinali, Francesca Frassinetti, Claudio Brozzoli, Christian Urquizar, Alice C Roy, and Alessandro Farnè. 2009. Tool-use induces morphological updating of the body schema. Current biology 19, 12 (2009), R478–R479.

[20] Dana R Carney, Amy JC Cuddy, and Andy J Yap. 2010. Power posing: Brief nonverbal displays affect neuroendocrine levels and risk tolerance. Psychological science 21, 10 (2010), 1363–1368.

[21] Bob Carroll and Julia Loumidis. 2001. Childrenís perceived competence and enjoyment in physical education and physical activity outside school. European physical education review 7, 1 (2001), 24–43.

[22] Noshaba Cheema, Laura A Frey-Law, Kourosh Naderi, Jaakko Lehtinen, Philipp Slusallek, and Perttu Hämäläinen. 2020. Predicting mid-air interaction movements and fatigue using deep reinforcement learning. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1–13.

[23] Anthony Chemero. 2011. Radical embodied cognitive science. MIT press.

[24] Nuttapong Chentanez, Andrew Barto, and Satinder Singh. 2004. Intrinsically motivated reinforcement learning. Advances in neural information processing systems 17, (2004).

[25] T Matthew Ciolek and Adam Kendon. 1980. Environment and the spatial arrangement of conversational encounters. Sociological Inquiry 50, 3–4 (1980), 237–271.

[26] Peter Dalsgaard and Christian Dindler. 2014. Between theory and practice: bridging concepts in HCI research. In Proceedings of the 32nd annual ACM conference on human factors in computing systems, ACM, 1635–1644.

[27] Frédérique De Vignemont. 2018. Mind the body: An exploration of bodily self-awareness. Oxford University Press.

[28] Bernard DeKoven. 2011. Coliberation. DeepFun. Retrieved from http://www.deepfun.com/coliberation/

[29] Bernie DeKoven. 2002. The well-played game: a playful path to wholeness. iUniverse.

[30] Robby van Delden, Sascha Bergsma, Koen Vogel, Dees Postma, Randy Klaassen, and Dennis Reidsma. 2020. VR4VRT: Virtual Reality for Virtual Rowing Training. In Extended Abstracts of the 2020 Annual Symposium on Computer-Human Interaction in Play, 388–392.

[31] Ansgar E Depping, Regan L Mandryk, Colby Johanson, Jason T Bowey, and Shelby C Thomson. 2016. Trust me: social games are better than social icebreakers at building trust. In Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play, 116–129.

[32] John Partomo Djajadiningrat, William W Gaver, and JW Fres. 2000. Interaction relabelling and extreme characters: methods for exploring aesthetic interactions. In Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques, 66–71.

[33] William H Edwards. 2010. Motor learning and control: From theory to practice. Cengage Learning.

[34] Lars Elbæk and René Engelhardt Hansen. 2019. Aesthetic and ethical value stances in sport, play, and movement-games. In European Conference on Games Based Learning, Academic Conferences International Limited, 210–XVII.

[35] Gabriele Ferri and Inte Gloerich. 2019. Take root among the stars: if Octavia Butler wrote design fiction. interactions 27, 1 (2019), 22–23.

[36] Chiara Fini, Flavia Cardini, Ana Tajadura-Jiménez, Andrea Serino, and Manos Tsakiris. 2013. Embodying an outgroup: the role of racial bias and the effect of multisensory processing in somatosensory remapping. Frontiers in behavioral neuro-

science 7, (2013), 165.

[37] Gerhard Fischer. 2001. User modeling in human–computer interaction. User modeling and user-adapted interaction 11, 1 (2001), 65–86.

[38] Jules Françoise, Sarah Fdili Alaoui, Thecla Schiphorst, and Frédéric Bevilacqua. 2014. Vocalizing dance movement for interactive sonification of laban effort factors. In Proceedings of the 2014 conference on Designing interactive systems, 1079–1082.

[39] Julian Frommel, Jan Gugenheimer, David Klein, Enrico Rukzio, and Michael Weber. 2017. CanTouchThis: Examining the Effect of Physical Contact in a Mobile Multiplayer Game. In Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems, 1609–1616.

[40] Shaun Gallagher. 2006. How the body shapes the mind. Clarendon Press.

[41] William Gaver. 2002. Design for Homo Ludens. I3 Magazine 12.

[42] William Gaver. 2009. Designing for homo ludens, still. In (Re)Searching The Digital Bauhaus. Springer, 163–178. Retrieved January 4, 2017 from http://link.springer.com/chapter/10.1007%2F978-1-84800-350-7_9

[43] William Gaver. 2012. What should we expect from research through design? In Proceedings of the SIGCHI conference on human factors in computing systems, ACM, 937–946.

[44] William Gaver, John Bowers, Andrew Boucher, Hans Gellerson, Sarah Pennington, Albrecht Schmidt, Anthony Steed, Nicholas Villars, and Brendan Walker. 2004. The drift table: designing for ludic engagement. In CHI'04 extended abstracts on Human factors in computing systems, ACM, 885–900.

[45] William W Gaver. 1991. Technology affordances. In Proceedings of the SIGCHI conference on Human factors in computing systems, 79–84.

[46] Ann M Gentile. 1972. A working model of skill acquisition with application to teaching. Quest 17, 1 (1972), 3–23.

[47] Ann M Gentile. 1987. Skill acquisition: Action, movement, and the neuromotor processes. Movement science: Foundations for physical therapy in rehabilitation (1987).

[48] Samuel J Gershman, Eric J Horvitz, and Joshua B Tenenbaum. 2015. Computational rationality: A converging paradigm for intelligence in brains, minds, and machines. Science 349, 6245 (2015), 273–278.

[49] James Jerome Gibson. 1979. The ecological approach to visual perception. (1979).

[50] Erving Goffman. 1974. Frame analysis: An essay on the organization of experience. Harvard University Press.

[51] Dave Gray, Sunni Brown, and James Macanufo. 2010. Gamestorming: A playbook for innovators, rulebreakers, and changemakers. O'Reilly Media, Inc.

[52] Anthony G Greenwald, Debbie E McGhee, and Jordan LK Schwartz. 1998. Measuring individual differences in implicit cognition: the implicit association test. Journal of personality and social psychology 74, 6 (1998), 1464.

[53] Edward T Hall. 1963. A system for the notation of proxemic behavior 1. American anthropologist 65, 5 (1963), 1003–1026.

[54] Edward T Hall, Ray L Birdwhistell, Bernhard Bock, Paul Bohannan, A Richard Diebold Jr, Marshall Durbin, Munro S Edmonson, JL Fischer, Dell Hymes, Solon T Kimball, and others. 1968. Proxemics [and comments and replies]. Current anthropology 9, 2/3 (1968), 83–108.

[55] Edward Twitchell Hall. 1966. The hidden dimension. Garden City, NY: Doubleday.

[56] Perttu Hämäläinen, Xiaoxiao Ma, Jari Takatalo, and Julian Togelius. 2017. Predictive physics simulation in game mechanics. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play, 497–505.

[57] Henry Head and Gordon Holmes. 1911. Sensory disturbances from cerebral lesions. Brain 34, 2–3 (1911), 102–254.

[58] Brandon Heenan, Saul Greenberg, Setareh Aghelmanesh, and Ehud Sharlin. 2013. Designing Social Greetings and Proxemics in Human Robot Interaction. University of Calgary.

[59] Alan R Hevner, Salvatore T March, Jinsoo Park, and Sudha Ram. 2004. Design science in information systems research. MIS quarterly (2004), 75–105.

[60] James Hollan, Edwin Hutchins, and David Kirsh. 2000. Distributed cognition: toward a new foundation for human-computer interaction research. ACM Transactions on Computer-Human Interaction (TOCHI) 7, 2 (2000), 174–196.

[61] Stefan Holmlid. 2007. Interaction design and service design: Expanding a comparison of design disciplines. Nordes 2 (2007).

[62] Kristina Höök. 2018. Designing with the body: somaesthetic interaction design. MIT Press.

[63] Kristina Höök and Jonas Löwgren. 2012. Strong concepts: Intermediate-level knowledge in interaction design research. ACM Transactions on Computer-Human Interaction (TOCHI) 19, 3 (2012), 23.

[64] Caroline Hummels, Kees CJ Overbeeke, and Sietske Klooster. 2007. Move to get moved: a search for methods, tools and knowledge to design for expressive and rich movement-based interaction. Personal and Ubiquitous Computing 11, 8 (2007), 677–690.

[65] Don Ihde. 1975. The experience of technology: human-machine relations. Cultural Hermeneutics 2, 3 (1975), 267–279.

[66] Don Ihde. 1990. Technology and the lifeworld: From garden to earth. (1990).

[67] Colby Johanson, Carl Gutwin, Jason T Bowey, and Regan L Mandryk. 2019. Press pause when you play: comparing spaced practice intervals for skill development in games. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play, 169–184.

[68] Staffan Jonsson and Annika Waern. 2008. The art of game-mastering pervasive games. ACM.

[69] Staffan Jonsson, Annika Waern, Markus Montola, and Jaakko Stenros. 2007. Game mastering a pervasive larp. Experiences from momentum. In PerGames 2007: Proceedings of the 4th International Symposium on Pervasive Gaming Applications.

[70] Helle Skovbjerg Karoff. 2013. Play practices and play moods. International Journal of Play 2, 2 (September 2013), 76–86. DOI:https://doi.org/10.1080/21594937.2013.805650

[71] Anouk Keizer, Monique AM Smeets, H Chris Dijkerman, Siarhei A Uzunbajakau, Annemarie van Elburg, and Albert Postma. 2013. Too fat to fit through the door: first evidence for disturbed body-scaled action in anorexia nervosa during locomotion. PloS one 8, 5 (2013), e64602.

[72] Adam Kendon. 2010. Spacing and orientation in co-present interaction. In Development of multimodal interfaces: Active listening and synchrony. Springer, 1–15.

[73] Konstantina Kilteni, Jean-Marie Normand, Maria V Sanchez-Vives, and Mel Slater. 2012. Extending body space in immersive virtual reality: a very long arm illusion. PloS one 7, 7 (2012), e40867.

[74] Johanna Koljonen, Jaakko Stenros, Anna Serup Grove, Aina D. Skjønsfjell, and Elin Nilsen. 2019. Larp Design: Creating Role-play Experiences. Out of print.

[75] Höök Kristina, Martin Jonsson, Anna Ståhl, and Johanna Mercurio. 2016. Somaesthetic Appreciation Design. In CHI 2016.

[76] Bruno Latour. 1996. On actor-network theory: A few clarifications. Soziale welt (1996), 369–381.

[77] Bruno Latour and others. 1999. Pandora's hope: essays on the reality of science studies. Harvard university press.

[78] Seunghwan Lee, Moonseok Park, Kyoungmin Lee, and Jehee Lee. 2019. Scalable muscle-actuated human simulation and control. ACM Transactions On Graphics (TOG) 38, 4 (2019), 1–13.

[79] Lauri Lehtonen, Maximus D Kaos, Raine Kajastila, Leo Holsti, Janne Karsisto, Sami Pekkola, Joni Vähämäki, Lassi Vapaakallio, and Perttu Hämäläinen. 2019. Movement Empowerment in a Multiplayer Mixed-Reality Trampoline Game. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play, 19–29.

[80] Bigna Lenggenhager, Tej Tadi, Thomas Metzinger, and Olaf Blanke. 2007. Video ergo sum: manipulating bodily self-consciousness. Science 317, 5841 (2007), 1096–1099.

[81] Conor Linehan, George Bellord, Ben Kirman, Zachary H Morford, and Bryan Roche. 2014. Learning curves: analysing pace and challenge in four successful puzzle games. In Proceedings of the first ACM SIGCHI annual symposium on Computer-human interaction in play, 181–190.

[82] Sally A Linkenauger, Jessica K Witt, Jonathan Z Bakdash, Jeanine K Stefanucci, and Dennis R Proffitt. Asymmetrical Body Perception.

[83] Lian Loke and Toni Robertson. 2013. Moving and making strange: An embodied approach to movement-based interaction design. ACM Transactions on Computer-Human Interaction (TOCHI) 20, 1 (2013), 1–25.

[84] Matthew R Longo and Patrick Haggard. 2012. What is it like to have a body? Current Directions in Psychological Science 21, 2 (2012), 140–145.

[85] Matthew Longo, Friederike Schüür, Marjolein PM Kammers, Manos Tsakiris, and Patrick Haggard. 2008. What is embodiment? A psychometric approach. Cognition 107 (July 2008), 978–98.

[86] Jonas Löwgren. 2013. Annotated portfolios and other forms of intermediate-level knowledge. ACM Interactions 20, 1 (2013), 30–34.

[87] I Scott MacKenzie. 1992. Fitts' law as a research and design tool in human-computer interaction. Human-computer interaction 7, 1 (1992), 91–139.

[88] Lara Maister, Mel Slater, Maria V Sanchez-Vives, and Manos Tsakiris. 2015. Changing bodies changes minds: owning another body affects social cognition. Trends in cognitive sciences 19, 1 (2015), 6–12.

[89] Angelo Maravita and Atsushi Iriki. 2004. Tools for the body (schema). Trends in cognitive sciences 8, 2 (2004), 79–86.

[90] Nicolai Marquardt and Saul Greenberg. 2015. Proxemic interactions: From theory to practice. Synthesis Lectures on Human-Centered Informatics 8, 1 (2015), 1–199.

[91] Elena Márquez Segura. 2016. Embodied Core Mechanics: Designing for movement-based co-located play. Department of Informatics and Media.

[92] Elena Márquez Segura, James Fey, Ella Dagan, Samvid Niravbhai Jhaveri, Jared Pettitt, Miguel Flores, and Katherine Isbister. 2018. Designing future social wearables with live action role play (larp) designers. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, 1–14.

[93] Elena Márquez Segura, Laia Turmo Vidal, Asreen Rostami, and Annika Waern. 2016. Embodied Sketching. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16), Association for Computing Machinery, New York, NY, USA, 6014–6027. DOI:https://doi.org/10.1145/2858036.2858486

[94] Elena Márquez Segura, Annika Waern, David Lopez Regio, and Luis Márquez Segura. 2016. Playification: The PhyseEar Case. Austin, Texas.

[95] Elena Márquez Segura, Annika Waern, Jin Moen, and Carolina Johansson. 2013. The design space of body games: technological, physical, and social design. In Proceedings of the SIGCHI conference on Human Factors in computing systems, 3365–3374.

[96] Andrew N Meltzoff. 2007. 'Like me': a foundation for social cognition. Developmental science 10, 1 (2007), 126–134.

[97] Maurice Merleau-Ponty. 2013. Phenomenology of perception. Routledge.

[98] Justin B Moore, Zenong Yin, John Hanes, Joan Duda, Bernard Gutin, and Paule Barbeau. 2009. Measuring enjoyment of physical activity in children: validation of the Physical Activity Enjoyment Scale. Journal of applied sport psychology 21, S1 (2009), S116–S129.

[99] William J Morgan. 2002. Social criticism as moral criticism: A Habermasian take on sports. Journal of sport and social issues 26, 3 (2002), 281–299.

[100] Ann Morrison, Stephen Viller, and Peta Mitchell. 2011. Building sensitising terms to understand free-play in open-ended interactive art environments. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2335–2344.

[101] Sean P Mullen, Erin A Olson, Siobhan M Phillips, Amanda N Szabo, Thomas R Wójcicki, Emily L Mailey, Neha P Gothe, Jason T Fanning, Arthur F Kramer, and Edward McAuley. 2011. Measuring enjoyment of physical activity in older adults: invariance of the physical activity enjoyment scale (paces) across groups and time. International Journal of Behavioral Nutrition and Physical Activity 8, 1 (2011), 1–9.

[102] Maaz Nasir, Kelly Lyons, Rock Leung, and Ali Moradian. 2013. Cooperative games and their effect on group collaboration. In International Conference on Design Science Research in Information Systems, Springer, 502–510.

[103] K.M. Newell. 1986. Constraints on the Development of Coordination. In Wade and Shiting (eds): Motor Development in Children: Aspects of Coordination and Control. The Netherlands: Martinus Nijhoff, Dordrecht, 341–360.

[104] Donald A Norman. 1988. The psychology of everyday things. Basic books.

[105] Roy Oman and Edward McAuley. 1993. Intrinsic Motivation and Exercise Behavior. Journal of Health Education 24, 4 (1993), 232–238. DOI:https://doi.org/10.1080/10556699.1993.10610052

[106] Humphry Osmond. 1957. Function as the basis of psychiatric ward design. Psychiatric Services 8, 4 (1957), 23–27.

[107] Antti Oulasvirta. 2019. It's time to rediscover HCI models. Interactions 26, 4 (2019), 52–56.

[108] Antti Oulasvirta, Per Ola Kristensson, Xiaojun Bi, and Andrew Howes. 2018. Computational interaction. Oxford University Press.

[109] Deepak Pathak, Pulkit Agrawal, Alexei A Efros, and Trevor Darrell. 2017. Curiosity-driven exploration by self-supervised prediction. In International conference on machine learning, PMLR, 2778–2787.

[110] Valeria I Petkova and H Henrik Ehrsson. 2008. If I were you: perceptual illusion of body swapping. PloS one 3, 12 (2008), e3832.

[111] James Pierce. 2014. On the presentation and production of design research artifacts in HCI. In Proceedings of the 2014 conference on Designing interactive systems, ACM, 735–744.

[112] Martin Porcheron, Andrés Lucero, Aaron Quigley, Nicolai Marquardt, James Clawson, and Kenton O'hara. 2016. Proxemic mobile collocated interactions. In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems, 3309–3316.

[113] Dees BW Postma, Koen APM Lemmink, and Frank TJM Zaal. 2018. The affordance of catchability in running to intercept fly balls. Journal of Experimental Psychology: Human Perception and Performance 44, 9 (2018), 1336.

[114] Dees Postma, Robby Van Delden, Wytse Walinga, Jeroen Koekoek, Bert-Jan van Beijnum, Fahim A Salim, Ivo Van Hilvoorde, and Dennis Reidsma. 2019. Towards smart sports exercises: First designs. In Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts, 619–630.

[115] Kruakae Pothong, Chris Speed, Ruth Catlow, Billy Dixon, Evan Morgan, Bran Knowles, Georgia Newmarch, Daniel Richards, and Leon Cruickshank. 2021. Deliberating Data-Driven Societies Through Live Action Role Play. In Designing Interactive Systems Conference 2021, 1726–1738.

[116] Catherine Preston and H Henrik Ehrsson. 2016. Illusory obesity triggers body dissatisfaction responses in the insula and anterior cingulate cortex. Cerebral Cortex 26, 12 (2016), 4450–4460.

[117] Fred H Previc. 1998. The neuropsychology of 3-D space. Psychological bulletin 124, 2 (1998), 123.

[118] Andreas Reckwitz. 2002. Toward a theory of social practices: A development in culturalist theorizing. European journal of social theory 5, 2 (2002), 243–263.

[119] Johan Redström. 2017. Making design theory. MIT Press.

[120] Giacomo Rizzolatti, Cristiana Scandolara, Massimo Matelli, and Maurizio Gentilucci. 1981. Afferent properties of periarcuate neurons in macaque monkeys. II. Visual responses. Behavioural brain research 2, 2 (1981), 147–163.

[121] Raquel Breejon Robinson, Elizabeth Reid, James Collin Fey, Ansgar E Depping, Katherine Isbister, and Regan L Mandryk. 2020. Designing and Evaluating'in the Same Boat', a Game of Embodied Synchronization for Enhancing Social Play. In Proceedings of the 2020 CHI conference on human factors in computing systems, 1–14.

[122] Shaghayegh Roohi, Asko Relas, Jari Takatalo, Henri Heiskanen, and Perttu Hämäläinen. 2020. Predicting Game Difficulty and Churn Without Players. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play, 585–593.

[123] Shaghayegh Roohi, Jari Takatalo, Christian Guckelsberger, and Perttu Hämäläinen. 2018. Review of intrinsic motivation in simulation-based game testing. In Proceedings of the 2018 chi conference on human factors in computing systems, 1–13.

[124] Robert Rosenberger and Peter-Paul Verbeek. 2015. A field guide to postphenomenology. Postphenomenological investigations: Essays on human-technology relations (2015), 9–41.

[125] Wolff-Michael Roth and Alfredo Jornet. 2013. Situated cognition. Wiley Interdisciplinary Reviews: Cognitive Science 4, 5 (2013), 463–478.

[126] Richard M Ryan and Edward L Deci. 2000. Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary educational psychology 25, 1 (2000), 54–67.

[127] Richard M Ryan and Edward L Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American psychologist 55, 1 (2000), 68.

[128] Richard M. Ryan, Christina M. Frederick, Deborah Lepes, Noel Rubio, and Kennon M. Sheldon. 1997. Intrinsic Motivation and Exercise Adherence. Int. J. Sport Pshychology 28, (1997), 335–353.

[129] Richard M Ryan, C Scott Rigby, and Andrew Przybylski. 2006. The motivational pull of video games: A self-determination theory approach. Motivation and emotion 30, 4 (2006), 344–360.

[130] Karin Ryding. In Press. Never let me go: Social and Introspective Play. In Hybrid Museum Experiences: Theory and Design, Annika Waern and Anders Sundnes Løvlie (eds.). Amsterdam University Press, Amsterdam, Netherlands.

[131] Katie Salen and Eric Zimmerman. 2004. Rules of play: Game design fundamentals. MIT press.

[132] Fahim A Salim, Fasih Haider, Dees Postma, Robby Van Delden, Dennis Reidsma, Saturnino Luz, and Bert-Jan van Beijnum. 2020. Towards Automatic Modeling of Volleyball Players' Behavior for Analysis, Feedback, and Hybrid Training. Journal for the Measurement of Physical Behaviour 3, 4 (2020), 323–330.

[133] Maria V Sanchez-Vives and Mel Slater. 2005. From presence to

consciousness through virtual reality. Nature Reviews Neuroscience 6, 4 (2005), 332–339.

[134]Stefano Scarpa and Alessandra Nart. 2012. Influences of perceived sport competence on physical activity enjoyment in early adolescents. Social Behavior and Personality: an international journal 40, 2 (2012), 203–204.

[135]Jesse Schell. 2019. Tenth Anniversary: The Art of Game Design: A Book of Lenses. (2019).

[136]RA Schmidt and TD Lee. 2014. Motor learning and performance: From principles to performance. Champaign IL: Human Kinetics Press.

[137]Richard A Schmidt and Craig A Wrisberg. 2008. Motor learning and performance: A situation-based learning approach. Human kinetics.

[138]Donald Schön. 2008. The Reflective Practitioner. How Professionals Think in Action. Routledge.

[139]Andrea Serino. 2019. Peripersonal space (PPS) as a multisensory interface between the individual and the environment, defining the space of the self. Neuroscience & Biobehavioral Reviews 99, (2019), 138–159.

[140]Kennon M Sheldon, Andrew J Elliot, Youngmee Kim, and Tim Kasser. 2001. What is satisfying about satisfying events? Testing 10 candidate psychological needs. Journal of personality and social psychology 80, 2 (2001), 325.

[141]Roland Sigrist, Georg Rauter, Robert Riener, and Peter Wolf. 2013. Augmented visual, auditory, haptic, and multimodal feedback in motor learning: a review. Psychonomic bulletin & review 20, 1 (2013), 21–53.

[142]Paul J Silvia. 2005. What is interesting? Exploring the appraisal structure of interest. Emotion 5, 1 (2005), 89.

[143]Paul J Silvia. 2008. Interest—The curious emotion. Current directions in psychological science 17, 1 (2008), 57–60.

[144]Aneesha Singh, Annina Klapper, Jinni Jia, Antonio Fidalgo, Ana Tajadura-Jiménez, Natalie Kanakam, Nadia Bianchi-Berthouze, and Amanda Williams. 2014. Motivating people with chronic pain to do physical activity: opportunities for technology design. In Proceedings of the SIGCHI conference on human factors in computing systems, 2803–2812.

[145]Wina Smeenk, Oscar Tomico, and Koen van Turnhout. 2016. A systematic analysis of mixed perspectives in empathic design: Not one perspective encompasses all. International Journal of Design 10, 2 (2016), 31–48.

[146]Lucy A. Suchman. 1987. Plans and situated actions: The problem of human-machine communication. Cambridge university press.

[147]Lucy A Suchman. 2002. Practice-based design of information systems: Notes from the hyperdeveloped world. The information society 18, 2 (2002), 139–144.

[148]Petra Sundström, Alex Taylor, Katja Grufberg, Niklas Wirström, Jordi Solsona Belenguer, and Marcus Lundén. 2011. Inspirational bits: towards a shared understanding of the digital material. In Proceedings of the SIGCHI conference on human factors in computing systems, 1561–1570.

[149]Richard S Sutton and Andrew G Barto. 2018. Reinforcement learning: An introduction. MIT press.

[150]Dag Svanæs and Louise Barkhuus. 2020. The Designer's Body as Resource in Design: Exploring Combinations of Point-of-view and Tense. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1–13.

[151]Pawel Tacikowski, Jens Fust, and H Henrik Ehrsson. 2020. Fluidity of gender identity induced by illusory body-sex change. Scientific reports 10, 1 (2020), 1–14.

[152]Ana Tajadura-Jiménez, Domna Banakou, Nadia Bianchi-Berthouze, and Mel Slater. 2017. Embodiment in a child-like talking virtual body influences object size perception, self-identification, and subsequent real speaking. Scientific reports 7, 1 (2017), 1–12.

[153]Ana Tajadura-Jiménez, Maria Basia, Ophelia Deroy, Merle Fairhurst, Nicolai Marquardt, and Nadia Bianchi-Berthouze. 2015. As light as your footsteps: altering walking sounds to change perceived body weight, emotional state and gait. In Proceedings of the 33rd annual ACM conference on human factors in computing systems, 2943–2952.

[154]Ana Tajadura-Jiménez, Stephanie Grehl, and Manos Tsakiris. 2012. The other in me: interpersonal multisensory stimulation changes the mental representation of the self. PloS one 7, 7 (2012), e40682.

[155]Ana Tajadura-Jiménez, Galini Pantelidou, Pawel Rebacz, Daniel Västfjäll, and Manos Tsakiris. 2011. I-space: the effects of emotional valence and source of music on interpersonal distance. PloS one 6, 10 (2011), e26083.

[156]Ana Tajadura-Jiménez and Manos Tsakiris. 2014. Balancing the "inner" and the "outer" self: Interoceptive sensitivity modulates self–other boundaries. Journal of Experimental Psychology: General 143, 2 (2014), 736.

[157]Ana Tajadura-Jiménez, Aleksander Väljamäe, Iwaki Toshima, Toshitaka Kimura, Manos Tsakiris, and Norimichi Kitagawa. 2012. Action sounds recalibrate perceived tactile distance. Current Biology 22, 13 (2012), R516–R517.

[158]Oscar Tomico, VO Winthagen, and MMG Van Heist. 2012. Designing for, with or within: 1st, 2nd and 3rd person points of view on designing for systems. In Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design, 180–188.

[159]Manos Tsakiris. 2010. My body in the brain: a neurocognitive model of body-ownership. Neuropsychologia 48, 3 (2010), 703–712.

[160]Vasiliki Tsaknaki, Madeline Balaam, Anna St\aahl, Pedro Sanches, Charles Windlin, Pavel Karpashevich, and Kristina Höök. 2019. Teaching Soma Design. In Proceedings of the 2019 on Designing Interactive Systems Conference, 1237–1249.

[161]Laia Turmo Vidal, Elena Márquez Segura, Luis Parrilla Bel, and Annika Waern. 2019. BalBoa: A Balancing Board for Handstand Training. In Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems (CHI EA '19), ACM, New York, NY, USA, LBW1414:1-LBW1414:6. DOI:https://doi.org/10.1145/3290607.3312909

[162]Laia Turmo Vidal, Hui Zhu, and Abraham Riego-Delgado. 2020. BodyLights: Open-Ended Augmented Feedback to Support Training Towards a Correct Exercise Execution. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, Association for Computing Machinery, New York, NY, USA, 1–14.

[163]Linda de Valk, Tilde Bekker, and Berry Eggen. 2013. Leaving room for improvisation: towards a design approach for open-ended play. In Proceedings of the 12th International Conference on Interaction Design and Children, ACM, 92–101.

[164]Anna Vallgårda and Ylva Fernaeus. 2015. Interaction Design as a Bricolage Practice. In Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction, ACM, 173–180.

[165]Anna Vallgårda and Johan Redström. 2007. Computational composites. In Proceedings of the SIGCHI conference on Human factors in computing systems, ACM, 513–522.

[166]Robby Van Delden, Pauline Aarts, and Betsy Van Dijk. 2012. Design of tangible games for children undergoing occupational and physical therapy. In International Conference on Entertainment Computing, Springer, 221–234.

[167]Björn Van Der Hoort, Arvid Guterstam, and H Henrik Ehrsson. 2011. Being Barbie: the size of one's own body determines the perceived size of the world. PloS one 6, 5 (2011), e20195.

[168]Peter-Paul Verbeek. 2005. What Things Do: Philosophical Reflections on Technology, Agency, and Design. Penn State University Press.

[169]Isabelle Viaud-Delmon, Jane Mason, Karim Haddad, Markus Noisternig, Frédéric Bevilacqua, and Olivier Warusfel. 2011. A sounding body in a sounding space: the building of space in choreography–focus on auditory-motor interactions. Dance Research 29, supplement (2011), 433–449.

[170]Annika Waern and Jon Back. 2017. Activity as the ultimate particular of interaction design. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems, 3390–3402.

[171]Annika Waern, Elena Balan, and Kim Nevelsteen. 2012. Athletes and street acrobats: designing for play as a community value in parkour. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM, Austin, Texas, USA, 869–878.

[172]Annika Waern, Paulina Rajkowska, Karin B Johansson, Jon Bac, Jocelyn Spence, and Anders Sundnes Løvlie. 2020. Sensitizing Scenarios: Sensitizing Designer Teams to Theory. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 1–13.

[173]William H Warren. 1988. Action modes and laws of control for the visual guidance of action. In Advances in psychology. Elsevier, 339–379.

[174]Robert C Wilson, Amitai Shenhav, Mark Straccia, and Jonathan D Cohen. 2019. The eighty five percent rule for optimal learning. Nature communications 10, 1 (2019), 1–9.

[175]Charles Windlin, Anna St\aahl, Pedro Sanches, Vasiliki Tsaknaki, Pavel Karpashevich, Madeline Balaam, and Kristina Höök. 2019. Soma Bits-mediating technology to orchestrate bodily experiences. In RTD 2019-Research through Design Conference 2019, the Science Centre, Delft, on 19th to 22nd March 2019.

[176]What is Nordic Larp? Nordic Larp. Retrieved December 7, 2020 from https://nordiclarp.org/what-is-nordic-larp/

MeCaMInD
Creativity in Motion

Report produced by: Annika Waern and Laia Turmo Vidal

The Method Cards for Movement-based Interaction Design (MeCaMInD) project explores how we can make a navigable and actionable method card toolbox in the fields of interaction design and sport & movement.
MeCaMInD also focuses on disseminating the insights of the toolbox to students and design professionals across disciplines, as well as providing a greater understanding of how to create and enhance a movement-based creative design environment.

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