Designing Exertion Interfaces for Health

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CHI 2007, April 28 – May 3, 2007, San Jose, USA
ACM 1-xxxxxxxxxxxxxxxxx.

Abstract
Exertion interfaces deliberately engage people in intense physical effort. Designers of such interfaces should consider ways to measure exertion, especially if their systems have the potential to lead to increased health.

Keywords
Exertion interfaces, exergaming

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces.

Introduction
Nintendo's Wii made its North American debut on 19 November 2006, becoming the first major video game system to emphasize physical movement as its primary mode of interaction. Unlike existing game controllers that control action through button presses, the Wii remotes use a combination of accelerometers and infrared sensors to track their position in 3D space. This allows players to control gaming experiences with physical gestures (along with traditional button pressing). The controller technologies suggest new modes of interacting with virtual worlds. Hitting a tennis ball becomes a matter of swinging the Wii

remote (much as one does in the physical world) rather than pressing a button. Madden 07 players use the controllers to throw passes, intercept plays, and evade opponents. Physical movement is an important and necessary part of many Wii games.

The combination of virtual worlds and physical activity has been referred to as *exergaming* or *exertainment*. A well-known exergame is Konami's Dance Dance Revolution (DDR) where players move to the beat of music by stepping on dance pads that connect to game consoles. Anecdotal evidence suggests that the exertion required to play the game can improve physical fitness. Numerous fan sites can be found on the Web (e.g., www.ddr4health.com, www.getupmove.com) where players describe losing weight after playing DDR for extended periods.

Health researchers have generally thought that extended periods spent playing video games displace time that could be used to engage in healthy, physical activity [8]. However, DDR, Wii games, and similar systems can also be viewed as examples of exertion interfaces, interfaces that promote deliberate, intense physical effort while interacting with computer-based experiences [4]. Studies of DDR have shown such exertion in the form of increased cardiovascular levels during game play [7, 9]. Computer-vision based games have also been shown to yield heart rates comparable with aerobic exercise [2, 3]. In my own pilot study, I played a variety of games using different exertion interfaces for a three month period which led to weight loss and improved blood glucose levels [6].

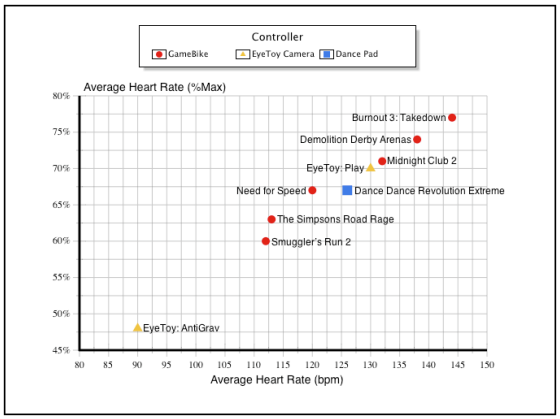

figure 1. Average heart rate in beats per minute and percentage of maximum heart rate for video games and controllers used to play them

I found that different game/controller combinations led to different levels of cardiovascular exertion (Figure 1). For instance, my average heart rate varied from 112-144 beats per minute when playing games with a stationary bicycle controller (Cateye's GameBike). Converting beats per minute to percentage of maximum heart rate shows differences in workout intensity—from light warm-ups to moderate/heavy exercise. This is somewhat surprising since the games were played with the same controller and movements, but personal motivation can lead to increased energy expenditures [5]. More engaging games may lead to more physical exertion.

Issues for the Workshop

If exertion interfaces are meant to increase physical effort, we need to a) quantify what we mean by "exertion", and b) develop techniques for designing

interfaces and environments that motivate physical exertion for long durations.

The first issue, quantifying exertion, may be accomplished by simply measuring average heart rate during game play. But other variables must be considered to track the long-term health effects of exertion interfaces, namely weight, blood pressure, blood glucose, and so on. Integrating physiological measures from wearable sensors into gaming interfaces can be used to collect data for researchers but also become part of the motivation for engaging with exergames. Gamers who are interested in beating previous high scores might find it similarly motivating to achieve higher cardiovascular levels, reduce weight, etc.

Many video games have ways to teach players what to do as they interact with them [1]. Exertion interfaces could incorporate similar techniques to promote health benefits. For instance, warm-up and cool-down activities are recommended by physical therapists to gradually prepare and relax the body before and after extended periods of activity. Building these practices into exergames in fun, motivating ways could decrease potential injuries and increase health benefits.

Similarly, inputs from worn sensors (e.g., heart monitors, continuous glucose monitors) and fitness histories could be used to proactively help players gradually increase fitness over time. For instance, an exergame could adjust its pace to keep a player's heart rate within a designated target range and alert them if they were above or below this threshold.

Exertion interfaces have the potential to increase health by motivating physical activity. How to measure and maintain rigorous levels of exertion remain open questions for interface designers and health researchers. My hope is that we can begin a dialogue on these and other questions during the workshop.

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