Investigating Uncertainty in Digital Games and its Impact on Player Immersion

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Abstract
Players often talk about unpredictability being integral to their gaming experience. Uncertainty in games is a relatively new topic where player reports and existing literature suggest that it plays a key role in making the gaming experience richer. However, there is little to no empirical investigation into how players experience uncertainty, or what additional impacts it may have on player experience. The work reported in this paper serves as a first investigation into measuring uncertainty through the manipulation of game visibility. The outcome of the impact of visibility on player disorientation, serves as an initial validation of the recently published Player Uncertainty in Games four factor scale. However, the lack of impact of the manipulation on immersion, raises new questions as to the relationship between uncertainty and other player experiences.

Author Keywords
Games; Player experience; Uncertainty; Immersion; Disorientation; Randomness.

ACM Classification Keywords
H.5.0 [Information interfaces and presentation (e.g., HCI)]: General - Games

Disorientation
The feeling of being unable to progress in their goals in the game due to a combination of sources such as mechanics knowledge, randomness, analytic complexity or simply being overwhelmed. For example, a player can feel disoriented if they are not sure of how the mechanics work or what are the best strategies to play with. The introduction of random elements, or being overwhelmed by what is happening in the environment could lead to this feeling [20].

Exploration
The feeling where players overcome challenges by discovering solutions towards a goal, either helping them refine the goal or plan actions forward [16].

Prospect
The feeling of having enough understanding of the game world to progress without seeking all details [16].

Randomness
The feeling of less control on the outcome where players leave the results to chance [9].

Introduction

The study of Player Experience (PX) concerns itself with the goals of game designers along with explaining player experiences. Designers want games to be fun as well as deliver a range of emotions and experiences. They want players to be engaged, return for more [7] and in some cases be involved enough to completely lose track of time [12]. While these qualities are very interesting, they are difficult to design for in practice. They are instead goal experiences that have a number of contributing factors.

Caillois [6] says that the outcome of a game should be uncertain in order to be enjoyable. Following a similar line of thought, Costikyan [9] places uncertainty right next to the established ideas of PX and argues about it's importance in defining overall game experiences. He presents 11 sources of uncertainty in games and makes a compelling case that uncertainty contributes to players' experiences making games the popular medium they are today. For example, in *Mario Kart* [15], players are uncertain if they will be able to push the acceleration with optimum timing to get the best start leading to an enjoyable experience. In comparison, games like *Hearthstone* [4] keep players engaged by adding uncertainty in the form of hidden information (what cards will the opponent play). In Lazzaro's 4 keys to fun, she explains how *Easy Fun* is related to exploration and curiosity fostered by different kinds of uncertain scenarios [13]. Analytical challenges and scenarios with multiple outcomes such as the narrative choices in *The Curse of Monkey Island* [14] encourage players to explore, and the uncertainity of the outcome keeps them interested [19]. In general, games can be seen linked to problem solving [1] where uncertainty plays a role in the resolution phase as the players progress towards a solution. In other cases, unpredictability of how AI or other random elements react in the game, raise the stakes and anticipation in the players, such as when the Alien will find you in *Alien: Isolation* [10]. Finally, inherent ambiguity in the game outcomes or the narrative, such as the end of *Mass Effect 3* [3], may leave players guessing long after the game is completed as to what really happened and what it means to them.

The above aruments clearly support Costikyan's line of thought adding validity to the sources of uncertainty. Furthermore, Golman et al. [11] say that people are attracted to uncertainty, with the unknown being enjoyable and Berlyne [2] has discussed curiosity in context of play providing additional weight. However, what is unclear is if all of the above described experiences are the same feeling, and whether those experiences converge or diverge in their contribution to enjoyment or not.

This paper is a first investigation into the feelings of disorientation that players feel in games. This work, manipulates one aspect of a game: the presence of a fog, to dramatically limit the visibility of a player on the playfield. This manipulation is perhaps one of the most simple and effective ways to limit player information and showcase their feelings of rise in uncertainty. In addition, this manipulation explores the validity of a recently proposed measurement tool and attempts to manipulate degree of immersion, a well understood concept.

Factors of Felt Uncertainty in Digital Games
Going beyond the systematic unpredictability, uncertainty holds meaning as a felt experience [16]. Following up on their work in information seeking [17], Power et al. have developed PUG (Player Uncertainty in Games) questionnaire to measure the feeling of uncertainty in games. An initial 4 factor scale have been reported in the work as contributing factors of the overall feeling [16]: Disorientation, Prospect, Exploration and Randomness. These factors are presented in the sidebar.

Uncertainty through the lens of Immersion

Immersion is greatly used to describe how player's feel [5] and to measure PX [12, 18]. It has been called as an experience of deep involvement in a game, during which players forget about their everyday concerns, lose track of time and become less aware of their real world surroundings [12]. Jennett et al. [12] have produced an extensively validated questionnaire which measures total immersion. Immersion being a big part of PX, makes an interesting first viewpoint from where uncertainty's relationship with PX can be looked at.

This study's hypothesis is that considerably restricting player's field of view in a well understood game genre of survival shooters will lead to higher disorientation. Disorientation should considerably overlap with randomness in the chosen circumstances. Prospect and exploration should remain more or less the same due to the clarity of mechanics and goals in the genre. The intention of finding uncertainty's relation with immersion is rather exploratory however from the above literature, immersion should not be negatively impacted by high uncertainty.

Study

This is a single experiment with a two step inference process where step 1 aims to determine the change in uncertainty by restricting game visibility whereas step 2 aims to explore the relationship between uncertainty and player immersion. It is a between participants experiment where players were asked to play a game, with one group having clear visibility and the other group with restricted visibility of the game. The player reaction was then studied using questionnaires and noting impromptu verbal reactions.

Method

Participants

31 participants - 3 female and 28 male were recruited via online platforms - Facebook, Messenger, Skype and Slack. The average age of the participants was 31(sd = 4.9), with the youngest player being 24 and the oldest being 45. All of the participants recruited had played shooters before and were familiar with the game genre and controls. Four participants reported they were out of touch yet familiar with the genre. None of the participants had previously played the chosen game.

Material

The game picked for the experiment was a third person survival shooter *Nightmares* [22], a *Unity* [21] tutorial modified to suit the experiment as a browser game. In this game, the player plays as the main character who has to shoot little stuffed toy zombies attacking it to score high points. The player has to shoot them before they 'kill' him by coming in close proximity. Nightmares was chosen because it has 2 very basic actions including moving and shooting, making the game easy to pick-up and play. Along with this, the goals of a simple shooter like this one is obvious for target players making the prospect clear. Music and sound effects were switched off in both conditions. The game was made to quit itself after 90 seconds and the players were to play for the entire length, the character would instantly re-spawn if it died within this time limit. The length of game was chosen to be 90 seconds to mimic standard short sessions of CounterStrike [8] .

Uncertainty data was collected using a 31 questions long PUG questionnaire with a 5 point Likert scale [16] and immersion data was collected using the Immersive Experience Questionnaire (IEQ) [12] .

Figure 1: Game with clear visibility. In the control condition, players could see the entire game world (vignette component = 0.25 [23])

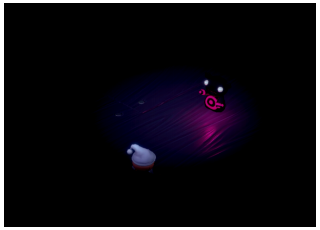

Figure 2: Game with restricted field of view. In the experimental condition players could only see a very small circular area around the main character (vignette component = 0.98 [23])

Game Conditions

The game was prepped for 2 conditions (shown in Figure 1 and 2)for the primary hypothesis that limiting game visibility would increase disorientation in players. Since the concept of disorientation revolves around the feeling of players feeling lost in a situation, the experimental condition was prepped to create a dense environment. In this game, the player cannot see much beyond their character. Not knowing where the zombies are coming from or how far they are given the dense black fog around the player's character would make the player's feel lost. In contrast, in the control condition the player's could clearly see the whole screen giving them a good indication of how much danger the character is in at every point and where are the safe points to hide. Different levels of vignette image effect [23] in *Unity* was used to introduces darkening and blur starting from the edges and corners of the image. Other than the black fog surrounding the player in the experimental condition, there was no difference between the two games.

Procedure

The study was a between participant design, where two different groups of participants played the two different versions. Participants were recruited online with the researcher conducting a remote synchronous study, interacting virtually with them throughout the process. The reason for recruiting online was to have more ecological validity and make sure participants do not answer questionnaires under any pressure. Participants were given an information sheet and asked for their consent and demographic details (age, gender). They were then provided with instructions to the play the game followed by the game URL and asked to immediately report after they had witnessed the 'Game Over' screen. Players were asked not to practice the game, this was done as the game controls should be familiar to the chosen participants and giving away any information would tamper with uncertainty data. Players were advised to keep a mouse and keyboard ready to start the game and find a relatively quiet zone for about 10 minutes. Players were given 90 seconds to play and report back to the researcher. Questionnaires for Uncertainty and Immersion(IEQ) were filled out by the players one after the other. The questionnaires were alternated to make sure the experiences are captured evenly for both components.

At the end of this, players were given a silent period of 2 minutes as a chance to add to their experience via chat. This is was not initiated by the researcher to make sure that the players are emoting out of their natural instinct rather than external probing. This was followed by a debriefing of the study.

Results

Firstly, it is examined whether changing the game visibility impacted uncertainty. The primary hypothesis being restricting player's visibility in a basic survival shooter will lead to disorientation. It was understood that randomness could overlap with disorientation while prospect and exploration would not show much difference. Summary of the results can be read from Table 1

Disorientation

The results supported the hypothesis and disorientation in the condition with low visibility was found to be significantly higher (see Figure 3) than when the players could see the game world clearly, demonstrated by a two- tailed t-test ($t = -3.63$, $df = 29$, $p = 0.001$) and the effect size defined by Cohen's d being 0.65. This can be explained as it is completely expected for players to feel lost and overwhelmed when they can hardly see where the enemies are coming from and where in the map can they move to.

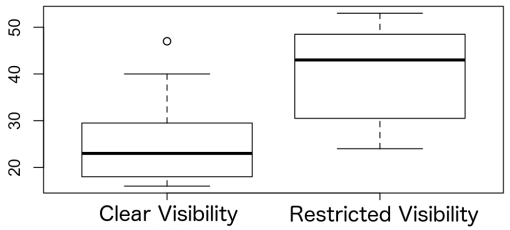

Figure 3: Disorientation with clear visibility and restricted visibility.

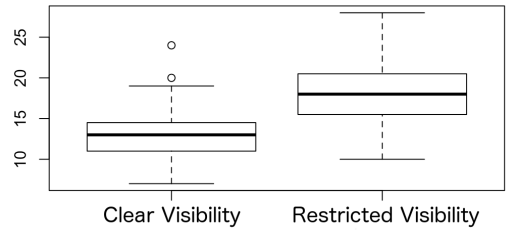

Figure 4: Randomness with clear visibility and restricted visibility.

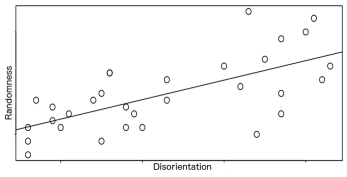

Figure 5: Correlation between Randomness and Disorientation. (r^2 = 0.44)

Randomness

Randomness also significantly changed between the two conditions (see Figure 4) as shown by the two tailed t-test (t = 2.86, df = 29, p = 0.007) and Cohen's d = 0.51. This can be explained by the strong correlation between randomness and disorientation(r^2 = 0.44) as can be seen from Figure 5. Understandably, in the game condition where the enemies approaching can't be seen, players believe they just randomly appeared from nowhere without being able to reason with it.

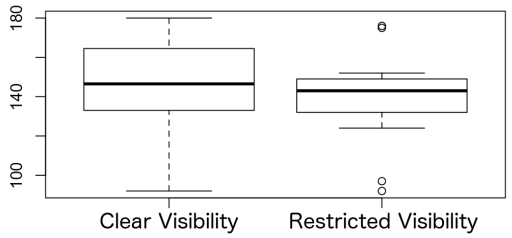

Figure 6: Immersion with clear visibility and restricted visibility..

Exploration and Prospect

As expected, Exploration and Prospect did not show any significant difference due to genre familiarity. Prospect (t = -1.3, df = 29, p = n.s). Exploration (t = 0.99, df = 29, p = n.s).

Immersion

In step 2, the relationship of uncertainty and immersion was studied. This was done by seeing the change between total immersion in the experimental condition (with restricted visibility) versus the control condition(with clear visibility). This was more exploratory in nature, however from the literature it was hoped that immersion should not be negatively impacted by the increased disorientation and randomness. There was no significant difference (see Figure 6) found in total immersion with or without uncertainty confirmed by a t-test (t = -0.51, df = 29, p = n.s.).

Discussion

For uncertainty, the results support the hypothesis. Results collected using the 31 questions PUG clearly indicate that considerably restricting game visibility, (enemy locations, hiding positions etc.) the disorientation component of uncertainty increases significantly. The correlation between

	Clear Visibility		Restricted Visibility		t(29)	p	d
	Mean	*Std.Dev.*	*Mean*	*Std.Dev.*			
Total Immersion	143.75	26.2	139.2	23.1	0.5	0.613	0.089
Disorientation	26	10.4	39.73	10.5	-3.63	0.001*	0.65
Exploration	21.8	5.3	23.8	5.8	-0.99	0.327	0.178
Prospect	18.37	5.8	15.8	4.4	1.3	0.179	0.234
Randomness	13.4	4.3	18.4	5.2	-2.87	0.007*	0.515

Table 1: Summary of results of the game played with and without clear visibility.

disorientation and randomness was predicted in the chosen experiment thus randomness also significantly increases. This is quite a positive outcome, especially given that the chosen players were familiar with shooter games. A number of the players enjoyed the challenge of the game, with one saying "*yeah, very small view field but still fun*" and another giving a suggestion for the limited field view version - "*personally, this one could be a mini-game*". This, along with self-reports, tends to indicate familiarity with this type of game and knowledge of how to play. As such, one might have expected them to be able to adapt to the limited view and rely on their knowledge to completely overcome the uncertainty introduced, the results tend to indicate this did not happen. While it is important to confirm this with alternate players unfamiliar with the genre, this is a good indicator that uncertainty was indeed altered and that the disorientation and randomness sub-scales capture facets of it as the game was controlled in all other aspects and it was made sure that players were certain about game objectives and controls. Having said that, this study cannot yet be generalized beyond simple shooters and needs further validation on other game types with better gender distribution where possible.

The game genre familiarity of the participants may explain the the lack of change in immersion. It could be the case that players in the reduced visibility condition still had a good experience due to their prior knowledge, and thus were able to achieve a state of immersion even with limited information. Alternatively, it could be related to the nature of the experiment - due to the desire to have high ecological validity in the experiment, people played on their own systems, with variable components and conditions. Immersion could be impacted by uncontrolled interruptions, or noise in the environment or even screen resolution. If there were a small effect, it may have been lost due to this variability.

The key takeaway is that felt uncertainty can clearly be manipulated and indeed be measured by PUG which captures the notion of player disorientation when it is tied to how much the players are able to see of their environment. Given the results even though the game type was familiar to all participants, large effect size and the ecological validity of the experiment, there is good reason to continue this line of inquiry in future studies.

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