Interaction Design for and with *the Lived Body*: Some Implications of Merleau-Ponty's Phenomenology

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In 2001, Paul Dourish proposed the term *embodied interaction* to describe a new paradigm for interaction design that focuses on the physical, bodily, and social aspects of our interaction with digital technology. Dourish used Merleau-Ponty's phenomenology of perception as the theoretical basis for his discussion of the bodily nature of embodied interaction. This article extends Dourish's work to introduce the human-computer interaction community to ideas related to Merleau-Ponty's concept of the lived body. It also provides a detailed analysis of two related topics: (1) embodied perception: the active and embodied nature of perception, including the body's ability to extent its sensory apparatus through digital technology; and (2) kinaesthetic creativity: the body's ability to relate in a direct and creative fashion with the "feel" dimension of interactive products during the design process.

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1. INTRODUCTION

In *Where the Action Is: The Foundations of Embodied Interaction*, Dourish [2001] defined embodied interaction as "the creation, manipulation, and sharing of meaning through engaged interaction with art[i]facts" [Dourish 2001]. For Dourish, embodiment is an approach to understanding human-artifact interaction that appreciates its contextual, situated, corporeal, and social nature. His perspective was inspired by the phenomenology of Husserl, Heidegger, Schütz, and Merleau-Ponty. The examples used by Dourish to illustrate embodied interaction were mainly taken from the research areas tangible interfaces and social computing at the time of writing (before iPhone and Facebook). Dourish contrasted his approach with that of cognitive science.

Dourish was not the first to apply phenomenology to Human-Computer Interaction (HCI). Winograd and Flores [1986] used Heidegger's phenomenology to argue against

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Some of the material in Sections 3, 4, and 5 appears in a different framing in an open-access encyclopedia entry for Interaction-Design.org provided by this author. These sections and Section 9.3 contain some material that has previously been published in Svanæs [2000]. However, the texts have been significantly rewritten and reframed for the present context. No other parts of this article have been published previously.
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the artificial intelligence approach to systems design. Within the participatory design tradition, Ehn [1988] used Heidegger's phenomenology to argue for a tool-based approach to systems design. Svanæs [2000; 2001] found Merleau-Ponty's phenomenology useful in explaining the holistic nature of interactive user experiences, and for context-aware computing. Robertson [1997; 2002] used Merleau-Ponty in the study of shared work practices within Computer-Supported Cooperative Work (CSCW). However, despite these earlier contributions to the embodied interaction perspective, Dourish [2001] was the first to reach a wider audience.

His book has been widely cited, and has been an important inspiration for many. Describing how it influenced her, Hornecker [2011] writes that "[s]eeing another Ph.D. student carrying this book or displaying it prominently on their bookshelves was like a secret Freemasons sign that triggered discussions ('Did you understand this bit here?')" [Hornecker 2011, page 21]. Many other HCI researchers also cite the book, if not always with such enthusiastic abandon. In a paper on the role of the body in HCI, Klemmer et al. [2006] write this.

> "More recently, Dourish suggests phenomenology and social science theory . . . as constituting an appropriate uniting lens for social and tangible computing. . . . . The project of this paper is distinct from this prior work in that our goal is to provide design themes, elucidated from the theoretical literature when appropriate, rather than provide an accessible entry for the HCI community into philosophy literature" [Klemmer et al. 2006, page 147].

Klemmer et al.'s criticism of Dourish can be seen as an argument in the ongoing discourse on the role of theory in HCI. As part of this discourse, Rogers [2004] analyzed the influence of various HCI theories, both within HCI research and on practitioners. Most of the practitioners interviewed by Rogers found the current HCI theories too complex to be of practical use in real design projects, whereas they considered HCI concepts such as *affordance*, *context*, and *awareness* to be of great value in their discussions with colleagues. Rogers concludes the following.

> "In sum, one of the main contributions of continuing to import and develop theoretically-based approaches in HCI is as a basis from which to enable new accounts, frameworks and concepts to be constructed. In turn, these have the potential for being developed further into a more extensive design language, that can be used both in research and design" [Rogers 2004, page 33].

As digital technology is constantly changing and its areas of use are expanding, HCI will always need new theoretical concepts. From Rogers' perspective, new conceptualizations of human-computer interaction are of value even when it is difficult to ascertain that the theories have any specific design implications.

Since 2001, the technological development has made phenomenology relevant beyond the "avant-garde" technologies described by Dourish. To a large extent, current off-the-shelf digital technology is inherently tangible, mobile, social, and ubiquitous. The design of everyday technologies such as mobile phones, social media, and full-body interaction games should consequently have much to gain from a phenomenological approach.

In parallel with the technological development, Interaction Design (IxD) has evolved and expanded both as a design discipline and an academic field over the last decade. The research focus in IxD has moved away from the cognitivist tradition in HCI towards approaches such as research-through-design [Koskinen et al. 2011]. IxD research has embraced "the third wave" in HCI [Bødker 2006]. This includes a strong focus on product properties that go beyond usability, such as aesthetics, fun, culture, branding, and the total user experience. Harrison et al. [2011] argue that three competing paradigms are currently present in HCI. The two first have their roots in human factors and cognitive science, respectively, while the third draws on a number of theories including embodied interaction as presented by Dourish. Common themes in the third paradigm are situatedness, embodiment, the particularity of each context of use, meaning construction, and values.

All human interaction with digital technology is embodied, in the sense that the technology is physically omnipresent in our everyday lives. An understanding of such technology consequently requires an understanding of the physicality of its contexts of use, including the physicality of its users. Although Dourish [2001] recognizes that Merleau-Ponty has a strong focus on the human body [Dourish 2001, page 114], there is surprisingly little focus on the body as such in Dourish's book. On embodiment, Dourish writes the following.

> "I am using the term largely to capture a sense of 'phenomenological presence', the way that a variety of interactive phenomena arise from a direct and engaged participation in the world . . . The lessons I want to draw from the phenomenological perspective will be broader (and less specific) than those that primarily occupied Merleau-Ponty" [Dourish 2001, page 115].

Fallman [2011] argues that HCI needs a philosophy of technology, and suggests that Ihde's phenomenologically inspired analysis of modern technology can be used to fill this gap (e.g., Ihde [1990]). Another approach is to turn to Merleau-Ponty's works and apply some of his key concepts to the analysis of human-computer interaction. The purpose of this article is to go beyond Dourish's analysis to show how Merleau-Ponty's phenomenology can provide insight into designing to support the lived body in human-computer interaction.

In *Phenomenology of Perception* [Merleau-Ponty 1962], Merleau-Ponty covered a wide range of topics related to the body, including free will, sexuality, and art. A full account of these topics and their relevance to embodied interaction is clearly outside the scope of this article. The focus here will be restricted to Merleau-Ponty's [1962] analysis of perception and *the lived body*.

The article starts with an overview of current references to Merleau-Ponty in the HCI literature. In order to be able to contrast Merleau-Ponty's perspective with other theoretical perspectives, a short introduction is given to conceptualizations of the human body in early HCI research. Heidegger's phenomenology is presented along with a discussion of this perspective's limitations for analyzing and designing human-computer interaction. Next, Merleau-Ponty's analysis of perception and the lived body is presented in some detail. Then some new concepts from the author's work, based on Merleau-Ponty's phenomenology [Svanæs 2000], are presented. These are: the *feel dimension* of human-computer interaction, *interaction gestalts*, and *kinaesthetic thinking*. These concepts are used in the analysis of two interaction design contexts, the first looking at interaction through a perspective of *embodied perception,* and the second looking at participatory design through a perspective of *kinaesthetic creativity.* The article ends with a discussion and some implications for design based on Merleau-Ponty's perspective of the lived body.

2. RELATED WORK

A discussion of Merleau-Ponty's current relevance for embodied interaction needs to contrast this approach with other approaches to HCI. A full account of the ways in which the user and the user's body have been understood in HCI would include a comparison of theoretical frameworks such as ethnomethodology, activity theory, Gibsonian (ecological) psychology, actor-network theory, and distributed cognition. However, such an analysis is outside the scope of this article. General comparisons of important HCI frameworks can be found in, for example, Svanæs [2000], Rogers [2004], and Harrison, et al. [2011].

2.1. The Body in Early HCI Research

The human body was implicitly present in much of the early research on human-computer interaction and computer-supported cooperative work. However, the human body as such was not explicitly discussed until the late 1990s. Loke and Robertson [2011] give a historical overview of relevant theoretical and philosophical perspectives on bodies and embodiment within HCI and CSCW. In addition to work inspired by phenomenology, their overview includes early work in CSCW, ethnomethodology, feminist theory, dance theory, and research on emotion. CSCW researchers have included the human body in their analysis of work practices since the early 1990s, according to Loke and Robertson: "Within early Computer-Supported Cooperative Work (CSCW), the need to design technology to enable people to work together over distance led to a recognition of the communicative resources of bodies acting within shared physical spaces" [Loke and Robertson 2011, page 118]. Of particular interest here are the detailed video-based workplace studies conducted by researchers with a background in the social sciences (e.g., Heath and Luff [1991]). Furthermore, Loke and Robertson refer to Suchman's early studies of human-artifact interaction [Suchman 1987] as an example of how an awareness of the ways in which bodies are situated in the world was introduced to HCI and CSCW from ethnomethodology.

Gaver [1992] applied J. J. Gibson's [1979] concept of *affordance* to an analysis of media spaces. Gaver explains affordances as

> "...properties of the environment that offer actions to appropriate organisms. They are defined with respect to both the environment and the interacting organism, and thus provide physical analysis that can complement sociological perspectives on situated action" [Gaver 1992, page 17].

In ecological psychology, the organism is the living body in its physical environment, but this concept was not explicitly discussed in Gaver's paper.

2.2. Merleau-Ponty in HCI

Since the early use of Merleau-Ponty in works by Robertson, Svanæs, and Dourish in the late 1990s and early 2000s, a number of works within HCI, IxD, and CSCW have explicitly referred to Merleau-Ponty's phenomenology of perception. A Google Scholar search on Dourish's title gives 1543 citations[1]. Of these, only 74 also cite Merleau-Ponty, and of these, less than half make more than passing reference to the underlying philosophy.

Hornecker and Buur [2006] present a theoretical framework for tangible interaction. They refer to Merleau-Ponty in the context of embodiment and space.

Fallman [2003] conducts a thorough analysis of phenomenology in his study of mobile interaction. He presents Merleau-Ponty in depth in relation to the bodily aspects of mobile technology. He motivates his focus on the body thus.

> "Consequentially, one of the main challenges of human–computer–world interaction is to reconnect the human body with HCI. Based in the legless and worldless desktop computer user, HCI has been primarily concerned with trying to understand the user's mind and how that affects design. The lack of interest in the body has however not been a conscious choice but rather an effect of the strong focus on mind issues" [Fallman 2003, page 190].

Moen [2005] discusses the kinaesthetic interaction experience from the perspective of Merleau-Ponty's concept of the lived body.

In "How it Feels, not Just How it Looks: When Bodies Interact with Technology" [Larssen et al. 2006], the authors discuss the role played by the kinaesthetic sense in human-computer interaction. This is discussed further in Larssen et al. [2007]. Loke

[1] scholar.google.com search string: "Dourish Where the action is", 28 Oct. 2011.

[2009] makes use of Laban movement analysis and Merleau-Ponty to reflect on design for moving bodies in interactive, immersive environments. Her cases include Sony Playstation Eyetoy and interactive artworks.

In Antle et al. [2009], the authors use Merleau-Ponty to discuss the role played by embodied metaphors in augmented spaces. Levisohn and Gromala [2009] use Merleau-Ponty in their reflections on embodied aesthetic experiences. Schiphorst and Kozel [2002] describe the Whisper project, where Merleau-Ponty was used as an inspiration.

Overbeeke [2011] combines Merleau-Ponty's ideas with the theories of J.J. Gibson [1979] to study a wide range of problems related to interaction design and user experience.

> "Lately, we turned more attention to phenomenology, in particular Merleau-Ponty. Why? Because designers are more and more designing 'living entities' [that is] systems that behave, learn about us, that adapt to us. We then get to very fundamental questions about being-in-the-world. How do I perceive that a system is perceiving me and how does the system perceives me perceiving?" [Overbeeke 2011, page 9].

In van Dijk [2009], the author argues for a renewed focus on improving usability from an embodied cognition perspective. He refers explicitly to Merleau-Ponty's phenomenology concerning the embodied nature of interaction. Deckres et al. [2011] study how perceptual crossing between user and artifact influences the user's feeling of involvement. They use Merleau-Ponty as a starting point for their discussion.

Furthermore, Kim and Seifert [2007] outline a framework for an aesthetics of interactive performativity. They discuss interactivity with reference to Merleau-Ponty. Finally, Höök [2009] studies how embodied interaction can create strong affective experiences, quoting Merleau-Ponty: "The body is not an object. It is instead the condition and context through which I am in the world" [Hook 1962, page 3593].

Summing up, we see that Merleau-Ponty's phenomenology has been applied to a wide set of technologies and research topics. The technologies include mobile phones, tangible computing, full-body computer games, technology for dance performance, and interactive art installations. The research topics have mostly been related to issues that go beyond usability and ergonomics, including the aesthetic, kinaesthetic, and meaning dimensions of the user experience.

Compared to the preceding authors, the present article will go into more depth concerning two aspects of Merleau-Ponty's phenomenology: (1) his analysis of perception, in particular its active and embodied nature, and (2) his concept of the lived body and how abstract movements allow us to use the body to explore possible futures in a creative manner.

3. HEIDEGGER: INTERACTION AS TOOL USE

Since the birth of HCI as a scientific discipline in the early 1980s, cognitive science has been the dominant paradigm for describing the human side of the equation. In *The Psychology of Human-Computer Interaction*, Card et al. [1983] presented a model of the user based on an information-processing metaphor. They model human-computer interaction as information flowing from artifact to user, where it is processed by the user's "cognitive processor", which in turn leads to actions such as pushing a button.

Already in the late 1980's, a number of researchers in HCI argued that the information-processing model reduces the user to a mechanical symbol-processing machine, leaving out important aspects of what defines us as human. One of the earliest criticisms of the information-processing approach to human-computer interaction was voiced by Winograd and Flores [1986] in their influential book *Computers and Cognition*. The book was primarily written as a criticism of artificial intelligence and cognitive science, but has strong relevance for a discussion of embodied interaction. Of the three

Fig. 1. The "toolness" of things. (Figure 1(a) courtesy of Baminnick (Wikipedia.org); Figure 1(b) courtesy of Carla Gomez Monroy et al. (fotopedia.com)

alternatives to cognitive science presented by the authors, the phenomenology of the German philosopher Heidegger (1889-1976) is best suited to the present context.

According to Winograd and Flores [1986], cognitive science takes for granted that human cognition and communication are symbolic in nature, and that symbols such as "cat" refer in a one-to-one manner to objects in the world. Heidegger's philosophy of being [Heidegger 1996] rejects this view, taking as its starting point our factual existence in the world and the way in which we cope with our physical and social environment.

3.1. The Toolness of Things

Heidegger is not easy reading, as he invented a complex set of terminology. To avoid the subject-object connotations of our words for the human being, he used the term *Dasein* to denote the subject in the world. In German, *Dasein* literally means "being-there", but its actual meaning is closer to "existence" or "presence".

The origins of modern phenomenology can be traced back to the works of the German philosopher Husserl (1859-1938), who was Heidegger's teacher. Husserl's phenomenological method consisted of conducting a process of what he called transcendental reductions. Reduction was not meant in the sense of "making less" but in the sense of "getting to the thing itself". The aim of the phenomenological method was to make explicit the "background" of a phenomenon, that is, the conditions that make a phenomenon appear to us the way it does. After such a reduction, a description of the phenomenon would include a description of the hierarchy of implicit "background" skills that make the appearance of the phenomenon possible. Heidegger broke with Husserl's project, eventually rejecting the very idea that it is possible to reach the thing itself.

Heidegger's opus magnum *Being and Time* [Heidegger 1996] from 1927 spans a wide range of topics. Among these, Winograd and Flores [1986] concentrate mainly on his analysis of tools. Heidegger used a carpenter and his hammer as an example of tool use (Figure 1(a)). Winograd and Flores argue that a computer can be viewed as a tool: for skilled users of computers, the computer is transparent in use; it is *ready-to-hand* (Figure 1(b)). When writing a document in a text editor, my focus is on the text, not on the text editor. But if my text editor crashes, my focus moves from the text that I am working on to the text editor itself. When we have such *breakdown situations*, the computer stops working as a tool and emerges as an object in the world.

Heidegger would describe a light switch (Figure 1(c)) as a tool for controlling the light. As part of our everyday life, a light switch is an integral element of our background of *readiness-to-hand*, and the interaction with the switch is, metaphorically speaking, transparent to us. It is only when the switch stops working as expected, or when we consciously choose to reflect on its nature, that it emerges from the *background* as an object.

Heidegger does not deny the fact that tools such as light switches exist in the world as objects to be viewed, touched, and manipulated. His point is that the essence of the switch only emerges through use. Its "switchness" is hidden from us until we put it into use. An important aspect of its "switchness" is that it allows for a certain kind of interaction. When the ape in the opening sequence of Kubrick's *2001: A Space Odyssey* movie first realizes that the piece of bone in front of him can be used to crack things, the "toolness" of the bone emerges to him—and from then on, bones are no longer only bones. The bone's "toolness" had been present all the time, but in order for the ape to recognize it, the ape had to put the bone into use. The interactivity of a light switch brings about a similar realization; its "switchness" emerges through use.

3.2. Meaning, Lifeworld and Equipmental Nexus

From a Heideggerian perspective, the specific meaning of the interaction with the light switch depends on the situation of use and the user's intention. Turning on the light as part of my everyday procedure when entering a room is not the same as turning on the light to see if the switch is in working order. In the first case the interaction is part of a wider goal, while in the second case it is a goal in itself. Cognitive science would miss this subtle difference, as it would model both interactions as the same goal-seeking information processing behavior.

Heidegger would also argue that in order to understand how an interaction is meaningful for a specific user, we would have to understand the *lifeworld* of that user, that is, the cultural and personal background that serves as a frame of reference and provides a context for every phenomenon and situation experienced by that person.

Heidegger further argues that tools exist in the shared practice of a culture as part of an *equipmental nexus*, as, for example, hammers with nails and wood. The hammer gets its significance through its relation to nails and wood, as the nail gets its significance through its relation to hammer and wood. The elements form a whole, and each element derives its significance from this whole. This nexus is close to what is often referred to in HCI as an *ecology of things*.

3.3. The Body in Heidegger

We have at the root of Western languages and culture a deep split between physical and mental (*body* and *mind*). This dualism is difficult to overcome. A discussion of the relationship between body and mind dates back to Plato and Aristotle, but the contemporary discourse on the subject has its origins in the work of the French philosopher Descartes (1596-1650). Descartes' writings had a strong influence on the course of Western philosophy and science. His philosophical project was to build a worldview based solely on reason. He argued that if everything can be doubted, the only thing anyone can know for certain is that he is the subject doing the reasoning: *Cogito ergo sum* (I think, therefore I am). Trusting nothing but reason, Descartes argues that the world consists of two domains: a "pure" mental domain (*res cogitans*), and a physical domain (*res extensa*) external to the mental domain. The two domains are ruled by different laws and are only connected through the pineal gland in the brain. The human subject is a self-conscious mental entity in *res cogitans* whose body exists in *res extensa*. Will and consciousness belong solely in the mental domain, while the physical world (including the human body) is like a machine ruled by natural laws. In Descartes' view, then, the subject is essentially an immaterial mind having a physical body. The body becomes an object for the mind. This is what is known as Cartesian dualism.

Although Heidegger made an important break with Descartes in *Being and Time* [Heidegger 1996], he did not go into detail about the bodily nature of "Dasein". He used practical examples, such as hammering, but he never showed how the structure of Dasein's corporeality influences Dasein's way of being in the world. Heidegger did not see inclusion of the human body as necessary to be able to escape the subject-object dichotomy of Western thought. This might come as a surprise, as some of his most famous examples, like hammering, involve corporeal issues. Heidegger acknowledged, however, that "[t]his 'bodily nature' hides a problematic of its own" [Heidegger 1996, page 143].

In the Zollikon seminars in the late 1960's, Heidegger provided more details about his ideas on the nature of the human body (see Aho [2009]). The French philosopher Jean-Paul Sartre had criticized Heidegger for writing only six lines about the body in the whole of *Being and Time.* Heidegger responded that Sartre was caught in the Cartesian conception of the body as a material object with properties because "the French have no word whatsoever for the body, but only a term for a corporeal thing, namely, le corps" [Heidegger and Boss 2001, page 89]. In German there are two words for body: *Körper* and *Leib*. *Körper* is the body as a material object, while *Leib* is the lived body. As Aho puts it: "[f]or Heidegger, corporeality merely indicates that the body is physically present (körperhaft). It fails to see the phenomenological problem of the body, namely that we are 'there' in a 'bodily' (leibhaft) manner" [Aho 2009, page 37].

Dreyfus [1991] points out that there is no way to infer from reading *Being and Time* that Dasein has a left and a right, a front and a back, etc. These properties of Dasein can only be explained with direct reference to the particular structure of the human body, for example, that left-right is symmetrical, while front-back is not. Despite later making clear the difference between *Körper* and *Leib,* Heidegger never addressed this point.

As pointed out by McCullough [2005], an analysis of the structure of the lived body also requires reference to the material properties of the world we live in.

An analysis of the up-down relationship can illustrate this. Up-down can be used both with reference to the world, and with reference to the human body. An example of the first is "the apple fell down", while "the spider crawled up my leg" exemplifies the second. If you stand on your head, the world appears "upside-down". For the body, the topology is that your feet are down and your head is up. In the world, down is the way things fall: up is the sky; down is earth. It follows from this that our understanding of up and down with reference to the world requires gravity. Imagine a person born and raised in weightlessness on a spaceship traveling in the void between stars. In weightless space there can be only one up-down relationship, namely that of the body. All other up-down relationships are references to life with gravity. In our everyday life we live with this duality of interpreting up-down both from the first-person perspective of the body and from the third-person perspective of the world. In some cases this duality creates ambiguities, as exemplified by the following statement: "While standing on my head, a spider started crawling up my leg." Which way did the spider crawl?

Heidegger's analysis of Dasein is a general description of any living subject's existence in any world. In order to gain a deeper insight into the specifics of bodily human existence in our everyday environment in a more concrete sense, we can look to the work of Merleau-Ponty.

4. MERLEAU-PONTY: PERCEPTION AND THE LIVED BODY

Besides Sartre, Merleau-Ponty (1908-1961) was the most influential French philosopher of the 1940's and 50's. Inspired by Heidegger, Merleau-Ponty stressed that every analysis of the human condition must start with the fact that the subject is in the world. This *being-in-the-world* is prior to both object perception and self-reflection. To Merleau-Ponty, we are not Cartesian self-knowing entities detached from external reality, but subjects whose existence is in the world, and whose self-awareness arises from interaction with our physical environment and with other subjects. Much of Merleau-Ponty's analysis was based on empirical findings. However, the resulting theoretical framework is not an empirically-based psychological theory such as activity theory [Leontjev 1978] or ecological psychology [Gibson 1979]. It should consequently be treated more as an inspiration for further research and reflections than as a fixed framework. The following sections present some of Merleau-Ponty's core concepts that have relevance for the design of human-computer interaction.

4.1. Perception is Active

In his major work *The Phenomenology of Perception* [Merleau-Ponty 1962] from 1945, Merleau-Ponty performs a phenomenological analysis of human perception. His purpose is to study the "precognitive" and embodied basis of human existence. The analysis leads him to a rejection of most of the prevailing theories of perception of his time. Throughout Merleau-Ponty's writing there is a focus on the first-person experience, and he dismissed the idea that perception constitutes passive reception of stimuli. His standpoint is in total opposition to the view that perception constitutes sense data being passively received by the brain, as found in Card et al. [1983]. For Merleau-Ponty there is no perception without action; perception requires action. Perception hides from us this complex and rapid process taking place "closer to the world" in "the preobjective realm".

Modern eye trackers allow us to observe these rapid perceptual interactions as they unfold in vision. The human eye sees clearly only in the central two degrees of the visual field, which is roughly equivalent to twice the width of a thumb at arm's length. When we see objects with our eyes, this is not a passive process of receiving stimuli; rather, it involves active movement of the eyeballs in search of familiar patterns. To a large extent, the details of these rapid perceptual processes are beyond our control. They occur at millisecond level. Thus, when we perceive the world, this "interaction with the world" has already taken place. As human beings we always live a fraction of a second in the past. Based on experimental data, Eagleman and Sejnowski [2000] quantified this delay to approximately 80 milliseconds (1/12 second).

All senses are active, including hearing, smell, and touch. The example of visual perception is used here primarily because eye tracking allows us to study the active nature of perception in detail for this sense modality. In hearing, to take a different example, we distinguish between listening and hearing. At a cocktail party with many voices, we can focus on one person and block out the rest. This is active perception in the auditory sense modality.

4.2. Perception is Shaped by the Phenomenal Field

Merleau-Ponty uses the term *phenomenal field* to denote the personal background of experiences, training, and habits that shapes the way in which we perceive the world. In Figure 2, we see the rapid eye movements of two different persons, a nonartist (A) and a trained artist (B), viewing the same photograph.

We see how the artist rapidly scans the whole image (Figure 2(b)), while the layperson mostly focuses on the girl's face (Figure 2(a)). The result of their different viewing styles is that they actually see different images.

4.3. Perception has Directedness

Merleau-Ponty saw perception as governed by a "preobjective" intentionality towards the world. Most of these interactions take place in "the preobjective realm". The role of intentionality in perception is illustrated in Yarbus's classic study of how tasks affect eye movements in vision [Yarbus 1967].

In Figure 3, we see how the eye movements of the same person viewing the painting in Figure 3(a) change depending on task (Figure 3(b) free examination; Figure 3(c) estimate the material circumstances of the family in the painting; and Figure 3(d) give the ages of the people). Asked to estimate the age of the persons in the painting (Figure 3(d)), the test subject paid no attention to the artwork on the wall. If asked to

Fig. 2. Rapid eye movements of layperson and artist (from Vogt and Magnussen [2007]; image courtesy of Magnussen and Vogt).

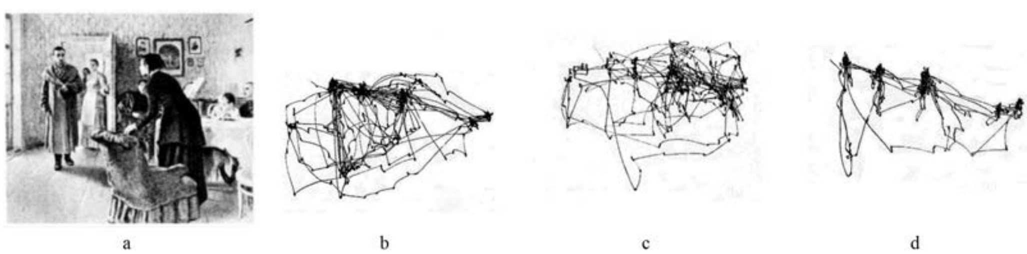

Fig. 3. Tasks affect perception (from Yarbus [1967], ©Springer Verlag).

recall what was on the wall, he or she would have been unable to do so, simply because the eyes never scanned that part of the painting. What we see in the world thus also depends on our intentions as directed by our tasks or goals.

4.4. Perception Can Be Mediated through Artifacts

The body has an ability to adapt and extend itself through external devices. Merleau-Ponty used the example of a blind man's stick (cane) to illustrate this. When a person has learned the skill of perceiving the world through the stick, the stick has ceased to exist only as a stick for that person. It has become part of the person's body, and at the same time it has changed it.

Merleau-Ponty describes a blind man's use of his stick as follows.

> "Once the stick has become a familiar instrument, the world of feelable things recedes and now begins, not at the outer skin of the hand, but at the end of the stick. . . The pressures on the hand and the stick are no longer given; the stick is no longer an object perceived by the blind man, but an instrument with which he perceives. It is a bodily auxiliary, an extension of the bodily synthesis." [Merleau-Ponty 1962, page 152].

Merleau-Ponty often used the term *instrument* where Heidegger would use *tool*. The blind man's stick is more than a tool; it is also an extension of his sensory apparatus.

4.5. Perception Involves the Whole Body

Merleau-Ponty saw perception as an active process of meaning construction involving large portions of the body. The body is a priori the means by which we are intentionally directed towards the world. When a person holds an unknown object in his/her hand

and turns it over to view it from different angles, the intentionality is directed towards that object. The hands are automatically coordinated with the rest of the body and take part in the perception in a natural way. Any theory that restricts visual perception to the eyes alone fails to fully explain the phenomenon. According to Merleau-Ponty, the body is an undivided unity, and it is meaningless to talk about the perceptual process of seeing without reference to all of the senses, to the total physical environment in which the body is situated, and to the "embodied" intentionality we always have towards the world.

4.6. The Lived Body

As human beings, we are aware of our body both as an object in the world and more directly as the lived body (*le corps propre*). *The lived body* 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.

In quoting a German text, Merleau-Ponty translates *Leib* as the lived body (*le corps propre*) and *Körper* as organism [Merleau-Ponty 1962, page 283]. This is the same distinction that was made by Heidegger. However, Merleau-Ponty goes further. It is as living bodies that we exist in the world, he claims, or, as he puts it: "The body is our general medium for having a world" [Merleau-Ponty 1962, page 146]. Giving priority to the lived body represents a radical break with Cartesian body-mind dualism. We are no longer minds in *res cogitans*, that have physical bodies (*Körper)* in *res extensa*. We are lived bodies (*Leib)*. The lived body manifests itself mainly as its possibilities of acting in the world. We have a world insofar as we have the capacity to act in that world. The lived body is an active body.

In some places Merleau-Ponty uses the term *the phenomenal body* for the lived body. He describes the difference between the lived (phenomenal) body and the objective body in the following manner.

> "[A tailor], when put in front of his scissors, needle and familiar tasks, does not need to look for his hands or his fingers, because they are not objects to be discovered in objective space: bones, muscles and nerves, but potentialities already mobilized by the perception of scissors or needle, the central end of those 'intentional threads' which link him to the objects given. It is never our objective body that we move, but our phenomenal body..." [Merleau-Ponty 1962, page 106].

4.7. The Body Incorporates Artifacts into its Structure

Merleau-Ponty was intrigued by the body's ability to adapt itself to changes in corporeal structure brought about by physical artifacts. He uses examples like wearing a hat and driving a car.

> "A woman may, without any calculation, keep a safe distance between the feather in her hat and things which might break it off. She feels where the feather is just as we feel where our hand is. If I am in the habit of driving a car, I enter a narrow opening and see that I can 'get through' without comparing the width of the opening with that of the wings, just as I go through a doorway without checking the width of the doorway against that of my body. The hat and the car have ceased to be objects with a size and volume which is established by comparison with other objects. They have become potentialities of volume, the demand for a certain amount of free space." [Merleau-Ponty 1962, page 143].

Toombs [2002] draws on Merleau-Ponty's concepts when reflecting on her own experiences as a wheelchair user.

> "For the person who routinely uses a wheelchair the device becomes a part of the body. One intuitively allows for the width of the wheels when going through a doorway; one performs the necessary hand/arm movements to move forwards and backwards without thinking about it. With habitual use the wheelchair becomes an extension of one's bodily range. Thus, when a stranger pushes my wheelchair without my permission, it is invading my personal bodily space." [Toombs 2002, page 256].

4.8. Body Schema

The body schema (body image/corporeal schema[2]) is our nonconscious knowledge of our lived body and of our potential for bodily actions in the world. In addition to our "bodily" knowledge of the position of our body at any given time, the body schema includes "tacit" knowledge of the structure and specifics of our body, such as the length of the arm. The body's ability to maintain a body schema is what enables us to move and act in the world in a skilful manner. If we use a tool, the body schema changes to include the tool as part of our lived body.

The body schema is constantly updated to reflect changes, both in bodily position and in bodily structure. When the blind man picks up his stick, an object in the external world (the stick) becomes part of his bodily structure. When a person moves her hand towards the cup of tea in front of her, she relates to this object as a thing positioned outside of her body. But when she grasps the object and moves it up to her mouth, the cup is no longer primarily an external object whose position she judges in relation to other objects; it has become something that has changed the structure of her lived body. When she places the cup back on the table, it leaves her lived body and resumes its function as part of the space of objects.

4.9. Bodily Space

Experientially, the structure of a person's bodily space is very different from the structure of the external (objective) space of objects. While external space is organized along axes such as near-far, a person's bodily space is constituted by that person's potential for action in the world.

The bodily space is different from the external space in that it exists only as long as there are degrees of freedom and a skilful use of this freedom. The bodily space is mainly given by the subject's specific potentials for action. Different bodies give rise to different spaces, and so do external factors such as clothing, tool use, and different kinds of prostheses. The bodily space is also changed by learning a new skill, as it changes the body's potential for acting in the world.

It is important to note that, according to Merleau-Ponty, we live in a world where objects are already filled with meaning as they present themselves to us. Our perception of our surroundings is thus very different from how a robot might see the world. Schwarzenegger's character in *The Terminator* would see a cup of tea in front of him as a neutral object in 3D space whose significance would be added onto it in the alternate reality layer. To a human being, the same cup of tea would be an object already filled with significance and potential for action.

4.10. Skills Acquisition

Merleau-Ponty uses the example of an organ player who has to play on an unfamiliar instrument to illustrate how we internalize external devices through learning. In the course of a single hour before giving the concert he manages to acquaint himself with all of its levels, pedals, and manuals. This is not an intellectual activity where the musician follows a logical course of action, but an interaction with the instrument aimed at "understanding" it. Thus, through skill acquisition and tool use, we change our bodily space, and consequently our way of being in the world. Metaphorically, we could say that by learning new skills and using technology we change the world we live in.

[2]I follow Gallagher's [2005] interpretation of "schéma corporel" and use of the term *body schema*.

4.11. The Dynamic Nature of Body, Tools and Objects

Used to navigate in a world of darkness, the stick becomes an integral part of the blind person's sensory apparatus. As such, the stick becomes an extension of the senses. But the stick can also be used as a tool for moving small obstacles. It can be used as a weapon, or to point to objects during a conversation. If made of wood, it could even be burned to produce a moment of warmth on a cold winter day.

What the stick *is* and how it relates to the body depends on its use. We refer to it as a stick, but only because this suggests the primary use intended by its designers. Both Heidegger and Merleau-Ponty would object to describing objects in the world as belonging to fixed categories with static properties and attributes. As a blind person's stick, its attributes of length and weight are important. As a tool for moving small obstacles, its strength would be important. As wood for burning, our concern would be how much heat it could produce. This is not to say that phenomenology rejects the very existence of objects in the world; it simply reminds us that what an object *is* depends on its use and the perceiver's frame of reference. The same is also true for how objects relate to the body (as objects in the world, as tools, or as extensions of the senses).

4.12. Concrete versus Abstract Movement

Merleau-Ponty distinguishes between movements made on purpose "as movements" and movements made naturally as part of a situation. He describes the former as *abstract*, the latter as *concrete*. If a person is asked to move the left foot in front of the right foot, the resulting movement is abstract because it is made outside the normal context of bodily movements. When part of everyday walking, the same kind of movement would be concrete.

Abstract movement is what enables us to step out of habitual behavior and use the body to communicate and explore alternative courses of action. Merleau-Ponty exemplifies his point with a patient "Schneider" who lacked the ability to perform abstract movements. This was part of a much deeper disability suffered by "Schneider", namely the inability to imagine anything at all beyond the present. For Merleau-Ponty, abstract movement or "play-acting ... to place oneself for a moment in an imaginary situation, to find satisfaction in changing one's 'setting'" is at the core of human nature [Merleau-Ponty 1962, page 156]. He reports about "Schneider" who lacked this ability.

> "He never sings or whistles of his own accord ... He never goes out for a walk, but always on an errand, and he never recognizes . . . [an acquaintance's] house as he passes it 'because he did not go out with the intention of going there'. . . . There is in his whole conduct something meticulous and serious." [Merleau-Ponty 1962, pages 156–157].

5. THE FEEL DIMENSION OF EMBODIED INTERACTION

How can Merleau-Ponty's phenomenology shed light on interactive digital technology? Merleau-Ponty never wrote about interactive computers. Any attempt to apply his theories to this subject area will therefore be a guess based on interpretations of his writings on other subjects. In Svanæs [2000], Merleau-Ponty's phenomenology is applied to an analysis of interactivity, or what we today would call *the interactive user experiences*. Based on data from controlled psychological experiments with Graphical User Interfaces (GUIs), and inspired by Merleau-Ponty's theories, three new concepts were proposed: *the feel dimension, interaction gestalts*, and *kinaesthetic thinking.* These concepts have proved useful in discussing the "feel" of the user experience and the role of the kinaesthetic sense modality in interaction design.

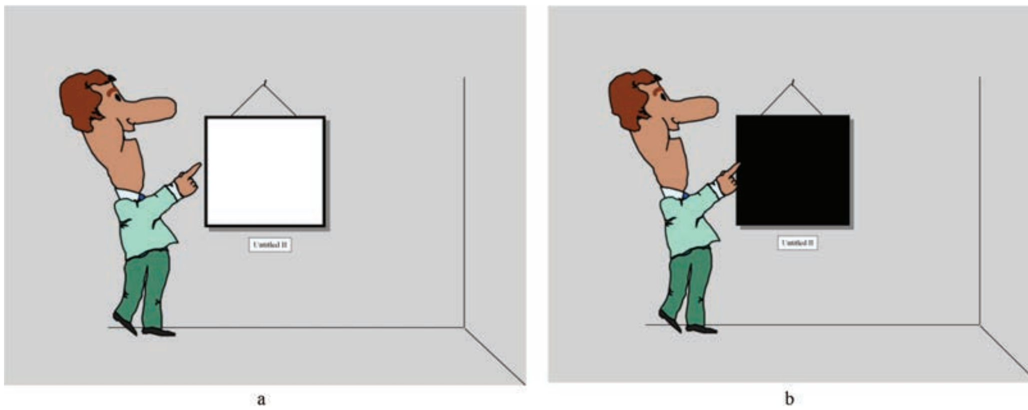

Fig. 4. Abstract interactive art.

5.1. An Example: Abstract Interactive Art

The integrated view of action and perception in Merleau-Ponty's phenomenology makes his ideas an interesting starting point for discussing interactive user experiences. A consequence of Merleau-Ponty's theory is that meaning emerges through interaction.

This is exemplified in Figure 4. It shows an imagined work of abstract interactive art, which is part of an imagined art exhibition called "Touch me". The canvas is white when first viewed (Figure 4(a)), but it turns black when touched by the gallery visitor (Figure 4(b)) due to an in-built touch sensor. A second touch brings back its initial white color (Figure 4(a)); it has toggle behaviour. How can Merleau-Ponty's philosophy shed light on the user experience in this constructed case?

Perception is shaped by the phenomenal field. In the preceding example, the frame of reference is given by the user's past experiences with modern interactive artifacts. This is the horizon of the user, that is, the phenomenal field that all his interactions take place in. Part of this phenomenal field is the habit of touching and clicking things to learn more, which originates from our life with modern interactive artifacts.

Perception has directedness. For a skilled user of modern interactive artifacts, the implicit invitation contained in the name of the exhibition ("Touch me") will give rise to a particular "directedness" towards this piece of art. Because of this "preobjective" intentionality, the artwork will present itself not primarily as a form to be viewed, but as something to be touched in order to learn more.

Perception is active. Perception of the artwork's behavior requires action. The resulting user experience is the integrated sum of its visual appearance and its behavior. Without action, we are left simply with the visual appearance of a white canvas, missing out on the intended user experience of this work of art, which emerges through interaction. The act of touching the artwork to learn more can be seen as part of the user's perceptual process of exploring its behavior.

Perception involves the whole body. Experiencing the interactive artwork requires not only visual perception, but also an arm and a hand. Arm, hand, and eye movements are integrated parts of the perceptual process that leads to perception of the artwork's behavior. The interactive experience is thus both created by and mediated through the body.

Using Merleau-Ponty's ideas, it becomes meaningless to talk about interaction purely as stimuli reception leading to actions. Certain aspects of interaction are better

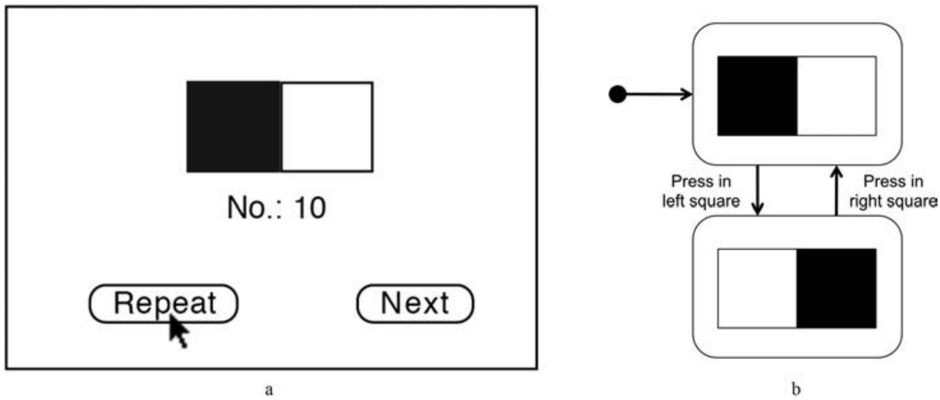

Fig. 5. Interactive stimulus used in the experiment.

described as perception. The gallery visitor *perceives* the behavior of the artwork *through interaction*. This perception involves arm, hand, and eyes in an integrated manner. This kind of embodied perception is immediate and "close to the world".

5.2. The Feel Dimension and Interaction Gestalts

Already in the 1990's, much had been written on the visual aspects of GUIs, whereas their interactivity had not been explored to the same extent. We often talk about the "look and feel" of a digital product. Using "look and feel" as a metaphor, the purpose of the research described in Svanæs [2000] was to study the *"feel"* dimension of the interactive user experience.

In order to describe the specific ways in which modern computers are experienced in use, Merleau-Ponty's theory needed to be supplemented with new empirical data. A psychological experiment was designed to study how users spontaneously structure interactive user experiences. The test participants (high-school students) were exposed to a number of simple abstract interactive stimuli on a PC display, containing one, two, or three interactive black and white squares similar to the imaginary artwork in Figure 4. They were asked to try out the stimuli while verbalizing what they were doing, and the resulting verbal protocols were analyzed in search of implicit metaphors. The experiment can be seen as Rorschach tests of the interactive user experience in that the stimuli were abstract and intentionally ambiguous.

A typical stimulus is shown in Figure 5(a). In this example the black square gets white and the white square gets black when the mouse is pressed in the black square to the left. A reversal of color also happens when the mouse is pressed in the black square when it is on the right, taking the subject back to the original situation. Its state transition diagram is shown in Figure 5(b).

Remarkable agreement was found in the subjects' description of the interactive stimuli. The one shown in Figure 5(a) was typically described as "it jumps back and forth when you click on it."

The test subjects in the experiment often described new interactive stimuli as modifications of earlier stimuli, for example, "it is like the previous one, but the right square is dead", without having verbalized the behavior of the earlier stimuli. In the analysis of the data from the experiment, this was interpreted as direct comparisons between different experiences of interactivity, not as logical analyses of the behavior of the stimuli. Borrowing from gestalt psychology, the term *interaction gestalts* was used to describe these basic elements of interactive user experiences [Svanæs 1993]. The conclusion drawn was that our experience of interactivity has gestalt properties, and that the smallest units of experience are not action/reaction pairs, but complete behaviors, such as the toggle behavior of the imagined artwork in Figure 4. In the same way as you see a rose, not a collection of petals, and hear a familiar musical theme, not a sequence of tones, you perceive the interactive behavior of an interactive artifact not as a collection of action/reaction pairs, but as a meaningful interactive whole.

The feel dimension and *interaction gestalts* can be illustrated with examples from everyday technology. When I drive a new car for the first time, the user experience of having taken the car for a drive is the sum of stimuli in a number of sense modalities: visual, auditory, tactile, and olfactory. In addition, the drive results in the kinaesthetic experience of actually having driven the car. This is *the feel dimension* of the user experience: how it feels to drive it. It includes how the car reacts on steering wheel, brake, and gas. The resulting *interaction gestalts,* such as the experience of operating the manual gear, are not logical composites of action/reaction pair, but atomic percepts in the kinaesthetic sense modality. If I drive a different car the next day, I will immediately recognize if this car's manual gear behaves in a different way. It will feel different in use. Such immediate comparisons of interaction gestalts do not require decomposition or analysis of any kind; we are at the atomic elements of the feel dimension of the user experience.

5.3. Kinaesthetic Thinking

An experiment was devised to test the practical usefulness of the idea of interaction gestalts for interaction design (see Svanæs [2000]). An editor for simple GUI elements was designed and implemented that allowed users to work directly with interactive single-square objects to construct complex behaviors from a set of basic objects with built-in behavior. The editor can be seen as implementing an algebra of interactive behavior. It was tested on high-school students with no background in programming. They were all able to construct new and complex interactive behavior from the initial set of elementary behaviors.

The fact that the test subjects were able to make sense of interactive behavior without breaking it down into action/reaction pairs seems to suggest that we are dealing with a mode of thinking that shares many traits with visual and musical thinking. Johnson [1987] proposed using the term "kinaesthetic image schemata" to describe experiential wholes resulting from interaction with our physical environment. In line with Johnson's terminology, the term *kinaesthetic thinking* was proposed to signify the kind of direct cognitive operations on *interaction gestalts* observed in the experiment.

6. DESIGNING FOR THE LIVED BODY: EMBODIED PERCEPTION

The theoretical and experimental work on GUIs reported in Svanæs [2000] was carried out around the turn of the millennium. The next two sections will explore how Merleau-Ponty's analysis of perception and the lived body can shed light on current "ubiquitous" off-the-shelf digital technology, such as smartphones and full-body interaction games.

6.1. Embodied Perception

Applied to an analysis of embodied interaction with digital artifacts, Merleau-Ponty's theories invite us to see interaction as perception. If a person tests out a light switch to see whether it works, this interaction can be regarded as an embodied perceptual act involving both eyes and hand. The hand is moved to the switch as part of the process of perceiving its behavior, in the same way that the eyes make rapid eye movements when seeing an image. The hand movements towards the light switch result from the directedness towards that specific object of perception, in this case to test its behavior. The interaction with the light switch leads to a user experience. The *feel dimension* of this particular user experience is the user's perception of the switch's interactive behavior. This behavior is experienced as an interaction gestalt that can be compared with other interaction gestalts through *kinaesthetic thinking*. This is similar to how visual gestalts of faces can be compared through visual thinking, or how auditory gestalt of musical themes can be compared through auditory thinking.

In more complex interactions, such as when an experienced computer user plays the game World-of-Warcraft, the perceiving body extends into the game. When the player tries out a new sword that she has acquired for her game character, she perceives its behavior through the mouse and the part of the software that allows her to control her character. Playing World-of-Warcraft is similar to riding a bicycle or driving a car in the sense that the technology becomes an extension of the body, but different in that the world is computer generated.

The term *embodied perception* is used in the following to denote human-artifact interactions whose nature is perceptual and bodily. Such perception is active, and it often involves technologies that allow the body to extend itself through external devices. As with embodied interaction, the term is strictly speaking meaningless, as perception and interaction must necessarily be embodied. (What would be the meaning of disembodied interaction or perception?) Consequently, embodied perception is primarily a perspective for discussing certain aspects of the bodily nature of human-computer interaction.

6.2. Example 1: Page Turning as Embodied Perception

If you ask people what they do when they read a book, they might say something like "I read the text, and then I turn the page." If you ask them how they read text in a Web browser, they might in a similar fashion say something like "I read the text on the screen, and then scroll down to see more." Most people, both laypersons and interaction designers, will describe reading as perception, and page turning and window scrolling as actions. If we take the perspective of Merleau-Ponty seriously, we should consider both reading and page turning/scrolling part of an integrated perceptual process. The trained hand turning the pages or dragging the scrollbar is as integrated into the reader's perceptual process as the eyeballs scanning the text. Hands and eyes are constituent, equally necessary parts of embodied perception.

A possible design implication of this perspective is that the digital reading experience should be designed not as a user interface to control the presentation of the text, but as an extension of the human perceptual apparatus. The scrollbar is not a tool for moving text (as a Heideggerian tool analysis would have it), but an extension of the human senses. Active perception is rapid, and requires tight mapping between muscle movement and response in order to function well and be easily learned by the body.

In an empirical comparison between reading on paper and reading online, O'Hara and Sellen [1997] commented on the fluency and speed involved in the handling of paper documents.

> "Movement through paper documents was characteri[z]ed by its speed and automaticity. For example, page turning in the [p]aper condition was often anticipatory, with one hand often lifting a page even before it was read, minimizing disruption between reading the text at the end of one page and the beginning of another ... Navigation through paper was quick, automatic, and interwoven with reading. In the [online] condition it was slow, laborious, and detracted from reading" [O'Hara and Sellen 1997, pages 338–339].

One of the main design implications they pointed out was a need to support quicker, more effortless navigation techniques. Their description of page turning as anticipatory fits well with Merlau-Ponty's observations that "there is vision only through anticipation and intention" [Merleau-Ponty 1962, page 471]; perception has a directedness towards its object of perception and is constantly anticipating the future.

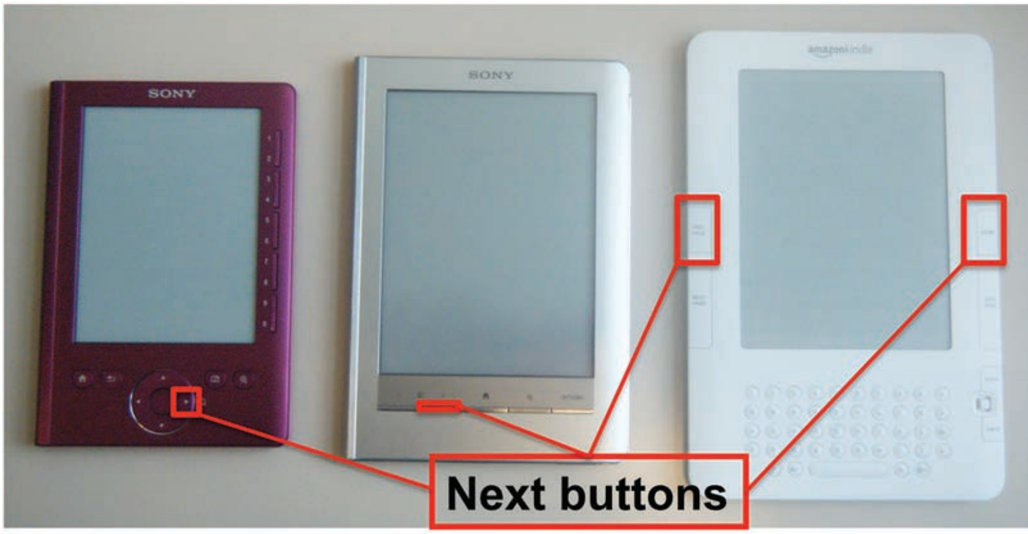

Fig. 6. Three eReaders (from Pearson et al. [2010]; my annotations, ©ACM).

6.3. Example 2: Interaction Details Matter in Embodied Perception

In their comparison of three different eReaders, Pearson et al. [2010] observed that "[a]lthough page turning may seem trivial, how the device changes pages is a rather fundamental feature that if implemented incorrectly, would seriously hinder the reading process. When using the device for reading only, the most commonly used function will be the 'Next' button as it is used every time a user wants to change the page". After a detailed assessment they concluded that page turning functionality had not been the primary concern of the designers of the eReaders: "The devices we evaluated have obviously been designed with aesthetics in mind, sometimes paying little attention to the position of such buttons."

As illustrated in Figure 6, the Amazon Kindle (right) had two "Next" buttons, one on either side of the screen, allowing one-hand navigation for both hands; while the two Sony products (middle and left) had less easily available "Next" buttons. Seeing page turning as an integral part of reading could have led these eReader designers to consider more carefully the placement of the "Next" buttons, as well as other design issues that support the bodily aspects of the reading experience. Seeing navigation as embodied perception might have helped the designers conceptualize their design problem differently.

6.4. Example 3: Text Scrolling as Perception

Given the shortcomings of text navigation reported by O'Hara and Sellen [1997] and Pearson et al. [2010], it is hardly surprising that the *scrolling wheel*, invented in 1993 by Eric Michelman, is one of the few additions to the hardware of the personal computer that has become a de facto standard feature. (It is worth noting, however, that it took almost 10 years from the time the first scrolling wheel appeared on the Microsoft Intellimouse in 1996 until a scrolling wheel became part of the Apple Mighty Mouse in 2005.) Figure 7 shows some product examples from the history of the computer mouse (7(a) Xerox Alto mouse (1973); 7(b) Apple Macintosh mouse (1984); 7(c) Genius Easyscroll (1995); 7(d) Microsoft Intellimouse (1996)).

Explaining how he came to invent the scrolling wheel, Michelman [2011] describes his observation that navigation was clearly a problem for software users:

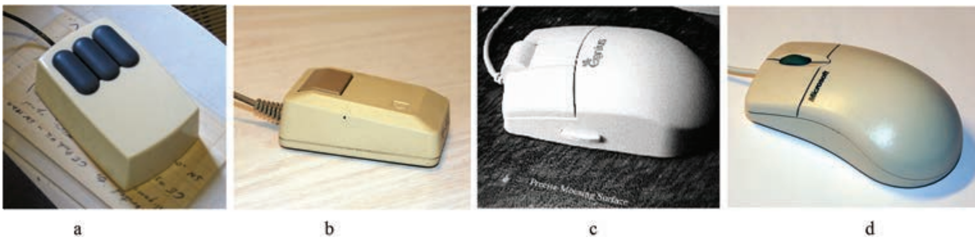

Fig. 7. Product examples from the history of the computer mouse (Figure 7(a) courtesy of Marcin Wichary (foto-pedia.com; Figure 7(c) courtesy of Roland Hechten-bery)).

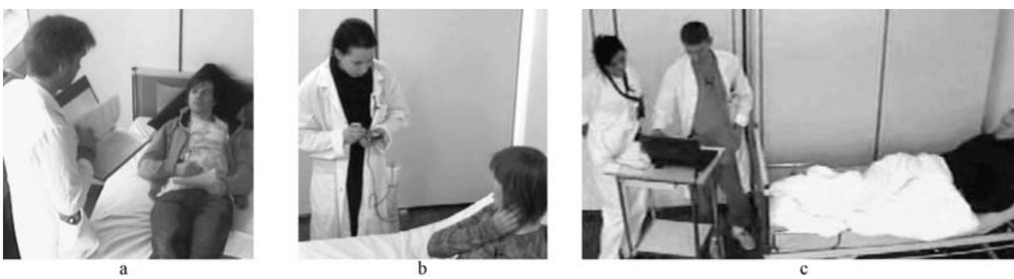

Fig. 8. Medical records: (a) paper based; (b) on a PDA; (c) on a laptop on wheels (from Alsos et al. [2011], ©Elsevier).

> "Back in 1993, as I was watching many Excel users do their work, I noticed the difficulty they had moving around large spreadsheets... I had the idea that perhaps a richer input device would help." [Michelman 2011, page 1].

The scrolling wheel resulted from the Visceral Excel project at Microsoft. "[This] was a project I started within the Excel group to try to bring back a more visceral experience to Excel usage" Michelman explains [ibid., page 1]. The fact that he uses the term visceral is relevant for the present discussion ("visceral: felt in or as if in the internal organs of the body" [Webster Dictionary 2012]). The closer we are to the perceptual processes, the more natural it is to use bodily metaphors.

We see, then, that in looking for the best practice in interaction design, navigation has been identified as interwoven with reading, and that the ideal reading technology is one that leads to a visceral user experience. This fits very well with seeing these aspects of interacting with computers as embodied and active perception.

6.5. Example 4: Information Navigation as Embodied Perception

In an experimental study of the use of medical records in hospitals, Alsos, et al. [2011] compared three technologies: (A) traditional paper-based records, (B) electronic medical records on PDAs, and (C) electronic medical records on "laptops on wheels". The physicians in the experiment reported that both the PDA and the laptop became a disturbing "third party" in their face-to-face communication with the patient. The fluency with which the physicians browsed the paper version of the medical records stood in sharp contrast to the effort needed to navigate the digital versions.

The physician's interaction with the paper medical record in Figure 8(a) integrates well with the physicality of the face-to-face dialog with the patient. The browsing and reading involves eyes, arms, and hands in a coordinated manner. The perception of the paper medical record is embodied, automated, and requires minimal attention.

In contrast, the physicality of the laptop on wheels (Figure 8(c)) does not allow for navigating and reading while simultaneously having a face-to-face dialog with the

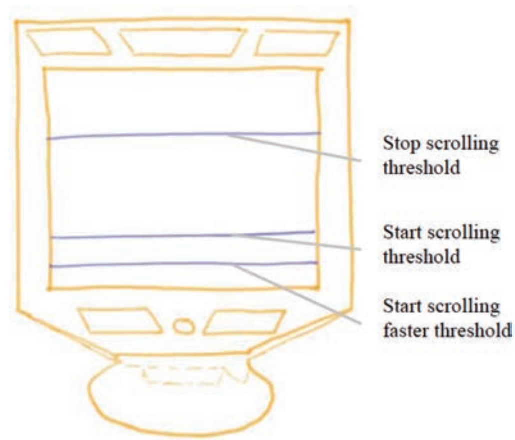

Fig. 9. EyeScroll: gaze-controlled scrolling (from Kumar and Winograd [2007], ©ACM).

patient. Navigation is slow and requires much attention from the physician. The lesson learned from this experiment is that care should be taken to improve the navigation fluency of electronic medical records and their integration into the work situation.

6.6. Example 5: Extending the Perceptual Apparatus

An interesting reading technology in this context is gaze-controlled text scrolling using an eye tracker as input device. Kumar and Winograd [2007] describe the *EyeScroll* system as follows.

> "[T]he system tracks the user's gaze. When the user's gaze location falls below a system-defined threshold (i.e. the user looks at the bottom part of the screen) EyeScroll starts to slowly scroll the page. The rate of the scrolling is determined by the speed at which the user is reading and is usually slow enough to allow the user to continue reading even as the text scrolls up. As the user's gaze slowly drifts up on the screen and passes an upper threshold, the scrolling is paused. This allows the reader to continue reading naturally." [Kumar and Winograd 2007, page 5].

Figure 9 shows how the EyeScroll system splits the display into four areas. A usability test of a similar system is reported in Raudsandmoen and Rødsjø [2012]. They report that after a few minutes of initial adaptation, the users ceased to be conscious of scrolling. The automatic gaze-controlled scrolling mechanism became integrated into the perceptual system, allowing the reader to concentrate fully on reading long texts.

This is similar to how the hand-eye coordination of the mouse becomes automated and integrated with the body of the user. When using a mouse as input device, experienced users do not move their hand; they move the mouse cursor on the screen. Experienced EyeScroll users do not control the scrolling with their eyes; they simply read.

6.7. Embodied Perception versus the Computer as Tool

With the design of eye-tracker-controlled scrolling, Raudsandmoen and Rødsjø [2012] found that in terms of response time and mapping between eye movements and scrolling of text, "God is in the details." When designing technology to support embodied perception, it is important to ensure that there is a good match between hardware and software and our sensory apparatus with regard to speed, feedback, mapping, and coupling. Most of the human perceptual processes are very rapid and require control and feedback loops at millisecond level. They are organic, and prefer analog over digital and continuous over discrete.

Not all interactions with computers are perceptual. Some days most of the interaction will be embodied perception, such as reading documents on a screen, while on other days, one might primarily be using the computer as a tool for filling in forms.

The previous examples have mainly described issues related to navigating and reading text. However, the embodied perception perspective can be applied to a number of other interactions, such as swiping pages back and forth on a smartphone, clicking links in Web browsers to navigate in hypermedia, navigating menus and submenus, scrolling the timeline in a video player, navigating an interactive map, and zooming in and out on pictures with two-hand manipulation.

7. DESIGNING WITH THE LIVED BODY: KINAESTHETIC CREATIVITY

In Svanaes [1997], *kinaesthetic thinking* was described as our ability to reason about the interactive behavior of GUIs in "the feel dimension", without having to make the cognitive detour of breaking the interaction gestalts into their logical components of states and transitions. The kinaesthetic sense modality becomes even more important when we move from GUIs to the design of technologies that involve large portions of the body, such as mobile computing and full-body computer games.

The kinaesthetic sense modality has been studied in psychology and dance theory, and its significance for the design of interactive technologies has been discussed in relation to dance and movement [Moen 2005; Larssen et al. 2006]. The notion of a separate kinaesthetic sense modality can be traced back to the early work of the dance theoretician Rudolf Laban [Laban and Ullmann 1963]. Laban defines the kinaesthetic sense as "the sense by which we perceive muscular effort, movement, and position in space. Its organs are not situated in any one particular part of the body, as those of seeing and hearing" [ibid, page 111].

Furthermore, Laban says the following about the process of composing a dance: "[T]his cannot be an intellectual process only, although the use of words tends to make it so. The explanatory statements represent solely a framework which has to be filled out and enlivened by an imagery based on a sensibility for movement" [ibid, page 110]. This imagery occurs directly in the kinaesthetic sense modality when the dancer uses the body as medium and material.

Merleau-Ponty's phenomenology has a strong focus on the lived body, seeing us as existing and acting in the world as bodily beings. The lived body skilfully acts in the world through *concrete movements*, but we also have the ability to step out of our everyday habitual behavior and reflect and communicate about alternative futures through *abstract movements*. This gives us a freedom that is exclusive to our species. While kinaesthetic thinking was used to describe the process of reasoning about user experiences of interactive GUI behavior in the kinaesthetic sense modality, the active use of the body through abstract movements to explore possible futures is better described as *kinaesthetic creativity.* The active use of the body in the design process becomes particularly important concerning the design of "the feel dimension" of interactive products.

The following examples will illustrate the body's ability to serve as a source of solutions to design problems in interaction design through kinaesthetic creativity. Kinaesthetic creativity makes it possible not only to use the body in the design process as an object to be studied or as a vehicle for acting out proposed solutions, but also to create design processes and environments that will take advantage of the ability of designers and users to explore and enact alternative futures through abstract movements. This will help us tap the creative potential of the body in interaction design.

7.1. Example 1: Kinaesthetic Creativity in Design-through-Enactment

In a research project on the use of role-play and low-fi prototyping for the medical domain [Svanæs and Seland 2004], a number of participatory design workshops were

Fig. 10. Kinaesthetic creativity in enactment (from Svanæs amd Seland [2004], ©ACM).

staged with health workers in order to explore the potentials for mobile and ubiquitous computing in hospital settings. The workshops were conducted in a full-scale model of a hospital ward. This made it possible to explore the ways in which new technology could fit into the physical and social context of medical work.

The initial workshops were set up as a sequence of three phases: (1) role-play of current practice scenarios; (2) design (by the participants) of mock-ups and paper prototypes of new products; and (3) testing out of these mock-ups in role-plays enacting future scenarios. The sequence corresponded to the phases of a user-centered design process: *understanding-context-of-use* followed by *design* and *evaluation*. This divide of the design process was not seen as ideal, but it was difficult to think of a better procedure.

Something interesting happened in one of the workshops. The health workers had designed a mock-up of a mobile device for use in hospitals and had devised a future scenario. They were struggling to integrate the mock-up into the future scenario. A nurse was holding a "blank" foam model in her hand, pondering what to do with it. The facilitator asked her, "What happens next?" At this point the nurse started tapping on the foam model with a pen. She was getting access to blood test results for the patient in the bed, she said. This was not something the group had designed. She was inventing functionality on the spot, while mentally being in the situation and imagining content and interactive behavior on the "screen". When the facilitator followed up and asked her to draw on a post-it note what she had "seen" on the foam model, she drew a screen with buttons and menus. This design was then brought into the future scenario (Figure 10). It became evident that this was the way to overcome the missing link between scenario building and design: allowing the mock-ups and paper prototypes to evolve "on stage" as the future scenarios were being acted out, rather than defining design as a separate activity.

The resulting designing-in-action technique is simple: Play the scenario until somebody sees a need or potential for new technology. Freeze the scene and pick a device to fit the need. Continue while imagining its functionality for that specific time frame. Stop to externalize (draw) the imagined screens, and continue the scenario with this new technology until the next freeze. At the end of such an improvisation the team will have designed both a future scenario and a low-fi prototype for that scenario.

This ability to imagine new functionality while acting out a situation is a good example of kinaesthetic creativity. It also shows how the kinaesthetic creativity of ordinary users can be activated, thus enabling them to spontaneously invent new functionality. The imagination and creativity addresses not only the functionality of the device, but also how the new device could be integrated into the physical and social reality of the work context and how it should feel in use. Interaction with digital devices in point-of-care situations is highly embodied, as illustrated in Figure 10. When the role-play is frozen, the concrete movements of the participants become available as resources for exploring possible futures through abstract movements.

Kinaesthetic creativity is rooted in our bodily intelligence. Like role-playing, storytelling, and tool making, it is a species-specific faculty of *Homo sapiens*. It is embodied and involves the kinaesthetic senses. This kind of bottom-up invention through the body only works as long as it is specific. The design materials and the physical environment enable the participants to become creative, and much care should therefore be taken during the design of the prototyping materials. This has similarities to the Montesorri Method's focus on the materiality of toys designed for learning.

7.2. Example 2: Kinaesthetic Creativity in the Design of Full-Body Interaction

As part of a Nordic cooperation on the use of sensor-based technology in physical rehabilitation, physiotherapists were invited to a participatory design workshop to explore the potentials of Nintendo Wii technology (see Young [2010]). The aim of the workshop was to use role-play and improvisation exercises to gain insights into the challenges and opportunities contained in this technology.

The workshop was implemented as a three-hour session involving five physiotherapists, two facilitators, and one technician. The participants had tested out some of the existing Nintendo Wii sports and exercise games to get acquainted with the technology prior to the workshop. The session followed the format of role-play participatory design workshops described in Svanæs and Seland [2004], where the facilitators' role is to support the participants and create an environment that fosters creativity, but to refrain from active participation in the creative processes or offering of design ideas.

Halfway through the workshop the participants were divided into two groups, each with one facilitator. The groups were asked to devise an idea for a Wii game to aid physical rehabilitation. An important part of the ideation process was to let the physiotherapists act out typical situations of use. The participants used inactive Nintendo Wii controllers as props, and blank whiteboards to simulate game displays.

One of the groups selected children with Cerebral Palsy (CP) as their user group. CP patients are often seated while exercising, and the physiotherapists focused on exercises designed to improve the flexibility and mobility of the arms. Figure 11(a) shows one of the physiotherapists taking the patient role and acting out a "rotation" exercise holding a game controller in each hand.

The facilitator asked the physiotherapists to imagine a game for this movement. A number of ideas emerged during the enacting of the movement. The final choice involved a small ball falling through a circular maze that was controlled by the user (Figure 11(b)).

The physiotherapists took the role of the patient user with ease, and through full-body enactment they improvised innovative games for the Wii platform. They made active use of their bodies to illustrate their points and to try out ideas. Many of the design ideas emerged as part of the acting out of exercises, and corporeality was important in all aspects of the ideation process.

As in the previous example, we see how abstract movements through enactment were used in the design process to try out possible futures and explore the feel dimension

a b

Fig. 11. Kinaesthetic creativity in the design of full-body interaction.

of the game. In addition, *abstract movements* also played an important role in the communication between the physiotherapists.

In Figure 11(a) the physiotherapist to the left observes the body of the enacting physiotherapist as an *objective body* (it is not her body), while the physiotherapist doing the enactment experiences the imagined interactivity of the game with her lived body. During the enactment she is of course at the same time aware that she has a body, but the first-person experience of imagining playing the game is mostly a "lived body experience" in the kinaesthetic sense modality. This is a very different experience from that of observing the imagined game being played by someone else. This might be the biggest difference between the "look" and the "feel" dimension of the interactive user experience; in the "look" dimension the user and the bystander see more or less the same thing on the screen, while in the "feel" dimension the feeling of using an interactive product is totally different from the feeling of observing someone else using it.

The physiotherapists designed the interactive user experience of their game *for* the lived body of their future users *with* their lived bodies. There is reason to believe that the richness of the insights and design ideas that emerged in the design workshop were due to the workshop participants being allowed to use their bodies to act out future use scenarios and explore the kinaesthetic dimension of the interaction, and that less ideas would have emerged without this approach. In a manner similar to how musicians and composers make use of their musical memory, creativity and communication skills to make music, our designers of full-body interaction used their kinaesthetic memory, creativity, and communication skills in the design process.

A consequence of Merleau-Ponty's phenomenology and his concept of the lived body is that we should aim for design processes that allow participants to make use of their kinaesthetic memory and creativity. Such processes also have the potential of fostering bodily empathy with the end-user.

8. DISCUSSION

Compared to the references to Merleau-Ponty in the HCI literature presented in Section 2.2, the analysis of embodied reading in Section 6 has similarities to Fallman's work [2003] concerning the role of the physical body in interaction. However, none of the reference works has made use of Merleau-Ponty to see the resemblance between human-computer interaction and active perception and thus reframed human-computer interaction.

The analysis in Section 7 has similarities to the works by Larssen et al. [2007] and Loke [2009] concerning the role of the lived body and the kinaesthetic sense modality in design. None of the reference works has, however, made use of Merleau-Ponty's distinction between abstract and concrete movement to discuss kinaesthetic creativity and the role of the body in designing interaction.

8.1. All Interaction is Embodied

Embodied interaction has often been identified with technologies such a ubiquitous computing, but less with more mundane technologies such as the scrolling wheel. A reminder that the embodied interaction perspective applies to all interactive technologies is therefore justified. Merleau-Ponty's phenomenology of perception can have a profound impact on the way we understand and conceptualize all interactive technology. The relevance of his embodied perspective increases with increased proximity between the technology and the human body; proximity is here not primarily meant in a physical sense, but in relation to the tightness of the coupling between body and technology. A gaze-controlled reading application such as the EyeScroll system [Kumar and Winograd 2007] placed 50 cm away from the user is in a tighter loop with the body than a slow wearable computer on the user's body that interacts through button pushing. The tighter the loop, the more integration between the technology and the lived body of the user.

8.2. Body - Mind

If we take Merleau-Ponty's perspective seriously, we need to stop talking about the user's body. Users do not *have* bodies; users *are* living intelligent bodies. The concept of the user as an intelligent living body is hard to grasp.

One way to overcome the Cartesian body/mind dualism is to refer to the human being as "body-mind". This is not a satisfying approach. First, "body-mind" has been overused by alternative medicine and the New Age movement, and has thus been given a mystical/spiritual twist that is, paradoxically, very Cartesian. Second, simply combining the two opposites of the dichotomy does not create any new understanding of the nature of the synthesis.

An alternative approach is to leave out one of the two. This is close to what Merleau-Ponty does when he talks about the lived body (*le corpse propre*) as something close to "the human being". It makes us bodies all the way down, and all the way up. This usage of the term "body" alerts us to our bodily nature; the part most neglected due to the Cartesian split. On the other hand, taking "mind" out of the equation in this way can easily give rise to a misunderstanding about the nature of the remaining "body". The human being as "body" is often thought of as tantamount to a beast without moral judgement and capacity for reason.

A third alternative is to take "body" out of the "body-mind" equation and talk about the human being as pure "mind". This requires, however, that we also give mind-like properties to the world. Such an approach would be regarded as mysticism by most people, and would not be fruitful.

A fourth alternative is the Heideggerian solution of inventing a new term for the human being. His "Dasein" is an attempt at overcoming the linguistic roots of the Cartesian split. Unfortunately, Heidegger's device did not have the anticipated effect, at least not beyond a small circle of Heidegger scholars.

To sum up, none of the four approaches offers a fully satisfying solution. In lack of a better alternative, this article has followed Merleau-Ponty in using "the lived body" as synonym for the human subject, thus its title.

8.3. Implications for Design

What implications does the preceding analysis have for design? Merleau-Ponty's phenomenology does not provide us with specific design guidelines, such as the right use of color in menu design, to take one example. Neither does his philosophy invite us to formulate a list of generic design principles. But it does give us an alternative perspective on human-artifact interaction and on creative aspects of the design process. Merleau-Ponty's perspective should not be seen as a substitute for existing perspectives in interaction design; rather, it should be regarded as offering the interaction designer more angles from which to approach the design challenge at hand. Hopefully, Merleau-Ponty's perspective will enable the emergence of new design alternatives. Having more design alternatives to choose from is in most cases a good thing.

For those parts of a product intended to support embodied perception, one should consider interaction techniques that allow for rapid coupling between user actions and system feedback. In order to allow for fluid integration into the perceptual apparatus of the user, the action-reaction coupling should be one that is easily "understood" by the body. The design of a 3D modeling app for a tablet/pad can serve as an example. Rotation of 3D objects on a handheld device can be achieved in a number of ways; clicking buttons on the display or tilting the device are two possible alternatives. A well-designed 3D rotation functionality that makes use of the tablet's accelerometers and gyros to detect tilting will probably allow for mediated embodied perception, whereas in most cases, clicking buttons on the display would be experienced as actions that indirectly cause the 3D objects to rotate. Embodied perception thus removes an unnecessary level in the interaction: the contact between the user and the computer-generated world of the application becomes more direct.

As illustrated in the discussion of kinaesthetic creativity, the body has a largely untapped potential for creative problem solving. Design processes that support kinaesthetic creativity often inspire design ideas that originate "from the body", as illustrated by the way in which the physiotherapists in the workshop improvised full-body interaction games through play-acting. The best way to kill such creativity is by remaining seated on chairs around a table, where the only activity is long verbal discussions. Designing for embodied interaction and perception is best done in the same sense modality, that is, with the lived body.

8.4. Validity Problems

The present analysis has to a large extent been a decontextualized exploration of how the body relates to different kinds of interactive digital technology, paying insufficient attention to phenomenology's insights about the importance of seeing each individual user and each situation of use as a unique context and frame of reference. Embodied perception and kinaesthetic creativity highlight only two aspects of Merleau-Ponty's rich philosophy. Taken out of context and focussing exclusively on its implications for design, there is a risk that the present analysis loses sight of the totality of Merleau-Ponty's perspective, and particularly his insights regarding how we always inhabit a world already filled with significance. Moreover, there are the parts of his philosophy dealing with the cultural, social, and communicative aspects of human life, which have not even been touched upon in the present analysis.

Some of the examples of embodied perception, like the scrolling wheel, are about technology alone, and are not situated in concrete contexts of use. Most of the other examples are from the laboratory, a fact that poses a number of serious validity challenges. Ideally, all of the examples should be from the field, like O'Hara and Sellen's [1997] observations of reading. It is, however, worth noting that in his analysis of perception, Merleau-Ponty mostly used generalized insights from everyday life and examples from laboratory experiments. Neither Heidegger nor Merleau-Ponty practiced what we think of today as social science, which involves a thorough analysis of empirical data and a continuous reflection on validity and bias. Evolving in the 1950's and 60's, the latter originated from other sources than the phenomenological tradition in Continental philosophy. Important contributors to the development of interpretive social science, such as Harold Garfinkel, relied heavily on phenomenology for their theoretical framework, but the actual phenomenological insights did not originate from such research.

This is as an indication that valuable theoretical contributions can result from reflections that do not originate from a "scientific" basis of hard data. In the present context, the value of the theoretical contributions must be judged by their applicability to real problems, and by the extent to which they have explanatory power and provide inspirations for design. Others will have to make that judgement.

8.5. Metaphorically Speaking

With phenomenology there is a danger of falling in love with the descriptive style. An example of how a phenomenologist might describe a teenager's use of her smartphone can illustrate this point.

> As a trained user of her mobile phone, the phone has been integrated with her lived body. When she navigates its menus and screens, her body extends deep into the software and hardware of the device. When typing text messages, her focus is not on the phone, not even on the text, but on the meaning that she wants to communicate. The fluency and speed with which she operates the phone indicates that it has become part of her; part of what she is and how she lives in the world. Like all human beings, she is present in the world and with her fellow beings through her living body. Her phone is clearly part of this living body, just like tattoos, piercing, clothes, and makeup. The phone contains her photos, her music, her contacts, and her text messages; all of this is part of what she is. As a communication device, the phone extends her range beyond what the physical body alone allows for. With the phone she is a different person. Without it she is less. She confirms this when we ask her about her phone. "Without my phone I feel like a part of me is gone", she replies.

The previous description is dangerously seductive and rhetorical in the sense that it tells a convincing story grounded in very little empirical data. The whole account is metaphor, and should not be taken as anything but metaphor. As metaphor it has a certain poetic ring to it.

Despite its metaphorical nature, it nevertheless has the potential to inspire and guide design. It tells us about the role played by the device in the user's life, and it gives hints as to the most important design qualities: Mobile phones for teenagers should allow for fluency and speed. They should integrate well with body, clothes, and tattoos. And most of all, they should be sturdy enough to never break, and have features that prevent them from being mislaid.

8.6. Designing for and with the Lived Body

The discussions of embodied perception and kinaesthetic creativity relate to how we design for and design with the lived body. By focusing on the user as lived body, we get a perspective that sensitizes us to the bodily aspects of human-computer interaction. This is not about bringing ergonomics back to HCI. It is not about the user as a mechanical body, but as a living and meaning-giving body in-the-world. While ergonomics primarily operates with a third-person view on the body, designing for the lived body implies taking a first-person perspective and treating the body with respect as a sentient entity.

The best way to design *for* the lived body is to design *with* the lived body. The benefit of designing for the body with the body is that it gives the designer direct access to how the imagined product will feel for the end-user. This is similar to how most composers compose by the piano. The music emerges in the composer's interaction with the musical instrument. In the same way, interaction design for the lived body should to a large extent be done through active participation of the lived body. The main challenge when planning interaction design projects is to allow room for this to happen.

9. CONCLUSIONS

The main purpose of the current analysis has been to show how some core elements of Merleau-Ponty's phenomenology of perception are relevant for a theory of embodied interaction. The focus has been on two aspects of Merleau-Ponty's phenomenology: (1) embodied perception, that is, the active and embodied nature of perception, including the body's ability to extend its sensory apparatus through digital technology; and (2) kinaesthetic creativity, namely the body's ability to relate in a direct and creative fashion with the "feel" dimension of interactive products during the design process. This analysis should be of value for interaction designers designing for and with the lived body.

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