

Foundations and Trends® in Human-Computer  
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# 10 Lenses to Design Sports-HCI

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**Florian ‘Floyd’ Mueller**

Exertion Games Lab, RMIT University, Australia

[floyd@exertiongameslab.org](mailto:floyd@exertiongameslab.org)

**Damon Young**

Exertion Games Lab, RMIT University, Australia

[damon@exertiongameslab.org](mailto:damon@exertiongameslab.org)

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Florian Mueller<sup>1</sup> and Damon Young<sup>2</sup>

<sup>1</sup>*Exertion Games Lab, RMIT University, Australia*  
[floyd@exertiongameslab.org](mailto:floyd@exertiongameslab.org)

<sup>2</sup>*Exertion Games Lab, RMIT University, Australia*  
[damon@exertiongameslab.org](mailto:damon@exertiongameslab.org)

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## ABSTRACT

Interaction designers are increasingly interested in the physically active human being. However, recent work suggests that HCI is still at an early stage when it comes to supporting the many virtues of engaging in sports. To advance this, we present a set of 10 lenses based on virtues aligned with sports activities to help designers to see physical activity not just as a way to prolong life, but as opportunity for personal growth. The Sports-HCI lenses facilitate learning how to appreciate a void (Reverie), finding pleasure in exertion (Pleasure), become humble (Humility), enjoy the stimulation that comes from fear (Sublime), be more aware of one's own body (Oneness), value sacrifice as a chance for a simpler existence (Sacrifice), bring beauty into the world through movement (Beauty), see benefit in pain (Pain), foster consistency for life (Consistency) and welcome patience (Perseverance). We examined related work and reflected on our own craft knowledge in order to articulate what opportunities interactive technology offers to every lens. With this, we aim to support interaction designers in facilitating the many virtues of being physically active.

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# 1

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## Introduction

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HCI researchers and interaction designers in particular are increasingly interested in supporting exertion experiences. These are experiences that require significant physical effort from participants (Mueller *et al.*, 2011), in contrast to the prevalent mouse and keyboard interactions in the field. In recent years, the increased availability and reduced cost of sensor systems have led to a plethora of wearables such as smart sport watches that can track exertion activities. There is also sport clothing that has sensors embedded to sense bodily responses to exertion activity such as heart rate, allowing for new ways to support the fitness activity. And there are also game console accessories (one of the earlier ones being the Nintendo Wii, then the Microsoft Xbox Kinect and now movement-tracking VR headsets) that sense body movement to enable exertion sensing in the living room. Technical advancements like these have led to an increased interest into exertion experiences by the research community, resulting in the term “Sports-HCI” (Mueller *et al.*, 2015). However, commentaries have also recently emerged that highlight that the field has only begun to facilitate the many virtues of exertion (Höök *et al.*, 2015; Márquez Segura *et al.*, 2016; Segura *et al.*, 2013).

We refer to the emerging discussions that criticize how current investigations in interaction design take a view on exertion that is too narrow (Marshall and Linehan, 2017; Marshall *et al.*, 2016a; Segura *et al.*, 2013). Their authors argue that this narrow view is a logical consequence of the often underlying assumption that people only engage in exertion activities solely to improve their physical health, therefore missing out on the many other benefits of being physical active (Höök *et al.*, 2016; Márquez Segura *et al.*, 2016; Marshall *et al.*, 2016b; Mueller *et al.*, 2016; Purpura *et al.*, 2011). If exertion only improves physical health, we could argue that it only helps to defer death. This is commendable, however, it does not say anything about the fact that exertion can also improve the quality of life. By taking this aforementioned narrow assumption, the interaction design community misses out on the chance to support such improvements to the quality of life. We note that a similar argument has previously been made in the context of human-food interaction, where Grimes and Harper have argued to go beyond an instrumental perspective on the coming together of interaction design and food to embrace an experiential perspective that celebrates our food interactions more holistically (2008).

We believe that works in HCI around exercise and health often make the underlying assumption that the human body can, like the computer, be seen as a machine (for example, see the early HCI illustration that depicts the human brain with in- and outputs like a computer (Card *et al.*, 1983)). However, we believe that by treating the human body as such a machine, we simplify our embodied existence too much (Damasio, 1999; Lakoff and Johnson, 1999; Westphal, 2016; Mueller *et al.*, 2018). We believe that engaging in exertion activities can enrich the human mind, while the mind guides and reflects upon the exertion activity, which ultimately helps us to grow as a human being. To help interaction designers engage with this, we introduce HCI to virtues aligned with sports activities that stress this important interplay. We believe that, so far, the role interactive technology can play in this has been underdeveloped. We believe that interactive technology can be used to “design sports” (Mueller *et al.*, 2011), and as such, we find that interaction design features a particular opportunity to develop exertion

systems that facilitate personal growth. Facilitating personal growth is important, as it can help people identify who they are, who they want to be and how to get there (Kretchmar, 2005; Young, 2014). As such, we see this article as an attempt to guide designers create interactive systems that help users to learn something about themselves, who they want to become and how to get there, through exertion experiences. We argue that interactive technology offers powerful opportunities to achieve this, and we hope this article enables a structured discussion on how this can be realized in the future.

However, so far, there is only limited understanding available on how to use interactive technology to facilitate personal growth through exertion experiences (with a few exceptions such as Mueller and Young (2017) or Mueller and Pell (2016)). To expand this understanding, this article makes a contribution in the form of a theoretical discussion of a set of 10 lenses that aim to aid designers who want to create interactive systems for exertion experiences. Prior work has used lenses before in order to sharpen interaction designers' perspectives on embodied issues (Klemmer and Hartmann, 2006; Dourish, 2001). We are inspired by this use of lenses. Our hope is that these lenses help designers take on particular perspectives on exertion experiences when designing technology. We believe lenses have the particular advantage that they highlight that designers can take on a range of particular perspectives on the same phenomena, and that there is no easy "right" or "wrong" when it comes to designing technology for such phenomena, rather, it always depends on what kind of perspective one takes. We unpack each lens into three components in order to provide designers with practical handles so they can engage with them in their design practice. We complement them with design examples from either prior work, our own design practice or fictitious examples to suggest how such thinking can lead to particular designs.

In particular, our lenses are inspired by the notion of virtues, the Latinized translation of the Greek word *arête*, which means "excellence". Virtues have been previously discussed in ethical philosophy in general (MacIntyre, 2013) and sports philosophy in particular (McNamee, 2008; Young, 2014), as well as in the context of HCI, but mainly to support

diverse user groups (Epstein *et al.*, 2013). A virtue is a desirable disposition, a tendency to do the right thing in the right time and place (Young, 2014), however, we caution that it is not possible to reduce a virtue to a simple design guideline, as it can only be developed by acting well in varied circumstances. Exertion activities can help to develop such excellent dispositions, and we argue that interaction design can support such developments.

Our lenses highlight that exertion experiences can support personal growth through learning how to appreciate a void (Reverie), find pleasure in exertion (Pleasure), become humble (Humility), enjoy the stimulation that comes from fear (Sublime), be more aware of one's own body (Oneness), value sacrifice as a chance for a simpler existence (Sacrifice), bring beauty into the world through movement (Beauty), see benefit in pain (Pain), foster consistency for life (Consistency) and welcome patience (Perseverance).

Our set of lenses is only a starting point as a result of our engagement with virtues and our own craft knowledge derived from having designed exertion experiences for over a decade (Khot *et al.*, 2014; 2015; Mueller *et al.*, 2011; 2014; 2010b; Pijnappel and Mueller, 2013; 2014). As such, we focus on lenses that we believe are underexplored and where technology offers unique opportunities for designers who want to expand the field. Our goal is to give design practitioners and researchers a set of directions to think about when they approach designing new sports-HCI experiences and a language for describing current ones. By letting the lenses emerge out of existing examples, we hope we enable the creation of new lenses and refinement of the existing ones. Our work therefore supplements other discussions that aim to drive the field forward (such as a game perspective (Linehan *et al.*, 2015) or a health perspective used to critique the field (Marshall and Linehan, 2017)).

The target audience for this article is design practitioners who want to create better interactive exertion experiences. Researchers can also use this article to analyze exertion systems in order to understand what virtues they potentially facilitate, providing them with a structured approach to discuss technology-augmented exertion experiences, allowing to go beyond single perspectives such as calorie expenditure as frame

of analysis (for a critique of such approaches see Marshall and Linehan (2017)). If we would continue to engage such a single-perspective on exertion experiences, we believe that the field will not be able to grow and reach its full potential. This will result in users missing out on profiting from the many benefits associated with exertion.

In summary, we have articulated the need for a new approach to the design of exertion experiences. We have also explained the reason why we look at virtues. In the next section, we will describe related work and what we have learned from this. In the section that follows we present our set of lenses. These lenses are accompanied by particular opportunities interactive technology offers to designers; as such, with our work, we aim to highlight how new technology enables novel ways to support old virtues. We also articulate examples of this thinking in practice from our own work in the field and other people's design examples.



# 2

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## Related Work

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The consideration of physical effort as part of HCI is not new; in particular the field of ergonomics has a long history of aiming to reduce any physical strain on the human body when interacting with machines and systems. While ergonomics generally aims to minimize a user's physical effort, more recent developments in HCI have stressed the benefits of physical effort as part of interactions with computers, often taking a sports perspective to highlight that computer interactions go beyond mouse and keyboard. For example, Mueller *et al.* proposed that HCI should embrace the opportunity to use interactive technology to “design sports” (Mueller *et al.*, 2003). To guide these developments of using interactive technology to support physical effort-based interactions, several theoretical frameworks (for examples see (Consolvo *et al.*, 2012; Isbister and Mueller, 2014; Klasnja *et al.*, 2011; Loke and Robertson, 2013; Mueller *et al.*, 2011; Segura *et al.*, 2013; van Dijk *et al.*, 2014)) have been developed in recent years, for an overview see (Mueller *et al.*, 2016). In order to guide the development of exertion systems, some of these frameworks draw from existing perspectives, such as the perspective to facilitate behavior change: for example, Consolvo *et al.* used behavior change theory to design interactive systems to promote more physical

activity in users' daily life (Consolvo *et al.*, 2012). Toscos *et al.* looked at goal setting theory in order to inform the design of their system that also aimed to promote physical activity (Toscos *et al.*, 2006). Similarly, Yim and Graham (2007) took a perspective of motivation support to understand the design of exertion systems. We note that not all works focused on increasing physical activity; this informed the design of additional frameworks. For example, Loke and Robertson (2013) wanted to highlight the “joy of movement” (Segura *et al.*, 2013) and therefore took a perspective of dance theory to understand the design of exertion systems. (2014) proposed to examine exertion through a lens of design patterns in order to design better systems, while Mueller *et al.* proposed examining the design of exertion systems through a perspective of the “responding, moving, sensing and relating” body when augmenting exertion interactions (Mueller *et al.*, 2011). These prior works have advanced the field through providing theoretical perspectives through which to examine exertion systems. However, academic work has highlighted that exertion is multifaceted (Marshall and Linehan, 2017) and hence even more perspectives are needed to fully understand how interactive technology can support exertion experiences.

One of the first theoretical critiques of the field from an HCI perspective was put forward by Purpura *et al.* (2011). The authors saw the emerging trend of fitness trackers and noted that they are designed only with a perspective on improving athletic performance as a means to enhance physical health, missing out on considering the many other perspectives through which exertion could be viewed. From a game design perspective, Linehan *et al.* (2015) have written that computer gamers do not like games to tell them that they need to improve their physical health. Instead, the authors argue, computer games should give players more options through which to examine the engagement with exertion games.

Marshall *et al.* (2016b; 2017) in their works stress that exertion experiences need to be seen from more perspectives than the seemingly prevalent focus on physical health. In particular, the authors argue that there are many exertion papers that report as their motivation to address the obesity epidemic. They articulate how this motivation is

ill-fated and misses key perspectives on why exertion is worthwhile that fall outside an energy-expenditure perspective.

Tholander and Nylander (2015) propose an alternative perspective on exertion experiences: the authors found through a study with sports enthusiasts that current interactive technology appears to mostly support instrumental perspectives, such as helping to achieve athletic training goals. However, these technologies fall short when it comes to seeing exertion through an experienced-focused lens that highlights the lived and felt experience of the participants. Without such a lens, the authors argue, interactive technology misses out on properly supporting sports enthusiasts: as their participants were not professional athletes, they have additional perspectives on their exertion experiences that go beyond making a living, and interactive technology should also support those perspectives. The work by Höök *et al.* (2015) points to the same missed opportunity of interactive technology to support the lived and felt experience when it comes to supporting a body-centric computing agenda. The authors draw on “somaesthetics” to highlight that designers can – and should – view exertion also from an experiential – and not just instrumental – perspective when creating interactive systems.

The aforementioned prior works highlight that there is a gap in our understanding of the design of interactive technology to support exertion experiences. In particular, as current approaches are seemingly focusing on a few particular perspectives of the exertion experience, our gap in knowledge is around what other perspectives exist and how they would inform the design of interactive exertion technology. Without knowledge about these additional perspectives, the future of the field will remain narrow and this will limit people profiting from the many benefits of exertion; hence this is an important point to address to bring the field forward. In order to fill this gap in knowledge, we present in the next section a set of 10 lenses for the design of exertion experiences. These lenses are all concerned with experiential aspects of exertion, answering the call for an experiential focus by Höök *et al.* (2015) and Tholander and Nylander (2015). We focus on what we believe are under-considered lenses. This means that there are more, and as such we understand our work as starting point rather than as complete

list. We also acknowledge that our selection is based on our personal engagement with the topic, it is therefore not a representative sample. We do, however, focus on experiential lenses, pointing out that there is also benefit to the articulation of instrumental lenses, however, leave these investigations for future work.

With these 10 Sports-HCI lenses, designers have a structured approach to take multiple perspectives on exertion experiences. We complement these lenses with an articulation of a set of opportunities that technology offers designers to support this particular perspective. Our contribution is only the starting point for a wider view on exertion and hopefully complements previously articulated perspectives to allow the painting of a more complete picture of exertion experiences. With our work, we hope to be able to contribute a few strokes towards this complete picture, with many more strokes to come.

# 3

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## 10 Sports-HCI Lenses

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We now articulate our set of lenses through which designers can examine the design of interactive technology to support exertion experiences. We highlight lenses that we believe are under-considered and offer opportunities for the field to grow, as such, these perspectives are not replacing, but complementing existing lenses prior work has identified, and are presented here to expand the field. We decided on the lenses through examining the literature and our own past theoretical and practical work, which involved an ongoing back-and-forth between conceptual thinking and practical design work, developed through an iterative and integrated process, an approach that has been previously successfully been used in order to expand the field of exertion interactions (Marshall *et al.*, 2016b).

We describe for each lens a sports example where this lens is particularly highlighted. We then unpack each lens into three key facets in order to provide designers with practical handles they can grab during their design practice. For each facet, we present opportunities we believe interactive technology offers to designers when aiming to design for exertion. We identified these technology opportunities by reflecting on our craft design knowledge of having designed exertion systems for over

a decade (Khot *et al.*, 2014; 2015; Mueller *et al.*, 2011; 2014; 2010a; Pijnappel and Mueller, 2013; 2014).

Prior work has highlighted the benefit of engaging in exertion activities oneself to design for exertion experiences (for example (Hamalainen *et al.*, 2015; Márquez Segura *et al.*, 2016; Pijnappel and Mueller, 2013)), as such, we also provide the reader with a typical exertion activity she/he can engage in, possibly with his/her students if in a teaching context, to fully transcend the lens by engaging with it. Of course, these (short) exercises can offer only a small spotlight onto a life full of exertion activities, nevertheless, we believe they can provide an easy entry point into our lenses. We hope that these exercises are practical activities complementing the text on the paper that together form the actual lens contribution.

### 3.1 Lens 1: Reverie

(Light) physical activity, such as taking a refreshing walk in the woods (Fig. 3.1), can stimulate the mind: research has shown that engaging in exertion can positively affect cognitive functioning (Cox *et al.*, 2015) including encouraging innovation and problem solving; this has also been recognized in HCI (Schraefel, M. C., 2015). The most typical example is walking, which does not require too much intellectual investment yet provides just the right amount of stimulation: this comes through the exertion itself but also through any new environment the person walking passes through. Engaging in light exertion activity allows the intellect to relax a little, which has been described by means of the transient hypofrontality theory (Dietrich 2006; Ladd). The theory proposes that during exertion activities, the prefrontal cortex, tasked to make general concepts and rules, is turned down while the motor and sensory parts of the brain are turned up (Dietrich, 2006). This presumably allows for the reorganizing of concepts and previously parted ideas to freely mingle and emerge again. This offers a chance to undo the usual intellectual rigidity, shake up intellectual routines and seek novelty. Within HCI, this has been recognized by Mark Weiser, who asked why computing cannot be as “refreshing as taking a walk in the woods” when he presented the idea of ubiquitous computing (Dey, 2016; Weiser, 1993).



**Figure 3.1:** A refreshing walk in the woods

The lens “Reverie” highlights the benefits of lone exercising and hence points to the social aspect of exertion (and the lack thereof). The importance of social aspects when it comes to exertion has been previously highlighted in the HCI literature (Mueller *et al.*, 2011), here we unpack reverie further: Reverie can emerge from lone exercising from within (Void), from a lack of social stimulation (Solitude) and from a change of social scenery (Mini-holiday).

### 3.1.1 Void

Reverie can emerge from exercising alone as it offers the opportunity to experience a “void”, this is a state of mind with a lack of calculative awareness, diffuse attention, and fleeting ideas and perceptions. This state of mind offers a healthy opportunity to avoid concentration – an idle mind, without some of the pathological effects of pharmaceuticals.

### Technology consideration

In order to support the emergence of a void, designers can regulate the amount of stimulation. We know that users' senses and motor skills are most alive in a tactile vibrant environment, as it enriches people's perception (Young, 2014, p.29). However, this can be unfavorable to the emergence of a void. To address this, many urban joggers use headphones in order to reduce the amount of stimulation arising from their busy environment. Designers can support this regulation further: for example, they might want to provide urban joggers with AR glasses (such as the jogging AR glasses (Tan *et al.*, 2015)) to help joggers focus on the important part (the path in front of them), while eliminating distracting visuals, such as advertisement billboards (Cuthbertson, 2015). Technology design can also regulate the amount of stimulation by increasing it: for example, joggers on treadmills often use TV and even virtual worlds (such as virtual running tracks (Häkkinen *et al.*, 2013)) to increase their amount of stimulation. Designers could extend this regulation further: they could sense any outside stimulation and in real-time adjust any digital stimulation dynamically so as to regulate the amount of stimulation so it most optimally facilitates the emergence of a void.

In our own work with joggers (Mueller *et al.*, 2012; 2010b) we have found indicators that a void has emerged in response to technology: with our system, joggers jogged at the same time, but in two different places, connected only through an audio-conference delivered via headsets containing microphones and headphones. During interviews afterwards, participants told us that when they were not conversing during the jog, they enjoyed hearing their partner's breathing, as it had a soothing function for them, similar to how the sound of waves from the ocean can facilitate the emergence of a void. This was facilitated by the headsets that blocked out much of the surroundings sounds while the headset's microphone – being so close to the mouth – amplified the sound the breathing of the jogger made. Designers need to consider safety when regulating such external stimulation: for example, blocking out external noise did not seem to be a health hazard for our joggers as they were in a non-busy park without traffic, however, this might have been different if they were jogging on roads where they needed to hear cars approaching.



### 3.1.2 Solitude

Interactive technology can enable new ways of engaging in exertion activities together: for example, it can allow users to exercise over a distance (Mueller *et al.*, 2010b) and over time (Sheridan and Mueller, 2010). However, not much research has been done to support the fact that exercising alone can be refreshing sometimes; the reverie lens highlights this to designers by stressing the importance of solitude, meaning the state or situation of being alone.

#### Technology consideration

If we look at today's mobile apps aimed at walkers or joggers, we find that almost all of them allow to share the activity with others in some shape or form, for example through supporting voice-communication, sharing any pace, length or duration achievements via social media, or supplying real-time data to allow competing with others (Consolvo *et al.*, 2008; de Oliveira and Oliver, 2008; Lin *et al.*, 2006). The lens "solitude" on the other hand highlights that engaging in exertion activity alone (both in the physical and virtual world) can be of benefit. Therefore we encourage designers to think about how to facilitate the conditions that allow for the emergence of solitude. For example, designers could use technology to celebrate solitude by making users aware that they are alone, reminding them that this is an opportunity to relax. By doing so, the system would highlight that solitude is a desirable state, rather than simply a lack of social relatedness. By lack of social relatedness we mean the current prevalent view in software design that suggests that more social media contacts is always better than a few or none, resulting in notifications such as "0 followers" that suggest one does not have enough friends). An additional and easy-to-implement way to support solitude could be to turn off all social media notifications when the system detects exertion activity in order to increase the chances of reverie to emerge.

It should be pointed out that highlighting solitude could also have disadvantages. For example, in our study with "Jogging over a distance" (Mueller *et al.*, 2010b), where remote joggers were connected via an

audio conference over a cellular network, especially female participants appreciated that the audio connection gave them a sense of not being alone, especially at night in public parks, which provided feelings of safety (due to the time difference between their locations, with some of them as far apart as Europe and Australia, one often had to jog after dark).

### 3.1.3 Mini-holiday

Reverie can also arise in the form of a “mini-holiday” from the everyday, helping users to let go of the concerns and social pressures that occur during everyday “regular” life. Engaging in exertion activities can provide a welcoming reprieve from everyday life that is so full of responsibilities and tasks. Holidays are valued because of their experiential character (*i.e.* I cannot send someone else on holiday for me if I am stressed); similarly, exertion activities also have an experiential character (*i.e.* I cannot send someone else jogging if I am stressed). As such, reverie highlights that exertion can provide a reprieve from the everyday, offering users an escape in the form of a mini-holiday.

### Technology consideration

We believe that designers who want to support the notion of mini-holiday can contrast the exertion experience with people’s everyday life, especially because most people already engage technology to manage their everyday life (such as using calendaring software), so it is relatively easy for a system to know about a person’s everyday life. A system could pull data from a user’s work calendar to point out how a scheduled exertion activity is different to his/her everyday life. This allows for a more personalized experience as it provides contrasting moments that are context-dependent (Abowd *et al.*, 1999): for example, a system could highlight how evening exertion activities might be a welcoming physically reprieve for an office employee; however, this might be different for a laborer with a physically demanding job.

### 3.1.4 Exercise tip

After reading this article, go outside for a walk and see what additional new thoughts this offers to your research.

## 3.2 Lens 2: Pleasure



**Figure 3.2:** Pleasure *from*, *in*, and *of* exertion

Exertion activities can facilitate many feelings of pleasure (Fig. 3.2). For example, pleasure can arise from receiving a medal in front of an audience, from having achieved a personal best, or from being selected to be part of a higher leagued team. Interactive systems have helped facilitate these feelings of pleasure, in particular game mechanics utilized under the term gamification (such as ladders, badges and high score tables), have been used. We highlight that there are additional ways of how pleasure can be facilitated, in particular through the felt experience

(Höök *et al.*, 2016) of extensively engaging one's body during exertion activities: firstly, through the pleasure arising from discomfort during an activity (Pleasure from discomfort), secondly through experiencing pleasure in oneself after an extensive workout (Pleasure in oneself), and thirdly through enjoying a firmer self as a result of repeated exercise (Pleasure of a firmer I).

### 3.2.1 Pleasure from discomfort

Many of everyday life experiences require caution, with social norms demanding us to restrain aggressive urges and the letting off of steam. This restraining of aggressive urges seems to be particularly prevalent in today's office environments, where interacting with computers often leads to frustration. Exertion activities, especially short, intense components of it, such as sprints, are the antithesis to this. They have a purity to them that is very simple and affords a single-mindedness that does not allow for second-guessing (Young, 2014, p.38). These intense, primal components of exertion activities enable participants to experience a change from the thinking part of what constitutes being in most of today's society. This primal aspect of fully exerting oneself comes with a sense of discomfort, which can facilitate a sense of pleasure.

### Technology consideration

We find that the exhaustion agony or even nausea that comes from intense exertion activity is rarely considered or even promoted by interactive technology. In particular, exertion console games have been criticized for only supporting "mild" exertion (Mueller *et al.*, 2009), juxtaposing them against traditional sports with their intense exertion actions. Part of this can be attributed to the fact that most technologies are still rather fragile and not designed to be able to handle intense physical activity, in response, research around "brute force" interfaces (Marshall *et al.*, 2016a; Mueller *et al.*, 2014) has emerged to change this.

### 3.2.2 Pleasure in oneself

Hume says that pride is pleasure in oneself, helping people to show they are valuing the right things (Hume, 2012). Pleasure in oneself has two aspects to it; the first is the cause of pleasure, for example muscular arms after having been to the gym. The second aspect is the object people attribute to themselves, which is seeing oneself as being more attractive because of the muscular arms.

#### Technology consideration

Social media technology allows people to take pictures of their physically improved body (they can even use filters that make their body look more toned, highlighting the cause of pleasure) after a workout and send it to a large number of followers in order to hear how many people find this body attractive, fuelling the object people attribute to themselves. Without the help of technology, reaching such a large number of people to fuel such pleasure would be difficult to achieve. However, such pleasure in oneself can lead to narcissism, especially with the ability of technology to reach such a large number of people, and should therefore be carefully designed (Rogers, 2014).

### 3.2.3 Pleasure of a firmer “I”

Exertion activities not only help to tone muscles, but also offer a firmer idea of oneself, allowing “to impress upon the world the stamp of one’s own existence” (Young, 2014). This firmer idea of oneself is not what people see when they look at themselves in the mirror, but rather the “I” as the “me-self” (Harter, 2015). People cannot see this “me-self”, however, they have a mental idea of it: Young (2014) explains that when people engage in exertion activities, the fact that people see, feel and experience the pedaling, pushing, pulling and so forth helps them to infer with more solidity that they are contributing towards the building of the “me-self”, reaching a firmer idea of themselves.

### Technology consideration

The pleasure of a firmer “I” reminds us of Wii tennis: the remarkable achievement of Wii tennis was not that it let people train tennis and therefore supported them in being better tennis players, but rather that it supported players in believing that they could become better tennis players by allowing them to act out what they believed were movements tennis players would do (Bogost, 2006). Berthouze *et al.*’s research showed the potential of interactive technology to support this: in an experiment, players of Guitar Hero who were encouraged to move more (through the star-power mechanic) believed they were more likely to be able to become rock stars than those who did not move (Bianchi-Berthouze, 2013). In order to facilitate this, the technology utilized fantasy elements (such as visuals of a concert stage and audio from a cheering crowd, etc.) in order to support the idea of a firmer “I”. So the combination of technology and exertion can aid people to physically act out desires for a better “I” while helping visualize what this better “I” experience could look like.

#### 3.2.4 Exercise tip

Try to run as fast as you can, for as long as you can. Are you experiencing pleasure from, pleasure in, or pleasure of exertion?

### 3.3 Lens 3: Humility

Humility refers to people’s awareness of their own (bodily) flaws and limitations. People can feel humble because they perceive some ugliness in themselves that makes them uncomfortable and unpleasant. This humility is heightened when exercising with others who are superior, as it demonstrates a not-so-favorable version of oneself. As such, the lens of humility teaches a person about his/her own fragility, and thereby encourages improvement. The previous lens pleasure works well in partnership with humility: when pleasure pushes on, humility pulls back, helping people to succeed by highlighting both drive and caution. We identify three ways how humility can be facilitated: by becoming

aware of one's own bodily limitations, by the physical environment, and by failing and trying again.

### 3.3.1 Awareness of one's own bodily limitations

In humility, people can find greater honesty, which gives them a new responsibility for living. Participants experience more of their "true" abilities, not what they imagine or their environment tells them they can do. Only if exertion is involved, can people physically experience the limitations of their own bodies, and as such these limitations become more real and help people be more honest with themselves. Once people are aware of their own bodily limitations, the resulting humility can help to improve.

### Technology consideration

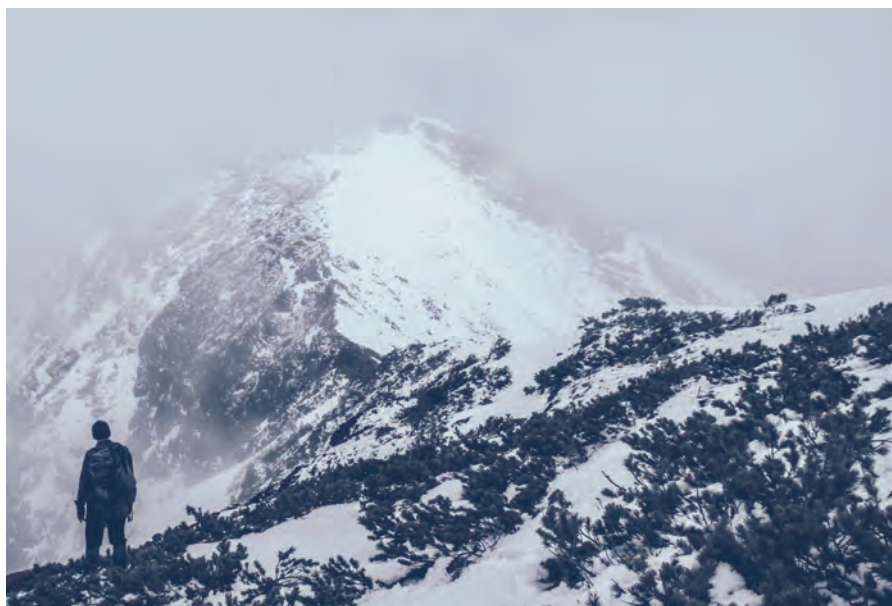
The potential of technology to facilitate awareness of bodily action as part of augmented exertion experiences has been previously highlighted (Mueller *et al.*, 2011), here we add that technology offers unique opportunities to allow for novel comparisons as a way to become aware of one's own bodily limitations. This includes:

- comparisons with expert sportspeople who otherwise might not be accessible. For example, an avid runner might not have the opportunity to run with other, similar advanced runners. Technology can enable running with avid runners all over the world (for example through systems such as (Mueller *et al.*, 2010a; Nike, 2012)), allowing even advanced runners to experience humility by seeing how many people are better. However, designers need to be careful: comparisons with too many people who are better can be demotivating as humility requires an honest assessment of one's shortcomings in order to utilize it as motivator to strive for better.
- comparisons with oneself. Technology allows for easy tracking of personal achievements (as promoted by the quantified self movement (Lupton, 2016)), hence allows for identifying one's

shortcomings compared to not just yesterday, but a year or ten years ago. This might help be more honest about one's aging, aiding to realize that over the years, different efforts are needed to nurture and cultivate one's body.

### 3.3.2 Environment features as lie detectors

Exercising with others can facilitate a sense of meekness as a result of feeling humble, however, people can also “yell them down”: people can use their minds to intimidate others to distract from their own limitations in order not to experience a sense of humility. In contrast, if people experience humility through the physical environment (such as a massive cliff face during rock climbing), they cannot “yell it down” or intimidate it (Fig. 3.3). The rock face is not only indifferent, it is also unstable and shows how fragile people are in comparison, providing opportunities to experience a sense of humility. This is the reason why climbers treat the Eiger's north face as a “lie detector”, as such



**Figure 3.3:** Humility teaches being honest with oneself



humiliating environmental features prompt brutal honesty: you recognize the terrain and weather, or you die.

### Technology consideration

Imposing cliff faces are examples of physical environment features that cannot be yelled down and therefore function as personal lie detectors. Such cliff faces also exist in digital form, for example in virtual reality rock-climbing systems (Crytek, 2016). However, designers need to be aware that with these digital counterparts, users can always “explain” any of their bodily limitations by referring to the VR world not being programmed right or experiencing bugs in the code. Therefore, VR environments cannot function as lie detectors to the same extent as the physical environment, suggesting that virtual climbing experiences do not hold the same potential to facilitate a sense of humility as augmented climbing walls (such as (Kajastila *et al.*, 2016)).

#### 3.3.3 Failing and trying again for its own sake

Mountaineer George Mallory is believed to have replied to the question “Why did you want to climb Mount Everest?” with the retort “Because it’s there” (Wikipedia, 2016). His quote highlights that engaging in exertion activities can have a self-purpose and enjoyed for its own sake. Csikszentmihalyi (1990) calls this “autotelic” and stresses that achievement requires both, ambition and failure. People do not overcome their insufficiencies by just thinking about them, they have to do, reflect on them, and then try again. Humility means people recognize that they are incomplete, and always will be, and any attempts to fail and try again are enjoyable for their own sake, not because people know they will achieve perfection.

### Technology consideration

We find that technology has been emerging that can help people see (and feel) their own failings and how they relate to a challenging world in particular through safety equipment and clothing that supports outdoor adventure activities (To appear). These technologies do not aim to

reduce the recognition that people are fragile and navigate indifferent and unstable environments (unlike many VR experiences that aim to make adventure “safe”), but rather, they try to enrich the experience by providing participants with a safety net that allows them to try out things that otherwise might simply paralyze them. For example, safety gear allows rock climbers to attempt moves with the knowledge that they can fail and try again, offering an opportunity to acknowledge one’s insufficiencies. The payoff is a sped-up experience of skillful striving.

Although safety gear has significantly benefited from technology in recent years (for example, climbing gear has become more robust and lighter, allowing for more difficult and longer routes), the inclusion of interactive technology is only emerging (as suggested by (To appear; Walmink *et al.*, 2014)) and we find this an intriguing area for future research.

### 3.3.4 Exercise tip

Try out an exertion activity that is completely new to you. Do you experience a sense of humility?

## 3.4 Lens 4: Sublime

The sublime is elicited from the feeling of fearful joy. A typical sport that encourages the sublime is swimming, which can cultivate fear with the size and power of the water, yet does so safely and with some emotional distance (Fig. 3.4). We highlight the following 3 facets of the sublime: by putting the body in and out of control, the world stimulates by threatening, allowing people to savor the precariousness of life.

### 3.4.1 In and out of control

A key aspect that evokes the sublime is the body being in and out of control. For example, the water accommodates the open-ocean swimmer, but also shakes and submerges him/her. The swimmer senses danger and feels the precariousness of their body in the enormous body of water, yet she/he is afloat, directing oneself, responding to the waves



**Figure 3.4:** Fearful joy during open-ocean swimming

and tidal forces. This encourages a sense of what we call the sublime: a kind of thrilled terror.

### Technology consideration

Technology can facilitate in and out of bodily control experiences, for example, prior work (Marshall *et al.*, 2011) has used breathing sensors to control a fairground bronco ride in order to allow riders to be in and out of bodily control: if they were breathing too much, the bronco would throw them off, taking bodily control, but if the riders were holding their breath, they were in control, however, they could only hold their breath for so long. Designers cannot only use mechanical devices such as fairground rides to facilitate the sublime: more recent work (Byrne *et al.*, 2016) suggests that galvanic vestibular systems that digitally control a person's sense of balance through electrodes attached behind the ear can also enable in and out of bodily control experiences; we see these internal interface mechanisms as compelling opportunities to facilitate future novel sublime activities.

### 3.4.2 The world stimulates by threatening

Exertion activities that evoke the sublime require both enjoyment and fear; for example, swimming reveals just how vulnerable people are (if they would stop swimming, they would drown); yet people enjoy the buoyancy. The point is not that the sea actually drowns people but rather that it could. This vulnerable aliveness arises only if both feeling vulnerable and feeling alive are in balance: a novice swimmer will simply feel panic in a choppy ocean, while a competent swimmer will not feel vulnerable in a local pool.

#### Technology consideration

Prior work has stressed the potential of technology to “balance” exertion experiences (Altimira *et al.*, 2016; Gerling *et al.*, 2014; Mueller *et al.*, 2012); here we extend this work by pointing to the potential of technology to balance between feeling vulnerable and feeling alive in order to increase the chances for the sublime to be evoked. For example, if sensors could detect that a competent swimmer in a shallow pool is too comfortable to experience a sensation of sublime, it could use displays installed at the bottom of the pool to make the pool look deeper and more precarious like the ocean, or with a movable pool floor, the system could increase the depth of the pool. Similarly, if a novice swimmer already feels vulnerable in the pool, the system could detect this through indicators such as hectic movements and in response heighten the pool floor.

### 3.4.3 Savoring the precariousness of life

The sublime highlights people’s unique relation to the world: separated enough to see it as something “other”, attached enough to be moved and shaken. By threatening in a safe way, the world stimulates, and by keeping people secure, it allows them to enjoy this stimulation. Exertion activities, in this, are a chance to savor the precariousness of life (Young, 2014). Perhaps it also encourages gratitude: a heightened awareness of life, which recognizes its vulnerability and beauty.

## Technology consideration

Technology can support the savoring of the precariousness of life by highlighting that people have limitations, yet they are secure and part of something bigger: the work by Hamalainen *et al.* (2015) illustrates this nicely by suggesting gravity as a design tool for exertion activities: gravity, although people constantly struggle with it (in their example in a skydiving simulator), keeps them secure (they know they will not fly “off”), all awhile not discriminating (everyone is affected by gravity). The authors propose that mixed-reality environments can facilitate novel experiences around gravity (for example through interactive skydiving harnesses), and we believe such augmented experiences offer people new ways to taste the precariousness of life, ultimately evoking the sublime.

### 3.4.4 Exercise tip

Go swimming in the ocean or a deep lake, and think about how deep it is below you, appreciate the fear that arises from it, but also what you feel from the recognition that you can easily reach the shore.

## 3.5 Lens 5: Oneness

The oneness lens helps focusing on the benefit of encouraging intimate familiarity with one’s own body, and “then transcend this with an impression of ‘oneness’ with the world” (Young, 2014). Whereas the previous lenses focused on shaping the “I”, the oneness lens refers to a brief liberation from the burden of being an “I”. It complements the other lenses by helping to get the focus away from the “I” and see the self as part of a bigger whole.

A typical activity in regards to this lens is yoga: oneness derived from yoga has been described as like “coming home after a long holiday, and looking at one’s house anew – only the house is me” (Young, 2014) (Fig. 3.5). Yoga can rekindle a familiarity of one’s body by making conscious what is usually unconscious, yet this is not externally (such as discovering a spot on one’s skin) but rather kinesthetically from within. Exertion activities can allow people to gain a vivid picture of their own body, but it is not just a mirror where one can see one’s body, it is also



**Figure 3.5:** Yoga at sunrise to reach oneness

felt: it is a felt picture of one's body. This can also promote the opposite: losing oneself in one's own body, allowing for a "brief emancipation from the experience of ourselves" (Young, 2014).

We believe seeing exertion through a lens of oneness will become more and more pertinent as many people, especially those working in office environments, have turned to activities such as yoga to deal with today's stresses. Prior work suggests that these practices can offer mental health benefits (Ross and Thomas, 2010), and we believe technology has the potential to support that (Höök *et al.*, 2016). In order to guide such developments, we highlight that oneness develops over time (borrowing from the fact that time plays a heightened role in exertion activities (Marshall *et al.*, 2016b; Mueller *et al.*, 2011): First, oneness supports developing a heightened awareness of one's own bodily practices, which in consequence helps people make themselves at home in their own bodies. Then, over time, oneness facilitates experiencing one's own body as a bodily record of one's life experiences.

### 3.5.1 Heightened awareness of one's own bodily practices

One facet of oneness that is particularly enabled through the slow movements and stretching activities of yoga is the ability to allow people to perceive a heightened sensation of their own bodily practices and the lifestyle they reflect. These exercises can help people become more aware of the incidents and accidents (for example, a replacement joint affects the type and quality of movements one can do) that define them, helping people to better comprehend themselves as physical, psychological and social beings.

#### Technology consideration

Research engaging technology to support a heightened sensation of one's own bodily practices is only emerging, but represents an increasing trend. We note that most current systems aim to highlight practices and lifestyles that are considered unhealthy and in consequence focus on remedy. For example, the "slouch device" (Lumo, 2016) is targeted at office workers prone to back pain: it is a small wearable sensor that alerts through vibration when the user is engaging in bad posture by sensing a slouching position. We believe such technology could also be used to heighten the sensation of one's bodily practices in order to not only rectify unhealthy practices, but rather help people feel more like themselves. For example, we believe emerging sensors such as breathing devices (Marshall *et al.*, 2011; Patibanda *et al.*, 2017) could facilitate a heightened sensation of people's own breathing practices and associated lifestyles, and in consequence help them feel more like themselves.

### 3.5.2 Making ourselves at home in our bodies

Through this heightened awareness of one's own bodily practices people can experience a richer conception of themselves, like an imaginary internal world that portrays the normally hidden architecture of muscles, bones, joints, etc. Young (2014) says: "This increased sensitivity to one's body is also a mental exercise, a labor of imagination and a creative act." Through exertion activities, people are making themselves at home in their bodies, allowing themselves to become comfortable in their own

bodies – or more aware of the forces making them uncomfortable. In particular if movements are unusual, such as slow moving and stretching, they can nudge people to become more intimate with their own body. So while activities such as bodybuilding build the body from the outside, yoga does it from the inside.

### **Technology consideration**

We note that making oneself at home in one's body is a complex aspect of human experience that often cannot be operationalized for technology design in a straightforward fashion, therefore we need to treat technology use with care. For example, for this lens, “health games” come to mind that allow people to “look inside” their bodies, helping people understand what is going on when being sick, often used in a hospital context (Kato *et al.*, 2008). One of the features of these games is that they can include fantasy elements: for example, such games allow children with cancer to “look inside” their bodies in order to experience a cartoon-like fantasy world inside their bodies that depict how their medications attack “bad” cells in order to teach the children why it is a prolonged process in which the child needs to actively participate in. However, so far, such games do not consider any bodily activity (although this is important even in hospitals (Huerga *et al.*, 2016)). We believe advanced sensor systems can change this in the future, for example, we can envision an augmented reality system that allows people to “see” how their muscles engage during rehabilitation exercises, as frail and injured they might be (extending medical science teaching with AR versions of the human body (Smith, 2016)). How this might help people make themselves at home in their bodies is an interesting area for future work.

#### **3.5.3 Bodily record**

Once people have a heightened sensation of their own bodily practices and made themselves at home in their own bodies, oneness facilitates experiencing the body as a fleshy record: how a person walks and runs, what his/her posture is and the various ways she/he gestures is unique



to a person and demonstrates individual quirks and a unique upbringing. The body can therefore be seen as a public display of one's joys and anxieties as well as any public achievements and failures. This explains the appeal of tattoos, as people use them to tell the story behind this record. And as the body ages, this record ages along with it, showing signs that are highly visible and are often worn with pride of a life full of experience. The notion of bodily record is not only applicable to a sports contexts: for instance software that previously only focused on people's faces to reliably identify individuals is now also analyzing gait as it forms part of one's unique bodily record (Wang *et al.*, 2010).

### Technology consideration

In recent years, projects have begun to emerge that relate to the notion of the body as a fleshy record. For example, work by Lo *et al.* (2016) showed electronic circuits that are directly attached onto the skin, allowing for electronic tattoos that enable new forms of displays of fleshy records. These displays could react to the wearer's immediate bodily actions, allowing for new ways of telling stories behind – and with – a bodily record. The notion of fleshy record is also visible in the current trend of prostheses that are not aiming to look like real limbs, but rather high-end technology devices. Wearers showcase their high-end prosthesis publicly and dress them along with their outfits (Ladner, 2015) rather than hiding them, utilizing the wearable technology as part of their fleshy record.

Although these works demonstrate the potential of technology to support the notion of fleshy record, there are still many unresolved issues: although technology can now deal much better with the malleability of human skin, recent examples (Lo *et al.*, 2016) highlight that the storage and replacement of batteries as part of these fleshy records is still a challenging problem, as is washing and cleaning.

#### 3.5.4 Exercise tip

Listen “inside” your body: which muscles are tense right now while you are reading this, which body parts are underused and overused?

### 3.6 Lens 6: Sacrifice

Many exertion activities come in the form of a game, for example a game of tennis. Previous research argued that when people are playing a game, they are voluntarily (Suits, 2005) entering a magic circle (Salen and Zimmerman, 2003) that has its own rules and rituals quite different to normal life. This alternative world requires toil and agony from the players. However, it is not always an unpleasant sacrifice, in fact, it can offer a simpler existence in return (Young, 2014, p53) (Fig. 3.6). We highlight three key facets to sacrifice: sacrificing for a simpler existence, sacrificing to commit, and sacrificing to be someone.



**Figure 3.6:** Jogging while others sleep as a form of sacrifice

### 3.6.1 Sacrificing for a simpler existence

When participants are engaging in exertion activities, they are giving something up: the avoidance of potential injury, time together with family and friends, and money required to pay for court hire and equipment. However, they are sacrificing these things in order to gain something else: a simpler existence situated in an alternative world that can often be more satisfying because the rules of the game are clearer than in “real” life, with all its ambiguity. The rules are also much more explicit, as they are written down in a rulebook where everyone can examine them beforehand, allowing them to decide if she/he wants to take part.

#### Technology consideration

We find that there is an opportunity for interactive technology to highlight what participants are giving up and what they are gaining in return, supporting the notion of sacrificing for a simpler existence. In particular, technologies such as sensors and telecommunication allow for this sacrifice to be conveyed to others, extending the range of sacrifice awareness. An (albeit simplified) example of a system that aims to achieve this is TickTockRun (Knaving and Wozniak, [2016](#)). It is an ambient awareness tool situated in the living room of advanced amateur runners’ families that uses running and sleep sensor data to show what the runners are giving up for their passion (it shows how long participants are away from their families as a result of their runs as well as any sleep they might miss out on). In return, the runners might gain a simpler existence (where their almost sole demand is to keep a certain pace, presented via an audio ticking sound). As such, we can say that the system aims to communicate this sacrificing for a simpler existence to the runner’s family using interactive technology.

### 3.6.2 Sacrificing to commit

When exertion participants are sacrificing, they are doing so in order to commit to the alternative world the activity offers. They know that if it all becomes too much, they can simply walk away. This means

participants commit wholly in intention, without absolute existential commitment (Young, 2014, p. 53).

Such sacrificing in order to commit stands in contrast to the notion of suspending disbelief, which has been often discussed in the context of digital games where players are willingly suspend their critical faculties and believe the unbelievable, sacrificing realism and logic for the sake of engagement (Salen and Zimmerman, 2003). With exertion activities, participants are not suspending disbelief: the involvement of the body facilitates a commitment to the alternative world that the body inhabits; only those with no commitment to the alternative world must suspend disbelief.

### **Technology consideration**

Technology can contribute to the appeal of alternative worlds by adding attractive elements (such as special effects (Volda and Greenberg, 2009)) or selectively hide certain information that discourages commitment to these alternative worlds. The forceful push-and-pull game by Cheng *et al.* (2017) is an example that does both. In the game, two players wear a head-mounted display and engage in forceful bodily actions by pulling on the same baton-string contraction. However, in the virtual world, they are acting alone on a virtual kite and virtual fish respectively (*i.e.* the other player is not represented). The game's design makes engaging with the alternate world appealing through attractive visual and audio effects. It also hides the information that another player is involved, as players might be reluctant to exert full force with each other, especially if they might be afraid that another player could get hurt.

#### **3.6.3 Sacrifice to be someone**

Exertion activities give participants a chance to be someone specific for a short time, allowing them to experience a life less ambiguous. For example, a player might declare that he/she is a goalie for the next 90 minutes, where any ambiguity and anxiety arising from everyday life and associated identity evaporate. The sore muscles and bruises are the price people are willing to pay for this brief simpler existence.

### Technology consideration

In traditional, non-augmented exertion activities, the new identities are often fixed for the duration of the game (for example, in soccer each team selects a goalie at the beginning of the game). Technology enables to be more flexible, for example, it can more easily allow for the switching of players' identities: wearable display technology (Page and Moere, 2007) allows for dynamically switching numbers on people's uniforms. Technology could also cement identities by providing additional means to demark certain roles; for example, we can envision augmented balls that make a warning sound when players besides the goalie touch the ball with their hands (Izuta *et al.*, 2010). Lastly, technology can highlight player's temporary identity, for example we can envision augmented reality apps on mobile phones that allow audience members to use the device's camera, directing it at the pitch, in order to identify which players are having which identity.

#### 3.6.4 Exercise tip

Tennis is full of explicit and implicit rules and rituals, so play tennis and ask yourself what you are giving up and whether it feels like a sacrifice.

### 3.7 Lens 7: Beauty

Engaging in exertion activities can also mean being driven by a desire for beauty (Fig. 3.7). This can result in an aesthetic joy, which can be described as the pleasure of bringing new proportions and harmonies into the world. Such beauty means people savor the look of a more toned body for its look, that is, for its own sake (rather than for some alleged moral or social superiority). It is acknowledged that this is a superficial pleasure – but no less important. For us, three facets of beauty are particularly pertinent when it comes to exertion activities: beauty through rhythm, beauty through order, and beauty through spectacle.



**Figure 3.7:** Beauty in movement

### 3.7.1 Beauty through rhythm

Beauty is not only about the beauty of a still picture of the human body (as in the picture above), but also about the beauty of the human body in action, because there is beauty in movement. In particular, bodily beauty often involves a rhythm to the bodily movement that can be useful to consider: for example, we experience exertion often with a specific beat (highlighted by, for example, the repetitive movement sound of a rowing machine, or the sounds of moving weights on an exercise station) or a rhythm in-between activities due to the required recovery periods, leading to daily or weekly exercise rhythms.

#### Technology consideration

Prior work on exertion has stressed the importance of rhythm (Mueller *et al.*, 2011): human beings (in contrast to most animals) are very good in identifying a beat, and exertion activities can support and benefit from this rhythm. Technology can highlight such a rhythm or provide

a rhythm to follow, for example through sonification efforts (Stienstra *et al.*, 2011), allowing people to identify a beat in their movements to facilitate kinesthetic learning.

### 3.7.2 Beauty through order

When working out, people are introducing new order: by refining their muscles, they are helping to refine their own physical form. People are burning calories and then fat, and tearing muscles to help them grow bigger and stronger. Through these experiences, people are creating new order in this “messy” life. This, in turn, provides the distinct pleasures that humans find in unity: the sense that a given experience has some harmony, ratio and order (Dewey, 2005).

#### Technology consideration

Beauty through order is not always immediately visible to the naked eye, for example a person might not see any new refined physical form of their body after a single visit to the gym. People have been using tools such as measurement tapes in order to be able to identify such small improvements towards the desired harmony (for example to measure bicep circumference increase); advanced technology can now measure such beauty through order with much greater precision and also across the whole body with ease: we can envision systems that use full-body 3D scanners in the gym to identify any refinements of physical form with unprecedented resolution across a person’s entire body.

### 3.7.3 Beauty through spectacle

The human body performing aesthetic actions is a visual achievement and the experience of muscles in action makes for an amazing show or spectacle. In contrast to simple button-presses, where there is not much spectacle (with exceptions being put forward by “button-smash” games like Jelly Polo (Sheinin and Gutwin, 2015)), if the whole body is involved, there is the beauty of muscles, skin and movement that can be quite mesmerizing to look at. For instance, a ballet performance celebrates the beauty of the body in action probably unlike any other

bodily activity. The point here is to see the muscles as a resource for self-expression and them in action as aesthetic achievements.

### **Technology consideration**

We find that technology can support beauty through spectacle by illuminating the spectacle, for example see the Pexel Shirt (Brooklyn Ballet Hacks, 2014) that highlights a dancer's movements through LEDs glowing in the dark that are attached to a tight fitting shirt as part of a ballet performance. Technology can also amplify the beauty, for example Glass Dance (Glass Dance, 2015) projects bodily movement onto a big screen to amplify the dancer's movements, making it accessible to larger audiences. Furthermore, technology can utilize "traces" (van Dijk *et al.*, 2014) that capture bodily movements to make them available for longer. For an example see the skateboard project (Pijnappel and Mueller, 2014) that captures skateboarding movements to "freeze" them in time so they become available for longer for the skaters to reflect on and bystanders to comment on. Similar trace functionality has been implemented for dancers, too (Lesia, 2014). Lastly, we find that technology can support beauty through spectacle by seemingly slowing down or speeding up time when moving in order to highlight the beauty of movement. For example, slow motion techniques have been extensively used in sports broadcasts to make the beauty of athlete's movements more easily discernable. Similarly, time lapses have been used to show beauty in aggregated data that develops over time, for instance new data visualization tools allow for the capturing of large amounts of bike usage data that results in visually stunning heat maps of exercise information: cleverly overlaying millions of bike trips can result in rich visual spectacles that allow for a heightened appreciation of bike usage, which in turn can inform public infrastructure developments for cyclists (such as promoted by Strava Metro (Strava, 2014)).

#### **3.7.4 Exercise tip**

Go bodybuilding; or bring a set of dumbbells and a mirror into the classroom, so students can see their muscles in action. Ask what part of the experience demarks beauty and why.



### 3.8 Lens 8: Pain

Pain is usually associated as something to avoid, with the field of ergonomics at the forefront when it comes to employing design to minimize a user's pain. Here we argue that pain as part of an exertion experience can be something elementary that should not be dismissed, and we articulate three facets of how pain can be appreciated: by conceptualizing pain as a reflection of freedom, by consequently changing the meaning of pain, and by regarding pain as a test of value.

#### 3.8.1 Pain and freedom

We argue that in exertion experiences, pain can be a reflection of the user's freedom: people have the autonomy (Rigby and Ryan, 2011) to participate and hence to choose the pain, this highlights their freedom (Young, 2014) (Fig. 3.8). Even though people might try everything not to experience pain, it might happen – in some circumstances, it



**Figure 3.8:** Pain and freedom

must happen. For example, it is impossible to be a boxer without pain. Participants choose to open themselves to the possibility of pain because they believe their skills, but also their trust in the opponent, coach and referee will prevent any serious harm. They seek a certain kind of uncomfortable challenge, but try to avoid disabling injury. We note that Young claims that people might actually prefer pain if it comes with freedom than comfort without liberty (Young, 2014).

### Technology consideration

In order to allow users to experience pain as freedom, technology designers need to ensure that participants have the opportunity to quit at any time. Benford *et al.* has previously highlighted that this is an important part of the ethics behind any uncomfortable interactions (Benford *et al.*, 2012). Most traditional sports have an easy-out option for quitting any pain, an example is the tapping in Judo. However, with the use of interactive technology, new ways of experiencing pain are possible, for example see the “electric shock games” that include the use of electric shocks as intriguing game elements. However, a too large AC current such as bigger than 21 mA can be sufficient to cause a player to go into an “electrical hold”: this is a condition wherein the muscles are contracted and held by the passage of the current – the player cannot let go of the electrified object (Cadick *et al.*, 2006). Designers that work with such current near the human body need to be aware of this, as assuming that letting go of any device to experience freedom might not be an option because of this electrical hold; an issue that might gain increased importance with the proliferation of skin-based interfaces.

#### 3.8.2 The meaning of pain

Pain always has meaning, and if people feel pain, they are experiencing two different things (Wall *et al.*, 1994): first there is the stimulus, then there is how people feel about this stimulus. Most often, this feeling is associated with negative thoughts: people are somehow injured or wounded, and they blame others for this discomfort, however accidental. Think, for example, of stepping on a child’s toy and feeling pain in the

instep. However, in activities such as martial arts, ballet, American football and so on people willingly allow themselves to feel the pain, so they do not feel angry about it. While the stimulus might be more intense than stepping on a toy, the experience of pain is diminished and becomes a reflection of physical virtue. In short, pain is a subjective experience, not a raw stimulus. This is why the meaning of pain is so important: because people can interpret a punch as fun, rather than agony; the meaning of pain is changed.

### **Technology consideration**

Technology can help change the meaning of pain. For example, it could facilitate a positive, entertainment-focused mood that frames the experience as a fun game, in which pain is seen as part of the experience. For example, most of the aforementioned electric shock games do that: by framing the electric shock as part of a fun game, they change the meaning of the resulting pain. This meaning is possibly quite different compared to experiencing the same current during electrical wiring as part of a repair job when someone else forgot to turn the power off: here the pain will make people angry, blaming others.

#### **3.8.3 Pain as test of value**

Pain as a test of value means that people are conducting exertion activities for a more balanced life, involving a “healthy refusal to treat pain as something automatically terrifying” (Young, 2014). Everything in life demands some kind of discomfort, therefore pain asks: “is this what I want, and how willing am I to suffer for it?” In other words, pain is a test of value, it “sharpens our perception of what is worthwhile in life, and just what we are willing to sacrifice to get it. Exercise, precisely because of its discomfort, is therefore a touchstone for an emancipated existence” (Young, 2014).

### **Technology consideration**

We believe the use of technology to support the notion of pain as a test of value is very much underdeveloped, probably because both pain and

value are subjective and hence cannot be easily sensed. However, we can envision technology that asks participants which achievements are worth which pain: for example through an interactive app to be used after ballet classes. This could aim to foster reflection on what it is people want and how willing they are to suffer for it, promoting thinking about what pain is worth enduring for within exertion activities, but also life in general.

### 3.8.4 Exercise tip

Have someone punch you on your thigh, and see if you can reframe the pain: as freedom, its meaning or as test of value.

## 3.9 Lens 9: Consistency

Many exertion activities are applauded for their wonderful quick actions, for example a beautiful free kick in soccer. However, a less prominent, but nevertheless important element of exertion activities is consistency (Fig. 3.9). Consistency is key in endurance activities such as long-distance running like marathons, but consistency also refers to regular exercise as part of daily living. We highlight 3 key facets to consistency: consistency as preparation for work and life, consistency for how not to lose the plot and consistency for a greater capacity to strive.

### 3.9.1 Consistency as training for work and life

Exertion activities, in particular endurance activities, are not just an antidote to the stress of a sedentary desk job. They are training for the labor of work and life itself, as regular exercise can develop improvements to work in particular and life in general, which contributes to a more productive and satisfying life. The previously described “Reverie” lens highlighted that the right amount of stimulation during an exertion activity can support cognitive functioning (*i.e.* a single walk already provides benefits), here we point to the fact that regular exertion activities can reduce symptoms of stress, anger and depression, alleviate anxiety and improve mood (C3Health, 2009). Studies also suggest that exertion activities can improve or maintain some aspects of cognitive



**Figure 3.9:** Regular exercise classes train consistency for life

function, such as the ability to shift quickly between tasks, plan an activity, and ignore irrelevant information. Regular exertion activity can also help people keep their thinking, learning, and judgment skills sharp as they age, while possibly even help people sleep better (Centers for Disease Control and Prevention). Some studies also suggest that regular exertion activity may also play a role in reducing risk for Alzheimer's disease and age-related cognitive decline. In particular, research with older people who exercised daily showed that, after one year, the group had improved connectivity in the part of the brain engaged in daydreaming, envisioning the future, and recalling the past, as well as improved ability to plan and organize tasks such as cooking a meal (National Institute on Aging). Furthermore, research in workplaces showed that leaders who are exercising regularly have increased stamina and mental focus (Leiter and Maslach, 2005; Neck and Cooper, 2000). Overall, research indicates positive effects from regular exertion activity such as reductions in absenteeism, increases in job satisfaction and increases in employee morale and retention (summarized by Clayton

*et al.* (2015)). The more general point is that regular exertion activity can develop a host of improvements to work and life.

### Technology consideration

Although consistency in exertion activities has many benefits, their long-term implications are challenging to utilize as motivators for people, as they are often not immediately accessible. For example, telling an 18-year old that his exercise consistency will benefit him after retirement might not be very motivating. Technology, however, can play a contributing role here: we can envision technology that a) makes small improvements as part of regular exertion activity more visible (for example by visualizing steady reductions of symptoms of stress through biosensors) or b) shows how larger improvements develop over time (for example by using fMRI to communicate how brain connectivity improved over the years). Technology so far mostly concentrated on visualizing how athletic performance improved, however, athletic performance naturally decreases with age, so, for example, a jogging app will not be able to congratulate forever on achieving faster times and achieving “personal bests”. In contrast, we highlight here that technology can also make visible the benefits of exertion consistency to work and life, not just athletic performance (as suggested previously by (Schraefel, M. C., 2015)).

#### 3.9.2 How to not lose the plot

Given how difficult it can be to resist the regular assaults on people’s character from overstimulation, conflicts of belief and value, and just ordinary malice, the regularity in the way people engage in exertion activities also helps to “not lose the plot”. Consistency cannot give life a purpose, but it can help people pull their lives back together towards some overall purpose. With this, there is an existential reward of regular exercise, which is a life of greater integrity and constancy. As such, consistency provides people with the faculties for a more consistent life story, training in becoming whole.

### **Technology consideration**

Technology, in particular mobile technology, offers opportunities to provide reminders to not miss their regular exercise classes, in order to live a life of greater consistency. Work by Mueller and Pell (2016) has suggested that participants who engage in extreme exertion activities such as mountaineering Mt Everest are increasingly valuing interactive technology to support their adventures, not just as a way to achieve the mountain top, but to support their mental wayfinding and becoming who they want to be.

#### **3.9.3 Consistency for a greater capacity to strive**

Consistency is cultivated best by confronting what is not pleasant. No animal would engage in a marathon race, but this highlights that it is all about going against one's instincts. People want to explore what it means to confront their instincts, so they can enjoy the feeling of being "alive". Therefore regular exertion activities heighten our sense of character by representing our willingness to choose less obvious pursuits.

These choices of less obvious pursuits provide them with opportunities to "color" their life: because people have cultivated dispositions such as courage and pride through regular exertion activity, they have the opportunity to also deploy them in the rest of their life. However, people cannot simply deploy them from one day to the next, they need to consistently strive to make the lessons of exercise permeate their everyday life. In summary, by engaging in regular exercise, people develop a greater capacity to strive.

### **Technology consideration**

We believe technology can help people in permeating the lessons learned from regular exertion activity into the office and the home, in particular by helping people realize what these lessons are (for example by regularly prompting gym-goers to reflect on what they have learned) and how they could be deployed in everyday life (for example by providing the above gym-goers with information about how they could implement their lessons learned into other parts of life). As this permeating of

lessons learned from regular exercise to everyday life is not a once-off process, but rather a life-long pursuit, we find that technology could make use of its ability to easily track progress over time. Furthermore, designers could draw on the fact that there is more and more data available from all facets of life (including exercise, work and home) and use it to show opportunities for permeating lessons learned from one area to another (for example, by highlighting that lessons learned in a basketball game of 5 players might be transferrable to a work team that also consists of 5 people).

### **3.9.4 Exercise tip**

Sign up for a regular exercise class to engage with the idea of consistency.

## **3.10 Lens 10: Perseverance**

Persistence refers to engagement in exertion activities despite difficulty or delay in achieving success. Here we argue that persistence is a valuable trait and people can nurture it by engaging in exertion experiences. We articulate three facets of perseverance.

### **3.10.1 Patience**

Learning patience is important, and exertion activities can help people with that (Fig. 3.10). Exertion activities do so by teaching people when waiting for the right moment, as sometimes people have to endure discomfort. Often this discomfort is the absence of stimuli, like when having to wait in a queue (To appear). However, exertion also teaches us that this discomfort can be physical, for example, when in a boxing match and waiting for the right moment to hit, all awhile enduring being beaten. So exertion helps us to increase our capacity to endure waiting by requiring us to deal with physical discomfort when waiting for the right moment.

### **Technology consideration**

Interactive technology has been previously used to support people patience's when queuing in queues (To appear), here we propose that





**Figure 3.10:** Patiently waiting for the right moment

technology could also be used to nurture patience in exertion activities. Prior research has been using video recordings to help athletes review their performance in order to help them identify when there is the best moment for a particular action without the immediate need, helping them to see the value of patience. Building on this, we can envision future systems such as AR glasses that tell participants that if they would wait just a little longer, there will be a more opportune moment just around the corner. For example, tennis players could wear such AR glasses and be informed that the average exchange is five more hits, highlighting to the player that an opportune moment is most likely yet to come, preventing the player to make an error as a result of an impatient attack that was executed too early.

### 3.10.2 Determination

Finding time to engage in exertion activities requires determination, as life is filled with work commitments, tasks and duties. Even if participants find time, they need to be determined to not let their work thoughts enter the game and distract them. In other words, this

facet asks participants whether they can endure all the other “stuff” life throws at them and still play the game?

### **Technology consideration**

Interactive technology can support participants’ determination to find the time to engage in exertion activities. For example, the scheduler of Android mobile phones offers a virtual assistant that if you tell it you want to work out, it goes through your calendar and identifies suitable empty slots, preferably even based around your past preferences, and schedules them for you. This highlights that supporting the design of exertion activities is not always about the immediate activity itself, but should also include efforts of supporting the determination of making physical activity happen within a busy life.

#### **3.10.3 Chronos vs. Kairos time**

The ancient Greeks had two words for time: *chronos* and *kairos*. *Chronos* refers to chronological or sequential time, as in 60 minutes in one hour, whereas *kairos* refers to a moment of indeterminate time in which an event of significance happens. We can therefore say that *chronos* has a quantitative, whereas *kairos* has a qualitative nature. *Kairos* refers to the right or opportune moment and highlights a knowing when the time is “right” based on a defined quality and purpose. When it comes to exertion activities, the notion of “flow” (Jackson and Csikszentmihalyi, 1999) has often been used to articulate how time can seemingly slow down or speed up for athletes, for example when a basketball player experiences his opponents seemingly acting in slow motion while taking the final shot before the buzzer ends the game. Here, time seems to stand still, even though *chronos*, the game clock, is still ticking, for the player, *kairos* describes a time when the player knows in an embodied fashion when the time is right to fire the shot.

### **Technology consideration**

Sports TV has been using slow motion (and to a lesser extent also fast forward) for decades to portray to audiences that there is *chronos* and

kairos time: they stress chronos by showing the game clock overlaid over the TV video stream, while switching to kairos when engaging slow motion as a way to provide alternative views on time, most often to depict how time could be perceived when actually involved in the game, as described above.

So far, such technology has mainly been used to convey both chronos and kairos time to audiences at home. We believe that, in the future, interactive technology could also be used to support both chronos and kairos time for players. For example, sports watches already provide long-distance runners with chronos time. In fact, interactive technology is not needed to provide chronos time itself, large clocks in stadiums have done this before the digital age, however, advanced technology allows watches to be smaller and hence wearable, allowing to have access to chronos time everywhere, while also enabling to start a stopwatch automatically: for example, most sports watches now sense physical activity such as running and start a timer automatically. We highlight here that how technology could support kairos time for participants during their exertion activity is an intriguing area for future work.

# 4

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## Discussion and Conclusion

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There is an increasing attention in HCI to support people investing physical effort as part of exertion experiences, yet theoretical work to identify associated frameworks to guide designers has highlighted that knowledge about the many perspectives designers can take when designing for exertion is still very much at the beginning. To contribute to this knowledge, we propose a set of lenses through which designers can view exertion when developing interactive technology for it. Our set of lenses complement existing perspectives and are derived with a focus on what we believe are underdeveloped perspectives on exertion, aiming to highlight unique opportunities for interaction designers. The lenses are grounded in the literature of philosophy reflected as a set of virtues, which are “desirable dispositions”. As prior work in other HCI areas has suggested, virtues can guide designers, however, it is important to note that participants are still required to do “the right thing at the right time”. This refers to Aristotle who argued that “doing the right thing” is not enough to be a virtuous person: a virtuous person tends to do the right thing at the right time, in the right way, and for the right reason, because it’s the right thing to do. Therefore becoming virtuous requires developing habits, because we become good by doing good things; this

means the lenses cannot be reduced to simple one-off guidelines. Yet overall, the lenses help designers to see exertion not just as a means of increasing physical health and hence ultimately deferring death, but rather as an opportunity to facilitate personal growth.

We unpacked each lens into three facets to provide designers with practical handles to grab when designing with a particular lens in mind. We then used the lenses to identify opportunities interactive technology offers to designers to support them based on related work and our own craft knowledge having designed exertion experiences for over a decade. We conclude the description of each lens with a description of a practical exertion activity that designers can engage in for an embodied experience of the lens' content; we hope this can also be useful when teaching the lenses to students, for example.

With the rise of interactive technologies that can sense the physically active human being comes the opportunity to support people being physically active. Initially targeted at elite athletes, the proliferation of cheap and easily affordable technology facilitates a wide range of people doing a wide range of activities. We note that most current approaches still focus on improving athletic performance to improve physical health. This means such approaches exclude many of the experiential, intellectual and ethical benefits exercise can provide. Therefore our contribution to a richer future of interactive design is to highlight the problems with a purely mechanical approach and provide a set of lenses through which designers can examine exertion experiences differently. These assume that exertion is not merely a purely mechanical activity, but includes multifaceted psychological and social aspects. As such, our work is situated within the tradition of a critical humanistic perspective on HCI that aims to support human values (Harper *et al.*, 2008).

Hollan and Stornetta argue that the impact of electronic media should not be measured by how well they can approximate the affordances of face-to-face interaction, but rather how they can surpass the constraints of co-presence and co-location to offer value that motivate their use even if face-to-face communication is available (Hollan and Stornetta, 1992). Similarly, we argue that technology should not just

aim to approximate existing exertion experiences, but rather go beyond what un-augmented physical activity offers.

As with all work around frameworks, our work has limitations. For now, our lenses are only propositions and need to be validated through actual design work, however, we presented some work that has done that, although mostly not explicitly based around a particular virtue, however, the writing of the work suggests that the creators very much had a particular virtue in mind. We believe additional design work will also help to refine the particular facets of lenses and maybe even the lenses themselves or identify additional lenses.

We acknowledge that our focuses on lenses is only a starting point, as new lenses will be articulated in the future. Lenses also only provide particular perspectives on phenomena, and hence can only offer initial guidance on a high level, rather than, for example, provide concrete guidelines, as such, our work could be complemented by more practical work.

We also acknowledge that we have not yet articulated any type of weight to particular lenses: as our sports examples show, some lenses are more important for some exertion activities than others. This requires designers to go through them and examine which ones are most suitable for their particular scenario.

We also highlight that we have yet examined if and how the lenses are independent or interdependent from each other. If we design interactive technology with one particular lens in mind, how does this affect the perspective afforded by the other lenses? Examining this could be an interesting avenue for future work.

Furthermore, although we do not have empirical results on the use of the lenses in design practice, we can report anecdotal evidence that the lenses have been very useful in our PhD traineeships: we find them particularly helpful in aiding new PhD candidates in finding their way to hone done on a particular design exploration. For example, we have referred to the Sublime extensively as a way to articulate the differences in augmented bouldering solutions, such as a VR (Kosmalla *et al.*, 2017) and projection-based (Kajastila *et al.*, 2016) bouldering wall. The VR wall appears to deliberately facilitate the sublime by making users

perceive they are staring into a 1000 meters abyss below them when climbing. Having this term Sublime allowed us to clearly articulate the differences in targeted user experiences of these systems, helping students in identifying open gaps in this design space that guide our design explorations.

An avenue for future work can be to use the lenses for people with injuries or disabilities, where most sensing technology often fails as they presume a particular “average” body shape and form. Using the lenses to support this user group will contribute to the ethical discourse around body-centric computing. As such, we see our work being situated within value sensitive design that stresses the importance of ethics when designing interactive systems (Epstein *et al.*, 2013), complementing prior work that calls for the consideration of human values as part of an interaction design agenda (Harper *et al.*, 2008).

Overall, with our work we hope to be able to contribute to the emerging field of designing exertion experiences. We believe that when designing interactive technology to support exertion experiences that go beyond what is currently available, we need an understanding of the multiple perspectives of what it means to not just having a body, but being an active human being. With our lenses, we hope we are able to provide designers with a starting point to explore these multiple perspectives, helping to facilitate the many virtues of exertion so that ultimately, more people can profit from the many benefits of physical exertion.

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