Jogging over a Distance: The Influence of Design in Parallel Exertion Games

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ABSTRACT

"Exertion games" are gaming interactions with technology in which users invest significant physical effort. They form part of an emerging phenomenon with many physical and social health benefits, and we believe that the social and exertion interactions are intertwined. Recent technological developments, particularly in the sports and game domain, have been proposed to augment these exertion activities. However, we only have a limited understanding of how this relationship between social and exertion aspects can be successfully facilitated by the design, especially in mediated environments. In this paper, we present initial findings of a qualitative study of "Jogging over a Distance" that illustrate how technology design can facilitate a social game experience despite participants running in opposite sides of the world. From this study, we derived conceptual themes that offer an analytical and descriptive account of the influence of design on the relationship between exertion and social aspects. Our work aims to support the analysis of existing, and provide guidance for, the design of future games that aim to utilize the many benefits of social exertion.

Author Keywords

Exertion Interface, whole-body interaction, exergame, exergaming, physical, audio, spatialization, sports, running, mobile phone, heart rate, physiological data, serious games.

CR Categories

H5.2. Information Interfaces and presentation (e.g., HCI): User Interfaces.

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INTRODUCTION

Over the past few years, a number of computer systems have emerged that place the user's muscles in the centre of the experience, fostering physical exertion as part of the interaction. By "exertion" we mean interactions with technology which require intense physical effort from the user [Mueller et al. 2003]. Computer games currently provide the most buoyant genre for exertion systems. For example, Konami's Dance Dance Revolution [Behrenshausen 2007], Sony's EyeToy [Larssen et al. 2004], Nintendo's Wii [Nintendo] and Microsoft's Natal project [Gamestrailer 2009] have all contributed to a design space that highlights the role of exertion in mediated interactions with technology.

Various benefits, in particular social and physical, are attributed to exertion activities [Weinberg and Gould 2006]. For example, the role of social factors in exertion activities has been investigated extensively from an athlete's perspective, where social facilitation theory suggests that having other human beings join an exertion activity can contribute positively to the experience [Weinberg and Gould 2006].

Sports research has also investigated effects in the opposite direction: that exertion can facilitate social effects. Studies suggest that participating in physical exercise together can facilitate social relationships [O'Brien and Mueller 2007], and that sports activities can contribute to team-building, bonding and social rapport experiences [Weinberg and Gould 2006].

Emerging technology has been proposed to support these social exertion experiences by helping to expand the range of available participants [Mueller et al. 2007b]. Such systems bring geographically distant participants together [Mueller et al. 2003]. However, it is not clear how the intertwined relationship manifests itself in these new

distributed experiences [de Kort and Ijsselsteijn 2008; Lindley et al. 2008], as mediated interactions can have distinct advantages and disadvantages when compared to face-to-face interactions [Thurlow et al. 2004].

We believe that a lack of understanding of the relationship between social and exertion aspects can limit the development of exertion games, preventing users from profiting from the benefits of exertion. In particular, we are interested in understanding the role of design in facilitating this relationship in distributed environments. The purpose of this paper is to contribute to this understanding by investigating the social experience of joggers separated by distance but connected through technology while engaging in an exertion activity.

We describe a study of a system we developed called "Jogging over a Distance" that uses heart rate data and spatialized audio to facilitate a social running experience for geographically distant participants. We present an initial analysis of user data that revealed design themes that provide an understanding of how the mediating technology facilitated exertion and social aspects. Our conclusions describe implications for the design of future games that aim to facilitate social and exertion effects.

BACKGROUND

In our previous work on understanding exertion interactions, we suggest differentiating between "parallel" and "nonparallel" activities [Mueller et al. 2008], inspired by similar notions coming out of investigations towards understanding physical play [Vossen 2004]. Our interest in this paper is in "parallel" exertion activities. A parallel game is a game in which each player performs his or her exertion actions independently from one another, and the players have no direct bodily influence upon the difficulty of the task faced by their opponents, as they cannot directly interfere with one another [Mueller et al. 2008; Vossen 2004]. A typical example from traditional sport is a 100m race. By contrast, in a "non-parallel" game a player can actively prevent the other player from achieving his/her goal. This can also be described in terms of how a player's performance is highly dependant on how the opponent allows him or her to play [Mueller et al. 2008]. A typical example from traditional, non-mediated sports is boxing. In colloquial language, the term 'exercise' is mostly reserved for parallel activities, in contrast to 'sports', which mostly refers to non-parallel activities.

Mediating non-parallel play can support social aspects [Mueller et al. 2009], however, supporting non-parallel play is often not desirable or feasible: not all exertion activities lend themselves to non-parallel interactions, for example we found that our joggers value their activity for lacking any possible physical impact by others that they see can be intimidating, not reciprocally appreciated or dangerous.

As non-parallel play can be a prominent facilitator for social aspects, parallel activities, with their lack thereof, face a unique challenge in offering a social experience to their participants, particularly in distributed environments. In this paper, we focus on the role of design in supporting a social experience in mediated exertion activities, even though they are of a parallel nature.

Designers have explored the role of design by having created mediated parallel exertion games that support geographically distributed participants. For example, the VR exercise bike allows for distributed races in an online environment [Bikeboard.at], and self-reported anecdotal evidence from participants suggest that the heart rate from remote riders motivated them to cycle faster. With the Shakra system [Anderson et al. 2007], where the aim is to increase participants' daily step-count with an augmented pedometer system, social progress exchange was found to be a beneficial aspect that encouraged participants to exercise more. The Fish'N'Steps system [Lin et al. 2006] used peer pressure to encourage increased participation. Consolvo et al. found in another distributed pedometer-based system that awareness of activity and social influence mechanisms are important [Consolvo et al. 2006]. The commercial Nike+ system uses sensors in shoes combined with text chat interactions through an online community of runners [apple.com]. These systems differ from the distributed exercise bike system in that their social support mainly focuses on the experience after the exertion activity occurred, rather than throughout the activity, i.e. the exertion activity and social interactions are often temporally detached, possibly limiting any benefits of their relationship.

Our work aims to extend these studies to contribute to an understanding of how users experience the social elements of parallel exertion games as well as provide insights into the role of design in facilitating these experiences.

Own Prior Work

Previously, we examined the use of location information to enhance exertion performance [O'Brien and Mueller 2007], and audio to support communication between joggers and identified its contribution to the user experience compared to when jogging alone [Mueller et al. 2007a], situating our work between sports and computer games [Mueller 2009]. We have since created a new system, based on feedback from this prior work, and this paper presents the first study of the user experience using this latest exertion system.

JOGGING OVER A DISTANCE

Fig. 1. Jogging over a Distance between Melbourne, Australia, and London, UK.

Approach

In order to contribute to an understanding of the role of design in facilitating the relationship between social aspects and exertion, we present a qualitative analysis of the user experience with *"*Jogging over a Distance*"*.

Our system uses relative heart rate data to control spatialized audio between geographically distant joggers. Our aim is to support social joggers, i.e. people who use exercise to socialize and socialize through the exercise [O'Brien and Mueller 2007]. We acknowledge that not all joggers like to talk when exercising, but for our target group, this is an essential part of the experience [O'Brien and Mueller 2007].

The Jogging over a Distance Experience

With Jogging over a Distance, two jogging partners arrange to run at the same time. Each jogger wears a headset and a wireless heart rate monitor strapped around his/her chest. Each jogger also wears a small pouch around his/her waist, which contains a mini computer and a mobile phone. Before the run, the system prompts users to enter their preferred heart rate for the run, which allows users to specify the physical effort they plan to invest based on their own physical capabilities.

While the participants jog, their heart rate data is sent wirelessly to a server. Each jogger can hear the audio of his/her jogging partner, captured through a microphone on the headset. The participants' relative heart rate data affects the position of the audio in a 2D plane oriented horizontally around the jogger's head.

When both joggers are at their preferred heart rate, the audio appears to come from right next to the jogger, similar to side-by-side. The same applies when both joggers divert by the same percentage from their preferred heart rate, for example, if both joggers raise their heart rate to 110%, the audio stays in the middle. But when the partner's heart rate increases, the audio moves to the front, and when the heart rate decreases, the audio moves behind for the jogger. This way, the jogger is able to detect whether the other person is putting more effort in, the same, or less, based on the relative heart rate to one another. The spatialized audio provides an indication of the relative heart rate of the jogging partner and acts as a guide when a runner needs to speed up or slow down in order to "stay" with his/her partner.

Design

Besides bridging physical distance, the mediating technology also enables participants of different physical capabilities to run together, something collocated joggers have difficulty with. The computer mediates people's relative heart rate, so it appears as if they are starting off running 'side-by-side', even though their absolute speed might be very different. This approach can enable users of different physical capabilities to run together, for example, a marathon runner and a novice, or a person in a wheelchair and a jogger could run together.

STUDY

In our qualitative approach, we used recordings from interview data we conducted with joggers who ran in pairs using Jogging over a Distance. Each run was between 25 and 45 minutes, and interviews lasted between 1 and 2 hours.

Participants

We report on 14 runs. Seven runs were with participants in the same city (Melbourne, Australia), with runners jogging on different paths. The other seven runs were with participants separated by over 16,000 kilometers, where one participant was in Australia (Melbourne) and the other in Europe (UK or Germany). We recruited 17 participants in teams of two, where each pair had prior social relationships: our joggers were either friends or siblings. The participants were recruited through a snowball system and were not compensated monetarily for their efforts. Participants were asked if they knew additional jogging partners they would like to run with, hence six runners ran twice and one participant ran with three different partners.

We asked the participants if they had a preferred heart rate they would like to run at, and if so, entered that as the baseline into the system. If they did not know their preferred heart rate, we provided them with a heart rate monitor before the study to let them determine which rate they would be most comfortable with. Participants were asked to run for as long as they wanted; as our focus was on the experience, rather than the performance, we did not ask them about (or compared our results with) their usual pace, as a result we make no judgment whether the system directly leads to performance improvement.

The participants were between 26 and 44 years old. Seven participants were female and ten were male. Their jogging experience varied from jogging regularly between 2-4 times a week (6 participants), to others running only occasionally (11 participants). During the course of the study, they jogged for an average of 39 minutes using the system.

Data Analysis

We analyzed the interview data using a grounded coding process to identify salient themes. Using an iterative process, we refined our concepts by drawing on the notes we took and created affinity diagrams [Neuman 2006].

FINDINGS

Participants commented that they would enjoy using such a system because it allowed them to catch up with friends while simultaneously helping them to get fitter *[P13, 2nd run]*. The same participant *[P13, 1st]* also commented that such a system could help him save time in his busy schedule as it allowed him to exercise while socializing. In particular, participants reported that they had an experience of "togetherness", indicating that the design facilitated a shared experience: *"It was great, because we jogged together" [P6], "this was almost as good as jogging together" [P9], "this was much better than jogging together, because I never had to slow down and wait for my partner" [P3]*. Our participants experienced a 'psychological sense of togetherness' *("It was good to have him with me, as he made me forget about the jogging" [P9])* as well as a 'kinesthetic sense of togetherness' *("I felt like he was there with me, going through the same pain as I was" [P13, 2])*. This experience of togetherness affected the participants' exertion levels: at least seven participants said they jogged further than they would have if alone: *"Because I could hear him jogging, I kept on running, if I would have been on my own, I would have stopped earlier" [P4]*.

This suggests that an experience of togetherness can be facilitated in mediated environments, even though the exertion activity is of a parallel nature, and that the technology design can play a facilitating role in this. We now describe what themes from Jogging over a Distance contributed to this experience of togetherness, and highlight the role of the mediating technology.

Sharing Pain

The participants pointed out that an important characteristic of jogging is the associated physical discomfort or pain that derives from the endurance they expose their body to: *"In the end, you get tired, and you just do not want to run anymore" [P9]*. However, the participants also noted that experiencing this physical pain together with their partner affected how this pain was perceived: *"Just knowing that someone else is going through the same pain right now makes it more endurable" [P9]* and *"because I could hear that [he] is going through the same pain with me, it made me keep going" [P6, 2nd]*. *"You get such a workout with the system, but the other person distracts you with the talking that you do not even notice it [the pain] that much. And in the end you feel great because of all the work you have done" [P13, 1st]*.

Our participants considered the physical pain associated with jogging a key part of the parallel exertion activity. They accepted the pain because of the positive feeling they anticipated afterwards, and appreciated the sharing of it with their partner, resulting in a perceived reduction of the associated discomfort. This pain and the anticipated positive feeling afterwards are unique characteristics of exertion activities.

Research on the production of endorphins during exercise suggests that the body produces more endorphins when exercising with others, compared to exercising alone, demonstrated by a higher tolerance to pain [Cohen et al. 2009]. This makes pain both a social and bodily phenomenon, and our participants experienced this intertwined relationship through 'a trouble shared is a trouble halved'. The Jogging over a Distance system appeared to be able to convey a social experience that facilitated a physiological response resulting in a perceived reduction of pain, even though the interaction was mediated. From a temporal perspective, this reduced pain could result in increased exercise duration.

Design Implications

In terms of design, the theme of shared pain has social and bodily implications: unlike performance, which has been recommended to being made not always visible for distributed participants to reduce evaluation apprehension [Hagger and Chatzisarantis 2005], the sharing of pain can have positive bodily and social effects, even in mediated environments. In regards to designing computer games, these findings suggest that the players of these games can benefit from being able to access the physiological state of their fellow players: if they are playing side-by-side, they can see the other person is sweating, but in a networked environment, this is not necessarily the case, hence designers should consider how this information could be captured and conveyed to the remote end. Furthermore, after these results, designers of exertion games might choose to see pain not only with a negative connotation, as it can facilitate social benefits.

Facilitating Collaboration

From our previous work on jogging in pairs [O'Brien and Mueller 2007], we expected moments to occur in which the social experience takes on a competitive element by runners subtly 'pushing each other' through slightly increasing their pace, often without explicitly stating it. In this study, however, the 'opposite' mostly occurred: *"I was not pushing myself to the max, as I wanted to be able to hear [him], and I was often waiting for him" [P3, 1st]*. *"It*

wasn't a race" [P2, 3rd]. All but two pairs said that when they heard their partner falling behind, they chose to slow down and wait for their partner: *"I could hear the other person in the back, so I slowed down until I could hear him better" [P11]*. One couple said they also spurred each other on *("Come on, you can do better than that!" [P14])*, but the majority of participants exhibited a collaborative behavior of 'waiting' for the other person by slowing down when necessary.

This does not mean the Jogging over a Distance system did not support competitive running: our last pair engaged in a competitive run, and made in the interview explicit that they utilized successfully the system's capability to support competition and that they enjoyed this competitive run. However, we found the general tendency towards collaborative behavior intriguing, and we propose the following preliminary explanation: Participants often noted in the interviews that they were not as exhausted as they would be when running alone, because they said they often slowed down for the other person. However, when probed about their experience, they often realized that they were also speeding up at times to catch up with the other person: *"You are right, I chose to run up the hill because I wanted to get my heart rate up…Yes, I would have not run up that hill if I'd be on my own" [P2, 3rd]*.

We believe the collaborative behavior was facilitated by the framing of the activity in a social context, but also by the limitations of the deployed technology. Competitive sport often relies on minuscule spatial characteristics: millimeters can make the difference in determining the winner in many athletics competitions [Weinberg and Gould 2006]. This reliance on high-fidelity resolution is hard to achieve in a spatial audio environment, as humans have difficulties identifying sound source locations with high accuracy, especially in a mobile outdoor environment [Marentakis and Brewster 2006]. In a non-mediated side-by-side scenario, joggers can use visual indicators to detect with much higher accuracy when someone is 'pushing' by running ahead. Our preliminary thinking is that the design limited this opportunity, which led our participants to choose more collaborative behavior.

In other words, the technology supported only a limited resolution, compared to a collocated exertion experience, facilitating a sense of ambiguity, which fostered the collaborative aspect of the exertion activity.

Design Implications

Our study shows that spatial characteristics supported by the technology design can foster social aspects such as collaboration. Designers can play with these spatial representations, to nurture a competitive or collaborative character in the interaction. As most conventional sports games are competitive, augmented exertion activities such as computer games might have a unique chance in introducing a new range of interactions with a more collaborative character.

DISCUSSION

We found through analysis of user data that a sense of shared pain can facilitate an experience of togetherness. We also found that technology design might result in the display of collaborative behavior. This extends prior work on mediated games by providing an understanding of the role of parallel and nonparallel activity in facilitating social behavior. Our results can also contribute to our understanding of shared experiences, which is often primarily focused on visual displays [Agamanolis 2003], by extending it to a shared audio space. Our findings can be applied to designs in the field of serious games that deal with exertion, sometimes called exergames, as the concept of pain can play a role in games that require extreme physical effort or want to facilitate a sensation of thrill. Computer game designers can also use our results to inspire more collaborative thinking in the ideation process.

CONCLUSION

This paper has focused on the nature of mediated exertion activities, a topic that has gathered considerable interest over the recent years, as it is believed to have many social and physical benefits. Our aim was to contribute to an understanding of the role of design in facilitating a social experience in a parallel exertion activity. We have presented a qualitative study of a novel distributed jogging system that supports social jogging between distributed runners of different physical capabilities. We found evidence that the technology design can facilitate the relationship between social and exertion aspects. Our work can provide guidance for designers who want to facilitate social experiences by adding exertion to an interaction, or enable social aspects to existing exertion games.

We hope our work contributes to an understanding of the relationship between social and exertion aspects, and what role technology design can play in facilitating this relationship in order to profit from the many benefits of exertion.

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