Design Influence on Social Play in Distributed Exertion Games

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ABSTRACT
Exertion games are an emerging form of interactive games that require players to invest significant physical effort as part of the gameplay, rather than just pressing buttons. These exertion games have potential health benefits by promoting exercise. It is also believed that they can facilitate social play between players and that social play can improve participation in exertion games. However, there is currently a lack of understanding of how to design games to support these effects. In this paper, we present a qualitative case study that illustrates how networked environments support social play in exertion games and how this can help to gain an understanding of existing games and support the design of future games. This work offers a preliminary analytical and descriptive account of the relationship between exertion and social play in such a game and highlights the influence of design with the aim of utilizing the attributed benefits of exertion and social play.

Author Keywords
Design space, Exertion Interface, physical, tangible, videoconferencing, sports, active, exhausting, team spirit, social, interaction.

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

INTRODUCTION
Over the past few years, a number of computer games have emerged that put the user's muscles in the centre of the play experience, requiring physical exertion instead of button presses to control the game. These games – exertion games - require physical effort from the player [27] and are at the centre of a new, popular genre of computer games. From the early arcade game Dance Dance Revolution [2] through Sony's EyeToy [12] to today's Nintendo Wii [42], these games have created an interesting trend in games that involves exertion as part of the play mechanics.

These exertion games have been attributed with various benefits. They are believed to contribute to physical health, addressing the obesity issue by encouraging energy expenditure from its players [15]. Furthermore, facilitating exertion in games is also associated with social play [38, 39], in contrast to the isolated character of traditional computer games [23]. Exertion games are believed to attract a wider audience than traditional 'hardcore' players and facilitate more social game experiences [4, 22]. Exertion games are often played with others [2], and research has suggested that these games can facilitate engagement, but also transfer the quality of the game from "hard fun" to "social fun" [22]. These games are also believed to be particularly suitable for a social context [11]. In sum, exertion seems to facilitate a social play experience.

Given that exertion games resemble sports in a number of ways, most notably in creating a game that involves some form of bodily contest, it should not be surprising that exertion games can also support sociality. After all, it is well recognized that sporting activities also have significant social benefits and sports games are associated with team-building, bonding and rapport experiences [41]. Although sports games can be a complex social phenomenon, through the evolution of sports games humans have learned how to utilize the social effects of sports and how to derive and include social benefits from and into their sports activities [41]. However, exertion games are a new phenomenon, and it is not clear how the associated social benefits manifest themselves in these new experiences [9, 22]. Furthermore, exertion games are often mediated, which poses unique opportunities but also challenges for social play. A lack of understanding of this relationship between exertion and social play can limit the development of games in this area, preventing players profiting from the benefits these new experiences can provide.

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Prior work on exertion games and social play has mainly considered collocated participants. However, networking advances can offer the benefit of expanding the range of available participants, enabling social play with friends and family far apart. Also, traditional computer games have already embraced social play through networked systems [34]. Exertion games might therefore benefit similarly from the advantages of networking technologies. On the other hand, mediated interactions can have distinct advantages and disadvantages when compared to face-to-face interactions [32], it is therefore not obvious if the social benefits attributed to exertion games are necessarily also applicable in such mediated environments. In particular, there is a limited understanding of the role of the game's design in facilitating social play in exertion games. The purpose of this paper is to contribute to this understanding.

OVERVIEW

We begin by describing prior work that laid the foundations for the investigation of social aspects in regards to exertion activity. We then describe our focus of contributing to this topic by beginning to provide an understanding of social play in exertion games through the means of a case study. It is a qualitative case study of "Table Tennis for Three" that describes how users experienced social play in a networked competitive exertion game. We argue that exertion games can facilitate social play, even in mediated environments; however, the game's design plays an important role. Our contribution includes design implications based on the empirical evidence that is aimed at supporting social play in mediated exertion games. We conclude by suggesting a research agenda for future work on the investigation of social aspects and exertion.

RELATED WORK

Theoretical Background

The consideration of social benefits of physical play in interactive systems is grounded in theoretical work on the human body and how it interacts with other embodied beings. Merleau-Ponty lays the groundwork by introducing a perspective that proposed that the mind and the body should not be investigated separately, but rather be seen as intertwined and mutually engaged [25]. He argues that this embodiment is a necessary precondition for social interaction, in which each person is participating in the same embodied existence as the other [25]. This link between sociality and exertion from a perspective of meaning making relates back to Heidegger's view that humans turn action into meaning. The meaning is not inherent in the exertion, but made meaningful through the social context.

Research in HCI has built upon these philosophical investigations: Winograd stresses the social aspect of meaning-making when interacting with the world using computing devices [43], pointing at the existence of a social component inherent in our bodily interactions. Dourish sees embodiment as both physical and social and believes the features of technological systems are related to the features of social settings [10].

Social Play and Exertion

Salen and Zimmerman frame games as social play when the relationships between elements in the game system are considered to be social relationships [34]. Although social play is an indirect, emergent outcome of players' experience with a game, and hence social play cannot be directly designed for, a game's design can contribute to the emergence of social play [34]. Webb et al. take it a step further and argue that affordances for social interactions can be designed for in exertion actions [40] and Gaver argues the physical environment plays a major role in these affordances [14].

Lindley et al. have found that the nature of a game changed when players were doing more than simply pressing buttons, from "hard fun" to more social play [22]. The authors propose that the users' actions were responsible for this change, however, others such as de Kort et al. [9] argue that other factors also have an important role in facilitating social play. Lindley et al. have picked a commercially successful game for their experiment, which might indicate that it had been designed for social play; unfortunately, we do not learn what these design factors are that facilitated social play. Furthermore, as their study only investigated limited exertion, it seems compelling to investigate what effects more severe exertion might facilitate.

De Kort et al. promote embodied play because they believe players have an intrinsic need to experience their physical and social environments kinesthetically [9]. The authors believe that social play can be designed for and propose "sociality characteristics" for games [9]. They are: the presence of others, opportunities for monitoring performance and actions, role and relationship, and interpersonal differences. These characteristics were compiled before Lindley et al.'s study, so specific considerations for exertion activities are missing, although de Kort et al. point out that exertion can "radically" impact social play [9]. Unfortunately, the authors present no empirical evidence for their sociality characteristics. Hoonhout and Fontijn on the other hand report on the design of an exertion game, and confirm that the "source of fun" was the social aspect [16], but give no further insights into how the game's design facilitated it or how it could be mediated.

Fogtmann et al. [13] add a social aspect to the work on free-form movements from Moen [26], arguing it affects competitive and collaborative exertion play differently. Their work extends the player role (competing or collaborating) characteristic from de Kort et al. by including exertion games, however, it does not give insights into the addition of exertion to de Kort et al.'s other aspects.

The consideration of social aspects in exertion activity has been investigated in other domains as well: sports research

has conducted experiments regarding interdependencies between physical activity and social communication to improve performance [41]. Working out together has been attributed with heightened engagement and fun, and it has been described as a facilitator to socialize [31]. Recent exertion studies on obesity intervention in high schools found improvements in students' social skills [33].

Research in sports games suggests many social benefits of exercising with others. However, finding the right exercise partner is not always easy and lack or loss of sports partners can negatively affect participation levels [31]. Telecommunication advances can help people find suitable exercise partners, and some exertion games have emerged that accommodate geographically distant participants. Fish'N'Steps is such an example. It is a mobile application that encourages participation through the use of peer pressure [21]. The proposed system works in combination with a pedometer to motivate an increase of a participant's daily energy expenditure. The system is more a performance measuring device than a game, and although the system supported an anonymous environment to protect the users' privacy, the participants reported that a face-to-face introduction would have been better, as they wanted to know who the other players were, strengthening de Kort et al.'s characteristic of monitoring performance [9].

Shakra [1] also supports physical activity awareness in a mobile setting, and the authors report on the beneficial aspect of competitive progress exchange as encouragement to exercise more. Consolvo et al. presents another distributed pedometer-based system implemented in a mobile phone that allows for social interaction [7]. Based on a study, the authors have identified design requirements. They agree with de Kort et al. that awareness of activity and social influence mechanisms are important, but did not find evidence for other factors.

Synchronous exertion games often include a videoconferencing component to allow for verbal and non-verbal communication, however, not many empirical investigations exist that can provide guidance on what features of a design can facilitate uptake. For example, exercise bikes have been networked to allow for distributed races in a commercial competitive environment. The exertion component appears to offer unique uses of supplementary physiological data to enhance the distributed experience, as participants reported that the heart rate from remote riders motivated them to cycle faster [5]. Breakout for Two is a synchronous exertion game for two players with an integrated video communication channel. An evaluation showed that players had a closer sense of connectedness as if they had played a keyboard-controlled game, and it has been suggested that the life-size videoconference contributed to it [27].

In our own prior work with *Table Tennis for Three* [29], we have conducted a quantitative analysis of player participation and demonstrated that engagement can occur in an exertion game, even if three players play at the same time in different locations, pointing out the unique aspects of three-player play. However, we have yet to investigate the relationship between exertion and social play.

GAP & RESEARCH QUESTION

Prior work suggests that exertion games can facilitate social play. Related work indicates that the game's design can play a contributing role; however, there is a limited understanding of how the design facilitates social play, in particular in mediated environments, as distributed games can extend the opportunities for social interactions. Research designs have suggested design requirements for either exertion games or social play, but have yet to investigate these aspects together in order to provide empirical evidence for a deeper understanding of the issue, considering the unique opportunities and shortcomings of exertion in mediated communication. Our work aims to narrow the gap by investigating the following research question:

How can the design of exertion games facilitate social play, in particular in mediated environments?

APPROACH

We approach the research question by presenting a qualitative analysis of one particular case study. This case study is a competitive exertion game called *Table Tennis for Three*. When we frame Table Tennis for Three as social play, we refer to Salen and Zimmerman's approach that the relationships between elements in the game system are social relationships: the players participate in social play, communicating via game play, "in which a game becomes a context for stylized communication, mediated through social interaction" [34]. Our focus is on the internally derived social interactions, as they emerge from the game's design [34]. By analyzing player data from this case study, we derive salient themes that provide an insight into social play in exertion games. We use them to generate design themes that are aimed at aiding others in analyzing existing and designing new games.

We acknowledge that our focus on one particular case study limits our findings, in particular to competitive synchronous games. However, we believe our results can still serve as a valuable starting point for future investigations to continue building evidence to further support, refine, and add to the described observations. The goal with this focused inquiry is to provide designers with transferable aspects of the application as well as inspire future work, as the field of exertion games is still in its infancy.

TABLE TENNIS FOR THREE

Fig. 1. Table Tennis for Three.

We begin by briefly describing the gameplay of Table Tennis for Three, a tangible game that uses a real ball, bat and table but supports players in three geographically distant locations. For a detailed description and implementation details see [28].

Gameplay

Each player has a ball, a paddle and a table tennis table. The table is set up so that the ball can be hit against the vertically positioned opposite half of the table (Figure 1). This setup is familiar to table tennis players who practice on their own by playing the ball against the board. This backboard has projected images of eight large 'bricks' on it. These bricks are identical for all players, i.e. they are synchronized across all three stations. These bricks are semi-transparent and are projected onto the backboard with a projector mounted to the ceiling. In addition to the bricks, it also projects two video streams of the other players in the game. One player is positioned on the left of the backboard, and the other on the right. Each table has a set of loud speakers and each player wears a microphone so the three participants can converse with each other.

The backboard is equipped with sensors mounted on the back that detect when and which brick the players are hitting (more technical details in [28]). These bricks 'break' when hit by the ball because the sensors register the location of the impact. All three players see the same brick layout and the same brick status. If a brick is hit once, it cracks a little. If it is hit again (regardless of by which player), it cracks more. The crack appears on all three stations (Figure 2). If hit three times, it 'breaks' and is removed from play, revealing more of the underlying videoconferencing: the player 'broke' through to the remote player. However, only the player that hits the brick the third and final time receives the point. This offers players a number of strategies for winning the game.

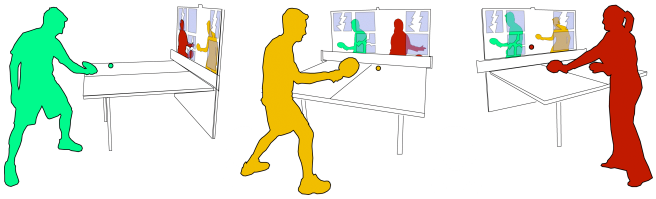

Fig. 2. The blocks are shared across the stations, a hit is visible to all players

The players can either try to crack as many bricks as possible by placing the ball quickly or they can poach points from other players by waiting for the opportunity to snatch away points through hitting bricks that have been already hit twice by the others.

Each brick that is completely broken scores one point, and the running score is displayed along the top end of the projection. Play continues until all bricks have been cracked three times and been removed from play. At this point the player who has scored the most points is announced as the winner and after a delay of 15 seconds, the game resets all the bricks and play can recommence.

STUDY

We are presenting results from a qualitative approach to analyzing the social play of Table Tennis for Three. We used video material of participants playing and interviews we conducted with them after the games. Each team played for at least 30 minutes, however, only one player was recorded at a time. If notable actions occurred on the remote end, this was observed through the videoconference. However, the video from the conferencing system was not included in the analysis. Videotaping the playing in action allowed us to record the social interactions the volunteers engaged in while capturing their exertion actions. The players were brought together into one room after the game, where we conducted detailed interviews with all three of them together. The interviews lasted from 20 to 60 minutes and contained open-ended questions about their experience and their interactions with the other players. We took notes during the interviews as well as videotaped the session.

Participants

Participants were recruited through personal contacts, email lists and word-of-mouth. The volunteers were asked in the advertising material to organize themselves preferably in teams of three. If they were unable to do so, we matched them up randomly with other participants in order to have always three people participating at the same time. We had one last minute cancellation; in this case we replaced the third player with a participant that had played previously. The data of this team was not used in this analysis, hence we report on 39 participants in 13 distinct teams. We

acknowledge that prior social relationships between participants can affect the social play interactions within the game [34], we therefore considered this aspect during the interviews. The participants were between 21 and 55 years old, whereas 26 were male and 13 female. Their previous exposure to table tennis was varied: 1 has never played before, 14 have played less than 5 times, 18 between 5 and 100 times and the rest have played more than 100 times before.

Data Analysis

We analyzed the video data using a coding process based on grounded theory [37] with the help of a database for all the video and analysis data. We acknowledge that such an approach benefits from an open mind towards the data, but as we already had conducted evaluations on related phenomena before, we realize this is hard to achieve, even in generic grounded theory approaches [30], and researchers therefore often use mixed forms when coding data [6]. Consequently, we drew on sensitizing concepts from our previous studies and the relevant literature.

An iterative coding process was used to identify important themes and ideas. We also used the notes and created affinity diagrams to further refine our concepts. Play and interview data was investigated separately first, but then analyzed in terms of mutual theoretical constructs to create a hierarchical set of overarching themes.

FINDINGS

We have identified salient themes of social play within Table Tennis for Three. We describe each by first highlighting instances in the game and then discussing their theoretical relevance before suggesting any design influences.

Exertion and Meaning

Players showed visible signs of exertion during the game, such as wiping off sweat of their foreheads and taking off layers of clothing. Although the players demonstrated that they exerted themselves ("Phew!"), the game did not appear to afford different levels of exertion intensity straightforwardly: based on a player's skill level, she/he most commonly played at an intensity that brought the ball back at a tempo that allowed for easy control. Some players smashed the ball. These smashes did not count more than a regular hit in terms of gameplay, however, players said they used these to send a message to the remote participants.

The game could have encouraged more physical play, as one player noticed. He suggested implementing a function that would break a block twice upon a hard hit, in order to reward more intense exertion actions. As another participant put it, there is "no reward" for playing with much exertion: if a player puts a lot of physical effort into a ball, the ball returns uncontrollably, and has to be collected from the back of the room, costing valuable time and therefore possibly points. He also pointed out that in traditional table tennis, performing a smash comes with a sense of "Schadenfreude", as the other player has to "walk outside the garage, down the street to collect the ball that I have smashed". This Schadenfreude is, although traditionally negatively associated, apparently "often reported as one of the positive elements in social gaming" [9].

Discussion: Exertion and Meaning

Meaning has been used previously in investigations of embodiment, as it is constructed in practical acts of engagement with social and physical worlds [24]. As exertion interactions describe a quality of the interaction, meaning can help us understand this aspect, we believe, because "interaction creates meaning" [18]. Our players associated meaning to their exertion actions, but the meaning was only made meaningful through the social context. The associated meaning arose from the exertion actions the players participated in, reproducing social interaction. The players expressed meaning through hitting the ball with varying intensity, and they also tried to read meaning out of the way the opponents played. Signs of exertion can indicate that one of them is exhausted and might make a mistake. These are all examples of how meaning played an important role in regards to exertion. We found with Dourish [10] that action and meaning is inseparable. Table Tennis for Three could have been extended in this regard: players expressed that they missed additional opportunities to assign and express further meaning, highlighted by the example of Schadenfreude.

Design Implication: Support Meaning Through Exertion

Networked exertion games should support meaning making through exertion. One way of contributing towards this would be by supporting various levels of intensity of the exertion activity.

Metagaming

Users not only demonstrated signs of exertion, but also affective expressions in abundance: Most verbal interactions were of emotional nature and not in relation to play directly, such as swearing, yelling, or dismissing the other player, but sometimes also words of encouragement were exchanged: "You are not trying hard enough!", "I'm going to beat you next time", or "You guys are hysterical!". Most of these verbal exchanges were of a joking nature, with elements of mocking, teasing or "fooling around", characteristic of social sports games [41].

The players supplemented their verbal comments with a gesture, such as throwing their hands in the air to indicate they won. One player jokingly made a fist to the other players, another participant put her tongue out. Players often applauded others on their performance, and some performed little winning dances. This was often accompanied by laughter, facilitating a humorous atmosphere.

The joyful atmosphere carried over into the interviews. The players created a playful atmosphere by joking about their

performance (we recorded 27 instances of loud laughing) and 11 players replayed certain parts of the games by extensively gesturing, which concluded in laughter. In particular, one team patted each other's shoulders and slapped each other comradely several times during the interview. Another team initiated a group hug.

The exertion activity served as a starting point for social interaction, but it also affected verbal exchange negatively. Players sometimes wanted to communicate verbally, but were not able to because they were too exhausted or too engaged in their exertion activity. A player made this explicit by saying "hang on…" when the beginning of a new game interrupted his dialogue. He continued his verbal exchange in the next break of the game after he recovered from his exhaustion.

Discussion: Metagaming

Metagaming is a social play phenomenon that refers to the relationship of a game to elements outside of the game. One way that metagaming occurs "during a game other than the game itself…are social factors such as competition and camaraderie" [34]. Our participants played a metagame by verbally and non-verbally commenting on the other players' performance and turning the game into a social spectacle. Larssen et al. [20] found the notion of "expressive latitude" particularly useful in the context of exertion games to describe such concepts that are not directly influencing the game outcome, but can have communicative aspects.

Another way of metagaming is what a player takes away from the game [34], we observed this in the retelling during the interviews. The retelling of what happened in a game is an important part of a "lived experience" [24]. Players predominantly used their exertion skills in the games, so they drew on these skills again during the reliving of the experience. This reliving of a "pleasurable kinesthetic stimulation" is believed to re-trigger the associated pleasurable emotions [19]. Re-enacting the exertion movements can also support the player's cognitive processes, helping them remembering certain parts of the game [22]. Players gave further meaning to these exertion actions by reliving and sharing them with others, the support for metagaming contributed towards a meaningful social play experience. These exertion actions supporting metagaming are missing in gamepad-controlled computer games, and the players have to rely on their cognitive skills to remember their lived experience and associated affective responses.

We identified another aspect of metagaming that is not considered in traditional games. Exertion can facilitate social interactions, but we have also observed that it can prevent players from engaging in dialogue, often simply because they are out of breath. This led to a social aspect of metagaming 'between games' that was unique to the exertion component of the games. The players in Table Tennis for Three invested physical effort, which lead to muscle fatigue and physical exhaustion. The challenge for the players was to regulate their energy level throughout the game by varying their exertion and using breaks between games to regenerate. Some players extended the breaks created by the game to accommodate their physical health needs; this often resulted in using these breaks for social play activity such as synchronizing start times (see below). The players used the opportunities created by the breaks for social interaction, in which arousal levels were often still high from the exertion activity that preceded them. These breaks can facilitate dialogue as they precede events players can talk about, for example our participants often discussed the last ball played.

Players in non-exertion games also include breaks in their activities. However, we argue that they are not as frequent as in exertion games, and are not motivated by a similar physiological urgency. A computer gamer using a mouse might schedule a break to do some repetitive strain injury-preventing wrist movements, however, its duration and frequency is very different to breaks in exertion games. Players in non-exertion games often *chose* to take a break, these games are not a necessity that their body *demands*. If the players take a break, they want to regenerate from the cognitive demands of the game, in an exertion game, the (cognitive) social interaction is a diversion from the main activity.

Design Implication: Consider the Body in Metagaming

Metagaming during, between and after the games is an important part of social play, and the expressive character of exertion seems to be particularly perceptive to facilitating this. Future designs should support opportunities for metagaming. This can include, but is not limited to, allowing distributed participants to retell the exertion activity with their body. Keeping a videoconference always on can support this. Shorter sets in the game's rules could facilitate breaks for recovery and therefore social interaction.

Synchronized Exertion

Emotional comments such as "I didn't say go (yet)! Stop! Stop! Stop!" or "You are a cheat, you started early!" indicate how the players used the videoconference to negotiate a common starting time for their games. This became a distinct element of social play for many players, accompanied by friendly verbal exchanges and social comments: for example, one player was about to serve and initiated a serving movement, but stopped in-between motion, to provoke a 'false' start, which resulted in loud laughter by all participants.

Discussion of Synchronized Exertion

We have found evidence that the synchronicity of the exertion action the game afforded contributed to the sense of a shared activity. The instance of the 'fake start' illustrates the contribution of exertion to this aspect: exertion actions require kinesthetic movements that include a range of motions [26], for our players it was a backswing,

a forward swing, the contact with the table tennis ball, and the follow through for one hit. Although only the contact with the ball "counted" towards the game, all elements form part of play. A comparison with traditional gamepad-controlled games might highlight the contribution of the exertion component: synchronizing play is more difficult with buttons, as they do not facilitate visible sequential movements (a simple flick with the thumb is sufficient) that remote participants could use as clues to negotiate shared activity, which in turn could lead to social play. However, as Lindley et al. point out, in a competitive game players might not want to reveal too much of their strategy through their movements, and might therefore conceal or perform misleading pre-movements [22], making for a complex set of kinesthetic interactions. This extends prior work by de Kort et al. [9] who suggested that synchronicity can facilitate a sense of the remote person. We have found that including exertion can facilitate social play as it can support coordination efforts that facilitate synchronicity.

Design Implication: Consider Exertion's Movements

Synchronizing exertion actions was an important aspect of social play for our players. This was afforded by kinesthetic movements, which designers could utilize in their designs to facilitate synchronicity. However, in networked games latency might need to be considered.

Uncertainty

Despite the players' best efforts, the ball often went unexpected ways: it hit the edge of the bat, and was diverted in the opposite direction. The ball also often bounced back quicker than expected, but a quick reaction on impulse of the player was able to deflect the ball in a manner that resulted in an unanticipated trajectory of the ball. The ball also often hit the edge of the table, being reflected off it in a surprising angle. Players looked amazed at how some of their hits returned the ball. These surprising situations are characterized by unexpected behavior of the ball that the players with their actions did not intend nor anticipate.

The challenging aspect of controlling the ball with the bat and the associated surprising actions that occurred contributed to the players' enjoyment, which was reflected in their verbal expressions: players often shouted short exclamations such as "yikes!" when the ball flew off in the wrong direction, often followed by a smile. This laughter was then answered with laughs by the remote players, and functioned as conversation starters. Players then switched their attention to the remote end if they heard such a surprise expression.

Discussion of Uncertainty

Unlike other exertion games such as Sony's Eyetoy [12] which uses image recognition to detect exertion actions, Table Tennis for Three exploits the affordances of tangible objects such as the ball, bat and table [10]. For our players, the tangibility of the play objects provided another advantage: it contributed to an uncertainty of play, creating opportunities for surprise. This notion of surprise was appreciated by the players, as it has been previously recognized in physical play [8] and augmented mixed reality games [35]. Our findings in regards to uncertainty contribute to Gaver's claim that the physical environment can provide affordances for social interaction in games [14], and Hornecker's suggestion that "the richness of bodily movement" in combination with tangible interfaces is particularly beneficial for social interactions [17]. Exertion amplified the chances and outcomes of tangibles' uncertainty: tangibility can support uncertainty without exertion; however, the extensive, fast and forceful movements exhibited in exertion play facilitated these surprising moments for our players. These chance encounters created further meaning for the players if they were shared, however, in our example it had to be made explicit through the videoconference, as the sharing mostly occurred through a participant expressing their surprise verbally.

In non-exertion digital game play, these chance encounters need to be artificially introduced as an element of chance is inherent in most games. Game creators have to take special care in finding an engaging balance between believable chance and randomness for the players [34]. For example, in an exertion game such as the Nintendo Wii Sports Tennis, the ball on the screen might also be controlled by an element of chance; but it will be generic, as it will never bounce off the furniture that surrounds the player. It will also not bounce off the racquet's frame in much unexpected ways, but if it does, the experience will be "fundamentally different", as players might not believe the probability by which it occurred, but rather assume a bug in the software [14].

Design Implication: Consider Exertion's Uncertainty

Exertion can amplify uncertainty afforded by tangible objects. Designers should be aware of this, in particular if they are coming from a traditional computer gaming practice and are used to introduce artificial uncertainty. They might also consider sharing this uncertainty amongst the players.

Breaking the Rules

Players adapted rules from traditional table tennis to suit the interactions afforded by Table Tennis for Three. Three teams even referred to table tennis and its rules in the interviews. Even though none of the teams discussed rules amongst each other before the game, they successfully engaged in gameplay by assuming the ball needs to be hit with the bat, cannot be returned volley, etc. Nevertheless, players changed the way they played when an opportunity arose, such as when a player could not return the ball with their bat, but was able to catch it with their hand (we detected 27 instances) to increase their chance of winning.

The players knew that this was 'breaking' the rules, because they pointed it out if they caught someone: a player yelled out loud "You cheat, you are a cheater!" (accompanied by laughter), because a remote player was using their hands, but then this player also used their hands. One player explained that it is hard to play against someone who is better: "You have to cheat, you know, to win".

Discussion of Breaking the Rules

Players appeared to transfer the 'ideal' rules from traditional table tennis to the 'real' rules of what made sense to them in this particular game by implicitly sharing this knowledge. This has been described as transformative social play, in which players actively engage with the rule system in order to shift or extend their relations with other players [34]. The exertion aspect appeared to contribute to this, as it provided a variety of opportunities for 'bending' the rules.

Some of our players showed dedicated player types behavior, such as extra zealousness toward succeeding at the game. Two players were so eager to improve that they asked if they could stay on after the interviews to practice. However, such a strong lusory attitude is believed to be vulnerable to cheating behavior [34]. Salem predicts an increase of this kind of behavior in mediated environments, as "a game is a kind of social contract" and face-to-face interaction implicitly police and enforce proper play, whereas with reduced presence of the other players, invoking the authority of the rules is limited [34].

We agree with Salen and Zimmerman that this aspect of rule-breaking is more likely to occur in exertion games; they attribute it to the "athletic nature" of the game [34]. Salen and Zimmerman compare it to a Chess game, in which a player will not gain advantage by having a little corner of the rook peek into an adjacent square. "But in the infinitely granular space of the real world, milliseconds and millimeters can mean the difference between winning and losing." [34].

Design Implication: Consider Increased Opportunities for Rule-Breaking

Players' active engagement with the rules of a game forms an important part of social play. Players might reshape the game structure by their actions, with positive and negative consequences. Designers need to be aware that both the mediated environment as well as the exertion aspect, two core aspects of mediated exertion games, facilitate such rule-breaking.

Awareness and Exertion Space

We recorded 98 instances where players had to pick up the ball from the floor. Less advanced players often had to interrupt their play to collect a ball. Collecting these balls almost always resulted in the players leaving the capture area of the videoconferencing camera. This often led to scenarios such as this: A player asks over the videoconference "Where did she go?" because the player in question had turned around and walked out of the picture, and it looked as if she was leaving the physical space, effectively ending the game. However, she was just collecting the ball at the side of the room.

This physical moving around affected the interaction between the players. Although the players could still talk to and hear one another via the clipped-on microphone, verbal interactions stopped when they could not see the other person anymore. This often led to a breakdown in conversation. The players then re-established their dialogue when they were back in the picture.

Discussion of Awareness and Exertion Space

A core form of social mechanism used to facilitate social interaction is awareness: people want to know what others are doing and letting others know what is happening [35]. Social awareness can provide a context for physical activities [10].

We use the term "awareness space" to describe the space the videoconferencing camera captures for the remote player, as this space analogy has been previously used in camera-based bodily interactions [11]. The camera space of the videoconferencing component in Table Tennis for Three is static, which led to the effect that the player could step out of the view of the camera, making the user "unsensable" for the camera, to use Benford et al.'s words [3]. When our players were stepping out of this awareness space, they were also leaving the social play space.

We also use the term 'exertion space', borrowing a concept of performance space in interactive art [36] and define it as the physical area the exertion activity is performed in. The exertion space did not match the awareness space in Table Tennis for Three, which affected social play. In collocated exertion games, the exertion space and awareness space are usually interconnected. In distributed games, however, these spaces might be disparate due to technical limitations. In non-exertion games this mismatch might not be significant, as players might not move much. In exertion games on the other hand, players' activities involve many large-scale movements, requiring an extensive exertion space, which might conflict with conventional awareness technology that is aimed at supporting focused awareness cues such as facial expressions.

Design Implication: Consider Awareness and Exertion Space

We have observed that a mismatch of awareness space and exertion space can affect social play. Future designs should consider that these spaces can be disparate in mediated environments. In particular, the exertion space might be larger than the gameplay suggests, as players move around during and in-between games.

OVERALL DISCUSSION

We have found empirical evidence that exertion games can facilitate social play, even in networked environments. Our

results confirm Lindley et al.'s finding that physical play can facilitate more social play, in comparison to button-pressing gaming, in addition, we have contributed to an understanding of how the game's design can play a facilitating role. We have extended prior work that suggests a relationship between exertion and social play by providing empirical data that shows how this can be facilitated. We have introduced the themes of uncertainty, synchronous exertion and meaningful exertion to de Kort et al.'s characteristics of games that can facilitate social play. We have also highlighted how the themes "metagaming" and "breaking the rules" from Salen and Zimmerman's work apply in the context of exertion. These themes formed the basis for our investigations on the influence of design in such games. It should be noted, however, that the proposed design implications are not intended to provide a comprehensive list. We have only highlighted a limited set of concepts, based on data we found in our case study. Other games might reveal additional implications, and not all of them apply to every game. Furthermore, it should be noted that it is the players who create social play which design features can only facilitate [34].

FUTURE WORK

An interesting aspect for further research is the investigation of the role of an audience in mediated exertion interactions. We have observed how exertion can "turn the body into a spectacle", as studies have described the performance aspect of exertion games, highlighting audience negotiation and participation to entice social play [2]. Considering the audience could therefore be a valuable augmentation to our understanding of social play in mediated exertion.

CONCLUSION

We have presented a qualitative analysis of player observations in a mediated exertion game with a focus on social play. We found evidence that exertion games can facilitate social play, even in mediated environments; however, the design of the game can be a contributing factor.

We extended prior work on social play and exertion by highlighting aspects of exertion games that can contribute to social play, which has led us to design themes that can be used to analyze existing and create future mediated exertion games. Our work has implications for theory as it suggests influencing factors for a relationship between exertion and social play. Furthermore, it offers starting points for future work that aims to utilize social benefits in mediated environments, as it can provide guidance on how to include exertion aspects, but also for exertion applications that are currently not supporting social play. Our work might also benefit other domains besides games, as exertion has been demonstrated to support other tasks such as learning.

We hope our work can contribute to a better understanding of exertion and social play and their relationship, furthering the development of this emerging research area and fostering their use in interactive systems to facilitate their benefits.

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