Exploration through video games

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6 Level Design for Spatial Exploration

The following chapter describes the design and development of the research game *Shinobi Valley*. This game is created to test level design variations and empirically measure player behavior changes. The design of its virtual world is a direct implementation of the testable design patterns for spatial exploration proposed in Chapter 5.

> The research question guiding this chapter's work is:
> **How can design patterns for exploration be implemented and evaluated for empirical study?**

Readers are recommended to refer to the Open Science Framework (OSF) repository of this study for a video of the game environment:
https://doi.org/10.17605/OSF.IO/MVR37

The study design of the *Shinobi Valley* experiment can be divided into two parts: the pilot study (discussed in this chapter) and the experiment (discussed in Chapter 7). This chapter provides a detailed description of the game's design, including how specific instances of the design patterns for spatial exploration are developed as part of its environment. It then discusses the pilot study, which investigates whether the developed instances of the design patterns are, in fact, capable of eliciting exploratory behavior in players, as well as the perceived quality of the game and its suitability for larger-scale testing.

This chapter addresses the research question by describing the implementation and evaluation of a particular subset of design patterns focused on spatial exploration. As such, it can serve as an example for future studies aiming to implement and study other design patterns for exploration in various forms.

It should be noted that, to test individual patterns, the game and study design are tailored to examine those specific patterns. Such customization is necessary to evaluate the efficacy of individual design patterns. The combination of patterns selected for this study should show an impact on the exploratory behavior of players; otherwise, there would be insufficient evidence that level design patterns can motivate players to explore on their own accord. Any limitations in implementation and the effect on player behavior are examined and discussed in detail as part of the experiment described in Chapter 7.

The most important outcome of this chapter is the documentation of design decisions made in the creation of *Shinobi Valley*, and the successful evaluation of its efficacy to motivate exploration through a pilot study with 24 participants. Before this study, no study attempted to measure the impact of level design patterns. Furthermore, until now, no game has been available to game researchers that allows for such a study while also capturing the necessary data to assess player behavior.

While this work is in service of the overarching research question, this particular pilot and experiment focus on design patterns for spatial exploration. An additional concern of the pilot study is assessing the game's quality for its use in a larger experimental study. Thus, the pilot study aims to answer the following research questions (RQs):

1. Do the implemented level design patterns motivate players to go out of their way to explore them?
2. Is the quality of the game sufficient to not negatively impact player behavior?
3. Does the game provide sufficient opportunities to gather behavioral data?
4. Does the game operate reliably?

The following sections describe the design of the game, the integration of design patterns, and the results of the pilot study. It is important to note that not all functionality described in this chapter is used in the pilot study. At the time of the study, some functionality was not yet completed but was also not required to fulfill the purpose of the pilot. As a result of the pilot, functionality was also modified or removed. Differences between the experiment (described in Chapter 7) and the pilot study are indicated throughout the chapter where necessary.

The chapter concludes by discussing the results and considerations of the pilot study before continuing with the experiment in the next chapter.

Chapter Publications

Work presented in this chapter has been published in this peer-reviewed venue:

- **Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play Companion (CHI Play Conference) – 2019**
  "Shinobi Valley: Studying Curiosity For Virtual Spatial Exploration Through A Video Game" (M. A. Gómez-Maureira et al. 2019)

6.1 About the Game: Shinobi Valley

Shinobi Valley figure 6.1 is designed as a single-player, third-person video game reminiscent of action-adventure games such as *Zelda: Breath of the Wild* — shortened to *Zelda:BotW* (Nintendo EPD 2017). Action-adventure games are loosely defined by requiring players to act quickly in real-time, usually by taking control of a virtual player character, such as "Link" in *Zelda:BotW*). They also involve narrative and situational challenges that players must overcome to progress in the game's narrative. Both aspects, *action* (requiring fast reflexes) and *adventure* (overcoming obstacles as part of a narrative), are implemented in *Shinobi Valley* on a rudimentary level to remain accessible to a wide range of people. This allows for experimental testing with a general audience, i.e., those comfortable with using a mouse and keyboard and capable of understanding the movements of a virtual character in 3D space.

As discussed earlier, many existing video games involve spatial exploration to varying degrees. In some games, such as *Zelda:BotW* or *Minecraft* (Mojang 2011), exploration can even be considered the game's primary purpose, featuring many design patterns that encourage it. Why, then, does it make sense to develop a video game for research purposes when existing entertainment games could be used instead?

What makes *Shinobi Valley* worthwhile for investigating design patterns is the amount of control it affords for research purposes. The majority of video games are developed to entertain their players. Rather than emphasizing specific design patterns or game

Figure 6.1: Screenshots of the game in the nature aesthetic. Player character walking on the primary path (left), and looking down from a mountain (right).

mechanics, they involve a wide range of them simultaneously to provide an interesting experience to players. This makes it difficult to assess to what extent each intervention contributes to the overall experience, especially since that experience is often more complex than *just* eliciting a desire for exploration. Setting up a controlled player experiment in an existing entertainment game would be highly ecologically valid but also packed with numerous confounding variables. Developing a purpose-built game makes it possible to aim for a deliberate balance between experimental control and ecological validity (Järvelä et al. 2015). While *Shinobi Valley*'s was created based on design heuristics, creating a new game can also cause unintentional consequences on the research results. The implications of this are reflected on in detail as part of the experiment, discussed in Chapter 7.

Apart from this balance, there are additional benefits to foregoing existing entertainment games for experimental purposes:

- **Free control over what can be logged.** Commercial video games rarely provide access to the underlying programming code, thus making it difficult to track and log game states. Open-source video games can mitigate this lack of access but are comparatively rare and often uneven in their aesthetic quality and usability design.
- **Ability to design for a manageable experiment length.** Existing video games are often meant to be played for several hours. Furthermore, games that focus on spatial exploration tend to be longer than games that ask players to face cognitive challenges or require fast reflexes. For experiment purposes, the overall duration

of an experiment needs to be kept as short as possible to ensure that participants experience a similar amount of content.

- **Ability to develop online and offline versions.** In developing a game for research purposes, versions can be created for testing in a lab setting (offline) and over the Internet. Offline testing allows for more detailed experiments that can include direct observation or physiological measures, while online testing can reach a larger amount of participants. Both may be combined to develop an experiment that supplements statistical data (gathering information from as many participants as possible) with more in-depth data points (more elaborate experiment setups with fewer participants).

Because of these reasons, *Shinobi Valley* is designed based on existing games rather than conducting experiments that use them directly.

Shinobi Valley is developed as a serious game to study players' behavior. The term "serious game" can bring to mind specific interpretations of how such a game might look and play because such games often pose clear educational or training goals. However, serious games are not defined by whether they educate but rather by what motivates their design and development: providing a non-entertainment purpose (Deterding et al. 2011; Harteveld 2011). In *Shinobi Valley* that purpose is to act as a testing environment for capturing and analyzing player behavior.

For players, this is evident in how the game is presented to them before they play it. *Shinobi Valley* is presented to players as "a gameplay experience research game", thus stating outright that playing the game fulfills a research purpose. Furthermore, most players will be made aware of the game through the context of finding participants and not on its own merits as something they might want to play, regardless of its connection to academic research. Although players are reminded of their role as research participants at certain moments (e.g., by asking for their feedback within the game or directly after it), the game is designed to get them into the mindset of playing an entertainment game. This mindset can be encouraged by typical game aesthetics and conventions outlined in this chapter.

This duality of *Shinobi Valley* as a video game and experiment tool makes it essential to distinguish between what perspective is described. In the current chapter, the focus is on the game's design and how it is presented to *players*. In Chapter 7, the emphasis is on the design of the experiment and how it is presented to *participants*. While there is overlap between the two perspectives, the distinction is important to note because the two roles exist in different contexts, even if they are assumed by the same person in this study. The game features design considerations for either of these roles. For the most part, the game is designed for video game players, given that it aims to simulate the experience of a commercial entertainment game. Whenever the game prompts players for research-related feedback or communicates information about the larger experiment, players switch their role to that of research participants.

When players start *Shinobi Valley*, they take the role of a monkey character in a ninja outfit ("shinobi" means ninja in Japanese). The ninja trope and the use of anthropomorphic characters are intended to create a playful backdrop to communicate to players that they are about to enter what is often referred to as the "magic circle" in the field of game studies (Huizinga 1971). They are entering a state of make-believe in which they suspend their disbelief in what could be considered realistic. This is easier to accomplish if the game world establishes a consistent look and feel, asking players to take on the role of a different entity rather than playing as themselves. Here the use of tropes, such as assuming the role of an agile ninja, can help players extend the explicitly shown and told narrative with their imagination, thus making the world appear richer in their minds.

Players see their character from a third-person perspective and find themselves in a 3-dimensional environment (figure 6.1), with a visually emphasized path leading them to their ninja master (figure 6.2). In order to test whether game design patterns motivate players to explore, the game is played in different experimental conditions. Depending on the condition, the game environment is shaped differently. For example, players in the *patterns present* condition can reach mountain peaks that are not present in the *patterns absent* condition. Two underground paths also only exist when patterns are present. The presence or absence of patterns is localized at "Pattern Instantiation Regions" (PIRs). The visual aesthetics differ depending on the experiment condition, with one featuring a *nature aesthetic* and the other presenting an *alien aesthetic* to players. A more detailed description of the experimental conditions and a rationale for their implementation are discussed in 7.

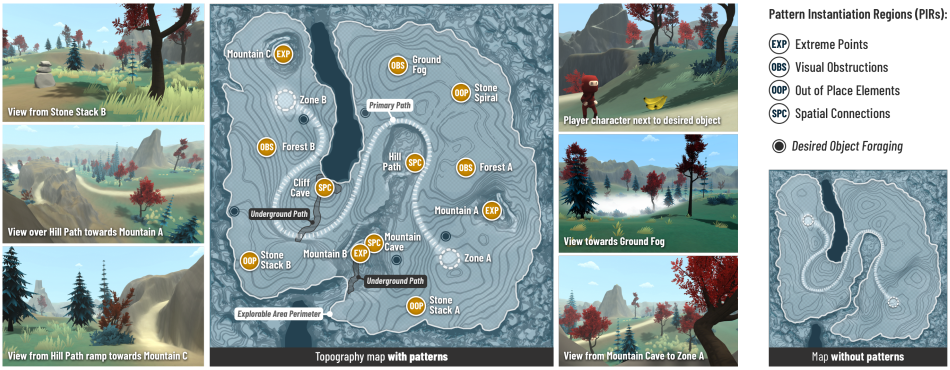


Figure 6.2: Bird's-eye view of the game environment with screenshots from various locations. The topography differs depending on whether spatial exploration design patterns are present. The map indicates the locations of Pattern Instantiation Regions (PIRs).

Regardless of the experimental condition, players can freely explore the environment surrounding the primary path. The explorable area is bounded by a perimeter of cliffs and other natural blockades. In the northwest quadrant of the terrain, a deep chasm prevents players from taking a shortcut but still allows them to see where the path they are following will lead them. While players are ostensibly tasked with following the primary path, given its very presence, the environment is designed to reveal as much as possible about where that path will take them. This is supposed to reduce the curiosity players might experience about the primary path itself, thus allowing for attention to wander toward the surrounding environment.

Within the environment, players of the *patterns present* condition can encounter several Pattern Instantiation Regions (PIRs). Each of these regions involves one of five design patterns hypothesized to invoke a desire for spatial exploration (see Chapter 5). All the patterns are visually distinct from the rest of the environment in some form. This is the case even for PIRs that feature *Visual Obstruction* (OBS) patterns, as that obstruction is still a visual feature. It is important to note that the game environment is not a featureless wasteland between these regions. Vegetation and terrain formations are designed to create an aesthetically pleasing and diverse surroundings for the player. The difference in the design is that their appearance does not suggest that players can find more upon closer investigation.

While players face no time pressure to finish the game in a certain amount of time, the game is designed to take around 10 minutes, assuming that players leave the primary path to explore the environment. Once players reach the end of the path, they encounter a ninja master in meditation. They are then told to wait five more minutes before they can interact with the master. This means the game is designed to make players wait for approximately half of their playtime. Capturing player behavior during a forced waiting period allows for assessing players that are primarily motivated by reaching the end of the path. For players that follow the path as quickly as possible, the play time can be as short as seven minutes, including the waiting time.

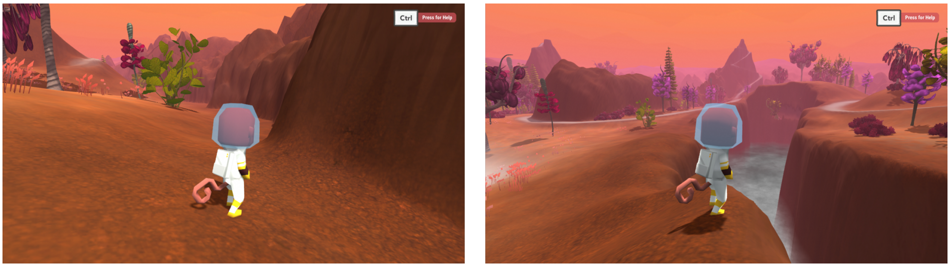


Figure 6.3: Screenshots of the game in the alien aesthetic. The Player character stands next to the cliff perimeter, restricting the explorable area (left) and standing next to the chasm in the northwest quadrant of the environment (right).

Shinobi Valley does not involve any hostile characters ("enemies" in the parlance of video games) or other threats. Players can jump from tall mountains without suffering any consequences. Players who jump into the chasm in the northwest quadrant are automatically transported to a nearby location next to it. This transport is accompanied by a visual fade-to-black and a gong sound effect. Both effects are reminiscent of similar mechanics in video games in which players are prevented from losing due to falling out of the explorable environment (referred to as "respawning"). In general, there is no actual losing condition in *Shinobi Valley*, as players can always complete the game by going to the master after they finish meditating.

The following sub-sections describe parts of the game design of *Shinobi Valley* in more detail.

Pilot Study Note:
The pilot study only uses the *pattern present* condition in the *nature aesthetic* to assess first whether patterns elicit curiosity. Additional conditions are only included in the wider study.

6.2 Game Controls

The control scheme in *Shinobi Valley* can be conceptually separated into *user interface controls*, such as activating the help menu or confirming information text, and *action controls*, which directly affect the player character. Players are at all times in either one of the two control schemes; never in both at the same time. For the most part, players take direct control of the player character, which is done by using a keyboard and a computer mouse or a mouse alone.

The *user interface control scheme* automatically becomes active whenever the game presents information in the form of text to the player. At that point, the player loses direct control of their character, and their mouse cursor appears on the screen. In this control scheme, players use the mouse to interact with buttons in the interface or left-click on message boxes to progress. Once all messages in a series have been shown, e.g., to explain how to control the player character, the control scheme switches to the "action control scheme".

In the *action control scheme*, players directly control the movements of their player character. The only user interface element visible when players take active control over their character is a visual reminder of what keyboard key they can press to open the help menu (the ***`[Ctrl]`*** key). In this control scheme, the mouse cursor is hidden from view. Any mouse movement directly translates to a corresponding rotation of the game camera (a virtual simulation of a real-world camera that controls what is shown on screen). The sensitivity of the rotation depends on the mouse sensitivity setting in the operating system. To give players an easy way of adjusting the sensitivity, players can modulate the translation between cursor movement and camera rotation at the beginning of the game and by opening the help menu during the game. It should be noted that rotating the game camera happens independently from the player character, as is a custom in many third-person video games. The head of the character instead faces the direction of the most recent locomotion input.

The player character can perform three locomotive actions in the game: walking, running, and jumping. The only additional action is to start an interaction with the master character, which is accomplished by approaching them closely. To perform actions with the player character, players can use just the mouse or involve keyboard inputs. By giving players a choice in how to control the game, *Shinobi Valley* becomes more accessible to a broader audience. Controlling a player character and navigating 3D space, while second nature to many gamers, does not come as quickly to people with less gaming experience or those who primarily play different types of games. Providing two control options increases the chances that players experience a gentle learning curve and can have a more similar gaming experience to one another. Achieving a similar playing experience across players that is not hampered by struggling with the controls is essential for the subsequent data collection and the use of *Shinobi Valley* as an experimental tool. The different input controls are active simultaneously, allowing players to switch between them at any moment as they see fit.

When using both the keyboard and mouse to control the game, players use the ***`[W]`***, ***`[A]`***, ***`[S]`***, and ***`[D]`*** keys to move their character (forward, to the left, backward, and the right respectively). This is frequently the default input control scheme in many 3D entertainment games on PC systems, which is also why it is supported in *Shinobi Valley*. As a variation to these keys, players can also use the arrow keys instead. The ***`[Spacebar]`*** key is used to jump, and the ***`[Shift]`*** key can be held down to run instead of walk. If the player character is controlled with the keyboard, its orientation is independent of the rotation of the game camera.

For players that prefer to only use their mouse, the left mouse button can be held down to start walking. If held for a longer time, the character starts to run automatically and continues to do so until the mouse button is released. The right mouse button can be clicked to jump. If players only use the mouse to control their character, they will lose the ability to move independently from the camera rotation. Holding the mouse button will always move the character forward in the same direction the camera is facing.

In addition to letting players choose how to control the player character, the game provides additional customization options that are frequently found in 3D entertainment games. One option is to adjust the rotation speed of the game camera. Depending on a player's mouse hardware and software settings, the camera might rotate too much or too little when they move their mouse. The game, therefore, features a sensitivity slider that adjusts the amount of camera rotation. Another option is to invert the camera's pitch direction (i.e., up and down). Similar to the direction in which one expects a document to scroll when swiping across a laptop trackpad, people have different preferences in how a game camera turns based on the direction the mouse moves in. Some prefer that the camera rotates up when the mouse moves up, while others prefer the reverse. In many games, as well as *Shinobi Valley*, it is possible to invert the direction to better align with an individual player's expectations. These options can be adjusted as part of the game tutorial at the beginning or accessed in the help menu by pressing the `[Ctrl]` key. The help menu also allows players to review all possible input controls during the game.

An overview of the game controls and help menu are shown in figure 6.6 as part of section 6.5.

6.3 Camera and Character

Shinobi Valley is a 3D game played from a third-person perspective. In games where the player controls a singular character, players typically see the game environment in one of three ways: first-person view, with an over-the-shoulder camera, and third-person view. A first-person view has the player control the camera as if looking through the character's eyes. Over-the-shoulder places the camera slightly behind the character and, as the name suggests, positions it as if it were over the character's shoulder. In contrast to the first-person view, this view allows players to see their virtual player character. The third-person perspective places the camera further away from the character, showing them within the environment from a certain distance.

The choice of camera perspective can signify a message to the player as to the type of game they will play. For example, a first-person or over-the-shoulder perspective is commonly used in shooter games. Third-person perspectives, on the other hand, can be commonly seen in action-adventure games, e.g., games in which the player solves puzzles, performs platforming challenges, or explores. Naturally, counterexamples exist, and many games offer the option between two perspectives (e.g., first- and third-person), but each perspective has its own prevalent associations as to the nature of the gameplay.

Shinobi Valley utilizes a third-person perspective to make the game accessible to a broad range of players. Not everyone plays shooter games, as they can have a bad reputation outside gaming communities due to their violent content. Secondly, the third-person perspective gives players a clearer understanding of what they can do in the game: jump and explore. Especially jumping in a video game can be challenging from a first-person perspective, as the player cannot gauge distances as easily as when they see the character on screen. Seeing the character on screen can make it easier for players unfamiliar with the controls, or this type of gameplay, to gain sufficient proficiency in a short amount of time.

Finally, the perspective allows players to see the character they are controlling. While in the first-person view, the implied message to the player is that they themselves are inhabiting the world. In the third-person view, the player more easily takes on the role of the character they are controlling. In *Shinobi Valley* this is preferred, as less mental effort is needed on behalf of the player to understand who they are in the game and what their purpose is if they can see the player character on screen.

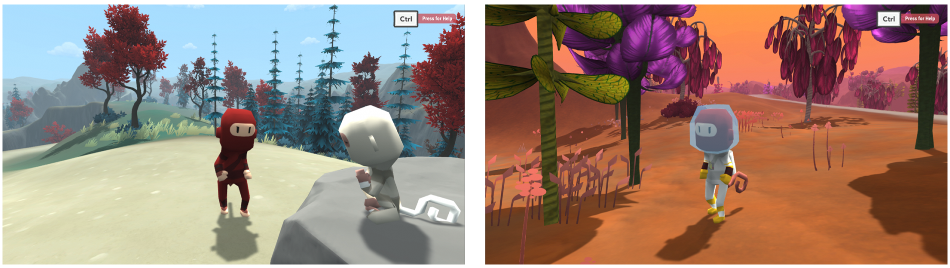


Figure 6.4: Player character and master in their nature aesthetic ninja outfits (left). Alien aesthetic spacesuit still shows parts of the ninja outfit (right).

In the game, players take on the role of a monkey ninja, or "shinobi" in Japanese, en route to meet their master. The visual appearance of these characters is cartoonish, with stout proportions, saturated colors, and simple textures. Depending on the experiment condition, both characters either wear ninja outfits (in the *nature aesthetic* condition) or space suits with helmets over their ninja outfits (in the *alien aesthetic* condition).

The ninja trope has been chosen because it allows involving characters that could conceivably venture out into rough terrain without being impeded by it. Although this characterization is superficial, to have any characterization at all means to involve a narrative element in the game. This, in turn, may cause players to “fill in the blanks” and expand on the limited narrative in their minds (Wesp 2014). While this may enrich the player’s experience, such a minimal approach to storytelling does not rely on high visual fidelity or the creation of explicit narrative content, thus requiring less time and effort to create graphical assets.

6.4 Environment and Game Aesthetics

The game environment in *Shinobi Valley* is designed to invoke a sense of openness and adventure. The terrain is varied and easily accessible regarding the required maneuvering skills. Areas of the terrain not part of the explorable area are indicated by steep and tall cliffs that communicate to the player that they will not be able to overcome them. Players can see roughly half of the total game environment into the distance, with a gradual increase in distance fog to provide a “realistic” limit to how far they can see.

Overall, the game establishes an atmosphere of a whimsical pastiche of ninja tropes. An emphasis is placed on the aesthetic consistency of game elements rather than a high level of detail or invoking a sense of overt realism. The latter is intentionally avoided to prevent players from developing expectations of realistic activities (e.g., the ability to perform acrobatic feats) that the game does not fulfill.

6.4.1 Visual Game Aesthetic

The visual aesthetics of *Shinobi Valley* is marked by bright saturated colors and the use of unusual colors for vegetation. Textures are kept simple and do not involve a high level of detail. Any detail visible in the texture is scaled to make the environment appear large. These visual design decisions are inspired by games such as *World of Warcraft* (Blizzard Entertainment 2004) that involve oversized and cartoonish textures to create a stylized version of real-life textures. In order to keep the game world from appearing too static, all vegetation is subtly animated to give the appearance of a constant gentle wind breeze. The game environment also features moving clouds in the sky for the same reason.

The visual aesthetic that players see in the game depends on what experimental condition is played. The game features two distinctive visual surroundings: a *nature aesthetic* and an *alien aesthetic.* Players only see one of these visual aesthetics during their play session.

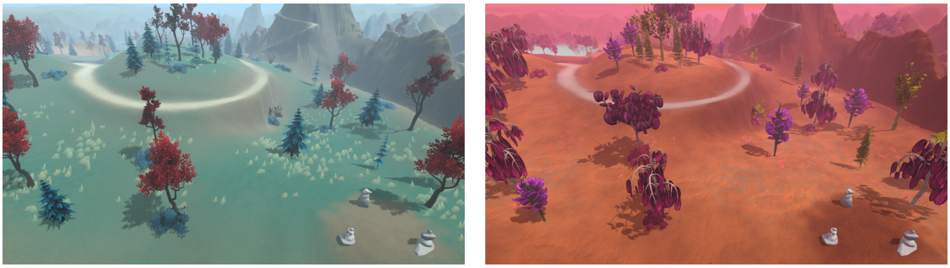


Figure 6.5: Overview screenshots comparing the two visual aesthetics of the game: nature aesthetic (left) and alien aesthetic (right). Note that all elements in the environment retain their location, including trees and bushes.

In the *nature aesthetic* the environment is tinted in green, blue, and brown hues under a blue sky. Bushes and trees approximate the shape and color of actual vegetation, with a reduced level of detail and intense hues compared to real-life examples. In this condition, the player character and the master wear ninja suits.

In the *alien aesthetic* the environment is dominated by red hues with a red-orange sky. Trees feature a wider range of color hues with intense saturation levels and have leaves that resemble insect wings. The vegetation is designed to appear alien yet organic without appearing too threatening or frightening. The player character and the master are shown to wear space suits over their ninja outfits. While the alien aesthetic is designed to match the style of the nature aesthetic closely, it might require a more substantial suspension of disbelief. This is because the game physics is not affected by the visual aesthetic (i.e., gravity remains the same), and the ninja trope is extended with science fiction elements.

Although the in-game visual aesthetic of the game differs depending on the condition, there is no difference in the visual aesthetic of user interfaces (UI). The UI features relatively large text, with longer text passages being broken up over multiple messages that players can progress through. Interactive UI elements are colored in bright orange. Non-interactive parts of the interface are kept in crimson red (the primary color for all interface elements in the game), white, and black. UI elements feature short animations whenever their status changes and in response to input from the player.

Such animations involve short bounces and movements of just a few frames that are meant to draw attention. Video games frequently feature these short animations to provide feedback that an action has occurred. Apart from this utilitarian purpose, they are also considered part of what makes a game feel like a game. Within the game development field, this is referred to as "juiciness" or "juicy design" and means the involvement of elements that are supposed to induce emotional satisfaction in players (Hicks et al. 2018). Juicy animations are particularly common in relatively simple games that are designed for mass appeal (known as "casual games"). This is also an association that is actively fostered in the aesthetic design of *Shinobi Valley*.

Pilot Study Note:
The pilot study features only the nature aesthetic. The alien aesthetic was added to the game after the pilot to consider whether a different visual aesthetic would influence the efficacy of individual design patterns.

6.4.2 Sound Aesthetic

The game features a minimal soundscape with only a few moments accompanied by music. During the game, players can hear atmospheric sounds consisting of subtle wind noises and infrequent interjections of birds chirping. The only other diegetic sound effects in the game are the footsteps of the player character and a short and bright sound effect that emphasizes every jump action. In addition to diegetic in-game sounds, the game features a few non-diegetic sound effects whenever the player interacts with a user interface, as well as a falling sound ending with a "gong" that is played when the player jumps into the bottom of the chasm. Musical emphasis is added at the game's beginning and end, thus acting as a tonal introduction and conclusion, respectively. The music involves primarily Japanese flutes to emphasize the game's premise.

The involvement of sound and music is minimal to suit the ninja trope and be pleasant for as many players as possible. Not having music or sound effects can make a game feel eerie or incomplete. On the other hand, music can feel repetitive or even annoying and needs to be appropriately mixed to not overpower the clarity of sound effects. Sound effects are also limited because players only have a few actions they can take in the game. Consequently, there are only a few moments in which feedback sounds are beneficial to communicate that an action has indeed taken place. Sound effects in the user interface are kept short and are more artificial than other sounds. They differ in their note sequence to give each action in the UI its own identifying sound (e.g., button press feedback, the appearance of dialogue messages, confirmation and progression to a subsequent message, and dismissal of a dialogue message).

Overall, the sound aesthetic in *Shinobi Valley* is designed to communicate the overall premise, provide helpful feedback, sound pleasant to most players, and convey emotional satisfaction by sounding "juicy".

6.5 Tutorial and Help Menu

The game features two systems to ensure that game controls are understood, aid accessibility, and reduce the chance of unintentional confusion for the player. The first is the tutorial game phase, an interactive step-by-step explanation of the game controls at the beginning of the game. Players can only start the game after completing this tutorial. First, players are requested to control the camera to look around. At this point, any other inputs are ignored to ensure that players understand how the camera controls work. After the camera has rotated a predefined amount of degrees around the yaw axis (i.e., left and right), players can progress. This step can be completed in as little as two seconds but is designed to take between 5-6 seconds for most players. In the following step, players are given the option to invert the camera's pitch direction and adjust the rotation sensitivity with a slider.

The tutorial then proceeds with the introduction of the movement controls, i.e., walking and running. Players first receive instructions for how to move their character with keyboard inputs, with a follow-up message that explains mouse-based controls as an alternative input option. Once again, players must show that they have understood how to use the controls by walking until they have left a predefined radius around their starting location. After they have done so, the tutorial concludes by informing players how they can jump and how to access the help menu. Neither of these needs to be proven by the player, given that the game can be completed without jumping, even if some areas are only accessible by doing so. With the tutorial completed, players are free to go anywhere in the game.

The second system aiding players is the help menu. It can be accessed during the game to review the control scheme, adjust the camera movement sensitivity, and invert the pitch axis (similar to how the scroll direction can be changed on computers to accommodate different user preferences).

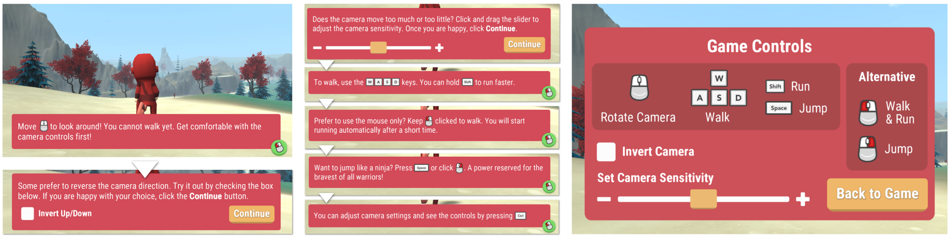


Figure 6.6: Screenshot sequence of the tutorial steps explaining game controls (left and middle). Screenshot of help menu and access to accessibility settings (right).

6.6 Game Technology

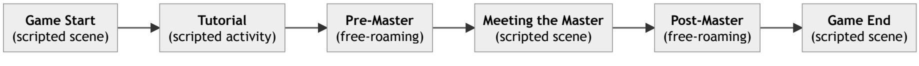
Shinobi Valley is developed with the *Unity* game engine (Unity Technologies 2018). The game is developed for WebGL deployment but can also be deployed for PCs running *Windows* or *macOS*. Most of the game code and assets are created specifically for this study. Some proprietary "middleware" packages are used to shorten the development time and increase the game's fidelity. Middleware includes voxel-based terrain shaping tools (Amandine Entertainment 2019; Roland09 2019), terrain painting tools (Procedural Worlds 2019), procedural texture creation (Filter Forge Inc. 2019), and a boiler-plate character controller for a humanoid third-person player character (Invector 2019).

In addition to the *Unity* part of the game, the game client, *Shinobi Valley* also consists of a server component written in PHP and MySQL. The server component is responsible for collecting player data generated by the client. All communication between the client and server is encrypted using 256-bit AES encryption with random IV generation. To ensure that the server is not overwhelmed with connection requests, all data is cached and submitted in a 5-second interval. The cache is only emptied upon receiving a confirmation from the server and is otherwise concatenated into the next submission cache to ensure that play data is not lost. This can lead to data being logged twice if the client did not receive the server's confirmation, but the data was successfully logged. Duplicate log entries created this way are merged based on matching millisecond time stamps during the post-processing of play data. Likewise, missing entries are flagged based on gaps in time stamps, given that game events are logged at pre-determined intervals.

The game only loads if a connection between the client and server can be established but does not interrupt an ongoing play session if the connection is lost later. In this case, the game continues attempting to submit the cached data at the pre-set 5-second interval. If a player terminates a play session and restarts the game, the server treats this as a new play session. In other words, players cannot continue an incomplete play session at a later time.

6.7 Game Phases in Chronological Order

In the game, players go through different phases that impact both whether they can control the player character and their understanding of the situation they are in. These phases always occur in the same order, without the possibility of returning to an earlier phase. The duration of phases depends on the player, but some involve fewer activities than others. The phases are:



1. **Game Start:** Presents information about the game's premise.
2. **Tutorial:** Provides an interactive explanation of game controls.

3. **Pre-Master Play:** Players are free to explore the game environment until they approach the master at the end of the primary path.
4. **Meeting the Master:** A short message dialogue informs players that their master is still meditating.
5. **Post-Master Play:** Players are again free to explore the environment until the master has finished meditating and is approached by the player again.
6. **Game End:** A short non-interactive sequence plays out, and players are thanked for playing.

Gameplay information described up to this point in the chapter has been primarily about pre-master and post-master phases, as this is where players are free to take control over their player character. These phases also take up the majority of the playtime. The following sub-sections outline some of the phases in more detail, especially concerning restrictions or impacts on the free exploration of the game environment.

6.7.1 Game Start

At the start of the game, players are greeted with an introduction screen reminding them to play without interruption and wear headphones or play in a quiet environment. Once they press the start button, the game will load and open up to show the player character for the first time. At this point, the player character is already positioned on the primary path and faces the direction in which it is headed.

One of the experimental conditions is whether or not players are given an explicit goal in the game. This is further outlined in Chapter 7. In short, players are either given an explicit goal with some narrative context or enter the game without either.

In the explicit goal condition, the game introduces the player character and what lies at the end of the player's path. This is followed by a short camera sequence or "cutscene", in which players get a preview of the entire path. The preview consists of three slow camera pans along the path toward its destination. In these sequences, players can also see several wooden signs pointing toward the end destination. These are meant to ensure that exploratory behavior of players is due to their intention rather than confusion. Once the camera sequence concludes, the camera returns to focus on the player character, and the tutorial begins.

For players that play in the implicit goal condition (thus lacking an explicit goal), the game starts directly with the tutorial. There is no introduction about the player character, what awaits them at the end of the path, or a cutscene preview of it. Likewise, there are no wooden signs indicating the direction of the destination.

Pilot Study Note: In the pilot study, all participants play in the explicit goal condition.

6.7.2 Meeting the Master and Post-Master Play

Once players have reached the ninja master at the end of the path, they will find them in a meditation pose. The game displays a text message informing the player that the master will still be in mediation for some time. In most cases, the message will tell players to return in "5 minutes or so". If players have already played for more than 10 minutes before meeting the master, the message will tell them to come back in "2-3 minutes or so". This time reduction is meant to unburden players who have already spent much time in the game.

If players approach the master again before the waiting time is up, a short message will remind them how much time they will still have to wait. Players are not given an exact time measure but instead are told to come back in "5 minutes", "3-4 minutes", "2-3 minutes", or "a minute", depending on how much time has passed. The waiting time is part of the game to capture player behavior when the question of what can be found at the end of the primary path is answered, and all players can do is wait.

Players are not given the exact timing down to the seconds to avoid focusing their attention too strongly on their timing. This is meant to make exploration more attractive than waiting for something to happen. Naturally, how players behave in this game phase is not comparable to how they behave before they meet their master. While the upcoming chapter will address this point in more detail, it is essential to note that the exploration that occurs after meeting the master is, at least in part, the result of alleviating boredom.

Once the waiting time has passed, the master will get up from their meditation pose and wait for the player to approach them. This means players can take as much time as they want to explore the game environment. The game does not inform the player that the waiting time has run out. Players can only find out by looking at the master (to see them in a different pose), and approaching them, which triggers the last game phase.

> **Pilot Study Note:**
> During the pilot study, waiting time was not reduced for players who had already spent much time exploring. The results of the study motivated this implementation.

6.7.3 Game End

After the master has finished meditating, players can approach them to initiate the end of the game. At this point, the master will greet the player with the following words (numbers indicate separate message boxes in sequence):

> (1) Oooh! There you are! We have awaited your arrival most impatiently.
> (2) Come, join me in meditation! Share with me the stories of your travels … in silence!

Afterward, the game shows a cutscene of the player character and the master meditating, ending with a fade to black. The game then shows a final information screen, thanking players for playing and informing them that a message box will open that brings them to the post-play survey (described in more detail in Chapter 7).

6.8 Pattern Integration

This section describes the integration of the design patterns hypothesized in Chapter 5 and meant to be evaluated through *Shinobi Valley*. One of the fundamental challenges of formulating design patterns for video games is that they need to be balanced in their scope. A pattern should not be defined with too much specificity, as it can become too descriptive of specific implementations. Design patterns are most valuable when they generalize to a wide range of similar circumstances. On the other hand, formulating such patterns too vaguely can make them more challenging to adapt to a given use case. *Shinobi Valley* presents a case study of how patterns to elicit curiosity for spatial exploration can be implemented. By describing the design considerations that go into the integration of each individual pattern, the game serves as an applied example for future implementations and related investigations.

Within *Shinobi Valley*, each hypothesized design pattern is implemented at three different locations and is positioned in such a way as to avoid clustering similar patterns too close to each other. Each location is referred to as a PIR. All PIRs are communicated visually as part of the topology and architecture of the environment. It would have been possible to emphasize the characteristics of the virtual space through how it reflects sound and thus acoustically communicate patterns. However, doing so would have introduced the need for stricter control over the acoustic environment in which players play. Instead, *Shinobi Valley* focuses on the *visual representation of design patterns.* The individual implementations of these patterns can differ in how prominent they appear to players. This is difficult to quantify, as it depends greatly on a player's location and camera perspective at any given time. To give an example, a player who aims the camera in a way that shows only the ground will have a harder time noticing the mountains. As a result, while each pattern is placed with the design intent to draw attention to itself under certain circumstances, the realization of that intent depends on the player's moment-to-moment decisions within the game environment. This section describes the design intent concerning the placement and design of the individual PIRs.

Pilot Study Note:
During the pilot study, participants who visit a PIR for the first time hear a gong sound effect and see a brief wind swirl of red leaves around themselves. This is meant to indicate to them that they have been successful in discovering a place of interest and provide positive reinforcement. This feature has been removed from the game for the subsequent study. Although games frequently provide similar feedback to players, it would have made it difficult to discern whether continued exploration results from a curiosity for features in the environment rather than collecting as many positive reinforcement cues as possible.

To not bias participants, the arrangement of the individual regions is designed to be diverse. Individual regions are not emphasized beyond the properties that make such regions examples of design patterns to elicit a desire for exploration. At the same time, the environment of *Shinobi Valley* was designed to appear as it would in other video games. Designing the environment with too strict parameters might result in players focusing on the artificial nature of the layout. Instead, the play direction is considered as a way to control for potential order effects in the environment design of *Shinobi Valley*.

An S-shaped primary path connects two areas in the environment. Informally, and unbeknownst to players, one area is labeled “A” while the other is labeled “B”. The play direction condition is then defined by the direction that the game is played: either A→B or B→A. The map of *Shinobi Valley* is designed to be reversible in spatial layout and PIR placement. When playing the game, players are randomly assigned to play the game in one of the two play directions. While the exposure of individual PIRs is expected to be impacted by play direction, the overall impact of PIRs should not be affected.

The master character and the stone they are sitting on change location depending on the play direction, with the player character starting the game in the opposite area. Depending on the game condition, they will also see wooden signs pointing toward their target destination. The placement of these signs is always the same, but the direction in which they point depends on the whether participants play from A→B or B→A.

6.8.1 Pattern: Reaching Extreme Points (EXP)

Three tall mountains in the game environment use the design pattern of reaching extreme points: one at each end of the primary path and one approximately at the midpoint. Each mountain can be climbed by taking a narrow path with several hairpin turns to the top. By the very nature of their shape, mountains stand out as visual landmarks from most locations and perspectives in the game environment. The environment in *Shinobi Valley* is generally designed as a mountainous area and thus features cliffs as boundaries and a long mountain range that separates the playable area. It is not only the extremity of a landmark that makes it a pattern for spatial exploration but also the intentionally shaped perception in the player that it is indeed reachable.

In *Shinobi Valley* this perception is encouraged by having a visually distinctive path leading up to the top of the mountain. Depending on the player’s location, the path can be seen from a long distance away. Its shape, relatively gentle angle of incline, and coloring communicate to the player that it is an intentionally created pathway to the top and,

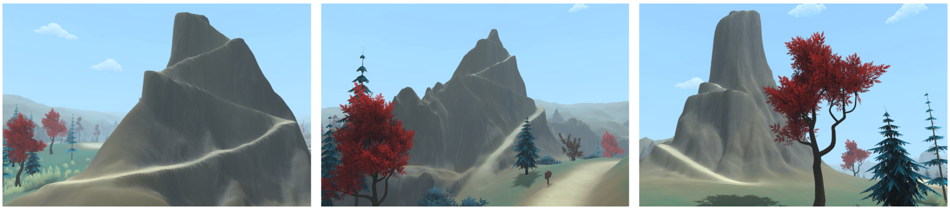


Figure 6.7: Screenshots from the three instances of the *extreme points* (EXP) pattern. Instances are labeled (left to right): *Mountain A*, *Mountain B*, and *Mountain C*.

thus, that the extreme point it leads to should be thought of as part of the explorable game environment.

Extreme points could have been implemented in other ways, such as involving tall artificial structures or areas surrounded by obstacles that threaten the player (e.g., a location surrounded by spikes). In many video games that let players roam freely, height is a threat, as the player character can be incapacitated through fall damage. In *Shinobi Valley* the only threat or punishment for falling is in the time it takes to reach the spot again, as walking up a mountain path takes time and requires somewhat precise maneuvering of the player character. Given that the game does not involve any simulated threats to the player character's health, tall mountains were chosen as the most fitting implementation of this pattern.

It should be noted that the chasm in the game environment can also be thought of as an extreme point. While the chasm has been designed to act as a natural boundary, players in the *Shinobi Valley* pilot study investigate it by jumping into it more than once. This illustrates that intentional signaling regarding what areas make up the explorable part of a game environment can be challenging. Video games typically involve a combination of techniques to guide player movement. This is done through real-world metaphors (the danger of falling from great heights) and following video game conventions (e.g., the player character seemingly remarking to itself that it does not want to go where it is steered to).

In many cases, a game can establish a convention at the beginning that involves only minor consequences to establish a vocabulary for guiding player behavior. As such, players would likely refrain from jumping into similar chasms after players had the opportunity to verify that the game does not consider them as explorable spaces. Nevertheless, this is a cautionary example that some parts of a game environment might be understood as design patterns without the designer's intention.

6.8.2 Pattern: Resolving Visual Obstructions (OBS)

The pattern of resolving visual obstructions is integrated into the game environment in two ways: two dense forest areas and one area with thick ground fog. Each forest area is located towards the first and last third of the primary path, while the area with ground fog is roughly at the midpoint of the path. These three implementations are roughly similar in the amount of space they occupy in the game environment but differ in how they stand out.

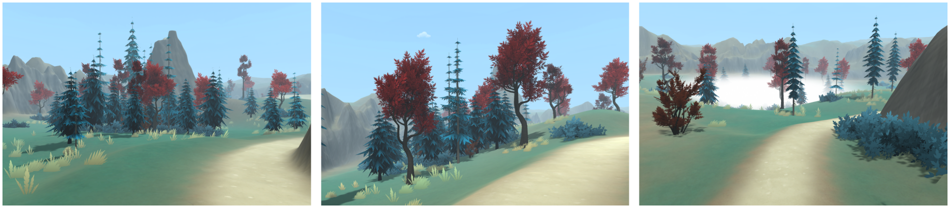


Figure 6.8: Screenshots from the three instances of the *visual obstructions* (OBS) pattern. Instances are labeled (left to right): *Forest A*, *Forest B*, and *Ground Fog*.

Forest areas create visual obstruction through occlusion due to a high density of vegetation, with small gaps of visibility meant to communicate that players can traverse these areas. On the other hand, the area with thick ground fog stands out by its bright white appearance. Visibility is completely obstructed, and it is instead the nature of the obstruction that communicates that exploration is possible. Fog may severely reduce visibility but does not impede a player's abilities. An essential aspect of the implementation of these areas is that they must be understood as active parts of the game environment by players of the game. Visual obstructions in video games are frequently not simply visual but also actual barriers that restrict the movement of a player character. Game environments are finite and often tightly limited to predefined paths. Whereas some games involve invisible borders in the sense that movement may be restricted without an apparent, in-game rationale, many games create a diegetic context for why movement is limited.

The visual design of such barriers communicates a different message than the one communicated by visual obstructions that can be resolved. Barriers need to appear insurmountable so that they do not elicit players' curiosity. After all, players will be unable to satisfy their curiosity, which creates a moment of disappointment and possibly weakens their suspension of disbelief, at least momentarily, if a game barrier lacks any diegetic rationale. This is also why the explorable area in *Shinobi Valley* is bounded by cliffs. The intention here is to let players know that while they can climb some mountains (either through a path or ledges that can be jumped on), they cannot climb this particular mountain cliff.

Visual obstructions that can be resolved need to strike a balance between creating an area that cannot be fully understood from afar and an implementation that suggests that players can do so by exploring more closely. In *Shinobi Valley* this happens through the material that is chosen to build such areas (both forests and fog are fundamentally permeable in the game), as well as their location. All three areas are situated entirely within the explorable area, with some distance from the boundaries of the game environment. The placement of OBS instances provides additional evidence to players that these areas can be explored if they choose to do so.

6.8.3 Pattern: Out-of-Place Elements (OOP)

The pattern of out-of-place elements is integrated through three ostensibly artificial structures in an otherwise natural environment. Two instances of the pattern consist of a trio of stacked stones arranged in a triangle formation. The third instance is a stone monolith with a stone spiral surrounding it. Apart from the stone formations, the ground color on which they rest is distinct from the surrounding environment, giving further emphasis to the location when seen from afar.

In the context of *Shinobi Valley*, OOP instances appear to indicate places of cultural significance purposefully. While every detail in a game is artificially created by its very nature, the difference for OOP instances is that they appear artificial in the context of their immediate surroundings. A cave on a mountain cliff may attract curiosity, but it is not a surprising feature of the landscape in *Shinobi Valley*. If, however, the game were to take place in a city environment, a hill with a cave next to a row of houses should elicit curiosity as part of the out-of-place pattern.

Figure 6.9: Screenshots from the three instances of the *Out of Place* elements (OOP) pattern. Instances are labeled (left to right): *Stone Spiral*, *Stone Stack A*, and *Stone Stack B*.

In the context of video games, players are also likely to form expectations when encountering similar objects close to one another. Such objects are frequently part of small cognitive challenges. This notion is further emphasized by having three stone stacks nearby, given that the number three is frequently used in game mechanics. Examples include creating order among three elements, finding a unique difference in one of three objects, or repeating an action three times to defeat an enemy.

On the other hand, the stone spiral instance is designed to focus attention toward a specific point of interest: in this case, the monolith at its center. This is akin to discovering a large "X" in the landscape, seemingly indicating the location of a treasure or a landing zone.

All OOP instances in the game are based on purposefully arranged stones as if conscious inhabitants of the world placed them. They are meant to communicate to the player that their character is part of a society that has marked something important. As with all elements in a game, players may experience this as a communication attempt by the game designer. However, by using diegetic game elements for this communication, players are more likely to sustain a state of suspended disbelief.

6.8.4 Pattern: Understanding Spatial Connections (SPC)

The pattern of understanding spatial connections is integrated into the environment as two cave systems and a path leading to a hill plateau. As is the case for other patterns, their location is distributed across the primary path, with two implementations closer to the ends of the path and one closer to the midpoint.

In contrast to other patterns discussed so far, spatial connections are more difficult to pin to a specific location. After all, the term implies the involvement of at least two places that are connected in space. In *Shinobi Valley* this pattern provides a clear view of a location without an apparent explanation for how this location can be reached. The path that leads players to each of the three locations is relatively hidden and thus requires them to actively look for a way to get there. The path that leads players to their destination, i.e., the connection aspect, is less important than the question of where such a path might exist. Once the path is found, the question is answered, and their curiosity is likely satisfied. On the way to the location, players might wonder whether the connection is getting them to where they think it should lead them, or they might look forward to the intrinsic reward of having reached the place that has elicited their curiosity.

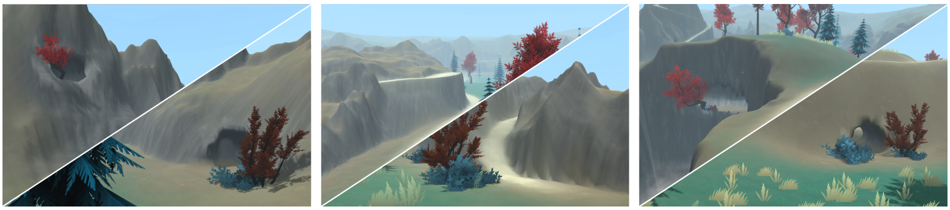


Figure 6.10: Screenshots from the three instances of the *Spatial Connections* (SPC) pattern. Instances are labeled (left to right): *Mountain Cave*, *Hill Path*, and *Cliff Cave*. For each, the left half shows the more visible part of the instance, and the right half shows the more hidden connection that provides access.

Both cave systems have a more prominent side that is supposed to attract attention. That side is either on a cliff side or the side of a mountain and cannot be reached from where players can see them. The caves feature trees that grow out of them to attract players' attention. The hill plateau stands out due to using the same texture as the primary path, despite not being connected to it. Players are invited to wonder about how that part of the path can be reached. For each instance, the part that allows players to reach the location attracting their attention is less visible and covered in slightly denser vegetation.

The challenge of implementing this design pattern is that it can elicit curiosity without being part of the SPC pattern. Players might stumble upon a cave entrance without encountering the part that is supposed to be more visible. Especially the *Hill Path* PIR is more visible from one side of the game environment than the other. This means that players might encounter the “solution” to their curiosity before encountering the part that is supposed to elicit it. Players might also have had their curiosity elicited but never find out how to reach their desired location, and thus give up on it eventually.

6.8.5 Pattern: Desired Objects Foraging (DOF)

Games often reward players for collecting specific objects, but such objects may also be used as motivators for exploration. *Shinobi Valley* uses bananas as objects of desire for the player to collect. These are functionally the same as coins in many other games, representing something of value to the player character.

In contrast to other instances, the DOF pattern is implemented at five locations. Two of them are placed directly on the beginning and end of the primary path to inform players about their existence. Picking these up also allows players to see that nothing else happens as a result of collecting bananas. The remaining three banana instances are thus more likely to be collected as part of the foraging motivation rather than to find out what happens when bananas are picked up.

The player character needs to touch bananas to pick them up. This causes their visual representation in the game world to disappear. No further action occurs, and players can also not collect the same banana anymore.

> **Pilot Study Note:**
> This pattern was only featured in the pilot study. It was taken out of the game for reasons that are further elaborated on in the discussion section of this chapter.

6.9 Pilot Study

A pilot study with 24 participants was conducted to assess the efficacy of *Shinobi Valley* as an experiment tool. Participants were recruited through convenience sampling in a University environment, with all having previous experience playing video games.

In this first part of the two-part study, the question at hand was to evaluate whether design patterns motivated players to leave the primary path. To answer this question, sub-questions had to be answered regarding the quality and stability of the game as a research tool. To do so, players filled in a post-play survey after completing the game.

The post-play survey included the following:

- **Demographic data:** age and gender
- **Gamer type self identification:** “Expert”, “Core”, “Casual”, or “Novice”
- **Frequency of playing video games:** Indication of hours per month
- **Validated game experience questionnaire:** assessment of game quality
- **Open questions and comments:** Free-text answers on questions of why players did or did not leave the path, as well as positive and negative aspects of the game

The following sub-sections elaborate on the questionnaire used in the survey, sampling, procedure, and pilot study results.

6.9.1 GUESS Questionnaire

In order to assess how participants experience the game, the *Game User Experience Satisfaction Scale* (GUESS) is included as part of the post-play survey. The GUESS (Phan, Keebler, and Chaparro 2016) has been developed to assess user experience satisfaction and provide insight into players’ attitudes and preferences. It consists of 55 rated statements divided over nine sub-scales. The following list and description of the sub-scales are taken from the original publication:

1. **Usability / Playability:** The ease with which the game can be played with clear goals/objectives and with minimal cognitive interferences or obstructions from the user interfaces and controls.
2. **Narratives:** The story aspects of the game (e.g., events and characters) and their abilities to capture the player’s interest and shape the player’s emotions.
3. **Play Engrossment:** The degree to which the game can hold the player’s attention and interest.
4. **Enjoyment:** The amount of pleasure and delight the player experienced due to playing the game.
5. **Creative Freedom:** The extent to which the game can foster the player’s creativity and curiosity, and allows them to express their individuality as part of the game.

6. **Audio Aesthetics:** The different auditory aspects of the game (e.g., sound effects) and how much they enrich the gaming experience.
7. **Personal Gratification:** The motivational aspects of the game (e.g., challenge) that promote the player's sense of accomplishment and the desire to succeed and continue playing the game.
8. **Social Connectivity:** The degree to which the game facilitates a social connection between players through its tools and features.
9. **Visual Aesthetics:** The game's graphics and how attractive they appear to the player.

The number of rated items per sub-scale varies between three and eleven items. Each item presents a statement that inquires to what extent participants agree on a 7-point rating scale. Each point on the scale is named and corresponds to a score: (1) "Strongly Disagree", (2) "Disagree", (3) "Somewhat Disagree", (4) "Neither Agree nor Disagree", (5) "Somewhat Agree", (6) "Agree", and (7) "Strongly Agree".

The average score within each sub-scale corresponds to the overall score of that sub-scale for the assessed game. The average score of all sub-scales is combined to score the game as a whole. The authors of the GUESS have demonstrated that it can be administered to participants with varying gaming experience and can be used to evaluate different types of video games.

In the *Shinobi Valley* pilot study, participants rate a total of 44 statements of the GUESS, providing results for seven sub-scales: "Usability/Playability" (11 items), "Play Engrossment" (8), "Enjoyment" (5), "Creative Freedom" (7), "Audio Aesthetics" (4), "Personal Gratification" (6) and "Visual Aesthetics" (3).

The sub-scales "Narratives" and "Social Connectivity" of the GUESS are excluded because the game does not involve such elements, or at least not to the extent that would justify their inclusion.

Usability and aesthetics are essential to assess whether the game experiment can fulfill the expectations that participants have when playing a game. Low ratings in usability could mean that player behavior is not due to intentional actions but rather the result of struggling with the technology. Likewise, the simulation of a game experience requires that participants also perceive the game as a game. Aesthetics play an essential part in that heuristic, as is evident by its inclusion in the GUESS.

The order of statements in the GUESS section of the survey is randomized for each participant.

6.9.2 Sampling and Procedure

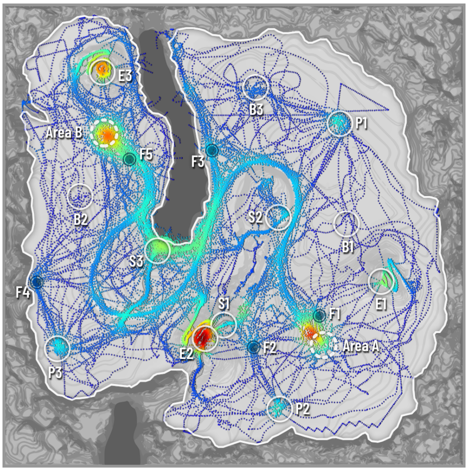
Participants were recruited through convenience sampling (Marshall 1996) from the University environment. The focus in this first part was to acquire data in a short amount of time and thus sample from a population that is accessible without more exhaustive recruitment efforts. The game and subsequent 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.

As mentioned throughout the chapter, the pilot study participants played the same experiment condition. The game featured an explicit goal statement, five hypothesized design patterns (each with multiple instances), and used the nature aesthetic. Participants were randomly assigned to one of two play directions to counter-balance order effects in the presentation of design patterns. A change in the play direction means switching the starting location of the player character and the ninja master around. This also influenced the direction of the wooden signs along the path, which would always point towards the direction of the ninja master, i.e., the explicit goal destination.

Some participants took part in the pilot in a lab setting so that the researcher could observe their gameplay and uncover any potential issues, e.g., technical errors or problems in understanding the experiment. For lab participants, a researcher was present throughout the experiment, positioned so that participants could contact them in case of questions, but without overlooking them from behind nor being in their peripheral view during the experiment.

In the lab setting, participants were asked to annotate a video recording, created automatically by the game when used in this setting, with how curious they felt during play. This was done with a modified version of the affect rating tool *CARMA* (Girard 2014) and an analog trigger that participants were instructed to squeeze to indicate higher curiosity. Depending on how far the trigger was squeezed, a higher value was recorded and time-stamped based on the video recording for subsequent evaluation. When playing in the lab setting, participants thus took longer to complete the experiment, as they re-watched their playthrough and annotated the curiosity they experienced through the analog trigger.

The purpose of including post-play affect ratings was to assess player curiosity at different moments in the game and to consider whether this method of acquiring data could be used in the more extensive study.



	Pattern Instatiation Region (PIR)	% of players	Time Spent [sec]
EXP	**E1:** Mountain A	41.7	11.6
	E2: Mountain B	75.0	22.0
	E3: Mountain C	66.7	13.5
OBS	**B1:** Forest A	12.5	7.2
	B2: Forest B	20.8	4.1
	B3: Ground Fog	66.7	3.5
OOP	**P1:** Stone Spiral	62.5	6.3
	P2: Stone Stack A	41.7	15.7
	P3: Stone Stack B	75.0	7.2
SPC	**S1:** Mountain Cave	45.8	4.0
	S2: Hill Path	50.0	4.1
	S3: Cliff Cave	66.7	9.4
DOF	**F1:** Banana A	75.0	–
	F2: Banana B	62.5	–
	F3: Banana C	91.7	–
	F4: Banana D	79.2	–
	F5: Banana E	100	–

EXP — Extreme Points
OBS — Visual Obstructions
OOP — Out of Place Elements
SPC — Spatial Connections
DOF — Desired Object Foraging

Figure 6.11: Heatmap showing an aggregate of all participant movements (left). Longer durations or overlapping movement paths are indicated by changing the hue from dark blue via green to dark red. A table of all PIRs (right) shows the percentage of players that have visited a PIR and how much time participants spent there on average.

6.9.3 Results

A total of ***24*** participants completed the game. Play sessions lasted for a mean of ***Mn=12.12*** minutes (***SD=4.8***). The random allocation of play direction resulted in ***15*** participants heading A→B (***62.5%***) and ***9*** heading B→A (***37.5%***). Out of ***24*** participants, ***22*** completed the post-play survey. The mean age was ***Mn=27.4*** (***SD=8.96***), with ***9*** players identifying as female (***41%***) and ***13*** identifying as male (***59%***).

The majority of players self-identified as "Core" players (***n=9***, ***41%***), with ***Mn=2.36*** (***SD=0.93***) if converted to a scale from 1 ("Expert") to 4 ("Novice"). The majority of players reported playing between 10-20 hours per month (***n=7***, ***31.8%***), with ***Mn=2.73*** (***SD=1.14***) if converted to a scale from 1 ("Less than an hour per month") to 5 ("more than 40 hours per month").

Player metrics were processed to create a heat map for each player (see figure 6.11 for an aggregated heatmap of all players). All PIRs were visited by multiple players, with both forest regions (instances of *Visual Obstructions* or OBS) being the least visited (***n=3***, ***12.5%*** and ***n=5***, ***20.8%*** respectively) and both *Mountain B* and *Stone Stack B* being the most visited (***n=18***, ***75%***). Every participant collected one instance of the *Desired Object Foraging* (DOF) pattern, with the least collected instance still being collected by ***15*** (***62.5%***). A total of ***16*** participants (***66.7%***) jumped into the chasm separating two sides of the primary path, out of which ***11*** (***45.8%***) did so at least twice. Most such jumps took place at the *Cliff Cave* PIR, indicating that at least some jumps are not intentional but a result of entering the cave from its visible side rather than the connected hidden entrance.

Results of 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: ***Mn=6.21*** (***SD=0.63***)
- Creative Freedom: ***Mn=5.15*** (***SD=0.75***)
- Enjoyment: ***Mn=5.18*** (***SD=1.01***)
- Personal Gratification: ***Mn=5.05*** (***SD=0.89***)
- Play Engrossment: ***Mn=4.78*** (***SD=1.03***)
- Usability: ***Mn=5.83*** (***SD=0.57***)
- Visual Aesthetics: ***Mn=6.12*** (***SD=0.71***)

Kendall's Tau-b (τ_b) correlations of survey results show three significant correlations (at $p<0.05$). Play frequency is correlated with gamer type self-correlation ($\tau_b=0.64$, $p<0.001$) and is inversely correlated with the *Play Engrossment* (PE) score ($\tau_b=-0.43$, $p=0.01$), while participant age correlated with the usability score ($\tau_b=0.34$, $p=0.039$).

Open-question results and comments left at the end of the survey indicated that the game's visual quality left favorable impressions. At the same time, the lack of challenge was experienced as unfavorable. Participants indicated leaving the path to explore the surrounding environment, noting various PIRs that stood out to them. Comments also mentioned the collection of bananas as a motivation for leaving the path. Participants who had explored the environment before talking to the ninja master commented on being annoyed at waiting without much to do.

6.10 Discussion

The focus of the pilot study was to assess the suitability of *Shinobi Valley* as a research environment for part two of the study. Before the study, it was unclear whether players would explore without being specifically prompted 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. Exploratory behavior was shown by all participants and for all PIRs, suggesting that the patterns successfully elicit curiosity for spatial exploration.

The average playing time of 12 minutes suggests that players generally spent more time exploring than would be expected if their motivation was to complete the game as fast as possible. Based on which PIRs were visited, there are indications that some patterns and instances are more successful in eliciting curiosity in players.

Players rated the game positively, with GUESS ratings 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: play frequency. It can be hypothesized that the lack of challenge reported by players contributes to the differences in the score, resulting in lower scores from participants who spend more time with 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 suitable experiment environment for a more comprehensive study.

Although the evaluation of the game was positive, certain factors will be different in the experiment as opposed to the pilot. The experiment involves a larger sample size and, thus, controls for contributing factors. Components of the GUESS questionnaire are used again, although those related to the game's quality (e.g., audio and visual aesthetics) are removed as the game's aesthetic quality is sufficiently assessed by the pilot study. It is also important to note that, while the game was well-received by pilot participants, they were recruited through different means than those in the experiment (online and anonymous recruitment, rather than convenience sampling and personal approach). This may cause a difference in game reception and willingness to invest time playing.

6.10.1 Changes Based on Pilot Study Results

Apart from assessing the suitability of *Shinobi Valley*, the pilot study also motivated several changes to the game based on participant feedback:

Removal of the *Desired Objects Foraging* (DOF) pattern: This pattern has been the most "attractive" in the pilot study but has also been perceived as a motivation that is difficult to classify as spatial exploration. Once players know that objects can be foraged for, they might be primarily motivated by collecting as many as possible or form expectations as to what might happen if they reach a certain number. In the context of a larger game, this can be desirable and combine well with other patterns. However, for experimental purposes, it makes it more challenging to attribute explorative behavior to the nature of individual patterns.

Removal of audio-visual feedback when visiting a PIR for the first time: Similar to DOF patterns, the audio-visual feedback of encountering a PIR for the first time could motivate players to "collect" all PIRs. Although this can be desirable in many games, it is not ideal for experimental purposes. This removal might reduce enjoyment, as a lack of game feedback can make the game feel less engaging. However, it makes player behavior easier to assess and attribute to curiosity for exploration based on individual patterns.

Reducing the waiting time by half if players have played for a long time: Since participants take the GUESS questionnaire only after playing the game, their last impression of the game likely affects their scores. Participants who have explored a large part of the game before meeting the ninja master are thus more likely to end their experience in boredom, which can affect overall scores. To mitigate this impact, the waiting time is thus reduced for players that have already played for a long time.

Dropping in-person testing and related measures: Although in-person testing worked well during the pilot study, the more extensive study had to be carried out during the first SARS-CoV-2 pandemic. Measures that were taken only in the lab, specifically participants' affective state over time, were replaced with short in-game surveys.

6.11 Conclusion

This chapter described the design and implementation of five design patterns meant to elicit curiosity for spatial exploration. The research question raised in the chapter has been addressed through a pilot study. The contributions of this chapter are twofold.

First, it shows, by example, the process of implementing and evaluating design patterns for empirical study. It highlights the many considerations that need to be considered in this process, both from a game design and a research standpoint. In doing so, the chapter answers the primary research question: *How can design patterns for exploration be implemented and evaluated for empirical study?* The process, methods, and procedures described in this chapter can serve as a basis for future work where other patterns are implemented for similar purposes.

Secondly, the example case study described in this chapter specifically examined design patterns for spatial exploration. Based on the results, the research questions examined by the pilot study can be answered thus:

1. The implemented level design patterns motivated players to go out of their way to explore them.
2. The quality of the game can be considered sufficient, given above mid-point ratings from a validated game experience questionnaire and positive participant feedback. The pilot study revealed a need for some adjustments implemented in response.

3. The logging system and subsequent survey captured enough data to evaluate player behavior. The pilot study did not reveal a need for capturing additional data.
4. The game operated reliably throughout the pilot study.

Based on these results, the next chapter describes the second half of the study: the empirical evaluation of level design patterns.