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Expanding exertion gaming ☆

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ABSTRACT

While exertion games-digital games where the outcome is determined by physical exertion-are of growing interest in HCI, we believe the current health and fitness focus in the research of exertion games limits the opportunities this field has to offer. In order to broaden the agenda on exertion games, we link the existing fields of sports and interactive entertainment (arguing these fields have much to offer) by presenting four of our own designs as case studies. Using our experiences with these designs we highlight three key strategies to guide designers in the creation of richer exertion game experiences: designing a temporal trajectory through games with reference to the way exertion changes over time, designing for the inevitable and not necessarily negative effects of pain in exertion games, and designing for the highly socially situated nature of exertion gaming.

1. Introduction

Exertion gaming – digital gaming where the outcome is determined by physical exertion – is of growing interest in HCI. Exertion games combine elements of physical activity as known from sports with interactive entertainment, particularly computer gaming (Mueller et al., 2011). This article examines the relationship exertion gaming has with both sports and interactive entertainment, exploring what we can learn from both areas in order to broaden the agenda for exertion games.

In our opinion, exertion gaming research has so far rather narrowly focused on health objectives, particularly energy expenditure, often fueled by grant objectives targeting the obesity epidemic. For example, many papers focus on measuring the energy expenditure of players engaging with the Kinect and Wii-mote controllers in order to determine if they are "as good as" traditional sports activities (e.g. (O'Donovan et al., 2012; Whitehead et al., 2010)). We believe that this can set up the expectation that people engage in sports, as well as exertion games, only for energy expenditure reasons. (If this were true, everyone would run marathons and nobody would play golf.)

In contrast, we believe that sports, interactive entertainment and exertion games can complement and learn from each other: after all, they all involve "games" (see Juul (2003) for an overview of definitions of "game"), and all have "play" at their core (using Suits' (1977) broad definition of play as activities where players voluntarily challenge themselves via unnecessary obstacles). This article sets out to articulate a broader exertion game agenda that goes beyond specific fitness objectives to support a wider range of human activities like bodily play (Márquez Segura et al., 2013). In particular, we believe a broader perspective can a) help explore the opportunities exertion games have to offer, b) aid in enriching exertion games, c) assist in addressing relevant issues in exertion game research, and d) improve the design of exertion games.

Several prior works offer theoretical accounts on exertion games: these works focus on different views of the human body from an augmenting sensing perspective (Mueller et al., 2011), the experience of engaging in pleasant movements (Márquez Segura et al., 2013), insights from traditional dance applied to movement-based games (Loke and Robertson, 2010), guidelines on how to design movement-based games (Mueller and Isbister, 2014), motivations to do more exercise (Yim and Graham, 2007) and applying behavior change models to motivate exertion (Consolvo et al., 2008). These prior investigations point towards the benefits of taking a wider view of exertion gaming that connects to other disciplines. In this paper, we explore the relationship of exertion

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games to sports and play, in order to consider the relevance of these disciplines to exertion game design.

While there is a growing body of theoretical work in this field, there is a shortage of research that combines critical perspectives from sports and entertainment. This article aims to bring together and expand these views by synthesizing theoretical perspectives and practical experiences to create a broader agenda for the design of exertion games. We are inspired by previous works that identified a trend towards more body-centric design perspectives, such as Klemmer et al.'s "How Bodies Matter" (Klemmer et al., 2006) and Dourish's "Embodied Interaction" (Dourish, 2004). In this tradition, we first present our critique of the current state of exertion game design and research, followed by a set of strategies for designers to consider when creating new systems, to offer inventors and futurists designer-oriented handles for where to start in contributing to this expanded exertion games agenda.

2. Incorporating sports and play into exertion games

In this section, we briefly present an overview of the work that we will be referring to throughout the article. Looking at the current HCI work on exertion gaming, much of it focuses on in some way on energy expenditure. How much energy expenditure exertion games promote in their players has been studied in many ways, such as by augmenting existing game mechanics with exertion based bonuses or penalties (Berkovsky et al., 2012; Chatta et al., 2015; Hassan et al., 2012), creating games for school physical education classes (Keskinen et al., 2014; Macvean and Robertson, 2013), replacing conventional input devices with exertion based gestural control (Guo and Quarles, 2012), studying how much energy the existing exertion games require to play (Chen et al., 2014; O'Donovan et al., 2012; Whitehead et al., 2010), and how one might motivate people to play exertion games more often (Macvean and Robertson, 2013; Nunes et al., 2014; Yim and Graham, 2007).

Further, there is literature on exertion as it relates to sports and play, much of it external to HCI. In particular, sports and health sciences have much to say about why people choose to do exercise (Ingledew and Markland, 2008), how people move during exercise and how hard they are able to push themselves (Ben Abdelkrim et al., 2007; Fernandez-Garcia et al., 2000), subjective aspects of exercise such as pain, fear and thrill (Addison et al., 1998; Benedetti et al., 2013; Jirásek and Hurych, 2012; Self et al., 2007), what effect exercise interventions have on people's overall lifestyle (Frémeaux et al., 2011), and also studies of the social aspects of sporting behavior (Delamont and Petrone, 2010). Health researchers have also presented longer term studies specifically focusing on exertion gaming (Baranowski et al., 2012; Owens et al., 2011). Gaming and play researchers have also discussed much that is relevant to exertion gaming, such as how to effectively create a temporal trajectory in a game (Bleszinski, 2000; Wesołowski, 2009), the purpose of failure in games (Juul, 2009) and broader philosophical questions such as why people choose to play games (Rigby and Ryan, 2011), and what actually defines gaming or play experiences (Juul, 2003; Suits, 1977).

As well as exercise-quantity focused research, there are also examples of exertion game research projects that are driven not by a desire to increase exercise-quantity, but more by using exertion primarily as part of game design. For example, Nenonen et al.'s (2007) Pulse Masters Biathlon uses heart rate and synchronised 'skiing' actions to control the action of a two-part skiing then shooting game, the 2nd author's Hanging Off a Bar (Mueller et al., 2012a), creates a game in which players must hang their body weight off a bar for increasing amounts of time, and MobyDick (Choi et al., 2014), which uses swimming strokes as input to a multiplayer game where 4 players must collaborate to battle a giant sea creature. There are also commercial exertion games, such as the full body dance game Dance Dance Revolution (Konami, 1998), and a genre of 'rhythm' games which followed that use increasingly fast series of dance moves as input. As well as games sensing body actions direction, pervasive games such as Human Pacman (Cheok et al., 2004) and the Rider Spoke cycling game (Rowland et al., 2009) often involve what Stanley et al. describe as 'exercise as a byproduct of the activity' (Stanley et al., 2010).

In order to explore the synthesis of perspectives from sport and gaming into exertion gaming design we describe below 4 case studies from our own work, which we take as starting points for wider reflections throughout the article.

The case studies were chosen from the work of our two labs because they started from different perspectives while blending different elements of sports and play, from augmenting of conventional sports for social and fitness purposes to a biosensor augmented physical amusement ride and a playful experience around running. By using these disparate case studies we aim to create an agenda for exertion games that is relevant to designers of a wide range of games and experiences.

2.1. Copy Paste Skate: Augmenting a street sport

Copy Paste Skate (referred to henceforth as CPS, Figure 1) (Pijnappel and Mueller, 2013) is an interactive skateboarding experience that supports the trick experience in skateboarding by offering feedback along three modalities that have previously been identified as key to the trick experience (Tholander and Johansson, 2010): visual, aural and haptic.

Visual feedback is provided by a life-size still visualization showing the path of movement of the skateboard during the trick, projected onto a wall just behind the skater. Each subsequent visualization is projected on top of the previous one, with visualizations disappearing after 3 attempts. Directional microphones capture the audio produced during a skater's trick attempt. The audio is then replayed at half the speed through large high-quality speakers to the skater and any by-standers. Right after completing or attempting a trick, custom-built flooring on which the skater performs vibrates based on the motions of the skateboard during the trick attempt. This offers a replay of the haptic experience felt during the trick attempt. Vibrations are produced by an audio transducer that takes the sensor input to create a vibration similar to the haptic experience felt by the skater, however, it is replayed shortly after, so that not only by-standers, but also the skater can experience a haptic reminder of the trick again, complementing the original trick. As with the audio, the time of the haptic experience is slightly stretched in order to allow experiencing the haptic sensation over a larger amount of time, responding to the fast duration of a trick. Based on observations and interviews with skateboarders two key design dimensions emerged that highlight how designing for skateboarding means both supporting the execution quality of tricks as well as supporting the trick originality (Pijnappel and Mueller, 2013).

2.2. Jogging over a Distance: A networked social fitness activity

In Jogging over a Distance (JoD, Figure 2) (Mueller et al., 2011, 2007), two jogging partners arrange to run at the same time, wearing stereo headphones, a microphone and a heart rate monitor. Before the run, users enter their preferred target heart rate, which stands for the physical effort they plan to invest based on their fitness levels and goals. While participants jog, their heart rate is sent to a server and then to the other jogger. Each jogger can hear the audio of their jogging partner. The participants' heart rate in relation to their target heart rate affects the position of the