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Shinobi Valley: Studying Curiosity For Virtual Spatial Exploration Through A Video Game

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Abstract

Curiosity is a strong motivator for human action, but the circumstances under which one becomes curious are not clear. This paper builds on the assumption that video games can be used as a stimulus for the experimental study of curiosity, and forms a basis in examining the type of curiosity motivated by spatial exploration. A video game was created that incorporates five proposed 'game design patterns' that may induce curiosity in players. The game, *Shinobi Valley*, was tested in a pilot study with 24 participants. Participants responded positively to the game and exhibited exploratory behaviour while playing without specifically being prompted to do so. The presented results suggest which of the patterns are most promising in inducing curiosity, and show that the game is of sufficient quality to be used in larger studies.

CCS Concepts

•**Applied computing** → **Computer games;** •**Human-centered computing** → *Empirical studies in interaction design;* Empirical studies in HCI;

Author Keywords

Game user research; Player motivation; Game design; Affective game design; Design for curiosity.

Figure 1: Screenshot of *Shinobi Valley*, showing part of the primary path (left half), a series of hair pin turns towards the 'Mountain B' region of interest (ROI), and the entrance towards the 'Cliff Cave' ROI. Signs point players to their target destination along the primary path.

Figure 2: Screenshot of the player character next to a banana pickup (at location 'E', see Figure 7).

Introduction and Related Work

Curiosity — defined as an intrinsic motivation to learn and explore [9, 10, 16], that is elicited by a need to resolve uncertainty [19] — has been posited as an important factor in many aspects of human life [17, 6, 11]. Currently, limited knowledge exists on the conditions under which curiosity is elicited intentionally. Video games provide complex virtual environments that can stimulate curiosity [18, 8, 4], and can therefore be used as stimuli in the experimental study of the subject. However, there are certain challenges in using existing games to study human behaviour due to the potential for confounding variables [7]. Since curiosity is in itself a complex phenomenon [6], this study presents a game specifically created to facilitate the study of curiosity, with the aim of providing a controlled testing environment and examine specific game design patterns [3] in detail.

Earlier work investigated which game genres are successful in eliciting curiosity [5]. Players ranked games they had played in order of how curious they made them. Games that were categorized as being about 'exploration' (i.e. providing "spatial or conceptual discovery that is not automatically brought to the attention of the player") ranked highest. Examples given of such games by participants were *The Legend of Zelda: Breath of the Wild* [14] and *The Elder Scrolls V: Skyrim* [2]. However, this study did not answer how this genre triggers players' curiosity. This paper describes the effort of conducting such an analysis.

By analyzing the design of the suggested games [5], design patterns were formulated that may stimulate curiosity in players. These patterns were implemented in the design of a video game, *Shinobi Valley*[1]. This paper further presents the results of a pilot study conducted with the game, with

the aim of analyzing **whether the patterns would induce curiosity in players and which were most successful in doing so**. A secondary objective was to **evaluate the quality of the game itself** as a tool for a larger scale study into curiosity motivated by spatial exploration.

Research Method and Design

The game developed for this study, titled *Shinobi Valley* (see Figures 1– 6), lets players assume the role of a monkey character in a ninja suit. Players see their character from a 3D third-person perspective, and can make it walk, run, and jump through a combination of mouse and keyboard controls.

Within the game, players are ostensibly tasked with following a pathway leading to their ninja master. Players are free to leave said pathway in order to explore parts of the environment that catch their interest. While facilitating this exploration is indeed the purpose of the game as a research instrument, it is not explicitly emphasized or encouraged by in-game text. The reason for this is to see whether players explore the environment out of their own natural curiosity, rather than being told by the game that they should and for a particular in-game purpose (e.g. finishing a quest).

The game environment consists of a green field surrounded by mountains and various forested areas. A single 'primary' path leads from one end of the map to the other, forming a rough S-curve. Along the path and in the surrounding areas are several regions of interest (ROIs), which are further described in the following section. When the player reaches a ROI, a particle effect and musical tone are played to acknowledge the fact that the player found it. Any further game-typical acknowledgements, e.g. points or achievements, are not given. Players are randomly assigned to one of two starting positions (referred to as locations A and B),

[1] For a video showing a play session of the game, visit: http://cil.universiteitleiden.nl/publicfiles/shinobivalley_chiplay2019.mp4

Figure 3: Screenshot of the 'Stone Spiral' region of interest (ROI), an implementation of the 'out of place element' pattern.

Figure 4: Screenshot showing the primary path, banana pickup 'C', 'Mountain B' in the top left, and the 'Cliff Cave' ROI in the center.

located at the two ends of the primary path. The goal is always positioned at the opposite end, with signs pointing out the direction towards it. These signs are prominently placed along the path to ensure that any exploration of the player is not due to getting lost.

To achieve a similar experiment time between players, the ending of the game is modified depending on the time spent playing when the player reaches the ninja master. When the player speaks to the master for the first time, they will be informed that he is meditating and that they need to come back later. Those who spent more time playing have to spend less time waiting for the master to finish than those who reached him quickly. Players who have already explored are therefore not punished with a long waiting period once they go to the master. Subsequent interactions with the master give an indication of the time left until he is done meditating. This text is always descriptive rather than a direct measure (i.e. 'about a minute' instead of an actual time).

Metric data was collected to chart the players' behavior during play. Location coordinates were logged at 0.25 second intervals. Additionally, interactions with ROIs were recorded. After gameplay, players were asked to fill in the GUESS questionnaire [15], which was developed to assess the quality of a gaming experience. The following sub-scales of the questionnaire were implemented: *audio aesthetics*, *creative freedom*, *enjoyment*, *personal gratification*, *play engrossment*, *usability*, and *visual aesthetics*. The survey provided insight in the experience of the players and the quality of the developed tool for further studies.

Game Design Patterns for Spatial Exploration

Through the list of game titles provided by participants in the aforementioned study [5], we outline a hypothesis for

five distinctive game design patterns that create an intrinsic motivation for spatial exploration in players. These patterns are based, in part, on work by Björk and Holopainen [3], who describe patterns as a collection of frequently used design choices that share commonalities in their function and implementation. Due to the re-occurrence of such choices, they can be considered as patterns that, taken together, build a 'language' for talking about gameplay. Each game design pattern stated in this paper is deliberately implemented in *Shinobi Valley* and designated as a ROI. The game features a total of 15 ROIs throughout the game environment for which players have to leave a marked 'primary' path to reach them (plus two that are placed on the path).

Pattern: Reaching Extreme Points
Games within the 'Exploration' genre frequently feature locations that are considerably higher than the rest of the game world. Games may turn the concept on its head and involve locations that are at an extreme depth (e.g. *Subnautica* [20] and *Minecraft* [13]). In *Shinobi Valley*, this pattern is recreated through three tall mountains that players can reach via trails taking several hairpin turns (see Figure 1). For two of the mountains the trail leading up to the summit is placed out of sight from the primary path and thus requires some effort to find. A third mountain is placed closer to the middle of the primary path and the trail to its summit, while still out of the way, is more easily visible.

Pattern: Resolving Visual Obstructions
Game environments may be deliberately obscured to motivate exploration. For example, strategy games often use a 'fog of war' [3] to hide parts of the game world. In our study, this pattern is implemented through an area covered in ground fog, as well as two areas consisting of dense bushes and trees. Both implementations require players

Figure 5: Screenshot of the 'Ground Fog' ROI, an implementation of the 'resolving visual obstructions' pattern.

Figure 6: Screenshot showing the player character (left) next to the ninja master (right), taking a meditation pose. If players approach the master too early a text box informs them to return at a later point.

to explore an area closely if they want to see what is obstructed. Note that we did not hide objects with this pattern.

Pattern: Out-of-Place Elements
Out of place elements are game objects that stand out in the context in which they are placed. This could be a single tree within a field of stone statues, or a stone statue in midst of a forest. Players understand games as designed spaces and might therefore ascribe meaning to elements that appear to break a perceived pattern. In *Shinobi Valley* three regions are meant to represent this pattern: two areas with stone stacks (stones placed on top of each other to form tall columns), and a stone spiral (see Figure 3).

Pattern: Understanding Spatial Connections
Games that allow players to navigate through an environment might feature complex, interconnected paths. Even when such paths are not designed to present a challenge in itself (as is the case in a labyrinth), exploration can be motivated by the desire to learn how spaces connect to each other. In our game, we created three regions that seek to motivate exploration in this manner: two cave systems (see Figure 1), and a path leading to a hill plateau. These patterns are designed in such a way that a location is marked as reachable (e.g. by using the same visual appearance as the primary path), but without a clear indication of how the player can get there. Players thus need to figure out how they can get to the location.

Pattern: Foraging for Desired Objects
Games often reward players for collecting specific objects, but such objects may also be used as motivators for exploration. This pattern is often used in conjunction with other patterns, both to signal that there is something that might be discovered through exploration, and as a signal that a designed region of interest has been discovered. In our study we separate this pattern from other patterns to bet-

ter understand its impact on player behavior. We distribute five banana objects that players can touch to pick up. Two of them are placed directly on the beginning and end of the primary path to inform players about their existence and effect (or indeed, non-effect) on gameplay.

Pilot Study: Procedure and Results

Participants were found through convenience sampling [12]. The game and subsequent questionnaire were accessed through a dedicated website, which first showed general information about the experiment and the consent form. When accepted, players were then directed to the game. After completing the game, they were automatically directed to the GUESS questionnaire. A number of participants took part in the experiment in a lab setting, so that the researcher could observe their gameplay and uncover any potential issues, e.g. bugs or problems in understanding the experiment. In this setting, participants were also asked to annotate a video recording of their session with how curious they felt during play. This was included to assess the method itself for planned future studies; the data was not used in the current pilot analysis.

A total of 24 players participated in the pilot study and completed the game. Play sessions lasted for a mean of 12.12 minutes (range 7.35 to 29.13, SD=4.8). 15 players (62.5%) played the game from point A to B, 9 players (37.5%) from point B to A. Out of 24 players, 22 completed the survey and provided demographic data. The mean age was 27.4 (range 18 to 61, SD=8.96). 9 players were female (41%). Players reported game experience from Expert (n=4, 18.2%), Core (n=9, 41%), Casual (n=6, 27.3%) and Novice (n=3, 13.6%). 4 players (18.2%) reported playing for less than an hour **per month**, 5 (22.7%) between 1-10 hours, 7 (31.8%) between 10-20 hours, 5 (22.7%) between 20-40 hours, and one player (4.5%) more than 40 hours.

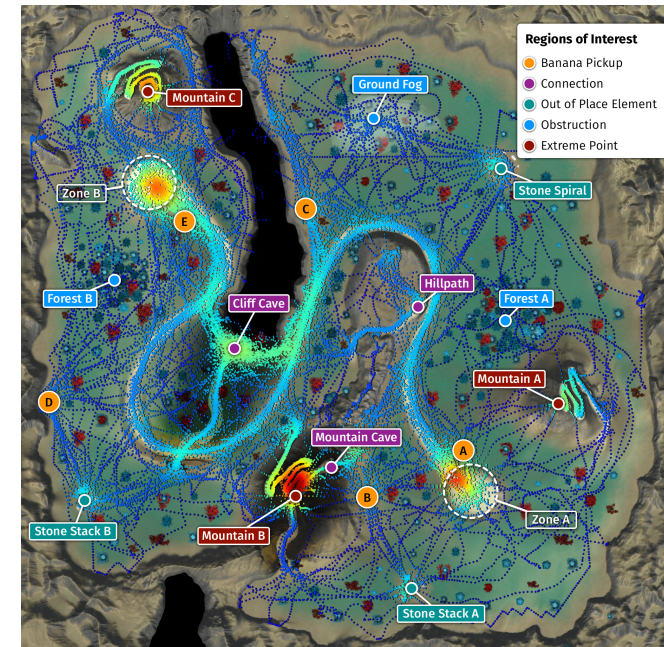|	%	Time
Mnt.Cave	45.8	4.0
Hill Path	50.0	4.1
Cliff Cave	66.7	9.4
St. Spiral	62.5	6.3
St. Stack A	41.7	15.7
St. Stack B	75.0	7.2
Forest A	12.5	7.2
Forest B	20.8	4.1
Ground Fog	66.7	3.5
Mountain A	41.7	11.6
Mountain B	75.0	22.0
Mountain C	66.7	13.5

Table 1: Amount of visitors per ROI in percent, as well as mean of time spent at each ROI in seconds. Note that the area size defining whether a player is within a ROI is always the same. Banana pickups disappear after collection and thus have no 'time spent' measure.

Metrics were processed to produce a heat map for each player (see Figure 7 for an aggregated heatmap of all players). The main purpose of this pilot was to see which patterns in particular were successful in facilitating exploratory behavior. Therefore, the focus in analyzing the metrics was on whether people deviated from the path and for what purpose. All ROIs were visited by multiple players, with both forest regions being the least visited (n=3, 12.5% and n=5, 20.8% respectively) and the stone formations and mountains being visited almost equally (the least popular in each visited by n=10, 41.7% and the most popular visited by n=18, 75%). For a more detailed overview of specific results, see Table 1. Each player collected at least 1 banana, with the least popular banana being collected by 15 (62.5%) players (see Table 2). 16 players (66.7%) jumped into the chasm (see Figure 4), out which 11 (45.8%) did so at least twice, which transported them to where they jumped off.

All items in the GUESS survey are assessed on a Likert scale from 1 (worst) to 7 (best). Mean ratings were above the midpoint in all categories: audio aesthetics = 6.21 (SD=0.63); creative freedom = 5.15 (SD=0.75); enjoyment = 5.18 (SD=1.01), personal gratification = 5.05 (SD=0.89), play engrossment = 4.78 (SD=1.03), usability = 5.83 (SD=0.57); and visual aesthetics = 6.12 (SD=0.71). Significant correlations are reported in Table 3.

Players could add open comments at the end of the questionnaire, responding to several prompts (e.g. "Did you leave the path during your gameplay session? If yes, why? If no, why not?"). The most common positive comments related to the visual quality of the game, while the most common negative comment regarded a lack of challenge. People frequently expressed an intention to explore the environment, noting how aspects of it stood out to them. A total of 6 people mentioned being motivated to explore once

they had to wait for the master.

Figure 7: Heatmap showing all routes players took and in which areas they spent most time (tinted red).

Discussion and Future Work

The focus of this pilot was on the validity of the presented research tool and which of the patterns induced exploratory behavior. It was not certain whether players would explore without being prompted to do so by the game. To make any possible exploration behavior surface as the result of curiosity, instructions in *Shinobi Valley* only related to controls and the goal of reaching the ninja master. However, **exploratory behavior was shown by all participants and with all ROIs, suggesting that the patterns were successful in eliciting curiosity for spatial exploration.**

Bananas	%
A	75
B	62.5
C	91.7
D	79.2
E	100

Table 2: Amount of players that collected each banana in percent.

Item pairs	Tau-b
Freq – Type	0.64**
Age – US	0.34*
Freq – PE	-0.43*

** p < 0.001, * p < 0.05

Table 3: Kendall's Tau-b correlations between survey items. Only results with p < 0.05 are reported.

The mandatory waiting time of the ninja master's mediation at the end of the game was implemented to prevent players focused on reaching the goal from not exploring at all. Therefore, it was likely that all players would show at least some exploratory behavior. Yet the average playing time suggests that players generally spend more time exploring than required. Based on which ROIs were visited, it can furthermore be deduced **which patterns show more promise in inducing curiosity in a larger number of players**. Considering that some people reported frustration in having to wait after already having explored, and that exploratory behavior occurred in many players regardless of the delay, this aspect will be reconsidered in follow-up studies.

Although not originally intended as a ROI, a number of people tried jumping into the chasm. The chasm itself could be considered an implementation of the *resolving visual obstructions* pattern or *reaching extreme points*, and will be considered as such in the follow-up study. It will be necessary to examine what motivated people to jump into the chasm to determine which pattern is more applicable.

The game itself was rated positively by users, with GUESS ratings all averaging above the mid-point. The lowest and most contested measure was that of *play engrossment* (PE). The items in this category relate to whether the player felt detached from their physical environment during play or from real-world events, e.g. time. PE is the only category in the GUESS that showed a significant correlation with another item in the questionnaire, namely play frequency. It can be hypothesized that the lack of challenge reported by players is a contributing factor to the differences in score, resulting in lower scores from participants who spend more time, and are likely more skilled at, playing games. Despite this, the overall score is still above the mid-point, and the

other measures indicate that the game is of sufficient quality to provide a valid test-bed for use in a follow-up study.

Future studies will be conducted with a larger sample size. Components of the GUESS questionnaire will be used, although those related to the game's quality (e.g. audio and visual aesthetics) will be removed. For the other components, correlations will be examined between scores and how people behaved during gameplay. Interviews will be implemented in the research protocol to gather qualitative data on players' motivations to engage with particular patterns. To guide the interviews, the annotated gameplay recordings (tested in this pilot, but not yet analyzed) will be used. Additional experiment designs may also be incorporated, e.g. A-B testing of the various patterns or investigating correlations with specific player types (e.g. [1]). The results from these studies will allow for an analysis of the patterns presented in this paper; specifically, which are more inductive to triggering curiosity and why. In turn, this may provide a first step in developing a framework in designing games for curiosity.

Conclusion

This paper presents five design patterns for inducing curiosity through spatial exploration, incorporated into the game *Shinobi Valley*. Players engaged in exploratory behavior, despite it not being part of the ostensible goal of the game or being scored for their performance. **All patterns were explored by participants to an extent, with some proving more successful than others.** The knowledge on which patterns were successful in particular may be beneficial to other researchers looking to study curiosity through spatial exploration. Furthermore, the presented tool was received well and provides a solid basis for studying design patterns in more detail.

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