Original Articles

Reflections on the Design of Exertion Games

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Abstract

The design of exertion games (i.e., digital games that require physical effort from players) is a difficult intertwined challenge of combining digital games and physical effort. To aid designers in facing this challenge, we describe our experiences of designing exertion games. We outline personal reflections on our design processes and articulate analyses of players' experiences. These reflections and analyses serve to highlight the unique opportunities of combining digital games and physical effort. The insights we seek aim to enhance the understanding of exertion game design, contributing to the advancement of the field, and ultimately resulting in better games and associated player experiences.

Introduction

EXERTION GAMES are digital games that require physical effort from players.[1–3] There has been an increasing interest in these games in recent years from both an academic and a commercial perspective because they can offer health benefits[4] and also novel play experiences.[2]

We focus on game design to facilitate engaging play experiences. We argue that designing exertion games is not about (a) designing a digital game, then (b) designing an exertion experience, and finally (c) combining both designs. For example, designing an exertion game cannot begin by developing a digital game, and then consequently adding exertion aspects to it. Similarly, an exertion game cannot be created with an exertion activity in mind, and simply adding a digital game on top. Therefore designing exertion games is challenging because game designers need to consider traditional game (non-physical) design knowledge and physical interaction knowledge. In other words, the complexity of exertion game design lies on the assumption that the physical interaction cannot be considered independently from the game. This explains how we perceive the design of exertion games as an intertwined design challenge.

In this article we offer insights on the exertion game design process based on our experiences of designing and evaluating these games. With this work, we hope to inspire and guide designers who are new to exertion games, are interested in designing them, or want to complement their existing knowledge on the topic.

This article starts with the description of a set of exertion games that show the diverse play experiences available in the field. This is followed by reflections on how specific design decisions contributed to the engaging player experience. We articulate how we derived these reflections based on our analyses of players' experiences. Our reflections are aimed to encourage other people interested in the topic to further explore the opportunities of exertion games. We then highlight a set of design tools that we have developed that are aimed specifically at designers creating exertion games. These tools (i.e., design cards and guidelines) are freely available and have been successfully used in a variety of contexts, and therefore we recommend their use to design exertion games. For example, these tools can be easily incorporated into design workshops and offer the benefit of a structured and proven approach to support the exertion game design process.

Following the descriptions of the tools, we articulate the limitations and highlight the advantages of our approach of reflecting on personal experiences as a method herein. We then describe directions for future work, and we conclude with a discussion on our contributions.

"Musical Embrace"

"Musical Embrace" is an exertion game that explores the use of social awkwardness as an engaging play ingredient.[5,6] In "Musical Embrace" two players are invited to control a sensor-equipped pillow with their torsos in order to collaboratively navigate a virtual world filled with sound sources. The pillow-like controller is suspended from the ceiling to fall at chest height. It is wirelessly connected to a screen that is positioned to the side to display the virtual environment players navigate.

In "Musical Embrace," players first need to collaboratively apply pressure to the four sensors situated on the corners of the pillow-like controller using their torsos. Each

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FIG. 1. ''Musical Embrace'' facilitates bodily interactions. (Color image available online at www.liebertonline.com/g4h)

FIG. 2. ''SweatAtoms'' three-dimensional prints material artifacts representing physical activity. (Color image available online at www.liebertonline.com/g4h)

sensor is mapped to the four directional keys (i.e., up/down and left/right) of the controller. If players apply pressure to the top sensors simultaneously, their viewpoint will move forward. Otherwise, if they apply pressure simultaneously to the bottom sensors, their viewpoint will move backward. Tilting the entire unit to the left or right will rotate the viewport to the left or right, respectively. The use of hands is not permitted; however, in order to intensify the pressure, we encourage players to use their arms to embrace the other player. The goal of the game is to move through the virtual environment with speed and accuracy to collect as many virtual rewards (i.e., coins) as possible. Players are guided to these reward locations through the use of audio cues, which increase in volume as the player moves in the right direction. After a minute, the game comes to a close and the system shows the players' score: the number of in-game rewards collected (Fig. 1).

Reflection: Connecting bodies

The design of ''Musical Embrace'' highlights the opportunity of using technology to connect bodies and support social play[7] as part of the exertion experience. In many conventional console exertion games, such as ''Wii Bowling''[8] and ''Kinect Adventures,''[9] the bodies of the players interact with the game independently from one another. In contrast, ''Musical Em-

brace'' shows how interconnecting the players' bodies and the resulting interpersonal bodily experiences can be a key ingredient of engaging gameplay. In particular, it is worth noting that this interpersonal bodily experience does not always need to be comfortable in order to be engaging, as suggested by Benford et al.[10] The technology used in ''Musical Embrace'' highlights how the design of the game, including hard- and software, can facilitate this interpersonal connection between players' bodies. Although the hardware encourages interacting with the controller from both sides, both players have to coordinate their bodily movements (and how their bodies interact with each other) in order to navigate through the shared virtual world. Prior work has highlighted how technology can connect exertion players over a distance.[1,11,12] ''Musical Embrace'' inspires us to consider the opportunities of technology to connect players' bodies together in order to support a social form of exertion play.

''SweatAtoms''

''SweatAtoms'' is a system that serves as a research vehicle to explore material representations of physical activity
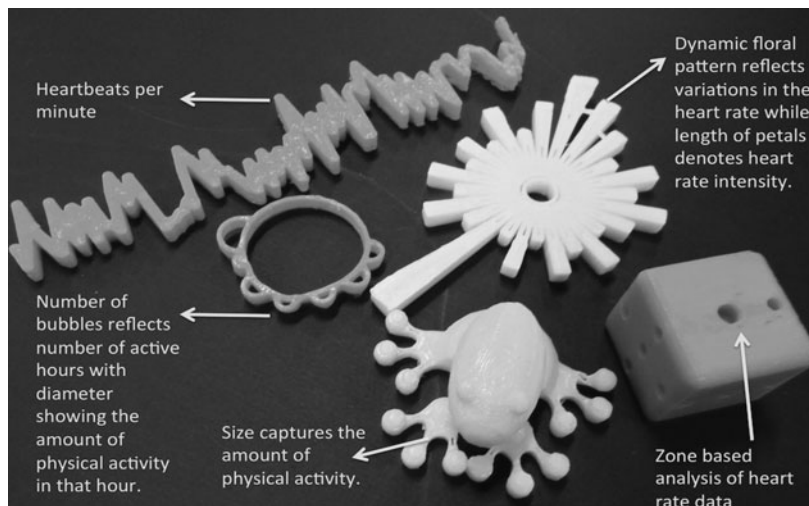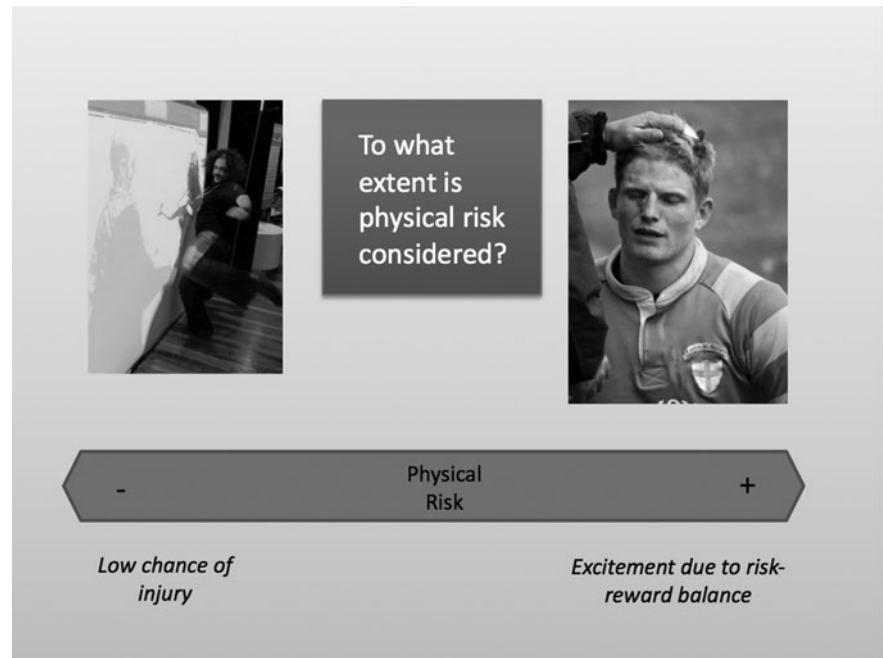

FIG. 3. The five three-dimensional printed representations of heart rate data. (Color image available online at www.liebertonline.com/g4h)

FIG. 4. One of the Exertion Cards that aim to guide the exertion game design process. (Color image available online at www.liebertonline.com/g4h)

in order to enrich the experience of being physically active.[13] Although it is not a game *per se*, SweatAtoms highlights a playful interaction around exertion that offers insights of using technology to support exertion experiences (Fig. 2).

''SweatAtoms'' transforms physical activity data based on people's heart rate into three-dimensional (3D) printed material artifacts. These artifacts aim to form an esthetic and informative expression of physical activity data in material form. We conducted an in-the-wild-study[14] by deploying the system in six households so that participants could experience different material representations of their physical activity for a period of 2 weeks each. Participants wore a heart rate monitor for the entire day, and our software took the heart rate data and at the end of the day turned them into material representations through a 3D printer that we installed in participants' homes. We are drawing on the idea that in about 10 years, everyone will have a 3D printer, and this affords new opportunities for creating not just copies of existing physical objects, but also novel material representations of invisible personal data such as heart rate. Our participants could engage with five different material representations, each highlighting different aspects of the exertion experience (Fig. 3).

The different material representations were as follows: (a) A conventional graph showing the heartbeats per minute; (2) a ring to be used as jewelry, reflecting the number of active hours during the day through its bubble-shaped extension; (3) a floral ornament to be used as decorative item depicting variations and intensity of heart rate; (4) a die showing an analysis based on heart rate zones; and (5) the size of a frog toy depicting the amount of physical activity per day as measured through heart rate.[13] These five items were created automatically every evening using the 3D printer, and we left it up to the participants how they interacted with these material representations. Through interviews, we found that these material artifacts could be used to inspire a new interest in participants' involvement with physical activity. The work

resulted in a set of three design recommendations to support physical activity using material representations: We recommend designers to see these representations of physical activity (1) as an opportunity to form an autotopography,[15] which refers to the understanding of the material artifacts as physical signs to spatially represent the identity of the user, (2) as personalized rewards, and (3) for reflection and reminiscence. With this work, we hope to inspire designers to consider new possibilities afforded by digital fabrication to support users' physical activity experiences.

Reflection: Reliving

''SweatAtoms'' reminds us that technology offers an interesting opportunity to reshape the athlete's engagement with physical activity. For example, a common form of reshaping exertion activities is to write down an athletic achievement, often used to motivate athletes to improve their athletic performance. In contrast, ''SweatAtoms'' reminds us that by capturing exertion activities, as is commonly done with emerging sensor technologies, we have the opportunity to reshape this activity differently, thus influencing how people engage with the physical activity. With our 3D printing system, we reshaped the physical activity affording an engagement in the form of reliving the exertion experience through fabricated physical artifacts.

Tools for Experiencing Our Bodies as Digital Play

In order to aid designers in creating games that allow experiencing our bodies as play, several tools have been developed.

Exertion Cards

The Exertion Cards (Fig. 4) are a set of design cards that are aimed to facilitate the design process.[16] In particular, the Exertion Cards have been successfully used in workshops in order to facilitate the ideation process of exertion games.

Students and professional designers have used the cards successfully in order to generate exertion game ideas.[16]

These cards are available to download and print and are free to use in educational and commercial contexts in order to advance the quality of exertion games.

Movement-based game guidelines

There is also a Web site and accompanying article[17] on movement-based game guidelines, which designers interested in this topic might find useful. These guidelines were developed based on the authors' combined experience of designing exertion games for over 20 years. These guidelines were also refined through the feedback from 14 experts in academic, indie, and commercial game development fields who had experience in movement-based game design. The structure of the guidelines is based on design patterns[18,19] and phrased in hopefully easy-to-remember wording that is appealing to designers. Each guideline includes Do's and Don'ts as well as explanations and examples. The anticipated use of the movement-based game guidelines consists of going through the Web site and examining each guideline with the provided examples and considering whether the current game design idea could be improved by considering the guideline.

In contrast to the Exertion Cards, the movement-based game guidelines are more aimed to ''check'' whether a designer's game idea has followed established principles. The Exertion Cards are more useful in the earlier ideation part of the design process.

We have trialed both tools in combination during a 6-day game design workshop, and the participants seemed to find them very useful for their design process. We therefore recommend that interested designers consider one or both tools in order to support their design efforts.

The URL for the Web site for the movement-based game guidelines is http://movementgameguidelines.org

Limitations

The work described here has the following limitations: First of all, the presented insights are derived from our personal view of the topic because they are based on our experiences of designing exertion games. We believe this personal view can offer beneficial insights, which are not available with other methods of reflection; however, this view suffers from limited external validity.

Second, there have only been limited numbers of exertion games presented. The two games presented tried to describe different contexts in which exertion games can play a role. However, by increasing the number of games, further contributions to exertion game design knowledge could be made. Furthermore, including reflections on other games could also extend the contribution.

Third, this work only brushes the surface of a deeper analysis of the presented games because of space constraints. Such an analysis could, for example, include empirical data or a research through design approach[20] in order to make further contributions.

Future Work

This research can benefit from future works in terms of examining more exertion games to derive further insights.

We encourage other design researchers in the field to undertake a similar analysis to derive a more comprehensive picture of the design of exertion games. Furthermore, additional tools that support designers in additional stages of the design process and through alternative ways and means might also benefit the field. For example, we are exploring the idea of communicating knowledge about the design of exertion games not just through cards and guidelines, but also through playing games. We believe that playing games is one way of understanding games, and can hence lead to better game designs. We are currently investigating ways to make this idea a reality.

Conclusions

In this article, we have presented a set of reflections on the design of exertion games based on the experience of designing several exertion games and the evaluation of players' engagement. The aim of this work is to advance the field of exertion games, and, as such, the reflections aim to serve as guidance and inspiration for designers who consider designing exertion games. This work stems from a personal account of designing these exertion games and therefore suffers from a set of limitations. However, it offers an intimate view resulting in direct and immediate reflective insights that other designers might find valuable. As such, the work does not aim to replace other prior work done in the field, but rather to complement it. In essence, this work aims to guide and inspire designers who are aiming to facilitate change through games, in particular through exertion games, in order to ultimately support players in profiting from the many benefits associated with the resulting experiences.

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