

# Evaluating a Networked Exertion Game

Florian ‘Floyd’ Mueller  
Department of Information Systems  
The University of Melbourne  
Australia

floyd@exertioninterfaces.com

## ABSTRACT

Physical leisure activities such as table tennis provide healthy exercise and can offer a means to connect with others socially; however, players have to be in the same physical location to play. We have developed a networked table tennis-like game that is played with a real paddle and ball, augmented with a large-scale videoconference. In this paper, we are presenting our approach of evaluating “Table Tennis for Three” through the use of questionnaires and interviews with 41 players, with a special emphasis on the bonding experience and physical exertion exhibited. With our evaluation work, we aim to demonstrate that networked exertion games can achieve similar benefits known from traditional physical leisure activity such as exercise, enjoyment and bringing people together to socialize.

## Categories and Subject Descriptors

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

## General Terms

Human Factors, Design.

## Keywords

Table-tennis, ping pong, evaluation, fun, questionnaire, interview, Exertion Interface, physical, tangible, videoconferencing, sports, active, exhausting, sweat, team spirit, social interaction.

## 1. INTRODUCTION

Physical leisure activities, such as table tennis, are an important part of people’s lives. The benefits of leisure activities on personal well-being have been widely discussed: from a mental health perspective, leisure is believed to have a beneficial effect on psychological well-being by promoting positive moods and it can help overcome loneliness [1]. From a physical health perspective, athletic leisure activities contribute to a healthier body, reducing the risk of obesity, cardiovascular disease, diabetes, and more [2][3]. Table tennis in particular is a popular leisure activity, played worldwide by players of all ages and capabilities. Table tennis helps to develop hand-eye coordination,



Figure 1. Table Tennis for Three.

agility and reflexes and can contribute to general fitness [4][5]. Due to its relatively low entry barrier, it can also serve as ice-breaker for social interactions. In fact, research has shown that many of the benefits of leisure are the result of its capability of fostering companionships and friendships [6]. However, the players have to be in the same physical location to play a game.

One way for allowing family and friends in geographically distant locations to enjoy leisure activities together is through networked computer games. These games offer players a shared experience, but often fall short in providing a personal, casual interaction, characteristic to collocated leisure activities. Computer games with their gamepad interaction are often criticized for their support of a sedentary lifestyle and social isolation of their players. In contrast, traditional leisure games support physical and athletic interactions such as jumping, kicking, throwing, and running.

## 2. NETWORKED EXERTION GAMES

To provide an opportunity to maintain connections with long-distant friends and relatives, we have incorporated mental and physical interactions similar to a table tennis game with telecommunication technology to create a new experience that allows participants to enjoy an exerting leisure activity together although geographically apart.

In our previous work *Breakout for Two* [9], we have demonstrated that a physical leisure activity (kicking a soccer ball) can be enjoyed by two geographically distant participants. Our evaluation of this prototype showed that the exerting activity is superior in promoting a social bond between the players compared to a similar mouse-keyboard interaction. With our

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

ACE’07, June 13–15, 2007, Salzburg, Austria.

Copyright 2007 ACM 978-1-59593-640-0/07/0006...\$5.00.

current work, we are aiming to show that the concept combines the advantages of networked computer games (supporting multiple geographically distant players) with the advantages of traditional exerting leisure games (health and social benefits). Our latest prototype demonstrates that this concept scales to three locations easily. In order to test our hypothesis, we have conducted an evaluation using questionnaires and interviews with 41 players, paying special attention to the bonding experience and physical exertion exhibited.

### 3. RELATED WORK

An example of another networked exertion activity experience is *Haptic Arm Wrestling* [10], which is installed in museums across the USA. The device includes a videoconference to arm-wrestle other visitors over the distance, however, no evaluation has been conducted. The *Virtual Fitness Center* [11] is a research project that uses networked exercise bicycles to motivate distributed cyclists; however the authors do not describe a formal evaluation. The *Wii* game console comes with a controller that contains accelerometers to support physical activities in its games. There are currently no evaluations available, however, its worldwide commercial success will lead to evaluation work probably soon. [12]. *PingPongPlus* [13] utilizes a table tennis table: a projection is augmented on the table that reacts to the impact of the ball; however, it supports only two collocated players.

*Airhockey over a Distance* [14] is a leisure game that is playable by players in different locations: it uses a physical puck that is shot out at the remote end by puck cannons. Evaluation using interviews and questionnaires showed a reported sense of “sharing the same table”. *Push’N’Pull* [15] is a networked exercise machine, which the players use as interface for a cooperative game, supported by a high-definition videoconference. It was evaluated during a conference with interviews, in which participants mentioned the lack of force feedback. *Virtual Tug-of-War* [16] is a physical group activity in which two teams were involved in a tug-of-war 13 miles apart from each other; however, no evaluation was reported. Several researchers have built virtual reality [17] and augmented reality versions [18][19] of table tennis. However, they either lack force feedback of the ball hitting the paddle, or are not playable by distributed participants. Furthermore, none of these approaches report on any formal feedback from the players.

### 4. TABLE TENNIS FOR THREE

We have designed a networked game that is based on table tennis, but can be played by players in three geographically distant locations [21]. Although it has different rules than table tennis, the use of a table tennis table and a paddle and ball inspired us to name it *Table Tennis for Three*. Through the inclusion of a videoconference, the game aims to support social interactions between the players. The gameplay is based on the successful elements of *Breakout for Two*, with a focus on the *Exertion Interface* [9], and an extension to three locations. Just like table tennis, it is easy to learn and supports a sense of achievement quickly. *Table Tennis for Three* provides a health benefit by encouraging physical activity and training reflexes as well as hand-eye coordination. However, *Table Tennis for Three* is not aimed to replace traditional table tennis, but rather be the “next best thing” if the participants cannot be in the same location together.

### 5. GAMEPLAY

Each player has a paddle and a ball and steps up to the table [24]. 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. The vertical part of the table is painted white to also serve as projection surface for a videoconference of the other two players. Projected on top of the videoconference are eight semi-transparent targets that players have to hit with their ball. These targets, or blocks, “break” when hit by the players. The blocks are synchronized across the three tables, so the other players see the same block layout and the same block states.

If a block is hit once, it cracks a little. If it is hit again (regardless by which player), it cracks more. If hit three times, it breaks and disappears, revealing the underlying videoconferencing completely: the player has broken through to the remote players. However, only the player who hits the block the third and final time makes it disappear and receives the point. This adds an element of strategy to the game: a player can try to snatch away points by hitting blocks that have already been hit twice by the other player. Each broken block scores one point, and once all blocks are cleared, the player with the most points wins the game.

### 6. EVALUATION

*Table Tennis for Three* was developed to create a sense of social rapport between three people simultaneously, although they are geographically apart. We were therefore interested in feedback from players and hence undertook an evaluation. We were particularly interested in whether the system supports social interaction. Furthermore, we were keen to find out if the system is fun and enjoyable for the players and considered a leisure activity.

#### 6.1 Participants

42 participants were recruited through personal contacts, email lists and word-of-mouth. They 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 in the experiment at the same time.

We had one last minute cancellation; in this case we replaced the third player with a participant that had played the system previously. The data of this player from this second instance was not collected; hence we had 41 distinct survey results.

#### 6.2 Procedure

The three participants were introduced to the game as a group and given a detailed explanation of the game. They were then escorted into three separate rooms which had a game station each. The volunteers had several practice runs with the game and help was always available in case of questions or technical difficulties. They played several rounds, lasting in total between 20 and 30 minutes. The game was followed by questionnaires the players were asked to answer. Subsequently, the three players were brought back together into one room and interviewed as a group about their experience.

### 6.3 Measures

After the participants played the game, they were asked to answer a questionnaire with 94 items. The questionnaire was designed to gain an insight into the players' enjoyment level, their sense of rapport between each other, and how the system can be improved.

Almost all questions were adapted from questionnaires used in related work to strengthen validity, provide consistency and allow for comparisons: Most questions were taken from a questionnaire from Breakout for Two [9], 19 questions were derived from the evaluation work in [8], and 10 questions were items from other previously used questionnaires [7][20][22]; if necessary minimally modified to suit our experimental design.

The questions were presented in random order to minimize a sequence effect. They were also partially negatively formulated, in order to avoid repetitive response patterns, but were inverted again for the analysis (marked with an 'n'). To avoid the Halo effect, instructions were given asking each participant to pay special attention to different contexts posed by each question, as suggested by Rotter [23]. The questions were to be answered on a scale from 1 to 5, ranging from "strongly agree" to "strongly disagree" on a common Likert scale.

Following the questionnaire, the players were asked to take a seat on a couch, where they were interviewed together. The interview lasted about 20 minutes; it was semi-structured and videotaped for future reference. The participants were asked to answer the questions in an informal style and freely discuss them with the observer.

### 6.4 Demographics

The participants were between 21 and 55 years old (arithmetic mean 31.63 years), whereas 27 were male and 14 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 8 have played more than 100 times before. 1 participant played in an organized club. For more than half (53.7%) it has been more than two years since they last used a table tennis paddle.

The participants' general sport participation was also very varied: 5 participate in some sort of sports more than 3 times a week, 10 2-3 times a week, 8 once a week, 10 1-3 times a month, and 7 less than that (1 did not answer).

### 6.5 Results

We analyzed the answers from the questionnaires and calculated correlations with a significant level of  $p \leq 0.05$ . The two outermost responses in the Likert scale were combined for a more easily reportable textual description of the analysis. The detailed findings will be reported in a separate publication, here we summarize the results:

The evaluation with the questionnaire showed that the majority of players had fun, they reported it created a sense of connectedness, and they were excited about being able to play "together", which gave them "something to talk about", although being in different locations. The affordance of the table tennis game allowed participants to quickly engage and interact, and most players (more than 70% for each question) reported that they enjoyed the game, considered it a workout, forgot the world around them when playing, and wanted to play again. However, at least two participants reported on a negative experience and one called it

"annoying". Both players mentioned they had trouble understanding the other players over the limited VoIP audio channel, which was probably one factor that affected their experience. This finding can result in design recommendations for future physical games that span multiple locations.

### 6.6 Interviews

We also conducted interviews to gain a deeper understanding of the players' experiences and their underlying motivations.

The interviews strengthened that exertion can contribute positively to a user's experience. The team who seemed exhausted the most also commented the most about the bonding effect: the game was good for "talking to people ... it gave something to talk about". The participants who showed signs of exhaustion, such as sweaty T-shirts and faster breathing commented that part of their exertion came from picking up stray balls as fast as possible in order to continue playing. If they missed the backboard, they had to collect the balls from the floor and from behind the table. A catching net or similar could provide useful here, they noted. Although winning was not of major concern for the participants, as indicated in the questionnaire, these suggestions indicate that the players took their participation seriously and tried to "be their best", even if this meant breaking a sweat. Future designs should support this notion, and aim to avoid any technological hurdles that can put a hindrance on people's efforts.

Players with previous table tennis experience noted that in order to hit the bricks on the upper row, the participants needed to play the ball high. This is opposite to conventional table tennis, in which the ball is played ideally just above the net in order to give the opponent the least possibility for attack. This observation might indicate that participants compared it to traditional table tennis, and they wanted to practice their skills with the aim of transferring them to the traditional social leisure experience.

The participants also made suggestions on how to improve the gameplay of the system: two teams proposed a game in which the player needs to attack and defend bricks, instead of only attacking them. They also suggested keeping the bricks colored if hit by the opponent, which could serve as simple visual indicator of who is winning, instead of reading the score. The scoring was a game component many participants commented on: it did not seem obvious which score corresponds to which player: displaying players' names instead of "Player 1" could avoid the ambiguity. Some participants commented on the video being more important than the audio, because "people are dancing when they win", which is contrary to the results from the questionnaire, in which the audio was attributed being of higher importance. Several participants noted that they were not able to imagine how such a system could work when they were explained that they will play a table tennis game with three players. However, as one participant expressed it: "...once I started playing, it was immediately clear what I had to do and you don't think about it anymore, you just play and interact".

## 7. CONCLUSION

*Table Tennis for Three* aims to combine the advantages of networked computer games (supporting multiple geographically distant players) with the advantages of traditional exerting leisure games (providing a social and health benefit). We demonstrated

that this concept can scale to three players in three locations. *Table Tennis for Three* aims to provide a social leisure experience, hence our evaluation approach focuses on the components of fun, exertion and social rapport. We have opted to gain feedback from players through a questionnaire, based on previous questionnaire designs centered on leisure experiences, and group interviews. Our results indicate that the system can aid players in creating a sense of social connectedness. This adds support to the claim that physical activity can be beneficial to social interaction. We hope to inspire researchers of other augmented leisure games to evaluate their systems with questionnaires and interviews in order to gain insights that can aid designers of future distributed physical activities.

## 8. ACKNOWLEDGMENTS

This work was initially supported by the University of Melbourne and CSIRO Collaborative Research Support Scheme. We thank Shannon O'Brien, Matt Adcock, Bo Kampmann Walther, Keith Gibbs, Irma Lindt, the IDEAS Lab, the Interaction Design Group and Ivo Widjaja. The picture was taken by Kerin Bryant.

## 9. REFERENCES

- [1] Coleman, D., Iso-Ahola, S.E. Leisure and Health: The Role of Social Support and Self-Determination. *Journal of Leisure Research*, vol. 25, n2, 1993, p111-28
- [2] Pate, R., Pratt, M., Blair, S., Haskell, W., Macera, C., Bouchard, C., Buchner, D., Ettinger, W., Heath, G., King, A., Kriska, A., Leon, A., Marcus, B., Morris, J., Paffenbarger, R., Patrick, K., Pollock, M., Rippe, J., Sallis, J., Wilmore, J. Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *J. American Medical Association*. Vol. 273, No. 5, 1995, 402–407.
- [3] Bauman, A. Three Million Members by 2010. Fitness Australia. [http://www.fitnessaustralia.com.au/\\_uploads/res/243\\_2135.pdf](http://www.fitnessaustralia.com.au/_uploads/res/243_2135.pdf)
- [4] Letts, G. Top 10 Reasons to Play Table Tennis. <http://tabletennis.about.com/od/whyplaytabletennis/tp/reasonstoplay.htm>
- [5] Shriver, E.K. Special Olympics Sport-Specific Sport Skills Program Guide. <http://www.specialolympics.org/NR/rdonlyres/e4zuoyhmp7svermg7yizq5wioqt2575g32gc24l3zu2gj3vqj4nmdql2ne5ibwrktim632pvgfbiighz6gu72yx7tf/Table+Tennis.pdf>
- [6] Coleman, D., Iso-Ahola, S.E. Leisure and Health: The Role of Social Support and Self-Determination. *Journal of Leisure Research*, vol. 25, n2, 1993, p111-28
- [7] Baños, R. M., Botella, C., Garcia-Palacios, A., Villa, H., Perpina, C. and Alcaniz, M. Presence and reality judgment in virtual environments: A unitary construct? *CyberPsychology and Behaviour*, (2000), 3, 327-335
- [8] Lindt, I. et al. (2006) Combining Multiple Gaming Interfaces in 'Epidemic Menace'. In *Proc. CHI 2006*, ACM Press (2006).
- [9] Mueller, F., Agamanolis, S., Picard, R.: Exertion Interfaces: Sports over a Distance for Social Bonding and Fun. In *Proc. CHI 2003*. Fort Lauderdale, USA: ACM Press, USA (2003)
- [10] Gizmag Article: Haptic Arm Wrestling hits the net. (2004). <http://www.gizmag.com.au/go/3562/>
- [11] Mokka, S., Väättänen, A., Väikkynen, P. Fitness Computer Games with a Bodily User Interface. In *Proc. of the 2nd International Conference on Entertainment Computing* (2003). ACM Press (2003), pp 1-3.
- [12] Wii Sports. [http://wii.nintendo.com/software\\_wii\\_sports.html](http://wii.nintendo.com/software_wii_sports.html)
- [13] Ishii, H., Wisneski, C., Orbanes, J., Chun, B., Paradiso, J. PingPongPlus: Design of an Athletic-Tangible Interface for Computer-Supported Cooperative Play. In *Proc. CHI 1999*, ACM Press (1999).
- [14] Mueller, F., Cole, L., O'Brien, S., Walmink, W. Airhockey Over a Distance – A Networked Physical Game to Support Social Interactions. In *Proc. Adv. in Comp. Entert. Tech. ACE 2006*, ACM Press (2006).
- [15] Mueller, F., Stevens, G., Thorogood, A., O'Brien, S., Wulf, V. Sports over a Distance. *J. of Personal and Ubiquitous Computing*, Special Issue on Movement Based Interaction. (2007) DOI 10.1007/s00779-006-0133-0. Springer Publisher.
- [16] New York Hall of Science - Press Room. [http://nyhallsci.org/nyhs-pressroom/nyhs-pressreleases/pr-tug\\_of\\_war.html](http://nyhallsci.org/nyhs-pressroom/nyhs-pressreleases/pr-tug_of_war.html)
- [17] Lawn, M., Takeda, T. Design of an action interface with networking ability for rehabilitation. *20th Int. Conf. of the IEEE Engineering in Medicine and Biology Society*, Hong Kong, 1998
- [18] Bianchi, G., Knoerlein, B., Székely, G. and Harders, M. High precision augmented reality haptics. In *Proc. EuroHaptics'06*, pp. 169-178, 2006.
- [19] Woodward, C., Honkamaa, P., Jppinen, J. and Pykkimies, E.-P. Camball - augmented virtual table tennis with real rackets. In *ACE Singapore*. (2004), pp 275–276.
- [20] Basdogan, C., Ho, C., Srinivasan, M. A., & Slater, M. An experimental study on the role of touch in shared virtual environments. In *ACM Transactions on Computer Human Interaction*, ACM Press (2000), 7(4), 443-460.
- [21] Mueller, F., Gibbs, M. A Table Tennis Game for Three Players. In *OzCHI 2006*, (2006).
- [22] Kim, T., & Biocca, F. Telepresence via television: Two dimensions of telepresence may have different connections to memory and persuasion. In *Journal of Computer-Mediated Communication* (1997), 3 (2).
- [23] Rotter, J. A new scale for the measurement of interpersonal trust. In *Journal of Personality*, Vol. 35, No. 4, Duke University Press, 1967
- [24] Mueller, F., Gibbs, M. Table Tennis for Three – the video. In *CHI 2007, alt.chi* (2007).