Experiencing the Body as Play

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ABSTRACT
Games research in HCI is continually interested in the human body. However, recent work suggests that the field has only begun to understand how to design bodily games. We propose that the games research field is advancing from playing with digital content using a keyboard, to using bodies to play with digital content, towards a future where we experience our bodies as digital play. To guide designers interested in supporting players to experience their bodies as play, we present two phenomenological perspectives on the human body (Körper and Leib) and articulate a suite of design tactics using our own and other people's work. We hope with this paper, we are able to help designers embrace the point that we both "have" a body and "are" a body, thereby aiding the facilitation of the many benefits of engaging the human body through games and play, and ultimately contributing to a more humanized technological future.

Author Keywords
Whole-body interaction; exergame; exertion games; play

ACM Classification Keywords: H.5.2. [Information Interfaces and Presentation]: User Interfaces - Miscellaneous.

INTRODUCTION
Within HCI's game design community, there is an ongoing interest in the intersection between interactive technology and the human body (for example see [2, 9, 17, 27, 33, 34, 36, 37, 43-45, 47, 51, 63, 73]). This is fuelled by technological advancements such as game console accessories like the Microsoft Xbox's Kinect allowing for bodily play, wearable technologies such as activity trackers supporting bodily competitions, and sensors in mobile phones enabling health interventions-turned-games. However, despite these advancements, critical voices have emerged that the field has not yet fully understood the human body and how to design interactive technology for it (for example see [20, 21, 33, 35, 37, 49, 55, 59, 60]). In particular, the critiques have lamented a seemingly dominant perspective on the human body that is overly simplistic [20], where the body is seen as controller for interactive game content. The problem with this perspective is that it obscures the fact that if we talk about the human body, we are not only talking about a physical body, but we also talk about a living human being.

To help game designers go beyond this perspective, in this article we introduce them to a phenomenological view of the human body that considers the human body both from a material perspective ("Körper") as well as a lived perspective ("Leib"). We extend prior philosophical work in this area by articulating what these perspectives can mean for game design. With the aforementioned advancements in technology, we believe the game design community now has a unique chance to develop digital games and play that not only *uses* the body as a way to control digital game content, but rather as an opportunity to experience the body *as* play. This builds on the idea that we need to consider that humans not only *have* a body, but *are* one. We see this paper as a starting point towards making this a reality.

When it comes to understanding how to design bodily games and play from this holistic perspective, however, there appears to be only limited knowledge available. To close this theoretical gap, we make a contribution in the form of discussing the German terms "Körper" and "Leib" for the game design community to articulate their implications for design in terms of emotions and feelings as well as stimulations and perceptions. We argue that these different perspectives on the human body can be valuable design resources for bodily games. To support this claim, we investigate existing bodily games and play systems of our own as well as other people's work. With these systems, we articulate a set of design strategies on how designers can utilize the aforementioned perspectives to facilitate engaging games and play experiences.

We believe that by continuing to take a limited view on the human body, the field will be unnecessarily constrained, not

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reaching its full potential and in consequence, players will not be able to benefit fully from the many benefits associated with bodily games and play. To address this, we wrote this article to aid practitioners interested in designing bodily games as well as for researchers who aim to understand bodily games and seek a framework to structure their analysis. With our work, we aim to contribute to the knowledge on how to utilize phenomenological thinking to support designers creating engaging bodily games and play, so that more players can profit from the many associated benefits, and ultimately contribute to a more humanized technological future.

RELATED WORK

Prior work has previously demonstrated that when our interactions with technology involve the body to a larger extent than the traditional mouse and keyboard interactions, the result is a significantly different user experience, which can be utilized by game design [42]. To understand and exploit this phenomenon, several theoretical frameworks have emerged in the HCI literature that each offer different perspectives through which the human body can be examined when trying to design for it. For example, Consolvo et al. suggested to design for the (unfit) human body through a perspective of behavior change [11]. Similarly, Toscos et al. proposed a perspective based around goal setting theory [68] while Yim et al. [72] proposed a perspective of motivation. More experiential perspectives have recently complemented these approaches, for example Segura et al. suggested a perspective that aims to highlight the "joy of movement" [60]. Mueller et al. [49] have introduced a perspective from sports philosophy to advance the field. Furthermore, Loke et al. [31] and Wilde et al. [70] suggested that a perspective of dance could be beneficial as dancers have a long history of engaging deeply with the human body. These works highlight seeing the human body from more than one perspective can have benefits for design.

When it comes to the human body and game design, Mueller et al. proposed a set of themes such as "rhythm" and "risk" that designers should consider when designing bodily games [44]. Similarly, Isbister et al. [25] and Mueller at el. [46] proposed design patterns in order to aid designers with practical recommendations for bodily games. These works have arguably brought the field forward, however, several academics have lamented that our understanding of how to design for the human body is still underdeveloped. Purpura et al. raised this critique at CHI suggesting that current body-based designs are almost exclusively treating the human body as an object that falls ill and can only be saved from dying thanks to technology [55]. Similarly, Linehan et al. critiqued the field from a game design perspective and provocatively titled their argument "Games Against Health" [30], suggesting that games that see the player's body only as a health-intervention opportunity will not be enjoyed. Similarly, Marshall et al. [37] critiqued the field for missing out on all the other perspectives through which the human body could be examined. Tholander et al. [67] proposed as alternative a dualistic perspective: designers should consider both an instrumental and experiential perspective when designing for a particular bodily experience. Our article extends these works by drawing from phenomenology to articulate how designers can take such dual perspectives, focusing on the human body (rather than the experience as in prior work) as the origin of the perspective.

We also note that highlighting the value of phenomenological thinking to the design of interactive systems is not new in HCI. Dourish [14] has with his book "Embodied interaction", which builds on Winograd et al. [71], brought interaction designers closer to this worldview. Works by scholars such as Djajadiningrat et al. [13] and Hornecker et al. [22] have then tried to make this worldview more accessible to interaction designers, which both Dourish and Winograd acknowledge is not easy due to the abstract nature of phenomenology [14, 71].

Svanaes has examined phenomenology's view on the human body from an HCI perspective [64]. He discussed in particular Merleau-Ponty's phenomenological perspectives on the human body [41], proposing that using his perspectives might result in "new design alternatives", assuming that "more design alternatives to choose from is in most cases a good thing" [64]. Similarly, Höök et al. [21] lamented the limited understanding of the field as evident by a dominant "instrumental view" on the human body in existing designs. She calls for an alternative perspective that aims to highlight the "pulsating, live, felt body" [21]. Our article is very much inspired by these works and aims to further contribute towards answering such calls for extended knowledge on body-perspectives that is readily applicable for design practice.

In sum, prior work revealed that when it comes to the human body and technology, in particular in regards to game design, the field has not yet fully considered that there are multiple perspectives from which one can see the human body, and if so, there is limited knowledge on how to engage with it from design practice. This limits the games being developed and hence the growth of the field, and in consequence, the games people play, which in turn limits people profiting from the many benefits of engaging the human body through games and play [49]. To address this gap, we present two new perspectives through which designers can examine the human body during gameplay. These perspectives aim to complement existing perspectives, hopefully resulting in additional design alternatives. The result is a more detailed picture of how to design bodily games and play.

THE HUMAN BODY: KÖRPER & LEIB

We are inspired by Merleau-Ponty's (who was in turn inspired by Heidegger) approach to phenomenology and in particular how he offers different perspectives on the human body [41]. It is acknowledged, however, that our

work draws on the German language (as did Merleau-Ponty's, however, he wrote in French), while it is also informed by phenomenological commentators in the HCI field (who mostly write in English), with any translations posing inherent limitations. Furthermore, we note that we are also inspired by later scholars who extended some of Merleau-Ponty's original ideas, for example Slatman [62] who draws on recent neuroscience advances in her discussions on the human body. Our intention is to make the body perspectives actionable for interaction designers; hence we acknowledge that this approach might inherently run into the danger of diverting from any original philosophical writings such as Merleau-Ponty's.

In this article, we propose that when we refer to the human body, we can take two perspectives: we can look at it from a perspective of a thing, the body being an object that has certain structural aspects. It is the vessel for another perspective: this perspective refers to the living body, a body that has feelings, sensations, perceptions and emotions [52]. It is important to note that these two perspectives are not looking at two separate things that exist side by side: they are not simply about a distinction between living and lifeless matter, instead, they refer to different views of one and the same body [62].

We highlight (as Merleau-Ponty did [41]) that looking at the German language might help to understand the difference between the two perspectives. We acknowledge that other scholars have previously examined how different languages besides German use different words for body discussions, for example see Eichberg [15]. The German language knows two different words to refer to the human body: "Körper" and "Leib". Körper comes from the Latin "corpus" and refers to the (mere) physical body; it is an objectified body, such as when referring to someone else's body. Körper also refers to a dead body or corpse, hence the non-surprising similarity to the English word "corpse".

Leib on the other hand refers to the living body (hence sometimes translated as "lived body" [64]). It is no coincidence that Leib and the English word "life" sound alike, they share the same origin [52]. The Leib is "the body as experienced by a person as himself/herself, which is different from seeing the body in the mirror as an object among other objects in the world" [52].

There are many German phrases where Körper could not be substituted for Leib. For example, "Leibspeise" refers to one's favorite food (that makes me feel well), "leibliches Wohl" means personal wellbeing, and a "Leibarzt" is a personal physician who cares for me as an individual [52]. Furthermore, within the phrase "bei lebendigem Leib verbrannt werden" (to be burnt alive) the term Leib can also not be replaced with Körper, as it refers to the living body. The result, however, is a "toter Körper", a corpse. Similarly, the expression "jemandem auf den Leib rücken" refers to someone getting to close, but not necessarily in terms of physical closeness, but in a way that the English language would describe as crowing or pestering somebody.

In summary, there are several key differences between Körper and Leib, listing them might make their potential for design more illustrative:

- Only humans and animals have a Leib. (One might argue that it should be "are Leib" instead of "have a Leib", however, there is the German expression "einen Leib haben" (having a body)). Robots do not have Leib (although this topic is certainly discussed in human-robot interaction [23]), however, animals do, so our work could also apply to animal-computer interaction (but we leave this for future work).
- Every Leib needs a Körper, but not every Körper needs a Leib. This becomes clear when considering that every human and animal has a Leib (see above), and all humans and animals have a Körper. However, a robot, for example, has a Körper, but not a Leib.
- The Körper has individual functions (the heart pumps blood, the ears are for hearing, etc.), however, the Leib does not have individual functions.

Another way to approach the human body and its Körper and Leib perspectives is to look at waves and particles in quantum physics: a photon is neither wave nor particle, it is both. How it shows up depends on which question one is asking. The same applies to the human body and its Körper and Leib perspectives.

KÖRPER & LEIB AND PLAY

So what do the perspectives of Körper and Leib mean for game designers? We argue that before new sensors entered the game design field, we have played computer games using mostly mouse and keyboard, joystick and gamepad; as such we have played *with* digital game content. Then with sensor advancements such as the Kinect, we have begun to play with digital content *using* our bodies (Körper). What we propose, however, is a vision where we are able to experience our bodies *as* digital play (Körper&Leib). This means we are not only engaging our Körper, but experience play through our Leib, in short, we call it *body as play*.

Figure 1. A vision for bodily games and play.

This vision is not a dichotomy, where games either support experiencing the body as play or are not, rather, it describes a dimension that allows the examination to what extent a

game facilitates experiencing the body as digital play. So far, bodily game design has predominantly considered the body of the player from a Körper perspective. As such, it treated the player's body as if it is at worst simply a controller to the digital play content, and at best, a toy the player plays with. We note that toys on their own are just objects, and only playing with them turns them into toys, so the interaction with the object makes it a toy. Therefore toy designers are advised to look at both the human and the object and how they interact in order to understand how to design "a toy". Similarly, if we look at the human body only from a perspective of the Körper, we only see the fleshy object. If we want to design for the interaction with the body, we need to also look at the human being that interacts with it, i.e. the Leib. We propose that only by understanding the interaction between Körper and Leib we can fully understand how to design bodily play. This is of course not easy, as unlike in the toy example above, there is a clear distinction between the child playing with the toy and the toy. For example, the child can be observed with and without a toy. We could also take the toy apart to see how it works, and we could give the child several toys to compare. All this is not possible with the Körper and Leib perspectives, they are inseparably interconnected and not easily examined individually. This makes designing bodily games challenging, nevertheless, with this article, we hope we put forward an initial step in the right direction.

An example of designing with a Körper vs. designing with a Leib perspective

We now present a simple example that hopefully illustrates the difference between taking a Körper vs. a Leib perspective when designing bodily games. Assume you have been previously designing gamepad games, and you are now tasked to design a bodily game using the Kinect sensor. The goal is to create a game similar to the many mini-games originally supplied with the Kinect. At some point in the game, you want players to confirm something, so you create an "OK" button (some might argue that there are better confirmation solutions, but we skip this for the purpose of this example [46]). Let us assume it is a big button that needs to be pressed with both hands. The question is now, where to place the button?

If you take a Körper perspective, you observe that players usually have their arms next to their torso. Therefore you place the button at the bottom of the screen, so that players have only a short distance to cover to reach the button, allowing them to press swiftly and without too much physical effort. However, if you take a Leib perspective, you know that raising both arms results in the so-called "winner-pose" associated with positive experiences (like demonstrated in game design [24]). As a result, you place the button high up on the screen, in order to aim for facilitating a positive user experience.

This example highlights how game designers should consider both perspectives: for example, if players have to press the button very quickly, they might not be able to if the button is too far away. Similarly, if they have to press a lot of buttons, they might get exhausted quickly, which could result in a negative user experience [26]. So designers benefit from engaging both perspectives in order to make informed decisions how best to support the Körper and the Leib of their players.

An ill-framed example of Körper game design

To provide an extreme example of what can happen if we only take a single perspective on the human body, we refer to the ill-famed "dwarf-tossing" that emerged in the '90s [69]: it is a pub game in which dwarfism-affected persons wearing padded clothing are thrown onto mattresses, and the winner is who throws the farthest. This activity has led to much cultural debate, with many countries forbidding it [69]. Taking a perspective of the Körper, one could argue (which seems to be the position of the organizers) that the activity is simply using the body as a toy, with it being completely safe due to padding and mattresses involved. However, a perspective of the Leib highlights that the toy is a human being with feelings and the game does not respect human dignity.

There are other examples where one's body is reduced to a Körper, many involve extreme situations such as rape, excessive violence and traumas. Slatman says that in these cases, "one will want to dissociate oneself from one's body" [62]. Designers aiming to create games to support victims or prevent such cases might therefore benefit from interrogating such a single body perspective, however, most of the time, we think that taking on both perspectives is advisable. In particular, what we want to highlight here is the interplay, the two-way connection, between the two. What the Körper does, the Leib experiences, which informs what the Körper does, and so on; hence designing for the interplay is what we consider the biggest challenge, but also the biggest opportunity. To illustrate what this means, we provide another example: we can easily sense bodily movement with sensors such as Kinect as described earlier. By sensing an arm movement, we have designed for the Körper. We know that the Leib is important for the experience, so we also want to design for that. Unfortunately, there is no sensor we can simply attach to the Leib. So how do we extend our designer's toolbox of sensors, actuators, etc. in order to "reach" the Leib? We argue that by looking at the interplay between Körper and Leib, it becomes clear that we can indeed use sensors and actuators with the Körper, and if we do this intelligently, we can hook into the interplay between Körper and Leib and as such get closer to "reaching" the Leib.

Emotions & feelings, sensations & perceptions

To understand how to design for this interplay, we again look at theory. Ots reminds us that the Leib refers to a body that has emotions and feelings as well as sensations and perceptions [52]. In contrast, the Körper of the table in front of you, for example, does not have any of these. However, it is also quite clear that the Leib needs the Körper to have

these emotions, feelings, sensations and perceptions. We propose that by looking at these characteristics of the Leib that are enabled by the Körper, we are able to better understand how to design for the interplay between Körper and Leib.

Emotions & feelings

A lot has been said in HCI on emotions and feelings (e.g. [54]), here we point to the interplay between the two and their relationship with the body. We acknowledge that alternative theories on the topic exist and agree that further research in this area is needed, however, this is not the focus of this article.

In order to describe our understanding of emotions and feelings, we draw from Damasio who says: "Emotions are more or less the complex reactions the body has to certain stimuli. When we are afraid of something, our hearts begin to race, our mouths become dry, our skin turns pale and our muscles contract. This emotional reaction occurs automatically and unconsciously. Feelings occur after we become aware in our brain of such physical changes; only then do we experience the feeling of fear" [29]. Interesting here is that emotions are physical states arising from body's responses to external stimuli, meaning that these responses are hard-wired and universal. Emotions precede feelings, nevertheless, they are tightly intertwined: with an increased feeling of fear usually comes an increased heart rate, aligning with our understanding of a tight interplay between Körper and Leib.

If we now put our designer hat on, we see that we can sense emotions, for example, we could use a heart rate monitor to sense increased heart rate. What the heart rate sensor data does not tell us, however, is how the person *feels* about this emotion: it could be fear, but it could also be that the person has just been exercising. Nevertheless, we can make some inferences about a person's feelings based on emotions, for example a feeling of calmness has rarely been associated with an excessive heart rate.

What we want to highlight here is that in order to design for the Leib, we can sense emotions, but should not stop there, we should also consider the resulting feelings as they are tightly interlinked and together form a key aspect of the experience of the Leib. As such, we propose that designers should not only sense bodily data from players, but also consider how they *feel* about them.

Sensations & perceptions

Slatman reminds us that every perception is based on sensory input, that is sensations coming from the various senses [62]. The difference between a perception of something outside of myself and the perception of my own body as Leib corresponds to differences in sensory input. Perceptions of something outside of myself are results from sensations that are not reflected within my body, whereas perceptions of my own body as Leib are results from "localized sensations". For example, when I perceive a red apple, I have particular color sensations that determine the fact that I attribute the quality "red" to this apple, but this quality belongs to the apple outside of me and is not found somewhere within my perceiving body. The red is not localized in my eyes [62]. However, in the case of the sense of being touched, sensations are localized. I feel *in* my hand that it is touched. Slatman suggests that these localized sensations "mainly occur through touch, pain, proprioception (i.e. the 'internal' perception of bodily posture and bodily boundaries), kinesthetic sensations (i.e. the 'internal' perception of bodily movement) and temperature perception" [62]. These localized sensations cause me to experience my body as mine (Leib).

When it comes to game design, we have a rich history of supporting perceptions outside of ourselves "that are not reflected within my body" [62] thanks to the prevalence of displays and speakers. In contrast, supporting localized sensations is rather rare. By supporting localized sensations, however, designers can support people experiencing their body as Leib, for example, Höök et al. has shown an augmented yoga mat that allows for temperature perception through digitally controlled embedded heat pads [20] and Leigh et al. showed a wearable system using robotics that engages with kinesthetic sensations [28]. We believe designs like these are a step in the right direction to support the Leib. When it comes to games, force-feedback steering wheels are probably the most common example of a device that allows us to experience our bodies as ours and hence support the Leib. We believe designers can support the perspective of the Leib by considering how to engage with these localized sensations.

KÖRPER & LEIB IN GAMES AND PLAY

We now investigate several existing games and play systems that exemplify our thinking. Some of these examples include work done by us while some are from others; we tried to select a diverse range of systems with different technologies, approaches, and objectives. Based on our experiences of designing, playing, exhibiting and reflecting on these games, we articulate a set of strategies on how designers can utilize Körper and Leib perspectives illustrated with our examples. The strategies have emerged through an iterative process in which thinking about the aforementioned concepts has also influenced our design practice in return. This process has been previously used successfully to develop a framework about sensing movement [4] and a framework for proxemics play [48]. By engaging with such a process, we believe we are able to paint a vivid picture of our perspectives that is abstract in nature yet close to design practice.

Balance Ninja

The first game we investigate is Balance Ninja [5], a two-player game that aims to facilitate an engaging vertigo experience [8]. In Balance Ninja, players must battle to keep their balance whilst under Galvanic Vestibular Stimulation (GVS) [6] triggered by an opposing player (fig.

2). Balance Ninja engages with the Leib perspective by allowing players to experience localized sensations of the vestibular sense through the applied GVS.

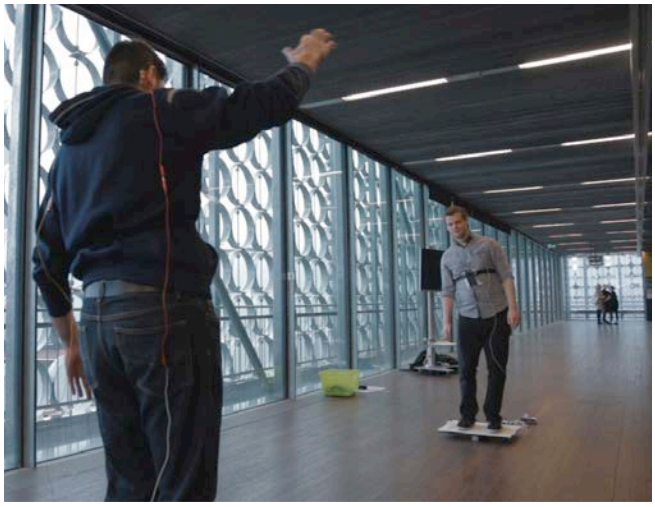

Figure 2. Balance Ninja.

The game begins as follows: both players stand on their own wooden board resting on a beam underneath. They both wear a mobile GVS system. GVS is a simple and safe way of affecting one's balance by applying a small current (+/-2.5mA) to one's vestibular system. Electrodes placed behind each ear deliver the current and the user feels a pull towards the anode, and also feels a loss of balance in that direction [7]. Players wear a tight-fitting pouch attached to their chest containing a mobile phone and the accelerometer readings taken from the phone affect the other player's GVS system. For example, if player 1 leans to the left, the GVS of player 2 creates a pull to the right for player 2 (and vice versa). The more player 1 leans, the greater the level of stimulation applied to player 2. The object of the game is to cause the opposing player to lose their balance and either step off the board or touch the board to the floor. Players are free to "attack" at any time. A point is awarded to the winner of the round and the first player to reach five points wins the game.

Looking at the Körper-Leib perspectives allows not only to examine the ways how designers can understand the player, it also allows the examinion of how a game might change a player's perspective on him/herself. For example, with Balance Ninja, players began with engaging their Körper when trying to balance on the board, however, as soon as the GVS is applied, their perspective appeared to shift to the Leib: a seemingly external force coming from the other player seems to take control of their body, resulting in players experiencing their Leib in a novel way. This might have facilitated an experience from "having a body" to "being a lived body". For example, players commented: "*The feeling itself was really, like new to me, except for when I was drunk!"*; "*The best bits were just how weird it was. It was - just, like, different."* and *"I've never known [anything] like that before!"*

Ava, the eBike

Figure 3. Ava, the eBike.

Ava, the eBike [3] is an augmented eBike (fig.3). It is not strictly a game, however, we include it here as it uses Körper and Leib thinking to support the playful experience of cycling. Bike riders usually lean their body forward to embrace speed, both when inputting more power while pedaling but also to slipstream. With Ava, a sensor detects when the rider leans forward and in result the electric engine accelerates. As such, the rider's kinesthetic experience of leaning forward to accelerate is digitally amplified, similar to an exoskeleton that amplifies human movement. In addition, Ava plays a sound through a handle bar-mounted speaker, similar to a car making an acceleration noise, as if the power came from the rider's body, supporting the playful character of the experience. A study revealed that users enjoyed riding with Ava; they said they felt like a super-human, as Ava appeared to give them "superpowers": their exertion effort appeared to be magically amplified.

LOLLio

LOLLio [50] aims to engage the user's body through taste as a playful interaction modality. Players use an interactive lollipop as a haptic input device that dynamically changes its taste. The authors describe three potential games that are controlled by the movement of holding the lollipop, measured through accelerometers in its base, and output informed by varying the amount of thinned citric acid that is injected through a hole in the candy at the top of the lollipop. During interaction with the device, small amounts of sour liquid are pumped from the grip through to a hole in the candy. By varying the rate of flow, different tastes in the interval sour–sweet are achieved.

LOLLio does not try to reduce calorie intake unlike most other technology-based food systems, but rather aims to highlight the Leib and its emotions in the eating process: one of the associated games gives all players one LOLLio, and players have to hide their facial expression when they receive sour liquid, as everyone needs to guess who is currently receiving a sour taste.

Nike+

Nike+ is a commercial jogging support app for mobile phones [1]. Similar to many other jogging systems (like

Runkeeper, MapMyRun, etc.), Nike+ offers running metrics, including pace and distance. After the run, Nike+ asks users how they felt about their jog through a smileyometer [32], this data is then accessible through the accompanying website. We note that we found it challenging to identify a popular commercial example (we want to include a commercial example to demonstrate the wide applicability of our work) that appears to offer an intention to support the Leib perspective. We chose Nike+ because it appears to be quite successful if going by the millions of users [1], and because it offers a competitive mode, which we see as a form of play [57]; however, we acknowledge that this example has apparent limitations as we do not know the designers' knowledge about or intention of the Körper-Leib perspectives.

Life Tree

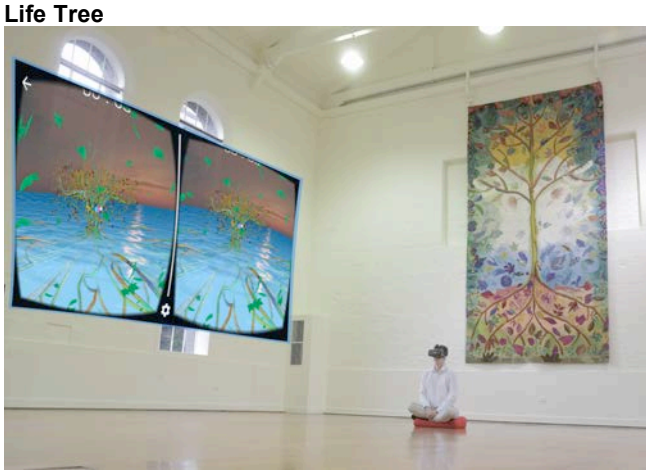

Figure 4. Life Tree including the HMD view.

Life Tree is a VR game that helps players practice a proper breathing technique (fig. 4) [53]. Proper breathing technique can reduce stress, promote feelings of relaxation, help with various disorders like ADHD and asthma, all the while improving our quality of life (for an overview see [53]). Moreover, the way we do our breathing affects our whole body [74]. Motivated by this, Life Tree was designed to help people practice breathing exercises in an engaging way, in particular the pursed-lip breathing technique, through the use of an HMD and a breathing sensor.

As the game begins, players see a colorless tree standing in the middle of a body of water. If players exhale, they can see leaves being blown towards the tree. A soft voice suggests players to sit down cross-legged. As the player sits down, an animation of the tree getting submerged into the water is triggered in order to replicate their bodily action. In order to visualize the exhalation of players, particle effects of leaves being blown towards the tree are used. The color of the leaves changes to a bluish-green shade if the players breathe rhythmically; otherwise, it changes to a greenish-brown shade. The goal of the game is for players to make the tree as colorful as possible.

Life Tree aimed to help players engage with their Leib through a) blocking out any outside distractions through the use of an HMD b) promoting them to sit down (sensed via the HDM's sensors) in a cross-legged position that is conducive to proper breathing c) providing feedback on breathing only through subtle color changes and animation, not telling what is right or wrong, and d) the use of instrumental music of the Indian instrument "Veena" that prior work suggested can enhance the effect of practicing Yoga [10].

DESIGN STRATEGIES TO ENGAGE THE KÖRPER-LEIB INTERPLAY IN DIGITAL GAMES AND PLAY

In order to provide designers with a better understanding of how they can utilize our theoretical thinking, we now describe a set of strategies identified from the games and play systems described above. These strategies aim to highlight the potential of using the Körper-Leib interplay as design resource. This set of strategies is of course not an exhaustive list, but rather a starting point where we aim to emphasize salient characteristics through our work of designing, playing, evaluating and reflecting on these design works. However, we believe that our work lays a foundation through a structured approach towards utilizing the Körper-Leib interplay to facilitate engaging bodily play experiences.

Use the limits of the Körper as facilitators for intriguing Leib experiences

This strategy is concerned with the extent to which the play system uses apparent limitations of the Körper as facilitators for intriguing Leib experiences. By limitations of the Körper we mean, for example, that we have to rest after sustained intense exercise, we cannot hold our breath indefinitely, we cannot balance on narrow surfaces without proper training, etc.

Balance Ninja significantly exemplifies this strategy, as the game takes the limits of the Körper – not being able to balance on a small beam very easily – and uses it to facilitate the emergence of vertigo, which we argue is an intriguing Leib experience. The struggling balancing act leads to a disorientation, that – if done right, i.e. not too much and not too little disorientation [5] – can lead to a "voluptuous" sense of vertigo, which the players very much appreciated [5]. As such, the limits of the Körper (limited balancing abilities) were used to facilitate an intriguing experience of the Leib (vertigo).

Here, the notion of training plays an important role: many limitations of the body can be altered through training, for example, people can train their bodies to sustain intense exercise for longer, they can train to hold their breath for longer, and they can train to improve their balancing skills. Balance Ninja players commented on this, referring to their balance training through past activities such as martial arts and surfing, and how much this prior training helped them within the game (with some mentioning how surprised they were that a simple GVS system could still mess with all the

years of training). We believe systems like Balance Ninja that draw on this strategy to engage the Körper-Leib interplay could be used to facilitate such training of bodily skills in an engaging way.

When riding Ava, limitations of the Körper are easily apparent: after riding any bike for longer periods of time, the legs get tired. And if your legs get tired, the rest of the body aims to "make up for it", and you use your entire body even more, especially when cycling up a hill. As such, the action moves from engaging mostly the legs (Körper-parts) to a more complete body experience (Leib), which the sensing of the leaning considers in order to facilitate a playful superhero experience, underlined by the audio that allows the rider to hear what their Leib experiences.

With LOLLio, players engage with the fact that the Körper can react to particular tastes, like sour or bitter, quite strongly, the authors describe it as "screwing up one's face" [50]. This leads to an unpleasant feeling (Leib), and the authors use it quite cleverly for intriguing game play around detecting and concealing emotions: everyone gets a LOLLio, and players have to guess who receives the sour taste, all while trying to hide their own unpleasant emotions from their co-players if they experience the sour taste themselves. As this is done in a game context, the unpleasant taste emotions and notions of deception are embedded in a joyful context, leading to positive feelings as part of the overall experience.

People using Nike+ know how physical exhaustion highlights the physical limits of the Körper in terms of how fast and far they can jog. The Nike+ system allows joggers to quantify these limits, however, it goes further: it allows joggers to also track how they felt about the run, by asking them to rate their run at the end with a smileyometer. The users are able to see aggregated data over all their runs how often they felt "great" or "tired"; connecting the instrumental Körper data (like distance) with the experiential Leib data (how they felt about it) might serve to highlight the positive experiences particular runs (which might or might not be the furthest/fastest) might have facilitated. This goes hand in hand with practitioner's training advice that suggests to people who want to run but find it challenging to motivate themselves (e.g. "this is going to be exhausting, I am not sure I feel like jogging") to think about how they feel after they have been jogging. Using a system like Nike+ could support this, as it not only provides a record of one's feeling after each run (albeit in a very limited format), but it also allows to see how often they felt "great" over the course of years. On a personal note, having experienced this system ourselves, with 1093km feeling "great", we can report that this facilitates very positive feelings.

Support players in exploring the interplay between Körper and Leib

This strategy is concerned with the extent to which the system supports players in exploring the interplay between Körper and Leib and how it facilitates growing their understanding of it.

Several Balance Ninja players reported that they discovered that closing their eyes contributed positively to their play experience: by closing their eyes, they said they were able to focus "on the inside" (Leib), allowing them to improve their balance abilities. However, they also reported that it seemed like cheating, as they felt that they are not playing with the other person and missing out on the social aspect of the game. As part of this, they played around with closing and opening their eyes, trying to understand the interplay of their abilities (Körper) and how they felt about it (Leib), especially within the social context.

We can envision future versions of Ava where riders can enter how they felt about particular rides. For example, a rider might enter into the bike computer that they did not enjoy riding by a noisy factory. In response, if the rider is about to go past the factory again, Ava provides additional power to the electric engine to allow the rider to swiftly ride by, asking if this improved how the rider feels about the noise now.

LOLLio could be designed so it measures indicators of how much players enjoyed the experience (through, for example, sensing facial expressions or amount of laughter). By visualizing this sensed data in relation to how much of the Lollipop the players ate, the designers could facilitate participants learning about the interplay, possibly even advance an understanding about how the Leib affects player's eating actions (Körper), contributing to more mindful eating [40].

By putting both people's instrumental and experiential jogging data next to each other, the Nike+ website allows participants to explore how their feeling about the run (Leib) affected their athletic performance (Körper) and vice versa: they can see that sometimes a negative smiley corresponded with a slow pace, but sometimes with a fast pace, and begin to explore why this is (for example, by checking how the weather was on these particular days). Supporting the exploration of this could help joggers become more aware of the complex relationship between Körper and Leib.

Life Tree offers soothing music and visuals at the beginning of the experience, aiming to facilitate a focus "inwards" (Leib). This is underlined by blocking out any unwanted distractions through the HMD and headphones. Only then participants are engaged with their breathing. As such, Life Tree aims to engage by focusing on the Leib first before paying attention to the Körper in order to allow players to become more aware of the interplay between Leib and Körper.

Consider facilitating a loss of bodily control in order to support a shift of focus to the Leib

With this strategy, we aim to highlight to designers to consider facilitating a loss of bodily control in order to

support a shift of focus to the Leib. This should not be a complete loss, however, and players should be able to regain bodily control.

Players in Balance Ninja experienced a loss of bodily control through the GVS, which was exacerbated by standing on the balance board. Players were trying to regain bodily control once the GVS kicked in by putting out their arms or moving their hips to stay balanced. This ability to lose some bodily control and then regaining it (Körper) appeared to be the source of much enjoyment (Leib). By providing players with the opportunity to lose and regain bodily control, a shift to the Leib seemed to have occurred.

Riding Ava can mean giving up some bodily control, especially when starting to ride, as balancing can at first feel a bit more challenging because eBikes are heavier and have a shifted center of mass compared to regular bikes due to the battery. Unlike other augmented eBikes (such as the Pollution-eBike [61] that controls the engine's power contribution through external air pollution data to support cyclists who are suffering from bad air quality with increased engine power), Ava supports a cyclist's bodily control over their experience: they can choose how much energy they request from their bike at any time. Interviews with participants suggested that this autonomy [56] in terms of control supported an engaging riding experience.

With LOLLio, players are mostly in control: they choose if and how they put the lollipop in their mouth. However, the authors use the pump-action to control when and how much citric acid is injected into the user's mouth. Here, the player voluntarily gives up some control over their body (Körper), mostly this will be an unpleasant experience if too much acid enters the mouth; however, it can also facilitate surprise and consequently result in a positive feeling (Leib).

Nike+ does not engage with loss of bodily control, probably due to the fact that it is a commercial product where safety aspects play a key role. However, we can envision future versions that use electronic muscle stimulation (such as demonstrated by [19]) attached to the jogger's legs. By sensing inappropriate stride technique, the system could take some control from the jogger through the electronic muscle stimulation system and correct the stride. While doing so, the system could ask the jogger how she/he feels when jogging with this altered stride.

We can envision future versions of Life Tree where in the beginning, breathing might be artificially suspended (for example through an augmented gas mask [38]) in order to focus participant's attention onto how stressful not breathing could be as a way to highlight the importance of breathing to everyday life.

Support a shifting of focus back and forth between Körper and Leib

This strategy is concerned with the extent to which the system supports participants moving their focus back and forth between Körper and Leib as a way to highlight the interplay.

In Balance Ninja, the experience of losing balance control facilitated laughter, however, this was because the loss of control was only temporary: as soon as the players put their feet on the ground, the players' attention shifted to the score, displayed on a screen placed on the side of the playing are: the focus was again "outwards". However, as soon as the GVS fired again, the focus shifted "inwards" again, highlighting the Leib experience. This shifting back and forth was further underlined by the use of rounds.

Ava supports shifting from Körper to Leib and back, rather rapidly, by drawing on the action of leaning forward. The interviews with participants confirmed this: the leaning forward (or backward) was the most intriguing part of the experience (unlike staying forward or upright), as it resulted in a change of speed, which facilitated the positive experience of gaining a superpower-boost. With traditional eBikes, riders can select to permanently receive the maximum power from the electronic engine; with Ava, the ability to amplify the boost and remove it again appeared to facilitate a more engaging experience, which we attribute to a deeper engagement with the Körper-Leib interplay.

LOLLio uses interactive technology to enable a more rapid focus shift between Körper and Leib compared to non-augmented food. For example, some of the games the authors describe could also be implemented with traditional lollipops with different flavors. However, through the novel citric acid-injecting mechanism, flavors can be more quickly changed, all while the lollipop is in the user's mouth. If we assume that the player pays attention to the way the Lollipop is held (Körper), as accelerometers sense movement of the handle, and the Leib perceives different tastes that are highlighted through the gameplay that focuses on stressing affective responses, we suggest that a rapid shift back and forth could occur in devoted players whenever a new flavor change occurs.

The Nike+ system only supports shifting from the Körper to the Leib at the end of the jog when participants enter how they felt. This could be extended through asking the jogger throughout the run, for example through speech input, supporting a shifting back and forth during the jog.

Life Tree aims to facilitate a shifting between Körper and Leib through every breath: by visualizing how every breath (Körper) affects the virtual tree (symbolizing the player's Leib), the participant's focus is taken back and forth, even further facilitated by the hardware: participants reported that the breath sensor placed in front of their mouth resulted in hearing their breathing louder than usual, which took their attention from the virtual back to the physical world.

Consider physical disparity as a way to shift focus between Körper and Leib

With this strategy, we aim to highlight to designers the opportunity to consider physical disparity as a way to shift

focus from the Körper to the Leib and back. By physical disparity we mean the distance between input and output [18], for example the physical disparity between mouse input and mouse pointer on a monitor is around 40 cm, with a laptop's touchpad it is 20 cm, and on a tablet almost none.

In Balance Ninja, the input was the body's sway from the upright position, sensed with the mobile phone. The output was the GVS sensation, applied to the mastoid bones behind the other player's ears. As such, there was a physical disparity of several meters. This goes against common usability principles that large physical disparities should be avoided. However, here, in this game context, being able to move one's torso (Körper) to influence the experience of another person (Leib) made for an intriguing game element.

In Ava, the input is the leaning forward of the upper torso (Körper), sensed through a mobile phone tightly attached to the chest of the rider. The output is the altered power applied to the electric engine, experienced through an increase in pedaling power. As such, the physical disparity is about 1 m. Here, the physical disparity is used to highlight that the entire body (so not a Körper-part, but the whole Leib) plays a role in cycling. In contrast, if taking a Körper perspective, a designer might only think about embedding sensors in the pedals, as this is where the action of cycling seemingly seems to happen. However, by using a rather large physical disparity, Ava highlights the involvement of the Leib in cycling.

With LOLLio, the authors describe that pressing a key on the controlling laptop releases the citric acid. This solution allows to visualize to participants what is happening in their mouth: participants can see on the laptop (for example through increasing numbers) how many milliliters of citric acid is currently pumped into their mouth. This physical disparity allows participants to see what is "going on" in their mouth. This, we believe, can further our understanding of how the use of technology can support an external perspective on the body (Körper) supplementing an internal perspective (Leib) in order to create an engaging playful experience.

With Nike+, the input is the jogger moving (sensed through the phone), the output is the calculated pace and distance displayed on the phone. The physical disparity is quite small, which we believe could facilitate a shift of focus, however, how this unfolds is an area for future work.

In Life Tree, the input is the breathing sensed through a sensor in front of the mouth, with the output displayed through the HMD. The physical disparity is therefore about 10 cm. Here, the close physical disparity is used to support the focusing on the "inside" (Leib): imagine that the tree's visualization would have been projected onto a large screen in front of the player, rather than an HMD. The large distance might have not supported the idea that the tree represents the player's Leib as much, but rather facilitated seeing the tree as occupying the physical space external to the player.

LIMITATIONS

One limitation is that we only scratched the surface of phenomenological discussions on the human body; there is much more detail we were not able to go into, including discussions on the experience of Körper-Leib in terms of metaphors (for example by referring to Svanaes [65]), narratives (for example by referring to the phenomenology of Rock Band [66]) and awareness (referring to somatics [58]). Future work might also explore further how our thinking could extend prior work around games and the body, such as De Koven's writing of social gameplay (where players often involve their bodies extensively) [12] and also Flanagan's discussions on subversive games (where players often break cultural norms around the use of their bodies) [16] as well as traditional button-press games (where players are often represented by an avatar with a three-dimensional "body") [39]. Furthermore, we acknowledge that we have not yet fully considered social aspects when engaging with the human body; Svanaes' so called "2nd" perspective might be a good starting point [64]. We have also not yet discussed human bodies that are beyond a culturally understood "norm", such as people with injuries or disabilities. We believe our work can also contribute to such investigations as it highlights that every human Körper in whatever shape or form has a Leib, advancing an ethical discourse on the body in games.

CONCLUSION

Interaction design and, in particular, game design has an ongoing interest in the intersection between interactive technology and the human body, fuelled by technological advancements. Yet, recent scholarly work suggests that the field has only just begun to fully understand the various perspectives through which designers can see the human body. To advance the field, we introduced two perspectives on the human body (Körper and Leib) and articulated implications for design. We discussed these perspectives by looking at a set of bodily game and play systems from our own and other's work. We see our work not as a complete investigation into the Körper and Leib in game design, but rather as a springboard for future investigations.

In summary, our work aims to contribute to the emerging intersection between the human body and interactive games and play. We believe that for a successful combination of technology and the human body, we need to move beyond seeing the human body as solely a "thing", instead we need to embrace that we both *have* a body and *are* a body. If we do so, we believe it is possible to experience our body as play. We hope with our work we are aiding in facilitating the many benefits of engaging the human body through games and play, ultimately contributing to a more humanized technological future.

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REFERENCES

1. Nike. 2018. Nike+. http://nikeplus.nike.com.
2. David Altimira, Florian Mueller, Jenny Clarke, Gun Lee, Mark Billinghurst and Christoph Bartneck. 2016. Digitally Augmenting Sports: An Opportunity for Exploring and Understanding Novel Balancing Techniques. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, 1681-1691.
3. Josh Andres, Julian de Hoog, Jürg von Känel, Julian Berk, Bach Le, Xizi Wang, Marcus Brazil and Florian Mueller. 2016. Exploring Human: Ebike Interaction to Support Rider Autonomy. In *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts*. ACM, 85-92.
4. S. Benford, H. Schnädelbach, B. Koleva, R. Anastasi, C. Greenhalgh, T. Rodden, J. Green, A. Ghali, T. Pridmore and B. Gaver. Expected, Sensed, and Desired: A Framework for Designing Sensing-Based Interaction. *ACM Transactions on Computer-Human Interaction (TOCHI)* 12, 1 (2005), 3-30.
5. Richard Byrne, Joe Marshall and Florian Mueller. 2016. Balance Ninja: Towards the Design of Digital Vertigo Games Via Galvanic Vestibular Stimulation. In *2016 Annual Symposium on Computer-Human Interaction in Play*. ACM, 159-170.
6. Richard Byrne, Joe Marshall and Florian Mueller. 2016. Designing the Vertigo Experience: Vertigo as a Design Resource for Digital Bodily Play. In *Proceedings of TEI '16: Conference on Tangible, Embedded, and Embodied Interaction*. ACM, 296-303. http://dx.doi.org/10.1145/2839462.2839465
7. Richard Byrne, Joe Marshall and Florian Mueller. 2016. Inner Disturbance: Towards Understanding the Design of Vertigo Games through a Novel Balancing Game. In *Proceedings of the 28th Australian Conference on Computer-Human Interaction*. ACM, 3010999, 551-556. http://dx.doi.org/10.1145/3010915.3010999
8. Roger Caillois. *Man, Play, and Games*. University of Illinois Press, 1961.
9. Alan Chatham and Florian Mueller. 2013. Adding an Interactive Display to a Public Basketball Hoop Can Motivate Players and Foster Community. In *Proceedings of the 2013 ACM Conference on Pervasive and Ubiquitous Computing*. ACM, 2493478, 667-676. http://dx.doi.org/10.1145/2493432.2493478
10. Martin Clayton. Communication in Indian Raga Performance. *Musical communication* (2005), 361-381.
11. Sunny Consolvo, Predrag Klasnja, David W McDonald and James A Landay. Designing for Healthy Lifestyles: Design Considerations for Mobile Technologies to Encourage Consumer Health and Wellness. *Human–Computer Interaction* 6, 3-4 (2012), 167-315.
12. Bernard De Koven. *The Well-Played Game: A Player's Philosophy*. MIT Press, 2013.
13. T. Djajadiningrat, K. Overbeeke and S. Wensveen. 2002. But How, Donald, Tell Us How? On the Creation of Meaning in Interaction Design through Feedforward and Inherent Feedback. In *DIS '02: Proceedings of the 4th Conference on Designing Interactive Systems*. ACM New York, NY, USA, 285-291.
14. P. Dourish. *Where the Action Is: The Foundations of Embodied Interaction*. Boston, MA, USA: MIT Press, 2001.
15. Henning Eichberg. Body, Soma-and Nothing Else? Bodies in Language. *Sport Science Review* 4, 1 (1995), 5-25.
16. Mary Flanagan. *Critical Play: Radical Game Design*. MIT press, 2009.
17. Florian Mueller, Martin R. Gibbs, Frank Vetere and Darren Edge. Designing for Bodily Interplay in Social Exertion Games. *ACM Trans. Comput.-Hum. Interact.* 24, 3 (2017), 1-41. http://dx.doi.org/10.1145/3064938
18. Jayden Garner, Gavin Wood, Sebastiaan Pijnappel, Martin Murer and Florian Mueller. 2014. I-Dentity: Innominate Movement Representation as Engaging Game Element. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems*. ACM, 2181-2190.
19. Mahmoud Hassan, Florian Daiber, Frederik Wiehr, Felix Kosmalla and Antonio Krüger. Footstriker: An Ems-Based Foot Strike Assistant for Running. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* 1, 1 (2017), 2.
20. Kristina Höök, Martin Jonsson, Anna Ståhl and Johanna Mercurio. 2016. Somaesthetic Appreciation Design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'16), San Jose, CA, USA*. ACM, 3131-3142.
21. Kristina Hook, Anna Stahl, Martin Jonsson, Johanna Mercurio, Anna Karlsson and Eva-Carin Banka Johnson. Somaesthetic Design. *interactions* 22, 4 (2015), 26-33. http://dx.doi.org/10.1145/2770888
22. Eva Hornecker, Paul Marshall and Jörn Hurtienne. 2017. Locating Theories of Embodiment Along Three Axes: 1st - 3d Person, Body-Context, Practice-Cognition. http://www.ehornecker.de/Papers/SomaestheticWS-embodimentshortie.pdf.
23. Bernhard Irrgang. Intersubjectivity," Other Intelligences" and the Philosophical Constitution of the Human-Robotics-Interaction. *Prajna Vihara* 9, 2 (2008).
24. Katherine Isbister, Michael Karlesky and Jonathan Frye. 2012. Scoop!: Using Movement to Reduce Math Anxiety and Affect Confidence. In *Proceedings of the International Conference on the Foundations of Digital Games*. ACM, 228-230.
25. Katherine Isbister and Florian Mueller. Guidelines for the Design of Movement-Based Games and Their Relevance to HCI. *Human–Computer Interaction* 30,

3-4 (2014), 366-399. http://dx.doi.org/10.1080/07370024.2014.996647
26. J Juul and M Norton. 2009. Easy to Use and Incredibly Difficult: On the Mythical Border between Interface and Gameplay. In *International Conference On The Foundations Of Digital Games*. ACM, 107-112.
27. Astrid Larssen, Lian Loke, Tony Robertson and Jenny Edwards. 2004. Understanding Movement as Input for Interaction–a Study of Two Eyetoy Games. In *Proceedings of OzCHI '04*.
28. Sang-won Leigh, Harpreet Sareen, Hsin-Liu Cindy Kao, Xin Liu and Pattie Maes. Body-Borne Computers as Extensions of Self. *Computers* 6, 1 (2017), 12.
29. Manuela Lenzen. n.d. Feeling Our Emotions. https://http://www.scientificamerican.com/article/feeling-our-emotions/.
30. Conor Linehan, Sabine Harrer, Ben Kirman, Shaun Lawson and Marcus Carter. 2015. Games against Health: A Player-Centered Design Philosophy. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, 2732514, 589-600. http://dx.doi.org/10.1145/2702613.2732514
31. Lian Loke and Toni Robertson. Moving and Making Strange: An Embodied Approach to Movement-Based Interaction Design. *ACM Transactions on Computer-Human Interaction (TOCHI)* 20, 1 (2013), 7.
32. Panos Markopoulos, Janet C Read, Stuart MacFarlane and Johanna Hoysniemi. *Evaluating Children's Interactive Products: Principles and Practices for Interaction Designers*. Morgan Kaufmann, 2008.
33. 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*. ACM, 6014-6027.
34. Joe Marshall, Alexandru Dancu and Florian Mueller. 2016. Interaction in Motion: Designing Truly Mobile Interaction. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*. ACM, 2901844, 215-228. http://dx.doi.org/10.1145/2901790.2901844
35. Joe Marshall and Conor Linehan. 2017. Misrepresentation of Health Research in Exertion Games Literature. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, 4899-4910.
36. Joe Marshall, Conor Linehan and Adrian Hazzard. 2016. Designing Brutal Multiplayer Video Games. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, 2669-2680.
37. Joe Marshall, Florian Mueller, Steve Benford and Sebastiaan Pijnappel. Expanding Exertion Gaming. *International Journal of Human-Computer Studies* 90 (2016), 1-13. http://dx.doi.org/http://dx.doi.org/10.1016/j.ijhcs.2016.02.003
38. Joe Marshall, Brendan Walker, Steve Benford, George Tomlinson, Stefan Rennick Egglestone, Stuart Reeves, Patrick Brundell, Paul Tennent, Jo Cranwell, Paul Harter and Jo Longhurst. 2011. The Gas Mask: A Probe for Exploring Fearsome Interactions. In *Proceedings of the 2011 Conference on Human factors in computing systems, extended abstracts*. ACM, 1979609, 127-136. http://dx.doi.org/10.1145/1979742.1979609
39. Paul Martin. 2012. A Phenomenological Account of the Playing-Body in Avatar-Based Action Games. In *Proceedings of Philosophy of Computer Games Conference*. 29-31.
40. Jennifer Mathieu. What Should You Know About Mindful and Intuitive Eating? *Journal of the American Dietetic Association* 109, 12 (2009), 1982.
41. M. Merleau-Ponty. *Phenomenology of Perception (Routledge Classics)*. Routledge, 1945.
42. F. Mueller, S. Agamanolis and R. Picard. 2003. Exertion Interfaces: Sports over a Distance for Social Bonding and Fun. In *SIGCHI conference on Human factors in computing systems*. ACM, 561-568. http://dx.doi.org/http://doi.acm.org/10.1145/642611.642709
43. Florian Mueller, Chek Tien Tan, Rich Byrne and Matt Jones. 2017. 13 Game Lenses for Designing Diverse Interactive Jogging Systems. In *Proceedings of the Annual Symposium on Computer-Human Interaction in Play*. ACM, 3116607, 43-56. http://dx.doi.org/10.1145/3116595.3116607
44. Florian Mueller, Darren Edge, Frank Vetere, Martin Gibbs, Stefan. Agamanolis, Bert Bongers and Jennifer Sheridan. 2011. Designing Sports: A Framework for Exertion Games. In *CHI '11: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2651-2660.
45. Florian Mueller, Martin Gibbs, Frank Vetere, Stefan Agamanolis and Darren Edge. 2014. Designing Mediated Combat Play. In *Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction*. ACM, 149-156.
46. Florian Mueller and Katherine Isbister. 2014. Movement-Based Game Guidelines. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 2557163, 2191-2200. http://dx.doi.org/10.1145/2556288.2557163
47. Florian Mueller, Rohit Ashok Khot, Kathrin Gerling and Regan Mandryk. Exertion Games. *Foundations and Trends Human–Computer Interaction* 10, 1 (2016), 1-86. http://dx.doi.org/http://dx.doi.org/10.1561/1100000041
48. Florian Mueller, Sophie Stellmach, Saul Greenberg, Andreas Dippon, Susanne Boll, Jayden Garner, Rohit Khot, Amani Naseem and David Altimira. 2014. Proxemics Play: Understanding Proxemics for Designing Digital Play Experiences. In *Proceedings of*

the 2014 conference on Designing interactive systems. ACM, 533-542.
49. Florian Mueller and Damon Young. 2017. Five Lenses for Designing Exertion Experiences. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, 3025746, 2473-2487. http://dx.doi.org/10.1145/3025453.3025746
50. Martin Murer, Ilhan Aslan and Manfred Tscheligi. 2013. Loll Io: Exploring Taste as Playful Modality. In *Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction*. ACM, 299-302.
51. Stina Nylander, Jakob Tholander, Florian Mueller and Joe Marshall. HCI and Sports. *interactions* 22, 2 (2015), 30-31. http://dx.doi.org/10.1145/2559206.2559223
52. Thomas Ots. The Silenced Body–the Expressive Leib: On the Dialectic of Mind and Life in Chinese Cathartic Healing. In *Embodiment and Experience: The Existential Ground of Culture and Self*, 1994, 116.
53. R. Patibanda, Mueller, F., Leskovsek, M., Duckworth, J. 2017. Life Tree: Understanding the Design of Breathing Exercise Games. In *CHI PLAY'17*. ACM. 19-31. http://dx.doi.org/10.1145/3116595.3116621
54. Rosalind Picard. *Affective Computing*. The MIT Press, 1997.
55. Stephen Purpura, Victoria Schwanda, Kaiton Williams, William Stubler and Phoebe Sengers. 2011. Fit4life: The Design of a Persuasive Technology Promoting Healthy Behavior and Ideal Weight. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 1979003, 423-432. http://dx.doi.org/10.1145/1978942.1979003
56. Scott Rigby and Richard Ryan. *Glued to Games: How Video Games Draw Us in and Hold Us Spellbound*. Praeger, 2011.
57. Katie Salen and Eric Zimmerman. *Rules of Play: Game Design Fundamentals*. The MIT Press (Boston, MA, USA), 2003.
58. Thecla Schiphorst. Bridging Embodied Methodologies from Somatics and Performance to Human Computer Interaction. Unpublished Doctoral Dissertation, University of Plymouth, UK, 2009.
59. m.c. schraefel. #Makenormalbetter. *interactions* 24, 5 (2017), 24-26. http://dx.doi.org/10.1145/3125393
60. Elena Marquez 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*. ACM, 2466461, 3365-3374. http://dx.doi.org/10.1145/2470654.2466461
61. Shaun Sweeney, Rodrigo Ordonez-Hurtado, Francesco Pilla, Giovanni Russo, David Timoney and Robert Shorten. *Cyberphysics, Pollution Mitigation, and Pedelecs*. arXiv preprint arXiv:1706.00646 (2017).
62. Jenny Slatman. *Our Strange Body: Philosophical Reflections on Identity and Medical Interventions*. Amsterdam University Press, 2016.
63. T. Stach, TC Graham, J. Yim and R.E. Rhodes. 2009. Heart Rate Control of Exercise Video Games. In *Proceedings of Graphics Interface 2009*. Canadian Information Processing Society, 125-132.
64. Dag Svanæs. Interaction Design for and with the Lived Body: Some Implications of Merleau-Ponty's Phenomenology. *ACM Transactions on Computer-Human Interaction (TOCHI)* 20, 1 (2013), 8.
65. Dag Svanaes and William Verplank. 2000. In Search of Metaphors for Tangible User Interfaces. In *Proceedings of DARE 2000 on Designing augmented reality environments*. ACM, 121-129.
66. J Tanenbaum and J Bizzocchi. 2009. Rock Band: A Case Study in the Design of Embodied Interface Experience. In *Proceedings of the 2009 ACM SIGGRAPH Symposium on Video Games*. ACM, 127-134.
67. Jakob Tholander and Stina Nylander. 2015. Snot, Sweat, Pain, Mud, and Snow: Performance and Experience in the Use of Sports Watches. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, 2913-2922.
68. T. Toscos, A. Faber, S. An and M. P. Gandhi. 2006. Chick Clique: Persuasive Technology to Motivate Teenage Girls to Exercise. In *CHI '06 extended abstracts on Human factors in computing systems*. ACM New York, NY, USA, 1873-1878.
69. Wikipedia contributors. 2017. Dwarf-Tossing. https://en.wikipedia.org/w/index.php?title=Dwarf-tossing&oldid=800700223.
70. Danielle Wilde, Thecla Schiphorst and Sietske Klooster. Move to Design/Design to Move: A Conversation About Designing for the Body. *interactions* 18, 4 (2011), 22-27. http://dx.doi.org/10.1145/1978822.1978828
71. T Winograd and F Flores. *Understanding Computers and Cognition: A New Foundation for Design*. Ablex Publishing Corporation (Norwood, NJ, USA), 1986.
72. J. Yim and T. C. N. Graham. 2007. Using Games to Increase Exercise Motivation. In *Future Play 2007*. ACM New York, NY, USA, 166-173.
73. Jeffrey Yim and T. C. Nicholas Graham. 2007. Using Games to Increase Exercise Motivation. In *Proceedings of the 2007 conference on Future Play*. ACM, 1328232, 166-173. http://dx.doi.org/10.1145/1328202.1328232
74. Damon Young. *How to Think About Exercise*. Picador, 2015.