Riding a bike in PAPERBOY^{TM}: A case study of embodied human-computer game interaction

Abstract

The impact of different game interfaces on people's game play has, so far, not received much attention in the scientific world. The present paper aims to contribute to a better understanding of the way people and their game play are affected by different game interfaces. A case study has therefore been undertaken to shed some more light on this issue. Two different input devices, a game pad and a modified exercise bike, were used for the game PAPERBOY^{TM}, a game where players control a paperboy on a bike. Preliminary results indicate that people played the game in a similar way, independent of which input device they used. However, the bike seemed to have an influence on the participant's expectations about the kind of interactions it allowed.

Keywords: Game play, gaming experience, embodied cognition

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1 Introduction

Computer games are being approached from a wide range of perspectives, but the actual activity of playing games with the player and her actions in focus has been of little concern to researchers in the past (Ermi & Mäyrä, 2005). According to Aarseth (2003), the player's actions are an essential part of game play activity and these actions are, of course, to a considerable extent shaped by the game interface.

The human use of and interaction with computer-based interfaces has been a continuous issue in various fields of *human-computer interaction* (HCI), but computer games have only in recent years become an issue on the agenda of scientists in this area. However, even if computer games as such so far only have been of minor importance for researchers in the area of HCI, there is a lot of ongoing research in this area which is directly or indirectly connected and of highly relevance to computer game research. In many sub-areas new technology is being tested and developed and behind this technology is the conviction of researchers that bodily experience is a factor not to be underestimated. The underlying intention in areas such as *haptic interaction* (e.g. Ruspini, Kolarov, & Khatib, 1997) and *pervasive/ubiquitous computing* (e.g. Headon & Curwen, 2002) is to develop technology that makes it possible for users to interact with a computer based interface in a way that feels more natural to them – a development that recently also has reached the computer-game society. EyeToy:Play™, for instance, is a collection of games which allows people to interact with its interface in a more natural manner since the interface is rather intuitive and does not require extensive learning or technical skills to be used successfully (the user's motions are captured by a colour- and motion sensitive digital camera device).

The *embodied interaction approach* to HCI put forward by Dourish (2004) can be considered a theoretical foundation for such ideas as it emphasises the embodied nature of human cognition and its impact on people's interaction with software systems. Dourish has very much drawn his inspiration from research in the area of cognitive science. Within the framework of *embodied cognition (EC)* researchers strongly emphasise the role of bodily activity in human cognition (e.g. Varela, Thompson, & Rosch, 1991; Clark, 1997). As Port and van Gelder (1995) put it:

> Cognitive processes span the brain, the body, and the environment; to understand cognition is to understand the interplay of all three. Inner reasoning processes are no more essential cognitive than the skillful execution of coordinated movement or the nature of the environment in which cognition takes place (p. viii-ix).

Traditionally, though, human-computer game interaction is mostly limited to pushing selected buttons on a keyboard or a console in order to control a virtual agent's movements. From a pure cognitive point of view, this is a rather unnatural way to move in and through an environment. It takes some time for people to learn, for instance, the mapping between "pressing the left arrow key" and "turning left". Most people would probably say that it feels quite 'natural' after some time of practice, but being able to control the movements of a virtual agent is not quite the same as being able to play a game successfully. Giving people, on the other hand, the opportunity to use and feel more parts of their bodies than just the tops of their fingers when playing games might substantially increase the performance of gamers. It is thus tempting to argue that people who are given the opportunity to actually walk through the game environment might find it a more intuitive way to interact with computer games. As Weiser (1988) pointed out,

> people live through their practices and tacit knowledge so that the most powerful things are those that are effectively in use [...] so embedded, so fitting, so natural, that we use [them] without even thinking about it.

However, we cannot ignore one important fact. Computer games have been spectacularly successful for around three decades now, despite apparently limited interactions opportunities. Many people playing games display, for instance, a remarkably skilled use of keyboard and mouse. Apparently, successful interactions between player and game take place whenever people get caught up in their gaming activity, regardless of the interaction mode. Furthermore, many games with more 'natural' input devices such as DANCE DANCE REVOLUTION™ or EYETOY:PLAY™ are mainly directed at 'casual players' with little or no gaming experience at all, and in web forums and alike there can also be heard critical voices about these new control systems.

This raises a number of questions about the potential of such kinds of input devices and the quality of interaction that is provided by them. That is, how natural is the interaction with a game interface through input devices such as dance pad and movement-sensitive cameras, and to what extent can the technology be implemented in other game genres? There is only a small number of games with more 'natural' input devices on the market, and all of these games are quite similar in their design and their target audience. Also, there exists very little empirical material providing new insights into how people's play of computer games is affected by different kinds of interaction technology, aside from some notable exceptions in the fields of ubiquitous and wearable computing (e.g. Cheok, Yang, Ying, Billinghurst, & Kato, 2002), and in an area which very much has drawn its inspiration from these fields, pervasive gaming (e.g. Warn et al., 2004; Schrader, Jung, & Carlson, 2005). Further research is therefore necessary to understand what different game interfaces afford to a person in terms of action opportunities and how this affects the player's game play. As Hirose (2002, p. 292) pointed out, "the body may change with tools [and these] changes in the body may alter the observer's action capabilities, and thus the observer must adjust perception of affordances to this changes in order to fit the environment"– be it a real or a virtual world.

2 Case study

With the above discussion in mind, a case study has been undertaken to investigate the impact of different input devices on people's game play in terms of performance, action frequency, and gaming experience. In this study, a modified exercise bike and a common game pad were used as input devices for the single player game PAPERBOY™; one group played the game with the game pad, while another group controlled the game character with the exercise bike.

The object of the game is to control a paperboy delivering newspapers along his route in a suburban neighbourhood. While delivering newspapers to subscribers, vandalising non-subscribers' homes and picking up new newspapers, the player has to avoid various hazards along the street to make it to the next level (Figure 1).

2.1 Method and setting

Participants in this study were 20 undergraduate students between 18 to 30 years. They are enrolled in the computer game development program at the University of Skövde, and all of them play computer games on a regular basis, even though the time spent on games per week varies considerably between them. Games played by the participants include, among other games, FPS games, adventure games, puzzle games, racing games, and strategy games. They usually prefer certain game genres, but all of them are familiar with most game genres on the market. Almost all of the participants played PAPERBOY™ in the past, when they were still kids, but most of them could not really remember what the game was about. All participants could therefore be considered 'untrained beginners'.

The setting used in this study was an apartment-like room in the university's game research lab which roughly corresponds to a common student's living and working environment (Figure 2); the room is equipped with video surveillance cameras to monitor and record user activities. For the bike-group, the sofa and the small tables in front of the TV were, of course, removed.

The participants were divided into two groups with 10 members each and simply informed that the purpose of this study was to investigate human interaction with computer games and that the playing session would be videotaped. A description of the game was available both before and during the playing session; some of the participants made use of it, but most of them preferred 'learning by doing'. Also, after each session, an interview took place and the participants were asked to fill a survey questionnaire. The combination of video recordings, interview, and survey questionnaire was expected to provide a more thorough insight into how the participants' game play was affected by the different input devices. The survey questionnaire included questions asking subjects about strategies used in the game and their opinion about the game in terms of difficulty and experience of fun. During the interview participants had the opportunity to talk more freely about the game and their gaming experience.

2.2 Expected outcome(s)

With Hirose's quote (2002) in mind, the exercise bike was expected to afford action opportunities somewhat different from actions opportunities afforded by the game pad. It seemed likely that players riding the bike would pay more attention to bike-related actions such as avoiding hazards along the street. The delivery of newspapers, on the other hand, was expected to play a less significant role compared to players who controlled the paperboy with the game pad; those in the game pad group were expected to focus more on delivering the newspaper and vandalising non-subscribers homes, because of the placement of the 'newspaper button'. In order to deliver a newspaper they simply had to push a single button on the game pad with their left thumb; they did not need their left thumb for anything else which means they never had to remove their thumb far from the button. Moreover, the game character was 'easily' controlled with the thumb-stick, which people used their right hands for (Figure 3). In the bike's case, on the other hand, people constantly had to switch between the steering axis, the newspaper button placed next to the steering axis' left handle, and the breaks. This made it much more difficult to control the game character (Figure 4). At the same time, people also had to push the pedals of the bike to keep moving.

2.3 Preliminary results and analysis

Preliminary results indicate that there is in fact no significant difference between the groups in terms of *performance* (e.g. "focused on vandalising non-subscribers' homes") and *gaming experience* (e.g. "playing the game was really fun").[1] The mean values in table 1 and 2 show that the participants in both groups ranked possible gaming activities in a similar manner. Both group focused more on activities such as 'scoring as much as possible', 'avoiding hazards along the streets', and 'delivering as many newspapers as possible', and less on activities such as 'exploring the game world' and 'vandalising non-subscribers' homes'. Both groups seemed also to have experienced similar difficulties during the game, which is indicated by the mean values in table 3 and 4. Both groups ranked activities such 'avoiding hazards along the street', 'winning the game' and 'getting new newspapers' as being more difficult than activities such as 'bonus scores' and 'exploring the game world'.

What caught our attention, however, was that the input devices seemed to have an influence on people's expectations about the kind of interaction they allowed. It was difficult to control the game character for both groups, but the bike group blamed the bike rather than the game

[1] The analysis of the video recordings is still ongoing.

while the game pad group, although experiencing similar problems, had a more negative attitude towards the game itself. This suggests that more intuitive input devices for computer games can lead to high user expectations that are difficult to match with the technology available today. The participants in this study were no novices, all of them have plenty of game play experience and are familiar with game pads. Riding a bike when playing a computer game might thus have been experienced as being somewhat odd, even though riding a bike in other, 'real-life circumstances', feels natural for most of them. The familiarity with the game pad and its 'innate' limitations may thus have been a reason why the game-pad group did not complain so much about the input device used, because they knew how a game pad works and how to use it. The bike, on the other hand, was an input device never encountered before in a gaming situation and all people could rely on was their knowledge about bike riding in the real world. Of course, this had to result in disappointment and a certain degree of skepticism among the bike group since a modified training bike connected to a computer so far simply cannot function like a real bike.

It has also become apparent that most of the participants did not like the game very much, which is clearly reflected in their answers on the survey questionnaires (see figure 5 and 6) as well as in their opinions expressed during the interviews. The reason for this is probably largely due to the nature of the computer game used in this study and less related to the different input devices. PAPERBOY™ was developed in the 1980s, a time when it was not possible to save the game status after each playing session. This meant that our participants had to start over the game every couple of turns, a game aspect that became quickly annoying for most of them because they did not really feel like they were making any substantial progress in the game.

3 Conclusions

So far, we know very little about how game play is affected by different input devices. The impact of different input devices on people's game play is an important research area that definitely needs greater academic attention. Further research regarding the impact of different control devices on game play can help us understand the player's actions with regard to a game environment that constantly affords different actions. The differing affordances that exist in both the real and the virtual world are somewhat of a challenge for people because the affordances of both worlds need to be combined for a game to be played successfully. However, many questions still remain, the question of how to approach this issue empirically being one of the most important ones. The presented case study can be considered a step in the right direction, but future research needs to address this question more thoroughly.

References

Aarseth, E. (2003). *Playing research: Methodological approaches to game analysis.* Paper presented at 5th International Digital arts and culture conference, Melbourne.

Cheok, A. D., Yang, X., Ying, Z. Z., Billinghurst, M., & Kato, H. (2002). Touch space: Mixed reality game space based on ubiquitous, tangible and social computing. *Personal and Ubiquitous Computing*, *6*, 430-442.

Clark, A. (1997). *Being there. Putting brain, body, and world together again*. Cambridge, MA: MIT Press.

Dance Dance Revolution. (1998). Konami.

Dourish, P. (2004). *Where the action is. The foundations of embodied interaction*. Cambridge: MIT Press.

Ermi, L., & Mäyrä, F. (2005). *Fundamental components of the game play experience: Analysing immersion.* Paper presented at Changing views: worlds in play, DiGRA conference,

Vancouver, 2005.
EyeToy: Play. (2003). Sony Computer Entertainment.
Headon, R., & Curwen, R. (2002). Movement awareness for ubiquitous game control. *Personal and Ubiquitous Computing*, *6*, 407–415.
Hirose, N. (2002). An ecological approach to embodiment and cognition. *Cognitive Systems Research*, *3*, 289–299.
Paperboy. (1984). Atari Games.
Port, R. F., & van Gelder, T. (1995). *Mind as motion*. Cambridge, MA: MIT Press.
Rambusch, J. (to appear). *The embodied and situated nature of computer game play.* Workshop on the Cognitive Science of Games and Game Play, Vancouver 2006 [Oral presentation].
Ruspini, D. C., Kolarov, K., & Khatib, O. (1997, August). The haptic display of complex graphical environments. *Computer Graphics and Interactive Techniques (SIGGRAPH 1997)*, 345–352.
Schrader, A., Jung, B., & Carlson, D. (2005). *Tangible interfaces for pervasive gaming.* Burnaby, BC, Canada, V5A1S6: Digital Games Research Association, 8888 University Drive, Simon Fraser University, Faculty of Education.
Varela, A. H., Thompson, E., & Rosch, E. (1991). *The embodied mind*. Cambridge, MA: MIT Press.
Warn, A., Benford, S., Goetcherian, V., Åkesson's, K.-P., Söderlund, T., Björk, S., et al. (2004). *iperg position paper.* Second International Conference on Pervasive Computing: Pervasive 2004.
Weiser, M. (1988). *Ubiquitous computing.* Computer Science Lab at Xerox PARC. (`http://www.ubiq.com/hypertext/weiser/UbiHome.html`)

Figure 1: PAPERBOY™ delivering newspapers along a suburban neighbourhood

Figure 2: The setting in which the presented case study took place

Figure 3: Newspapers are controlled with the right thumb, the bike is controlled with the left thumb

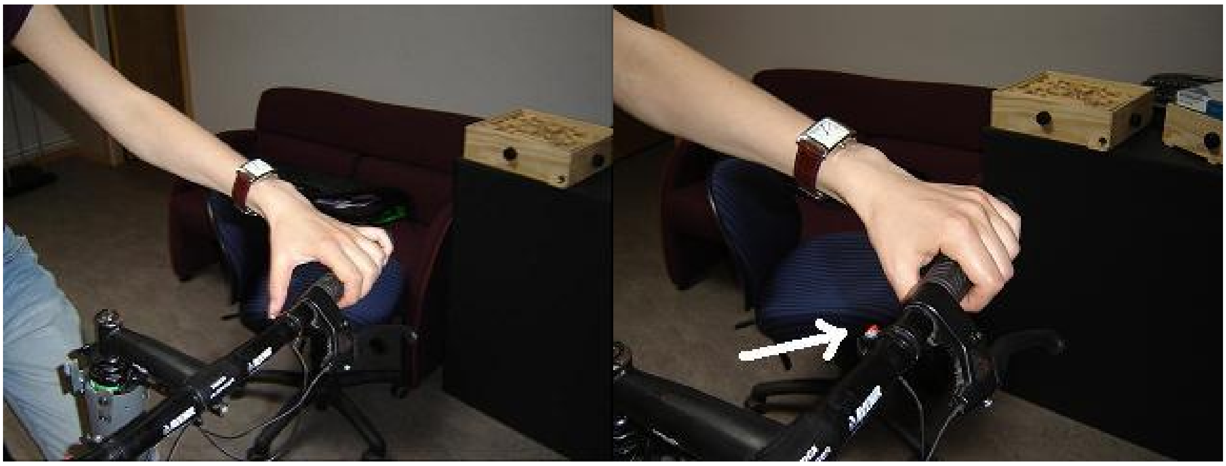

Figure 4: Switching between the steering axis’ left handle and the newspaper button

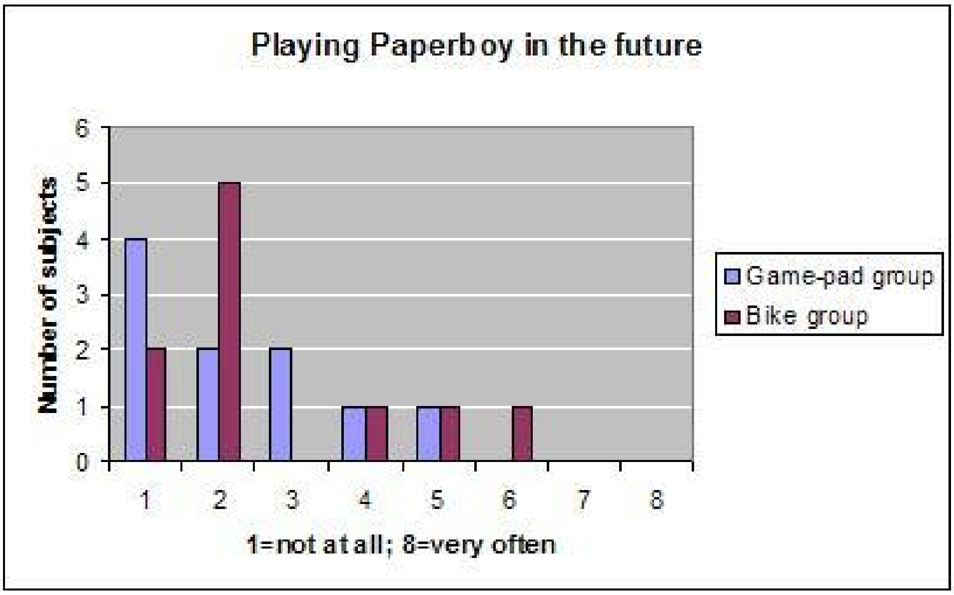

Figure 5: To get a feeling of whether or not the participants enjoyed playing the game, they were asked if they would play the game in the future.

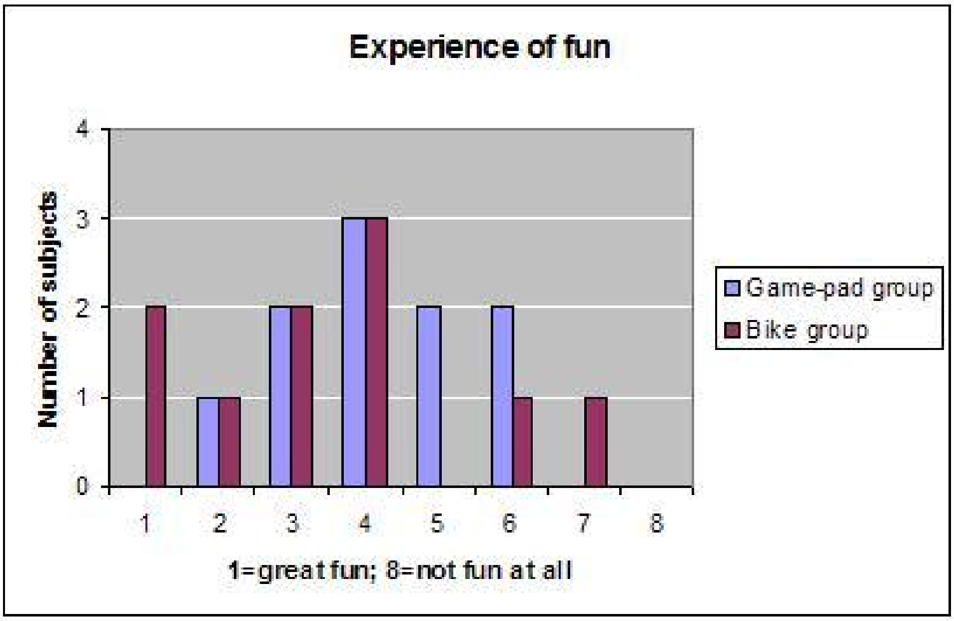

Figure 6: The participants were asked how much they enjoyed playing the game.

Table 1: Strategy ranking – game pad group (1=very important; 8=not important at all)

Activity	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	$\sum$	$\overline{x}$
Avoiding hazards along the street	1	1	2	2	5	1	2	1	6	1	22	2.2
Getting as many scores as possible	3	3	1	1	1	2	1	4	1	7	24	2.4
Delivering as many newspapers as possible	5	2	3	3	3	3	5	6	2	2	34	3.4
Bonus scores	4	5	7	4	7	5	4	3	4	3	46	4.6
Winning the game	2	8	5	8	2	7	6	2	3	5	48	4.8
Getting new newspapers	8	4	4	6	4	4	3	5	7	4	49	5.9
Getting as many new customers as possible	6	5	8	5	6	6	7	8	5	8	64	6.4
Exploring the game world	7	5	6	7	8	8	8	7	8	6	70	7.0

Table 2: Strategy ranking – bike group (1=very important; 8=not important at all)

Activity	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	$\sum$	$\overline{x}$
Avoiding hazards along the street	2	1	1	1	1	1	3	2	3	6	21	2.1
Getting as many scores as possible	1	3	2	3	2	3	2	3	1	5	25	2.5
Delivering as many newspapers as possible	3	2	3	2	3	2	6	4	4	8	37	3.7
Bonus scores	6	5	7	7	7	5	4	5	7	3	54	5.4
Winning the game	4	8	5	8	8	8	1	8	8	1	54	5.4
Getting new newspapers	5	6	4	8	4	6	8	6	5	2	54	5.4
Exploring the game world	7	7	8	8	5	7	5	1	2	4	59	5.9
Getting as many new customers as possible	8	4	6	8	6	4	7	7	6	7	63	6.3

Table 3: Degree of difficulty – game pad group (1=very difficult; 8=not difficult at all)

Activity	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	$\sum$	$\overline{x}$
Avoiding hazards along the street	1	2	1	1	1	1	1	2	4	1	15	1.5
Winning the game	2	1	3	3	4	3	3	1	1	2	21	2.1
Getting new newspapers	8	4	4	2	6	2	2	5	2	4	41	4.1
Getting as many scores as possible	3	4	2	7	5	4	4	4	7	6	46	4.6
Getting as many new customers as possible	6	3	5	4	3	8	7	6	3	3	48	4.8
Delivering as many newspapers as possible	5	3	7	5	2	6	6	3	8	5	50	5.0
Bonus scores	4	3	6	6	7	5	5	3	6	7	57	5.7
Exploring the game world	7	4	8	8	8	7	8	7	5	8	70	7.0

Table 4: Degree of difficulty – bike group (1=very difficult; 8=not difficult at all)

Activity	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	$\sum$	$\overline{x}$
Avoiding hazards along the street	1	1	1	1	1	1	2	4	2	1	15	1.5
Winning the game	2	1	2	2	3	2	6	1	1	2	22	2.2
Getting new newspapers	3	3	3	3	2	3	8	5	4	3	37	3.7
Getting as many new customers as possible	4	4	6	1	7	6	3	3	6	4	44	4.4
Getting as many scores as possible	5	8	5	2	4	8	4	8	5	6	55	5.0
Delivering as many newspapers as possible	8	7	4	3	5	5	1	2	7	8	50	5.0
Bonus scores	6	5	7	2	8	7	5	6	3	5	54	5.4
Exploring the game world	7	2	8	2	4	4	7	7	8	7	56	5.6