Towards understanding engagement in games: an eye-tracking study

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Abstract

Purpose – *The purpose of this paper is to report research undertaken in developing improved understandings of players' interaction and emotional experience of electronic gaming.*

Design/methodology/approach – *The research explores a variety of techniques designed to explore user/player insights into interaction, through consideration of user satisfaction, engagement or immersion. Non-invasive eye tracking technology is used to augment data derived from these more traditional approaches to the assessment of emotional responses. It is postulated by the authors that from this exploration of insights related to usability, improved games level learning and recognition of new inherent revenue opportunities based around in-game advertising, will be better understood.*

Findings – *As the number of participants in this pilot study is small it is perhaps too early to draw firm conclusions from the data collected. However, the study does establish that it is technically possible to configure the eye-tracker and ancillary equipment to record the eye movements of game players. The study has uncovered further areas worthy of investigation such as the influence on eye movement of, player skill and experience, the nature of activities within the game, and the best ways to indicate the importance of key objects within a game.*

Practical implications – *The methodology presented within this paper shows that the application of eye-tracking solutions can be used to evaluate engagement in games. The findings provide interesting and innovative ways for the games designers and in-game advertisers to improve their performance.*

Originality/value – *From an academic perspective, this research is innovative in the way it has developed a methodology for analysis of player engagement within electronic games. This methodology offers valuable insights into game design improvement and in-game advertising opportunities.*

Keywords *Indoor games, E-learning, Eyes, Tracking*

Paper type *Research paper*

Introduction

It can be seen that at least three factors provide the motivation for academic and enterprise interest in the nature of computer games interaction. Computer games are multimillion-pound business; there is growing interest in using games as a vehicle for teaching and learning; and, third, interaction with computers permeates our lives both at work and play.

In a rapidly growing global electronic games market, where the US market alone is in valued excess of $7.4 billion in 2006 (ESA, 2006), new schools of thought point to complementary design features which may create a ''positive'' user experience. Debates centred on learning, satisfaction, engagement and financial business purpose have more recently come to the fore. In a world where physical product designers have recognised for a long time that good product design should also elicit emotional and favourable responses to encourage higher and longer sales, the measurement of players' interaction with a game is becoming an important challenge and future industry sustainability key.

Within the UK, the gaming market is the third largest in the world and is worth more than £2 billion to the UK economy making a £200 million positive balance of trade in 2005 (ELSPA, 2005). The average UK adult woman plays games 7.4 hours per week and the average adult man plays 7.6 hours per week. Far from the stereotypical image of the teenage male the average age of a gamer is 33, with 25 per cent of regular gamers over the age of 50 (ESA, 2006). Furthermore, for about 20 or more years games in digital format have been of interest to academics as a means of enabling learning (Hsiao, 2007); one of their strengths being that they are thought to encourage engagement and immersion:

> Enjoyment and fun as part of the learning process are important when learning new tools since the learner is relaxed and motivated and therefore more willing to learn (Bisson and Luckner, 1996, as cited by Hsiao, 2007, p. 2).

Despite this huge amount of human computer interaction that is taking place there has been little serious research into issues of games design and usability. Several researchers have long argued that usability evaluation needs to go beyond the engineering focus of efficiency and effectiveness stating it is the total user experience that is important (Dillon, 2001; Wright, 2003; Lindgaard and Dudek, 2003). This is particularly so in the evaluation of games where ''fun'' takes precedence over usability. Successful games are assessed by the degree to which they excite, entertain and challenge and many researchers in the field have urged that more must be done to explore players'' experiences and develop evaluation methodologies in order to evaluate the success of techniques deployed (Allen *et al.*, 2003; Desurvire *et al.*, 2004).

How can experience[1] be measured? The obvious answer is to ask the players, but when to do this: as they play? This approach risks their distraction from the game. At the end of the game when memories might have already faded or been re-constructed? To date researchers involved with the assessment of satisfaction have used interviews and questionnaires (Lindgaard and Dudek, 2003) potentially making the results problematic and subjective due to memory degradation and/or rational reconstruction by the user. Marsh *et al.* (2006), describe how, using a combination of a tool based on activity theory and the automated collection of keyboard/joystick activity, they have been able to analyse player experience while playing games. The authors believe that eye-tracking players while they play games with a non-invasive eye-tracker may provide some insights into these questions as well. The reasoning behind this line of thought is that the eye has close links with the brain and models of perceptual mechanisms. The overt visual attention detected by the eye-tracker gives us a window on a player's cognitive systems and has been used to evaluate learning, skill level and cognitive processing (Rayner, 1998; Goldberg and Kotval, 1999; Duchowski, 1995). Further more, eyes have long been associated with emotion (Coan and Allen, 2007). In the field of human computer interaction specific eye movement metrics have been associated with stress and people's assessment of visual appeal of static scene (Renshaw *et al.*, 2005; Renshaw, 2004). Certainly an objective measure of satisfaction which cannot be seriously influenced by the user would therefore be a useful addition to the usability evaluator's tool box.

Although much work has been done in analysing static scenes (Webb and Renshaw, 2008) the study of visual perception of dynamic scenes is inherently more difficult as the objects that are being fixated on are in constant motion. It is therefore difficult to relate the position of the fixation to any particular object without a painstaking visual analysis of the scene. Notwithstanding this difficulty and using data from this study we explore methods for visualising gamers'' experiences of dynamic scenes and for analysing the data statistically.

Eye-tracking is now considered to be a *de facto* standard offering from commercial human computer interaction (HCI) organisations and usability consultants. Eye-tracking as a technique for measuring physiological responses to visual stimuli has the advantage that responses can be recorded in real time and, using the technology referred to in this paper is non invasive. Video and audio recordings, overlaid with recordings of eye movements, are captured and can, by means of event time stamping, be integrated with player keyboard activity for subsequent analysis.

Success in achieving the next game level may depend upon the player locating a specific object visually, using such cue detection devices as saliency, movement, shape, colour and position in the presence of distracters. There is a balance to be struck between challenge and frustration, a player becoming ''stuck''. Can an awareness of the player's visual interaction with a scene of environment identify problem areas and additionally are there eye movement behaviours that can be correlated to the degree of success a game has in avoiding these frustrating situations? Renshaw (2004) counted the number of eye regressions (back tracks to already seen areas) participants made as they worked with static displays. The results seemed to indicate a potential relationship between the incidence of regressions and satisfaction; they found the lower the number of regressions the higher the level of satisfaction. To measure the same things in mobile scenes in games is more complex and will be returned to later in the planned research activity, as an area of new investigation.

In the experiments reported in the current paper it was decided to consider the duration and distribution of fixations. Fixation duration is thought to relate to the cognitive effort being expended; the greater the fixation duration the greater the cognitive effort (Goldberg and Kotval, 1999; Duchowski, 1995) whereas, the distribution of fixations may be of interest to those wanting to generate funding for games development through advertising.

From this research analysis two important features related to the deployment of eye-tracking technology have been identified. First, in the rapidly expanding area of games-based learning the eye-tracking facilities allow us to compare naïve and experienced players and identify learning techniques for successful development in much the same way that video analysis might assist speakers improve their performance. Second, from user gaze analysis, in-game advertising development frameworks can be established to create new business models, akin to pricing policies operated on formula one racing cars, where advertisers pay more for larger and more visible locations. Improved usability, through in-game learning and higher revenue streams through advertising will become increasingly important for games development but at the moment there is little evidence as to their overall effectiveness in advertising. It is important therefore that an attempt be made to work towards new metrics for measuring their effectiveness and ''fun'' (Blythe *et al.*, 2003). This challenge has profound implications for games investors, production companies and designers. They all strive to maximise user acceptance through new interactive narratives, compelling story-telling techniques and exciting game play over an entire game's life-cycle. In an era where production costs, designer team size, and game sophistication continue to increase, applying valuable usability design principles to the game development process early in the production process can lead to substantially financial benefit. Our current work with eye-tracking in games has allowed us to examine and evaluate player's interaction and provide a foundation for further study and business model refinement.

In order to test the ideas described above it was decided to evaluate the players' experiences whilst they played two separate levels of the game *Tomb Raider*. These levels were chosen because even expert players find it difficult to move onto the next level. It was anticipated that eye-tracking may illuminate why this was and that the eye movements may provide indicators of increasing frustration or boredom. Players' reaction to both games was captured during play by aurally asking the players how they felt at one minute intervals increasing to once every second in the last ten seconds of play. Questionnaires were also used to enable triangulation of any eye movement behaviour. The questionnaires captured the expertise and experience of players and their overall level of satisfaction with the last game of the two games they played.

Research objectives

The techniques deployed in this research are designed to provide evaluators with detailed re-playable records of how a player interacts with a game. The research also explores a variety of techniques (including eye tracking) designed to explore user/player insights into interaction, through consideration of user satisfaction, engagement or immersion. It is postulated by the authors that from this exploration of insights related to usability, improved games level learning and recognition of new inherent revenue opportunities based around in-game advertising, will be better understood.

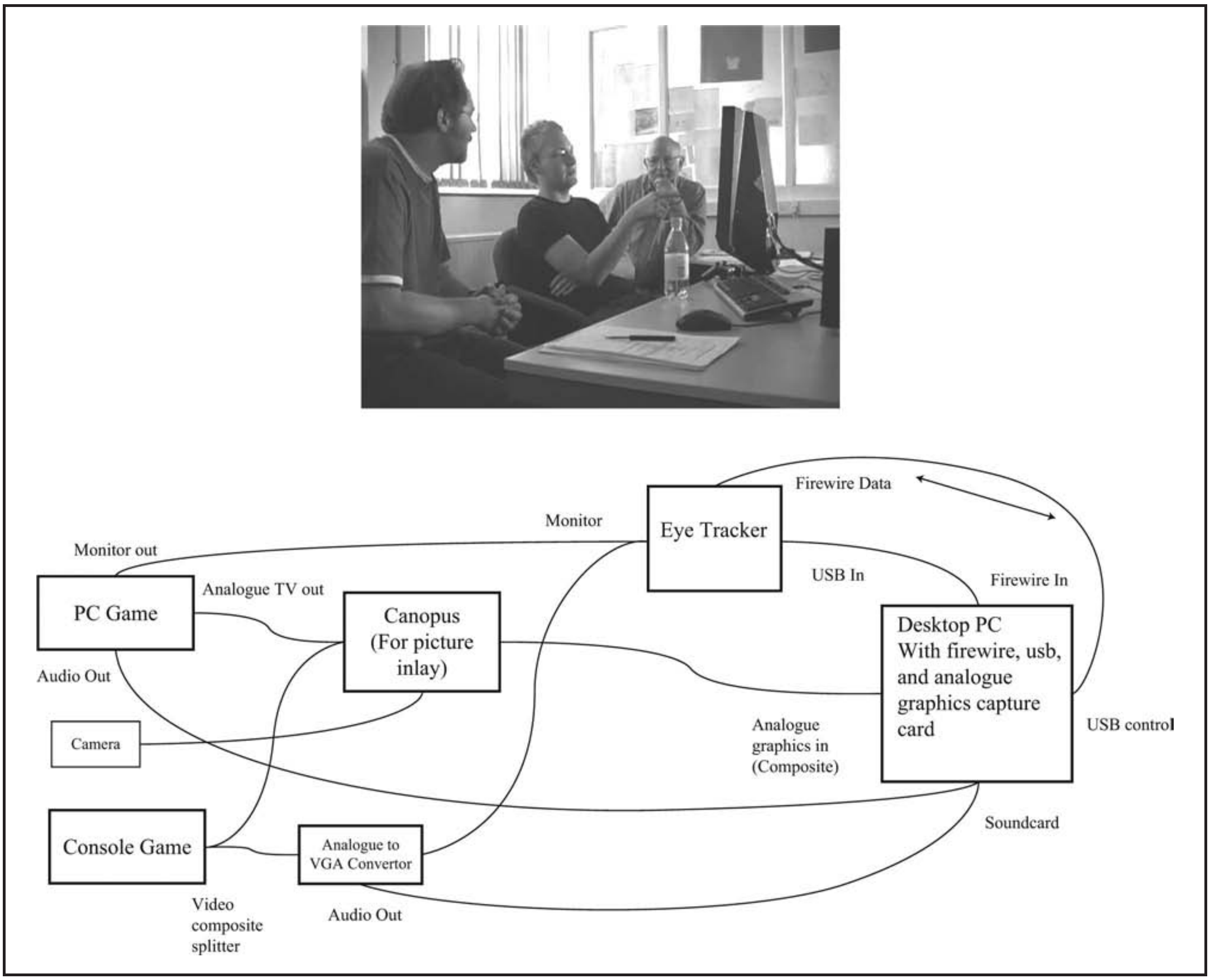
Resources

Tomb Raider levels ''Peru 12 ball puzzle'' and ''England 08 pool area'' were selected prior to the experiment for comparison. These were selected because in the first level ''Peru 12'' there were few attempts to attract or guide the player, whereas in the second ''England 08'' there were more obvious clues given to the players as to where to interact with the scene to proceed forward. Notably a visual highlighting system for interactive objects, and an audio cue intended to specifically direct the players' attention to a specific usable object. Each player played the same game in the same order on a Pentium 4 PC using a Playstation 2 Dualshock game controller. The images were displayed on a Tobii 1750 Eye-Tracker, which can capture eye positions every 50th of a second. The eye-tracking data were collected on a Shuttle Small Form Factor PC. An electronic switching device enabled the rapid switching of display between the games stimulus PC and the eye-tracking PC. The eye-tracking software was configured such that eye positions were aggregated into fixations if they occurred within 40 pixels of each other within 100 ms, the stimulus type used was external video. Figure 1 details the equipment configuration used in the experiments.

Participants

Five participants were selected on the basis of their gaming skills and experience, i.e. the participants were considered to be proficient at game playing. They were familiar with the control interface and conventions of similar ''3rd person action'' games, but were also specifically asked to confirm they had not played the two levels of *Tomb Raider: Legend* used in the experiment. All the participants were male undergraduates, aged 20-29 and educated to degree level. All had previous game playing experience but none had played the game at these designated levels.

Figure 1 Equipment configuration



Methodology

On arrival the participants were briefed in a general way as to the nature of the experiment and the experimental process to be deployed. They all completed a profile questionnaire (Appendix, Figure A1) giving details of themselves and their gaming experience. The Eye-Tracker was then calibrated to each participant's eyes. Prior to each game the participants were informed that they had to solve the puzzle presented by that level. They were also told that during the course of the experiment they would be asked how they felt at regular intervals during the game and that they were to reply using single word expressions such as, fine, great, frustrated, etc. They were not told that the time to solve the puzzle was strictly limited to five minutes, nor that the frequency of probing would increase to one second intervals in the last ten seconds of play. This strategy was employed to assist in building the tension the players were under during the experiment. Timing started from the start of the eye-tracking data recording, the display was then electronically switched to show the game, which the participant then activated.

The responses by the participants to the verbal pole (as to how they were feeling) were recorded manually. After a brief pause for the benefit of the players and to allow the set up of the second level an identical procedure was used for the second game. During both gameplay sessions the players' interactions in the game were captured to video simultaneously with the capture of the eye-tracking data allowing a composite image of both to be made for later visual analysis. After both games had been completed the participants were asked to complete a questionnaire giving details of their feeling about the last game played. Finally an interview was conducted with each player about their experience of playing the second level. During this interview they also had the opportunity to view their interaction in the game along with overlaid eye-tracking data.

Research findings

Analysis of verbal in-play probes

Most participants had difficulty in articulating how they felt as they played the game; ''errs and uhms'' making up much of the responses. However, the most frequently uttered ''proper'' words are reported in Table I. The table shows that frustration was the predominantly stated emotion. However, in the early stages of game play for both games the terms ''interested'', ''easy'', and ''intrigued'' also occurred. Words that are associated with more negative emotions exceed those with more positive ones indicating perhaps pressure experienced by the players whilst being subjected to this mode of emotion gathering.

Table I Frequency of in-play responses

Word used	*Frequency*
Frustrated	15
Bored	6
Confused	5
Lost	5
Annoyed	3
Total count of words associated with negative emotions	*34*
Puzzled	3
Guessing	1
Intrigued	7
Good	3
Wondering	3
Easy	2
Interested	1
Total count of words associated with positive emotions	*20*

Results from the post-evaluation questionnaires

Participants were asked to indicate the strength of their agreement to a series of statements about their experience/feelings about the last game played on a scale of 1 (strongly disagree) to 5 (strongly agree) (Appendix, Figure A2). Data from all seven participants is included in these results. Five participants' scores had a median of 3, 1 of 4 and 1 of 2 (see Table II). The overall interpretation of these scores is that the players had neither a strongly positive or negative feeling about the game.

Analysis of eye movement data

In the first level ''Peru 12'', the initial task was un-stated i.e. the participants were not told what to do. The object of the game was to manoeuvre a large stone ball into one of the three indentations present in the floor texture. This would cause a mechanism to move certain walls and allow the player to progress towards solving the puzzle. Within the first minute of play all the players had identified the ball and the indentation and instigated this mechanism (see Figure 2A).

The further parts of the puzzle required more investigation and some advanced climbing/manoeuvring skills and none of the players advanced much beyond the initial interaction described above. Although they all stated their frustration at some point on this level, it is questionable whether they would do so within a more typically relaxed gameplaying environment. In this instance the addition of eye-tracking overlay does not seem to inform us of anything additional to a normal analysis of gameplay footage, except to confirm the effective saliency of the ball, the clues offered by perceived indentations and the importance of the central character (Lara) as objects with which to interact.

On the second level (''England 08'') a number of indicators and cue were put in place to help the player identify the object that would help them solve the physical puzzle. In order to open the door (A) to the next level, the player must find a large object to rest on the pressure plate (B). The object available is a coffin (C) that is resting on a shelf above the pool area (Figure 3). In addition to the use of visual indicators (twinkling lights) placed on all interactive objects within this level there is also an audio cue that is played when the player enters the box (D) from any direction. The audio cue is as follows:

Table II The time taken (seconds) for the participants to manoeuvre the ball into the floor indentation

Participant	*Time taken to start the ball rolling (seconds)*
1	58
2	27
3	53
4	36
5	39

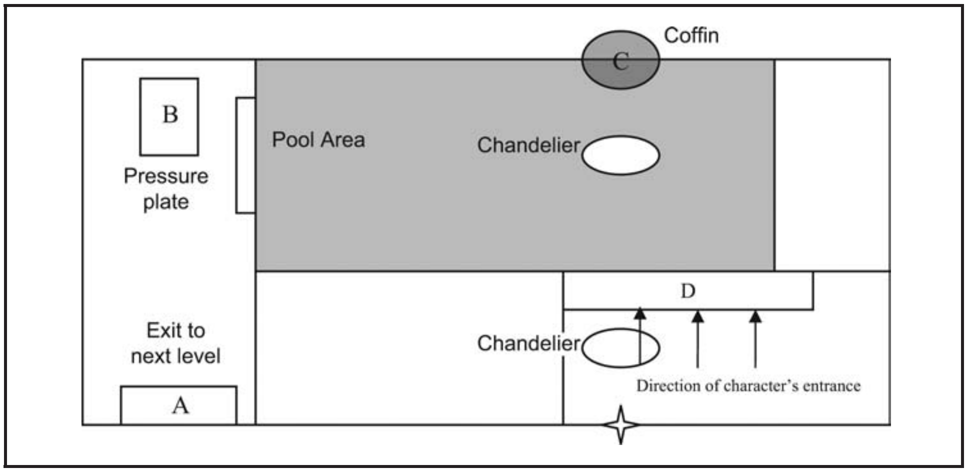
Figure 2 *Tomb Raider Legend*, ''Peru'' and ''England'' levels

A
Peru 12

B
England 08

C
England 08

Figure 3 Schematic of game 2 area



Voice 1: You see that crate up on the shelf over there? You could use that on the pressure plate.

Voice 2: It's not a crate, it's a coffin. Someone's revered ancestor is in there.

It would seem a reasonable expectation that simultaneously with or soon after hearing this advice the player would seek the object being referred to. Indeed during the interview the players all confirmed that this was their sole aim from this point onwards. However, visual inspection of the eye-tacking data determined that only one of the players fixated on this key object and attempted to interact with it. The audio cue only appears to be triggered when entering the area D from the direction indicated by the three arrows i.e. facing the item (C), the coffin, with which the players need to interact. However this overlooks the fact the due to the camera placement the player could be looking in the correct direction (Figure 4) or in fact the complete opposite direction (Figure 5).

This information, uniquely available via eye-tracking, appears to indicate the potential of these techniques in analysing certain game interactions and design issues as the authors had suggested.

Quantitative analysis of the eye tracking movement data

Fixations, their duration and location are the principal output of the eye tracking system. Their recorded attributes are now discussed. An examination of the fixation data collected showed that for two of the seven participants there were significant periods during game play in which eye movements were not captured. It was decided, therefore, to exclude the data from these participants from the quantitative analysis that follows.

The individual mean fixation durations for each player for each game are shown in Table III.

The data show there to be very little difference in the fixation durations of an individual player as they played each game. However, there were noticeable differences in mean fixation durations between players (Table III). Further research will be needed to establish whether these differences are due to skill levels or experience.

A 2 (game) $\times$ 6 (player) repeated measures analysis of variance (ANOVA) indicated no main effect of game [$F(1,4) = 0.076$ sig. > 0.05] but a significant main effect of Player [$F(5,20) = 145.7$ sig. < 0.05] and a significant interaction between game and player [$F95,20) = 6.58$ sig. < 0.05].

The mean values of fixation durations were plotted over time. Figure 6 shows the variation in fixation durations every ten-second time interval for both levels of the game. Overall the mean fixation duration does not vary very much throughout the game as is shown by the near horizontal line of best fit in Figure 6. Data for game 2 (not shown in Figure 6 for the purpose of clarity) show similar traits. A student's *t*-test on the data and showed no significant difference in mean fixation duration between the games (Table IV).

Figure 4 Character looks in the correct direction (at the coffin) at the time of the audio cue

Figure 5 Character looks in the incorrect direction (away from the coffin) at the time of the audio cue

Table III Mean fixation durations (in seconds) for each player for each game

Player	Mean fixation durations in seconds throughout the games: Game 1	Game 2
1	225	239
2	382	346
3	412	490
4	559	533
5	740	639

Figure 6 Variation in mean fixations in ten second intervals for games 1 and 2

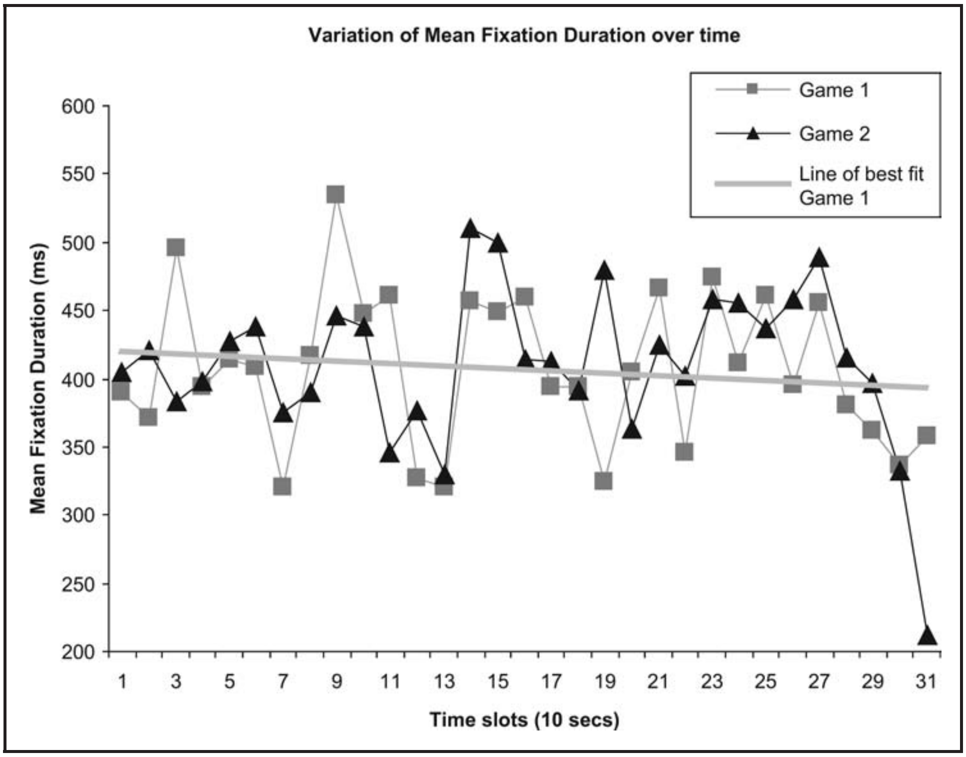


Table IV Comparison of mean fixation durations for games 1 and 2

Game	Mean fixation duration (seconds)	Standard deviation
Game 1	407.4	55.7
Game 2	410.5	58.3

Note: $t = 0.28$ df 30 significance > 0.05

As the graphs in Figure 6 show there are fluctuations in the mean fixation durations from time to time. However, no relationship was found between the variations in mean fixation duration and the timing (once every ten seconds) of the verbal probing as to the participants'' feelings nor was there any significant variation in fixation durations during the ten-second countdown period at the end of each game. To determine a possible cause of these fluctuations a visual inspection of a selection of the higher mean fixations was undertaken. This showed that higher fixations occurred when objects were being steered around in the game or when the character in the game climbed ladders.

Distribution of mean fixation durations over the screen real estate

Reference has already been made to the potential interest of advertisers in this research as knowing where gamers spend their time looking should help advertisers to optimise the placement of their clients advertisement. We therefore examined the spatial distribution of fixations during the game. In static scenes fixations are usually analysed in terms of objects or areas of interest. This is not feasible in dynamic scenes because of the amount of time it would take to manually attribute each fixation for a given time span (e.g. one second) to an object of the game's duration. Instead we looked for an alternative way of addressing this problem. We decided to count the number of fixations falling within a grid of virtual cells across the surface of the PC screen.

The eye-tracker records the position of each eye in terms of *xy* coordinates every 50th of a second. These positions are then aggregated into fixations if they fall within a certain radius of each other, within a certain time. The *xy* coordinates of a fixation are the mean of all the eye positions attributed to that fixation. In order to determine the distribution of fixations over the screen the screen was divided into a 10×8 cell matrix based on the $1{,}024 \times 768$ pixel density of the screen resolution setting. Each fixation was then attributed to a cell in the matrix. For example a fixation with the coordinates 345, 568 would be allocated to cell 46. The total fixation duration for each cell can thus be computed. To standardise the results the proportion of the total fixation duration was computed and the results for both games. There were no fixations recorded in cells where x exceeded 7 or y exceeded 6. It will be noticed that in both games the greatest proportion of fixation durations fall in the central core of the display screen shown by the darkest coloured cell (Figure 7). Data from this central core (highlighted by the black border) was analysed by a repeated measure 2 (game) $\times$ 9 (cell) ANOVA.

The results show a peak in the mean proportion of fixation duration to be in the centre of the screen in the case of both games but with a wider distribution being evident in the case of game 2. A 2 (game) $\times$ 9 (cell) repeated measures ANOVA shows a significant main effect of game [$F(1,29) = 4.226$ sig. < 0.05] and of cell [$F(8,232) = 155.757$ sig. < 0.05] and a significant interaction between game and cell [$F(8,232) = 15.969$ sig. < 0.05]. The approach described above was repeated to include the means of the proportion of fixation durations immediately outside this core area (a 5×5 cell matrix) but no significant differences between the games were evidenced. A 2 (game) $\times$ 25 (cell) repeated measure ANOVA shows no main effect of game [$F(1,30) = 0.008$ sig. > 0.05] but a main effect of cell [$F(1,30) = 133.733$ sig. < 0.05] but no interaction between game and cell [$F(1,30) = 1.974$ sig.0.05].

Figure 7 Distribution of fixations game 1 (left), game 2 (right)

Game 1

Vertical Cell \ Horizontal Cell	1	2	3	4	5	6	7
1	0.0	0.00	0.01	0.01	0.00	0.00	0.00
2	0.0	0.01	0.04	0.06	0.03	0.01	0.00
3	0.0	0.04	0.14	0.34	0.06	0.01	0.00
4	0.0	0.02	0.05	0.11	0.02	0.00	0.00
5	0.0	0.00	0.00	0.00	0.00	0.00	0.00
6	0.0	0.00	0.00	0.00	0.00	0.00	0.00

Game 2

Vertical Cell \ Horizontal Cell	1	2	3	4	5	6	7
1	0.00	0.01	0.01	0.01	0.00	0.00	0.00
2	0.00	0.03	0.09	0.14	0.04	0.01	0.00
3	0.00	0.05	0.15	0.23	0.06	0.02	0.00
4	0.00	0.02	0.04	0.05	0.02	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key: Proportion of fixation duration

- 0.05 - 0.15
- 0.16 - 0.25
- 0.26 - 0.35

For the advertiser this means that the prime location of advertisements would appear to be in the centre of the screen but that the nature of the activity being undertaken by the players is also a factor. Games that demand intricate manipulations of objects or players have a higher concentration of fixations in the centre of the screen than games in which there is a larger element of searching around for objects. In this kind of game the advertising real estate is expanded beyond the centre.

Research conclusions

The data analysed in this experiment come from a very small sample of participants and it is perhaps too early to draw firm conclusions from just a limited series of experiments. However, we list below one or two indicators of where future research may bear fruit.

The capturing of the players' experience in terms of skills before the game, their experiences during play and their answers to post-evaluation questionnaires all seemed problematic and have caused us to rethink the way we assess skill and experience. It has been suggested that instead of asking players to rate their own skill level it would be better rate their skill based on the scores they achieved in a similar game.

Most players had difficulty articulating how they felt while playing; few were able to say in one word how they felt without hesitation. We attribute this to cognitive overload caused by the complexity or the demands of the game rather than some for of inability to reason or express themselves under less demanding circumstances. This phenomenon does indicate the difficulties there may be in determining how players feel using this method and indicates the importance of looking for alternative methods such as eye-tracking or approaches advocated by Marsh (2007).

The eye-tracking results indicated the majority of fixations seem to fall in the centre of the screen but that when players are not involved in controlling moving objects there is evidence that fixations may be more widely spread. We have indicated one way of assessing whether such variations are statistically different. This knowledge might be of interest to those wanting to optimise where to place information/instructions for players.

The post evaluation questionnaire is in its early days of development and the results seem rather neutral. It is not possible to say at this stage if this is a true reflection of the player's feelings.

As well as building on the information derived from these experiments and verifying the process in respect of the analysis of fixation distribution. We intend to further explore how best eye movements can be attributed to significant objects (i.e. in-game advertisements) in games rather than rely on the distribution of fixations over a screen. If this can be automated we believe it will yield more pertinent information about object perception, its timing, the players' understanding and the object's importance. In addition to their use for analysis these techniques, once established, may also yield novel ways of game interaction. This change has created profound implications for games investors, production companies and designers, who strive to maximise user acceptance through new interactive narratives, compelling story-telling techniques and exciting game play which span over an entire game's life-cycle. In an era of increasing production costs and game sophistication applying valuable usability design principles to the game development process early in the production process can lead to substantially financial benefit.

Summary and considerations

The results of this experiment have established that it is technically possible to configure the eye-tracker and ancillary equipment to record the eye movements of game players. Our initial trials seem to confirm that eye-tracking can provide insights with valuable potential application in investigating problematic game design issues and/or confirming the player's identification of particular interactive objects. We have also indicated a methodology, the results from which, measures the extent of the distribution of fixations during game play and its dependency on player activity during game play.

Within the marketing industry, there is growing acceptance that interactive electronic games can and will provide increasingly valuable opportunities for advertising and in-game product placements. This is further supported by the rapid growth if ''total immersion'' games such

Linden Lab's Second Life, where vast numbers of users act as residents within an all encompassing digital world.

The challenge for the paper authors is to expand this emergent methodology to allow the size, placement and content of in-game adverts to be evaluated in terms of user gaze and recollection. Additional work is also required to better integrate the eye-tracker's fixation data with data from the game's software engine in terms of the location and presence of game related objects. Commercialisation of this concept into an effective ''business model'' for the authors, game producers and would-be advertisers, is currently under investigation.

Note

1. The term experience is used here and elsewhere in the paper to encapsulate the concepts of fun, sense of flow, thrill, excitement, frustration and engagement felt by the players as they play a game.

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Appendix

Figure A1 Pre-evaluation questionnaire

Name, Age, Gender
E-mail contact
Education (Please tick the highest qualification achieved):
CSE, A Level, City and Guilds, Degree, Professional/postgraduate

Experience	Computing	Gaming	Games Design
No experience at all			
Basic (little skill, basic options only)			
Intermediate (can perform most tasks competently)			
Expert (do not need any help to perform tasks)			

Frequency of use	Computing	Gaming
Every day		
Weekly		
Monthly		
Occasionally		
Never		

Disability and accessibility needs
Do you usually wear contact lenses or glasses to read a PC display screen Y/N
Do you consider yourself to be disable within the terms of the Disability Discrimination Act 1995? Y/N
If yes does this affect the way you use a computer? Y/N
If yes please state in what way.

Figure A2 Post-evaluation questionnaire

Please indicate how much you agree or disagree with each of the following statements by circling just one of the numbers using the 5 point scale below in which 1 = strongly disagree, 2 = disagree, 3 = neither agree or disagree, 4 = agree, 5 = strongly agree

Ref	Question	Score				
		1	2	3	4	5
1	At times I felt bored					
2	At times there was too much information on the screen					
3	I always knew where to go next					
4	I felt the help information given is not very useful					
5	I felt the layout made finding information difficult					
6	I felt the game responded very quickly					
7	I felt at times the need to get some help					
8	I felt disorientated at times					
9	I really liked the overall graphical design					
10	I felt the layout was consistent throughout					
11	I found the game easy to navigate					
12	I never felt the need to ask for help					
13	I thought the information was relevant					
14	I was disappointed with the overall appearance					
15	I was not sure where to go next					
16	It was easy to forget how to play the game					
17	It was fun to use					
18	Overall, I am satisfied with the amount of time it took to complete the tasks					
19	Overall, I found it difficult to complete the tasks in this game					
20	The information provided was not what expected					
21	I felt the game responded too slowly					

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