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Utilization of Visual Cues to Improve Navigation in Metroidvania-style Level Design

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Abstract

This study investigates how visual cues can enhance player navigation in Metroidvania-style level design. This research aims to address the critical need for effective visual cues in improving player navigation within non-linear Metroidvania game levels. By delving into this aspect, we seek to not only enrich the gaming experience for players but also contribute valuable insights to game developers and researchers interested in improving their level design. Using a between-subjects design, we created a non-linear game prototype in Unity, representing the Metroidvania genre, along with three variants incorporating different levels of visual cue markedness, resulting in four versions in total. Data was collected through think-aloud protocols, observations, surveys, cued recall debriefs, and semi-structured interviews to assess participants' responses to the visual cues and their navigation strategies. The results indicate that integrated cues provided the clearest guidance, allowing players to quickly understand their objectives and navigate effectively. Subtle cues preserved the sense of discovery, while emphasized cues effectively highlighted specific items or secrets.

Keywords: Metroidvania, non-linear level design, navigation, video game, visual cues.

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1. Introduction

1.1 Problem Statement

Visual cues play a crucial role in games, often employed to support three different tasks or purposes, encouraging players to: discover interactive objects or hidden areas within a scene; observe objects or areas that require timely action or response; and navigate to key spatial locations within the game world (Dillman et al., 2018)

For instance, in the game *Mirror's Edge* (Electronic Arts, 2008), red objects are used to navigate players. Each red object effectively indicates the next step for the player. A subgenre of 2D platform games, “Metroidvania”, a portmanteau derived from the names of two renowned video game series, *Metroid* (Nintendo, 1986) and *Castlevania* (Konami, 1986). It is characterized by extensive map layouts, guided non-linear level and utility-gated exploration and progression (Cook et al., 2012) In non-linear level design, the sequence of game actions is primarily determined by the player (Kremers, 2009). Due to the vast levels and nonlinear exploration, players often need to return to previously explored areas, termed as “backtracking” (Oliveira et al., 2020). As backtracking is a kind of wayfinding task, and wayfinding needs visual cues, studies suggest too little, too many or not understandable visual cues will natively affect player experiences (Barbosa, 2017). Previous studies also suggest that frequent backtracking can lead to player boredom (Wahlberg, 2015).

Therefore, in Metroidvania-style games, the use of visual cues plays a significant role in player navigation. For example, in *Donkey Kong Country: Tropical Freeze* (Nintendo, 2014), bananas are served not only as collectibles but also as navigational aids. In Figure 1.1, besides the bananas on the iceberg on the right side guiding the player, the glowing handle on the ship also indicates to the player that it is an interactive object. Although *Donkey Kong Country* is not a Metroidvania titled game, as a platformer, it shares many similarities with Metroidvania games, which are also a sub-genre of platformers. The use of visual cues for navigation in *Donkey Kong Country* holds significant value for borrowing in Metroidvania titled games.

Figure 1.1

Bananas are visual cues in Donkey Kong Country (Nintendo, 2014).

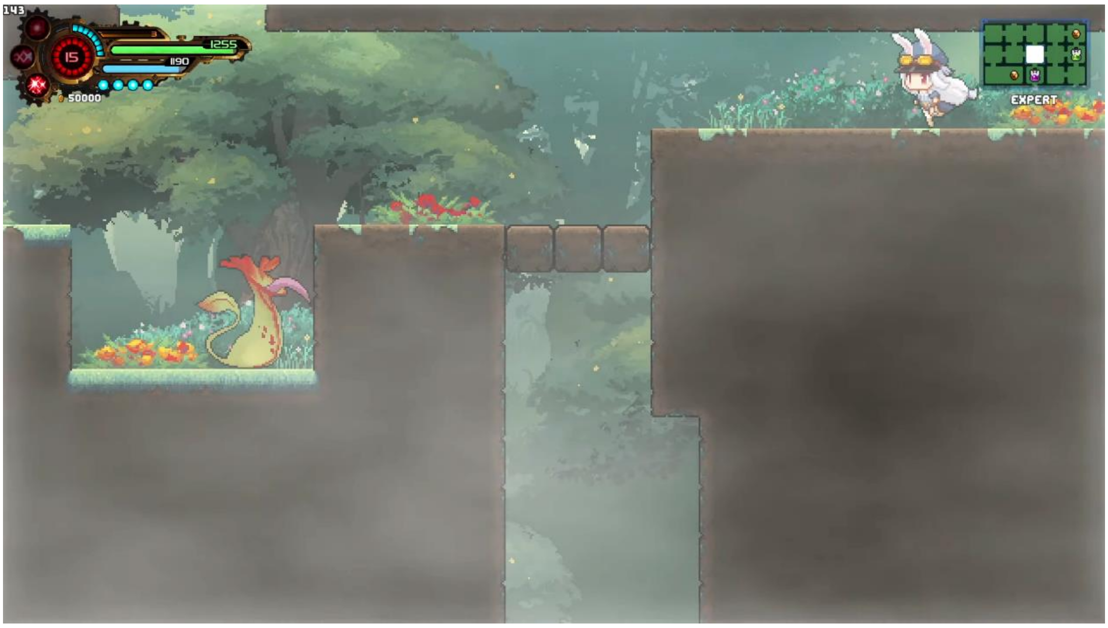
However, improper use of visual cues can confuse players and lead to disorientation, as is evidenced in certain games. For instance, in *TEVI* (CreSpirit, 2023), the misty maze area received unfavorable reviews from critics and the player community (Demajen, 2024; Volodymyr Azimoff, 2023).

Figure 1.2

The maze-like map in TEVI (CreSpirit, 2023).

Figure 1.3

Red rose bush is a visual cue in this room.



As shown in Figure 1.2, despite the clear connection between adjacent rooms on the mini-map, players are unexpectedly transported to a completely different room upon reaching the exit. Despite the designers' introduction of visual cues like red rose bushes on the map as shown in Figure 1.3, attempting to guide players to the correct exit, the intended effect was not achieved. Both games utilize visual cues for player navigation, but why did *Donkey Kong Country* succeed while *TEVI* did not? This question inspires our curiosity. If we design a Metroidvania-style level, and conduct multiple tests by introducing different visual cues, observing and analysing how players explore with the assistance of these visual cues, we may be able to obtain an answer.

1.2 Motivation

We have chosen the Metroidvania genre for its unique mechanics and dedicated fan base. These games boast expansive worlds where players progressively unlock new abilities, unveiling previously inaccessible pathways and fostering a sense of open-ended exploration. However, without adequate visual cues, players may quickly become disoriented and unsure of their next steps. The gaming community has highlighted that they might stop playing if they are feeling lost and directionless when playing these games (ScOULaris, 2022). Despite the genre's nearly four-decade-long history since the release of the original *Metroid* (Nintendo, 1986), Metroidvania games continue to captivate players, as evidenced by the anticipation surrounding upcoming releases like *Hollow Knight: Silksong* (Team Cherry, n.d.), which currently ranks fourth on the Wishlist of the digital game distribution platform Steam (Steam Search, n.d.). Moreover, while research by Dillman et al. (2018) has identified 3 dimensions of visual interaction cues, with go cues showing potential in guiding players, studies on visual cues specifically within the context of Metroidvania games are scarce.

This research aims to address the critical need for effective visual cues in improving player navigation within non-linear Metroidvania game levels. By delving into this aspect, we seek to not only enrich the gaming experience for players but also contribute valuable insights to game developers and researchers interested in improving their level design.

1.3 Research Question

How can visual cues be utilized to improve player navigation in Metroidvania-style level design?

To better address this research question, we can break it down into two sub-questions:

Sub-question 1: How do different visual cues affect the amount of time required for a player to finish the game?

Sub-question 2: How do different visual cues influence players' decisions on when and where to go?

1.4 Brief Overview

This thesis begins with an in-depth literature review about visual cues, non-linear level to establish the context, followed by a detailed theoretical framework. The methodology section will provide insight into the design and execution of the study. Results, analysis, and discussion sections will follow, leading to a conclusion that summarizes key findings and suggestions for future research.

1.5 Limitations

Due to participants coming from different backgrounds, unexpected variables may affect player behavior. We could only address this issue by increasing the sample size. Additionally, our research findings may not be applicable to other types of games requiring visual cues for navigation. We developed a prototype of a Metroidvania game along with three variations, each featuring different visual cues but the same level design. Due to the time constraints, we could not explore combining 3 different markedness of cues to cross reference or validate the result from testing them individually. Using our own game rather than existing ones as a research tool constrained the playable area and game duration, limiting our exploration to a finite number of navigation or backtracking tasks.

2 Background

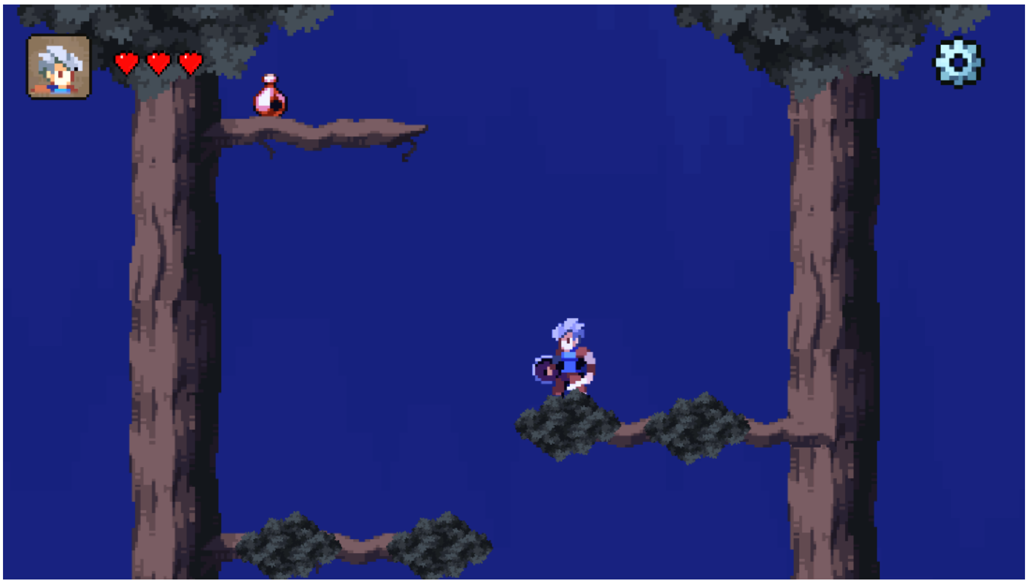
2.1 Game Overview

Our game is developed using the Unity engine, supports both gamepad and keyboard controls and features a pixel art style. Drawing inspiration from Metroidvania-style non-linear design, our level design incorporates areas that necessitate players to acquire upgrades for progression. The game world is divided into three main areas: Meadow, Underground, and Treetops. Players can obtain two critical upgrades: double jump and slide. The double jump upgrade empowers players to jump twice, accessing higher regions, while the slide upgrade facilitates evading monster attacks and maneuvering through narrow terrain. Additionally, various items are strategically placed throughout different rooms, serving as rewards for thorough exploration.

These items include potions to increase player health and swords to boost attack damage. Our game encourages backtracking, inviting players to revisit rooms after acquiring upgrades to claim item rewards. As illustrated in Figure 2.1.1, early on, players may encounter items atop trees, inaccessible due to insufficient jumping height. However, upon acquiring the double jump ability later in the game, players can backtrack to the room and utilize the newfound ability to acquire the potion.

Figure 2.1.1

Players can discover the potion by jumping onto the branch.



Save points are placed in challenging rooms, allowing players to retrieve full health after saving and respawn after they are dead. We have designed a total of five types of enemies. Typically, they patrol on platforms or in designated areas. When they detect players or are attacked by players, they will chase and use skills. For instance, as shown in Figure 2.1.2-A is the boar using skill to bump player in a high speed; figure 2.2.2-B is the bee finds player and uses its skill to hit player in an elegant curve.

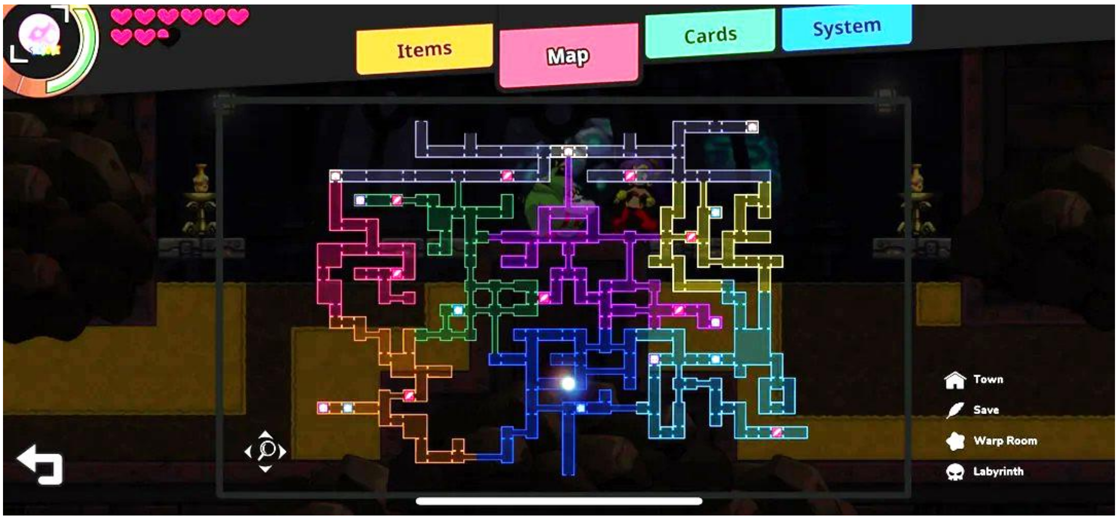
Figure 2.1.2

The boars' skill is bumping player in a high speed, the bees' skill is hit player in a curve

The objective of the game is to reach the mine. The core route is to obtain the slide upgrade, use the slide to acquire the double jump upgrade, and then use the double jump to reach the mine. Although most modern Metroidvania games feature maps to assist players with navigation, as shown in Figure 2.1.3, we opted not to implement the map functionality to better explore how visual cues can aid players in navigation.

Figure 2.1.3

The in-game map of Shantae and the Seven Sirens (WayForward, 2019).



2.2 Literature Overview

2.2.1 Metroidvania

"Metroidvania" is a subgenre of 2D platform games, whose name is a portmanteau of two famous series, *Metroid* (Nintendo, 1986) and *Castlevania* (Konami, 1986). Typical Metroidvania games feature large level maps and non-linear exploration gameplay based on areas that can only be reached after attaining items in other areas (Cook et al., 2012). These maps include numerous items and enemies of varying difficulty levels (Oliveira et al, 2020). Some classic titles of Metroidvania games are *Castlevania: Symphony of the Night* (Konami, 1997) and *Super Metroid* (Nintendo, 1994). These titles are remarkable milestones of this genre, so it is important to understand the history behind the birth of Metroidvania genre (Oliveira et al, 2020).

The first game in the series, *Metroid* (Nintendo, 1986), introduced many console gamers to a vast, explorative 2D platform world. *Super Metroid* (Nintendo, 1994) is the second sequel to *Metroid* (Nintendo, 1986) after *Metroid II: Return of Samus* (Nintendo, 1991), and brought significant changes, making the game easier. It was the first in the series to introduce an inventory screen and multidirectional shooting, as well as a map system. Specifically, it automatically shows players a small map of the surrounding rooms that they have already visited, and then shows them a map of the entire area once they access a map terminal. *Super Metroid* (Nintendo, 1994) inspired another aspect of modern Metroidvania games with more linear sections, which could provide a better experience in certain aspects. These more linear areas are often designed to help players find and familiarize themselves with some more crucial upgrades so that they are not entirely unprepared or confused when they need them later (P S, 2019). As shown in Figure 2.2.1, *Super Metroid* (Nintendo, 1994) utilizes color as visual cues, where blue doors indicate doors that can be opened with regular bullets, while red ones cannot. Cracked stones on the ground with reflections indicate that they can be destroyed.

Figure 2.2.1

Color as visual cues in Super Metroid (Nintendo, 1994).

Three years later, *Castlevania: Symphony of the Night* (Konami, 1997) incorporated elements found in RPGs such as attributes, leveling, spells, and summoning familiars. Together, these two series form the basis of Metroidvania that players are familiar with today (Yu, 2021). In 2004, *Cave Story* (Studio Pixel, 2004) became the poster child for indie success. *Cave Story* also showed the viability of Metroidvania as a medium for telling mysterious and intricate stories.

One of the modern representatives of Metroidvania undoubtedly includes *Hollow Knight* (Team Cherry, 2017). Apart from evident technical upgrades like better graphics, modern Metroidvania games often have a more balanced pace and more linearity. Unlike in *Metroid* (Nintendo, 1986) or *Castlevania: Symphony of the Night* (Konami, 1997), where the games quickly unfold once you start gaining new abilities, modern games tend to unfold more gradually throughout gameplay. However, *Hollow Knight* stands out in navigation. All area maps start incomplete, and players need to get another item to complete them. Even then, you cannot see your position or useful locations like benches and shops unless you go there. Although it also features a fast-travel system between specific locations, you must first find the stations yourself and then pay in-game currency to unlock them.

Therefore, using visual cues to aid player navigation is crucial, as in *Hollow Knight* (Team Cherry, 2017) where each area has its unique color code to distinguish from one another, with story elements here and there as well. These visual cues serve as a guide for exploring Hollownest, such as the path from the Forgotten Crossroads to Greenpath. As we approach Greenpath, the sight of a few green plants lets us know we're entering a new area (Gaming Gnosis, 2023). As shown in Figure 2.2.2, the upper part depicts the scenery as the player leaving the Forgotten Crossroads, while the lower part shows the player entering Greenpath. The increasing presence of green plants guides and signals to the player that they are entering a new area.

Figure 2.2.2

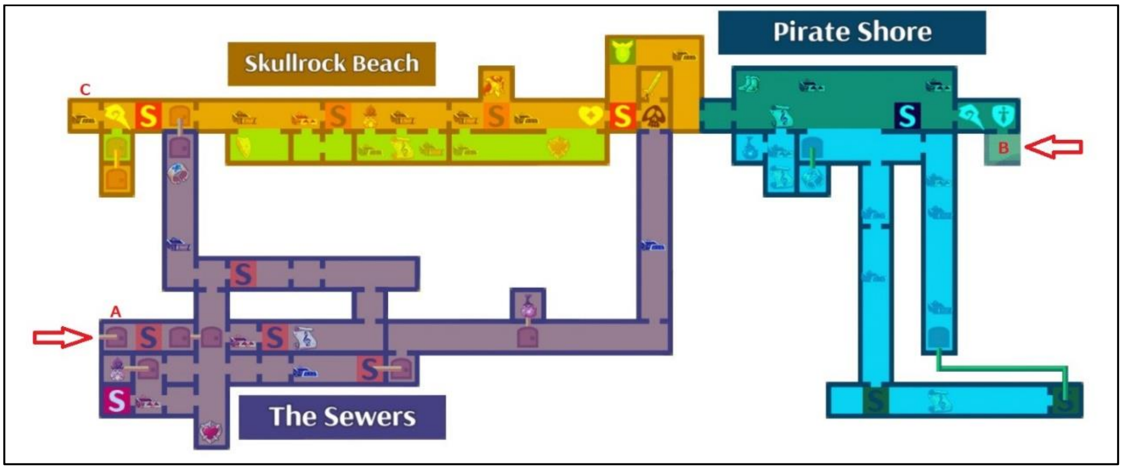
When players get close to Greenpath, the color of green becomes more and more to navigate and signal players.

2.2.2 Non-linear level design

In non-linear level design, the sequence of game actions is primarily determined by the player (Kremers, 2009). Non-linear level design is widely used in games like *Monster Boy and the Cursed Kingdom* (FDG Entertainment, 2019) and similar Metroidvania titles. For example, in Figure 2.2.3, when a player aims to obtain the treasure chest in room C, they can choose to go up from room A to reach room C, or proceed continuously leftward from room B to reach room C. However, issues arise in non-linear level design when players may need to backtrack to previously explored areas (Oliveira et al., 2020), leading to complexities in maintaining player engagement and ensuring an interesting and immersive level experience. Research on backtracking in Metroidvania-style games suggests that non-linear levels can become more monotonous than linear ones when rooms or challenges are repeated multiple times (Wahlberg, 2015).

Figure 2.2.3

A backtracking level in Monster Boy and the Cursed Kingdom (FDG Entertainment, 2019).



2.3 Theoretical Framework

2.3.1 Visual cues

Dillman et al. (2018) categorized visual cues found in video games into three dimensions: purpose, markedness, and trigger. They analyzed existing video games and identified different types of visual cues based on these dimensions.

Dimension 1: Purpose - These cues assist players in one of three ways: discovering interactive objects, examining certain aspects of the environment, or navigating to specific locations within the environment.

Dimension 2: Markedness - This dimension refers to the integration of visual cues into the game environment or how they stand out from it. They focused solely on the visual presentation or design of the cues: subtle, emphasizing a particular object, integrated into the environment, or overlaying it.

Dimension 3: Trigger - This dimension considers how visual interactive cues are triggered for visibility. They identified four levels of triggers based on a player's agency over the trigger, from explicit actions to triggers caused by other agents, and ultimately to persistent cues.

Although study by Dillman et al. (2018) was focused on 3D augmented reality video games, they also utilized visual cues from 2D games as example when analyzing the visual cue framework. Therefore, their framework can be applied to the design of 2D games as well.

Typically, visual cues in video games span multiple dimensions, with a corresponding visual cue found in each dimension (Dillman et al., 2018). Taking an example from *Ender Lilies: Quietus of the Knights* (Adglobe Live Wire, 2021), as shown in Figure 2.3.1, fire pits are persistent emphasized go cues to help players in navigating. Our research focuses on how visual cues can aid player navigation. Therefore, within the purpose dimension, the visual cues are fixed as go cues, which provides navigational assistance through environment (Dillman et al., 2018).

Figure 2.3.1

Fire pits are persistent emphasized go cues.

In three identical game prototypes with visual cues, we introduced three different types of visual cues in the markedness dimension: subtle cues, emphasized cues, and integrated cues. According to Dillman et al. (2018), subtle cues seamlessly blend into the environment, making them difficult to distinguish from the surroundings. These cues appear to be part of the level or environmental design, utilizing lighting and contrast to draw players' attention to environmental features. Emphasized cues highlight existing objects or surfaces within the game environment through various visual effects, such as outlining the contours of objects, highlighting objects, or dimming all other objects around the emphasized one. Integrated cues take the form of virtual objects added to the scene, which are visible to players but not actually part of the game world. These virtual objects can track objects within the game world, updating their positions correctly within the viewport as players change their view.

While overlaid cues discussed by Dillman et al. (2018) are typically used in HUD components such as mini maps, not in the game environment, since our research focuses on the game world, we did not use overlaid cues. In the triggers dimension, to control variables, we opted for persistent cues, which are shown all the time. This choice aligns with the type of visual cues often used in Metroidvania games, providing consistent guidance throughout gameplay.

3 Methodology

3.1 Positionality and Reflexivity

In qualitative research, particularly within the social sciences, the positionality of researchers significantly influences both the research process and outcomes (Wilson et al., 2022). Therefore, it is imperative to acknowledge our own positionality and reflect upon it before proceeding further. Each author of this study identifies as a gamer or possesses some level of gaming experience, pursuing a bachelor's degree throughout the project's duration. As our participants primarily consist of individuals from our social network, most fall within the age range of 20 to 30 years old and have gaming experience, positioning both us and our participants as insiders in the realm of gaming and game design. Hence, we can present information accurately and truthfully between participants and reader as insider (Holmes, 2020).

However, this limited diversity could potentially skew our results and render them less applicable or misleading to outsiders. For instance, our familiarity with complex gaming mechanics or conventions may lead us to overlook the challenges faced by novice gamers who are just starting to explore the gaming world. As insiders, we might take for granted the intuitive understanding of game interfaces or some visual elements, failing to recognize the potential confusion or frustration experienced by newcomers. This oversight could significantly impact the applicability of our findings to game designers seeking to cater to the needs and preferences of this demographic.

Our prior experiences of getting lost in games or encountering excessive wayfinding cues have inspired and guided our research focus on observing players and comparing the effects of different cues. However, the necessity for constant observation imposes limitations on the quantity of data we can gather, as we are unable to accommodate multiple playtesters simultaneously.

3.2 Between-Subjects Design

To address our research questions, we employed the Between-Subjects design methodology (Bhandari, 2021). The motivation behind employing the Between-Subjects design methodology in our study lies in our aim to minimize the potential impact of the learning effect on participant responses and behaviors. We utilized a game prototype devoid of visual cues as the control group, while the independent variable comprised different markedness levels of visual cues in markedness dimensions. By introducing three types of visual cues, subtle cues, emphasized cues, and integrated cues (Dillman et al., 2018) into the game prototype without any visual cues, we created three versions with visual cues. By assigning each participant to only one experimental condition, we sought to prevent any potential carryover effects or biases that could arise from repeated exposure to different versions of the game.

The simplicity of this research method, as noted by Simkus (2023), is a key advantage. By ensuring that each participant experiences only one set of visual cues, we can directly compare the effects of different cue types without the interference of learning or adaptation over time. Additionally, this approach reduces the duration of playtesting compared to sequentially testing all four versions, mitigating participant fatigue and maintaining engagement throughout the process, as highlighted by Budiu (2024). Furthermore, participants were kept unaware of their group assignment to prevent unintentional or intentional changes in their responses, as emphasized by Bhandari (2021). This helps to maintain the integrity of the data collected. The straightforward arrangement of testers also facilitates the swift collection and analysis of data, contributing to the efficiency of the research process.

However, this research method has certain limitations. Firstly, it requires a large pool of participants. Since each participant tests only one of the game versions, and we have a total of four versions, this method necessitates a substantial sample size. Another limitation is the potential threat to validity posed by individual differences. As different participants provide data for the same game version, individual differences among participants may introduce error into our research results. Therefore, we must be vigilant in minimizing these potential differences to ensure that our conclusions are related to the experimental conditions rather than other factors. The only effective solution we can take is to recruit more participants and increase the sample size, thereby enhancing the credibility and generalizability of the study.

3.3 Data Collection

3.3.1 Demographic Information Survey

This survey was taken from Barbosa (2017), as detailed in Appendix A, and primarily aims to gather information on players' basic information, gaming preferences, and habits. One of the reasons for choosing this survey was the relevance and reliability of Barbosa's study, which focused on players' reactions to navigation cues in 3D action-adventure games, aligning with the scope of our research. Therefore, this survey is highly applicable to our study. When analyzing visual cues, we will consider participants' completion times when applicable as a reference. However, since most participants are random samples from our social network, some testers may not be familiar with games or hardly play games, resulting in longer completion times, which could affect our analysis of how visual cues influence player navigation. Therefore, before analyzing interview data and gameplay recordings, we will refer to this survey to exclude any outliers.

3.3.2 Think Aloud Protocol

We want to explore participants' thoughts during gameplay: how they reason to choose specific paths and ignore others, what attracts their attention, what does not, and how they interpret the different colors, lights, icons, and other elements presented to them. Verbal protocols allow us to glimpse into what might be happening in participants' minds, a method that requires them to think aloud while performing tasks during the test. Essentially, any issues related to the usability of the game screen can be addressed through verbal protocol analysis (Isbister, 2017).

Ericsson and Simon (1984) explicitly stated in their framework that any inferences participants make about their own cognitive processes or viewpoints should not be considered for analysis, as they do not represent reliable data. Instead, only verbalizations involving what participants are attending to and in what sequence should be considered. Data collected earlier by Nisbett and Wilson (1977) suggested that humans are not adept at reporting the deeply underlying factors that influence their decisions. Regarding verbal protocols, their conclusion was that these protocols would primarily consist of observed facts and decision outcomes, which researchers can then interpret to understand potential underlying cognitive processes.

Regarding the method of data collection, it is crucial to explicitly state the expectations for participants and what they are to verbally report before the game testing. We require participants to continuously verbalize their thoughts while playing the game. These prompts are brief, non-directive, and use neutral phrases such as “keep talking”, rather than phrases that would prompt specific answers. Even if they believe what they are saying is meaningless or when they feel there is nothing significant to say, we emphasize the importance of them continuing to verbalize. Verbal reports are recorded using Open Broadcaster Software (Version 30.1.2; OBS Project, 2012), which is also known as OBS. We also take notes during the session. Instances where participants made choices, expressed confusion, or engaged in backtracking were particularly noted, as a reference for the semi-structured interviews conducted after the game session, both as a backup and to support subsequent analysis.

Thinking aloud has long been a controversial topic, with debates primarily focusing on whether it is possible to express one’s thoughts on task performance reliably and effectively. The consensus is that if researchers are aware of its limitations and the testing is adequately prepared and guided, verbal protocols do yield valid data (Isbister, 2017). Furthermore, verbal protocols are less suitable for asking participants to describe in detail the cognitive processes that they employ during game interaction, that is, asking them to make inferences about their own cognition. Hence, we rely on verbal thinking aloud data to infer these processes, combined with the interaction with the game. Therefore, the entire gameplay process of players is recorded using OBS.

3.3.3 Completion Time and Completion Rate

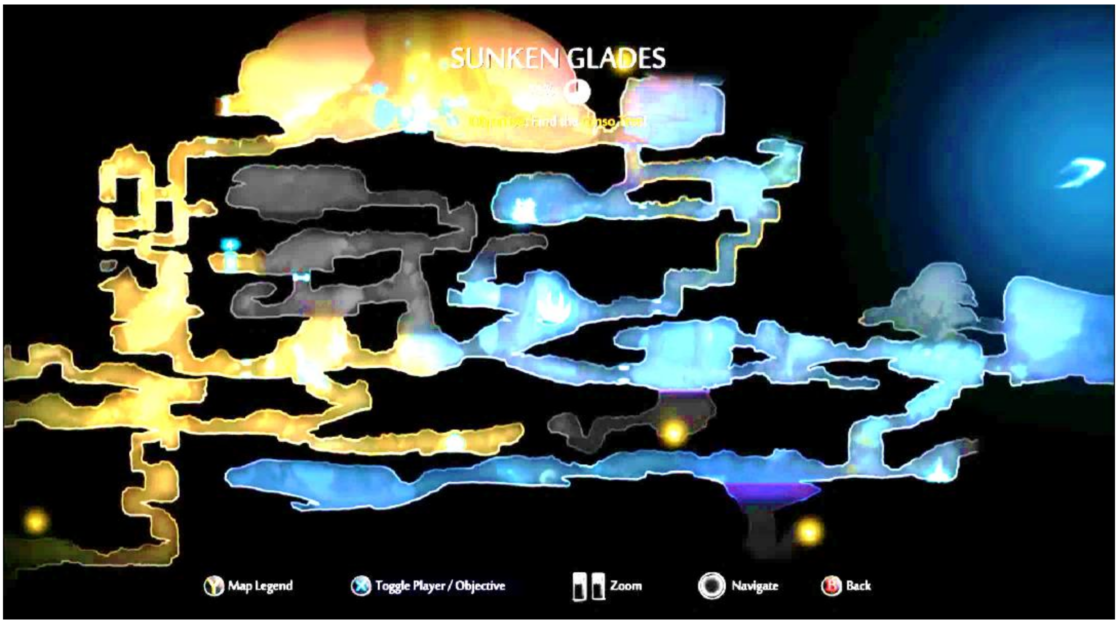
From a quantitative perspective, we focus on Sub-question 1: How do different visual cues affect the amount of time required for a player to finish the game? We collected two datasets from player gameplay recordings: completion time and map completion rate. Completion time refers to the difference in time between when players start the game and when they reach the endpoint or display the completion screen. Map completion rate is the ratio of the number of rooms explored by players to the total number of rooms in the game. The purpose of map completion rate is to reduce the margin of errors when comparing completion times between different game versions.

Our game falls under the Metroidvania genre, it encourages players to explore rooms while also forcing them to re-evaluate the paths they have taken (Oliveira et al., 2020). There are 20 rooms in the game, of which only 11 must be explored to complete it. Therefore, players with different preferences may introduce margin of errors in completion time. For example, players who prefer speed running versus those who prefer full completion will likely have significant differences in completion time, even if they both navigate better with visual cues. Hence, when comparing data between different versions, if the deviation of the average map completion rate of one version from the average map completion rate of the other versions exceeds 5% (i.e., one room's deviation), we should exclude extreme data and recalculate.

The calculation method for map completion rate is similar to that used in *Ori and the Blind Forest* (Microsoft Studios, 2015). In this game, as shown in Figure 3.1, the gray areas on the map represent areas that the player has not yet explored, while the colored areas represent areas that the player has explored. When the camera following the character in the game covers an unexplored area, it is identified as explored on the map. We used a similar method by replaying player gameplay recordings to observe if the player's camera covered at least 95% (allow 5% deviation) of the scene. If it did, we would consider the room explored. We adopted this relatively strict criterion because we observed during playtesting that some participants would enter a new room and immediately leave after a few seconds, never returning to the room in subsequent gameplay. Therefore, we standardized this method as our criterion for judgment.

Figure 3.1

The grey areas on the map represent areas that the player has not yet explored.



3.3.4 Cued Recall Debrief

Due to the limitations of think aloud protocol, we employ cued recall debrief (Bentley et al., 2005) and semi-structured interview to collect additional subjective data from participants after they finish playing the game. Cued recall debrief is a retrospective thinking aloud method. It involves immersing users back into a level of emotional reaction equivalent to what they experienced during actual interaction with the system. Participants explain which factors disrupted and/or improved their navigation process while relying on visual stimuli. We utilized screenshots from each room as visual stimuli as shown in Appendix B. Debriefing sessions were audio recorded and transcribed for analysis. Transcripts were coded based on the essence of partial or full sentences.

3.3.5 Semi-structured Interview

The semi-structured interview is a widely used research method in the social sciences, characterized by its flexibility and exploratory nature (Stock et al., 1955; Magaldi & Berler, 2020). Unlike structured interviews, which follow a formalized set of questions, semi-structured interviews allow for new questions to arise based on interviewee responses (Flick, 2002). While interviewers typically have a framework of themes to explore, the conversation remains informal, resembling a purposeful dialogue (Rubin & Rubin, 2005).

According to Ruslin et al. (2022), qualitative researchers tend to favor the use of semi-structured interviews. Firstly, these interviews allow for in-depth information gathering compared to structured interviews. Secondly, they offer a balance between flexibility and direction, unlike unstructured interviews which lack a clear focus. This flexibility enables researchers to adjust the interview to fit changing research questions while maintaining a predetermined framework.

Hence, we chose to conduct semi-structured interviews to gain a deeper understanding of players’ perspectives and interpretations regarding level design and encountered visual cues. The interview structure began with simple inquiries into participants’ gaming habits, followed by discussions about their specific experiences during the testing levels, and tailored inquiries based on observations and records. And our qualitative analysis of this data can help us answer Sub-question 2: How do different visual cues influence players' decisions on when and where to go? For a detailed list of the interview questions, please refer to Appendix A.2.

3.3.6 Thematic Analysis

Thematic analysis is an inductive method used to systematically identify, organize, and gain insight into patterns of meaning across a dataset (Braun & Clarke, 2012). It is commonly used to analyze qualitative data. When conducting thematic analysis, researchers familiarize themselves with the collected data by transcribing and reading recorded interviews. They then create codes based on the reading of each interview and attempt to find patterns among the codes they have noted. Once patterns are identified, they are reviewed to determine their relevance. The reviewed patterns are then compared with the theoretical background to draw conclusions.

The advantage of thematic analysis is that it provides researchers with great flexibility in interpreting data and allows for easier handling of large datasets by categorizing them into broad themes (Caulfield, 2023). However, thematic analysis is often very subjective, relying on the researcher's judgment (Caulfield, 2023). Therefore, ensuring consistency and transparency becomes an important concern, necessitating rigorous checks and balances throughout the analysis process.

We utilized thematic analysis to process data obtained from think-aloud protocols, cued recall reports, and interviews to understand how route cues influence players' wayfinding decisions. We followed the steps recommended by Braun and Clarke (2006): 1. Transcribe the data (if necessary), read and re-read the data, and note initial ideas. The transcription tool we used was the transcription feature in Google Translate (version 8.9.0; Neural Machine Translation, 2006). It is easy to use and highly accurate. 2. Systematically code interesting features of the data across the entire dataset, collating data relevant to each code. 3. Organize the codes into potential themes, gathering all data relevant to each potential theme. 4. Review the themes to ensure they relate to the coded extracts and the entire dataset, generating a "map" of the analysis. 5. Continuously analyze to refine the specifics of each theme and the overall story the analysis tells, generating clear definitions and names for each theme. 6. Produce the report.

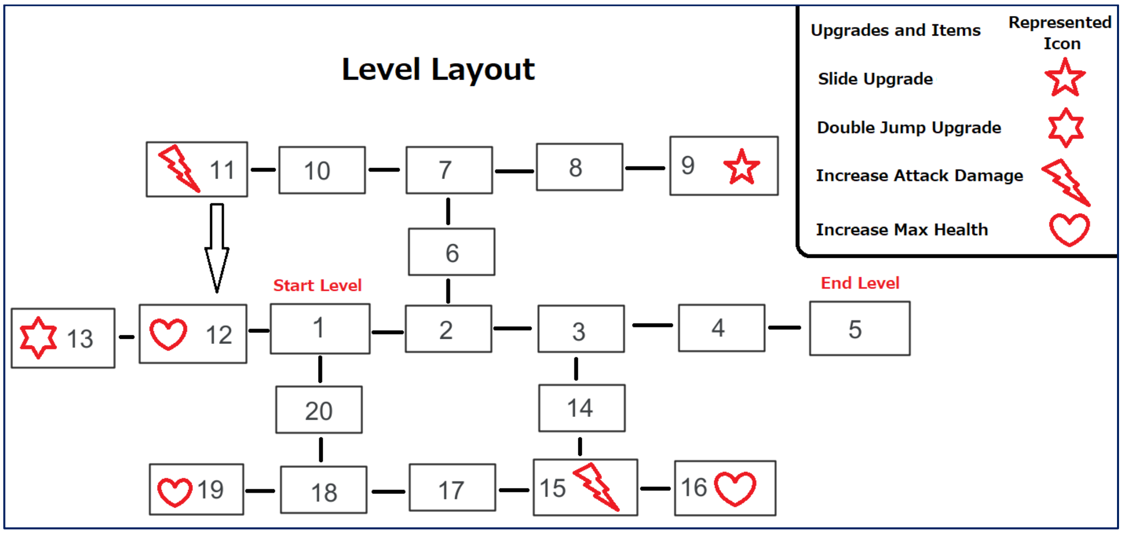
3.4 Level Design

3.4.1 Metroidvania-style non-linear level design

To conduct testing, we utilized the Unity engine to create a prototype game with an exploratory Metroidvania-style level (Cook et al., 2012). This non-linear level requires players to acquire abilities to unlock specific areas, allowing them to explore freely. As mentioned in section 3.2 Between-Subjects Design, we introduced three types of visual cues into the game prototype without any visual cues, creating three new game versions. By maintaining the same level layout across these four game versions, we aimed to minimize the impact of level design elements (such as terrain and background) on player behavior. This controlled variable method ensures that any observed behavioral changes are attributed to visual cues rather than differences in level design. Figure 3.1.1 depicts the structure and layout of the Metroidvania-style non-linear level used in the testing. As shown, the game features two upgrades: the slide ability upgrade and the double jump upgrade, placed respectively in rooms 9 and 13. To showcase non-linear level design, as depicted in Figure 3.2.1, rooms 1-3-15-18 and rooms 2-7-11-12 form two looping areas where players can freely explore rather than being confined to a fixed path.

Figure 3.2.1

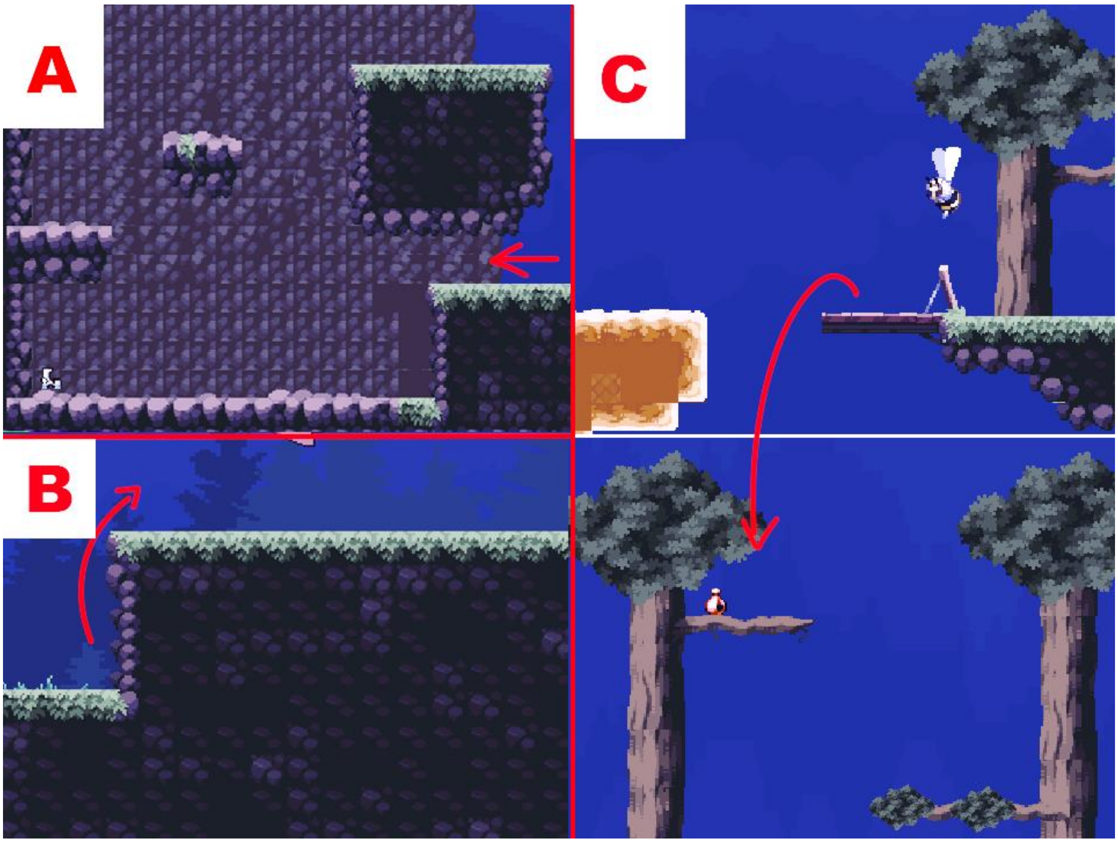
The level layout of our game.



To emphasize the Metroidvania style, we incorporated terrain obstacles that require ability upgrades to pass through in some rooms and placed items that can only be obtained after acquiring certain upgrades. In Figure 3.2.2.A, which is part of room 13, the boots shown represent the double jump upgrade item. To acquire the double jump upgrade, players need to use the slide ability to traverse a narrow area between two platforms. In Figure 3.2.2.B, part of room 4, players need to use the double jump to reach a platform and enter the room on the right. In Figure 3.2.2.C, players have multiple solutions to a puzzle within room 12. They can choose to use the double jump upgrade to jump onto a high branch and obtain a potion or jump down from a broken bridge in room 13 which is above room 12, both leading to the same reward.

Figure 3.2.2

Three different rooms show the Metroidvania level design.



3.4.2 Implementation of subtle cues

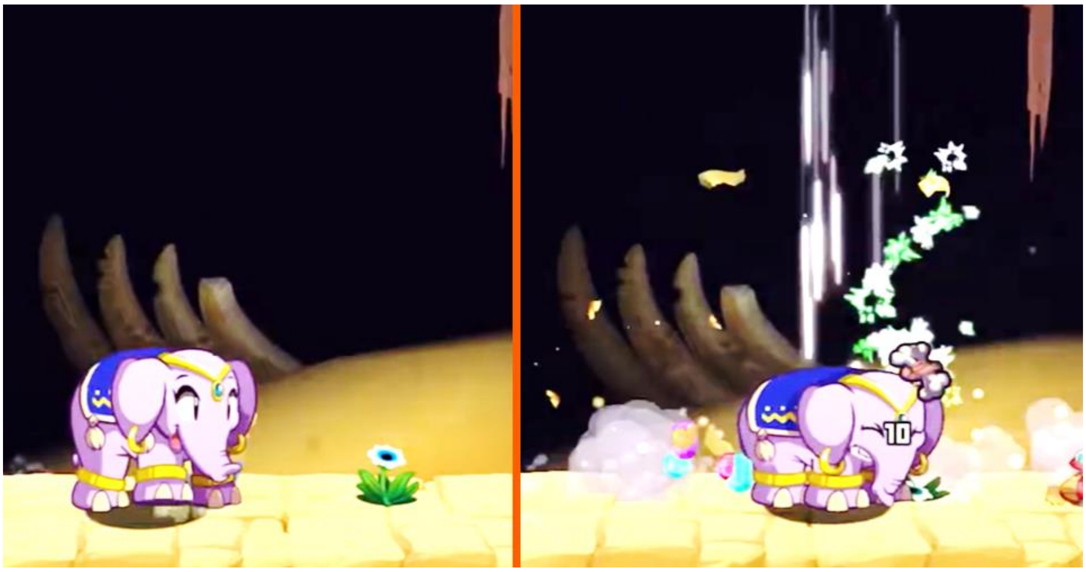
In the subtle cue version, we incorporated various visual cues, primarily including the following: as depicted in Figure 3.3.1-A, we added scaffolding to all paths requiring sliding to provide players with hints. This method of subtly indicating the need for special abilities with visual cues is frequently used in *Shantae: Half-Genie Hero* (WayForward Technologies, 2016). For example, as shown in Figure 3.3.2, players can transform into an elephant to stomp on flowered ground for rewards.

Figure 3.3.1

The scaffolding, fences and lights were frequently used in this version.

Figure 3.3.2

Every spot where players can stomp has a flower for a hint.



In Figure 3.3.1-A, a row of fences is placed at the far right of the room to connect two adjacent rooms. Similarly, in 3.3.1-B, fences extending beyond the rooms' sides can be observed. This style of visual cue is often used in *Rabi-Ribi* (CreSpirit, 2016) to link adjacent rooms, as illustrated by the bushes connecting the left and right stages in Figure 3.3.3. Additionally, in Figure 3.3.1-B, streetlights are installed, providing illumination to guide players to move right. However, in this version, some rooms' streetlights produce overly strong illumination, deviating from the definition of subtle cues and leaning more towards emphasized cues. Furthermore, the grass and purple tiles near the toxic marsh depicted in Figure 3.3.4 serve to connect rooms on both sides and utilize the color code mentioned in *Hollow Knight* (Team Cherry, 2017).

Figure 3.3.3

The bushes connect two rooms.

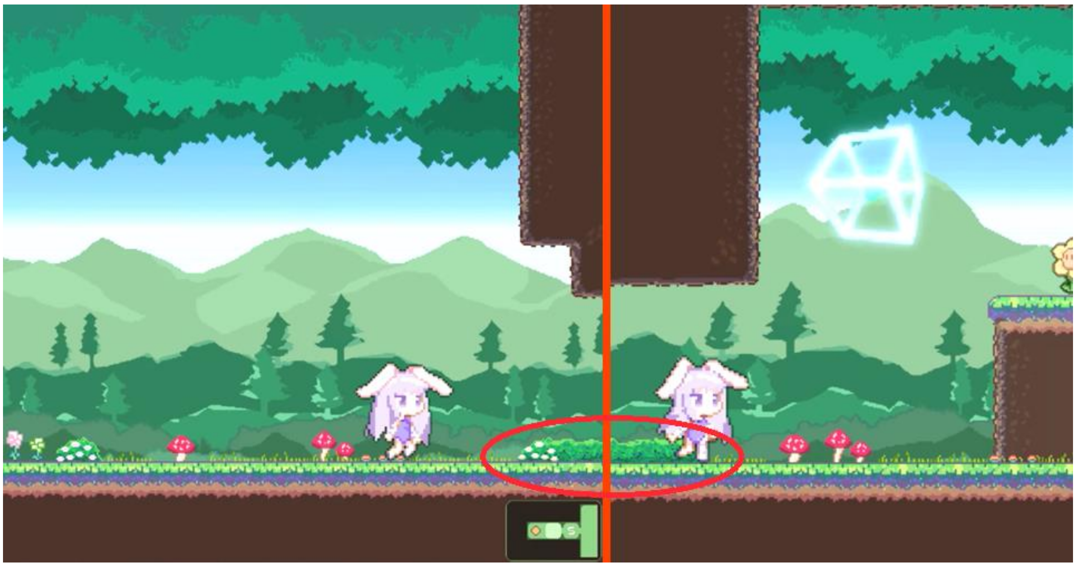
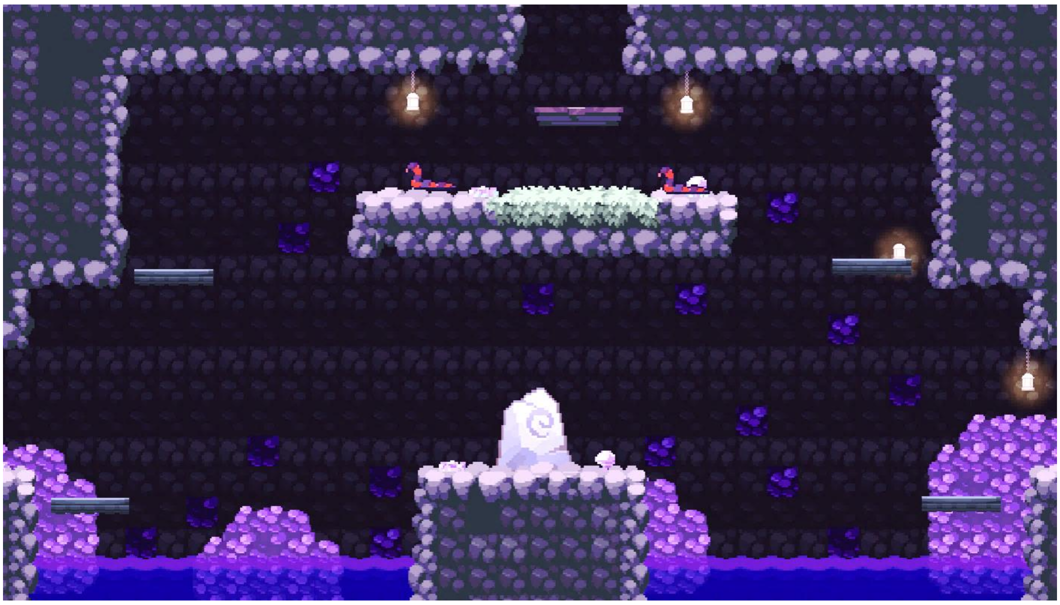


Figure 3.3.4

We also implemented color code in this version.



3.4.3 Implementation of emphasized cues

In this version, we primarily utilized visual cues highlighting items or platforms to guide players. For instance, in Figure 3.4.1, we employed orange and blue highlights to differentiate steps and moving platforms. The lights on the right side are also highlighted in yellow. This method of using highlights to direct players is commonly seen in *The Witcher 3: Wild Hunt* (CD Projekt Red, 2015). In the game, when the player uses witcher senses, it highlights interactive objects in red, and highlights objects that have already been examined yellow, as shown in Figure 3.4.2.

Figure 3.4.1

We use different colors to highlight stairs and moving platforms.

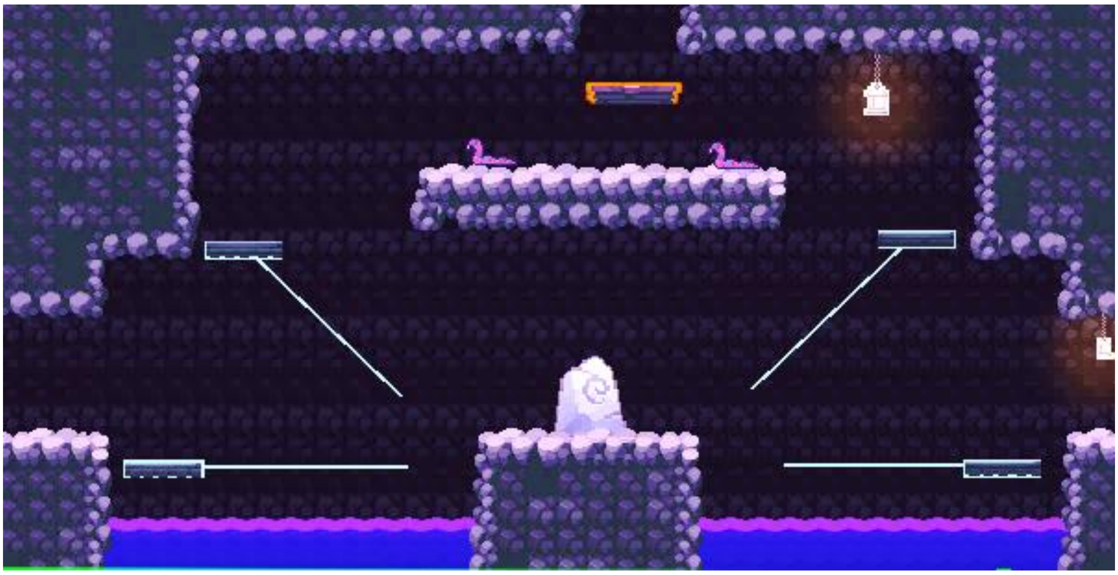


Figure 3.4.2

When players use witcher sense, key object will be highlighted.

3.4.3 Implementation of integrated cues

For the integrated cue version, we primarily used arrows to indicate accessible exits, with animated arrows added to the rooms leading to the slide and double jump upgrades to attract players' attention. As shown in Figure 3.5.1, besides arrows indicating exit locations, we also placed arrows with item silhouettes in areas requiring special abilities. In *Dead Cells* (Motion Twin, Playdigious, 2018), as depicted in Figure 3.5.2, arrows were also used to guide players to the location of doors.

Figure 3.5.1

We use different arrows to indicate exits and places to use abilities.

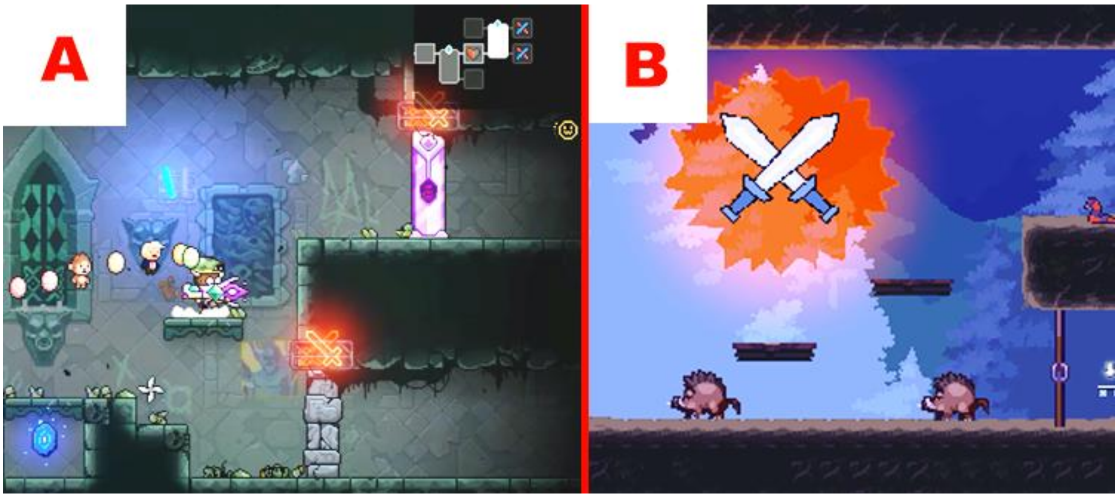
Figure 3.5.2

The arrow above the door hints at the player.

In rooms where all monsters must be defeated to open the door, we utilized a sign similar to the challenge room markers in *Neon Abyss* (Team17, 2020), as shown in Figure 3.5.3-A, to indicate to players that progress requires combat, as depicted in Figure 3.5.3-B.

Figure 3.5.3

We use a similar visual cue pattern to indicate to the player that fighting is required in this room.



3.5 Participants

This study invited a total of 45 participants, approximately 50% of whom were students from the game design program. The control group had 10 participants, the subtle cue group had 10 participants, the emphasized cue group had 11 participants, and the integrated cue group had 14 participants. The number of participants is not related to the groups; we randomly assigned them to each group, ensuring that the workload among our researchers was roughly equal.

3.6 Procedures

80% of the tests took place in classrooms at Uppsala University Campus Gotland. 15% of the tests were conducted in an office in Uppsala. The tests were conducted individually, with only one member observing, recording, and interviewing one participant each time, each participant played only one of the versions. The remaining 5% of the tests were conducted online, where we used Discord (Version 10.0.19045; Discord Inc., 2015) and OBS to record the participants' game screens.

We welcomed each participant and clarified the purpose and procedures of the study to them through a participant information sheet (without providing too many details). After obtaining their consent, we proceeded to explain the game controls. We used laptops for the gaming session, offering two control options: gamepad or keyboard, based on participants' preferences. The control options were available for participants to review at any time on the game's pause menu (see Appendix C). Next, we used OBS to record the session. We made efforts to ensure a quiet environment during playtesting to prevent participant distraction and ensure recording quality.

Then, the participants began the game without any time limits. We never mention timing the play session to the participants to prevent them from opting for a speedrun. Upon reaching the endpoint, a gratitude message was displayed on the game screen. Following gameplay, participants completed a survey questionnaire independently. Subsequently, a cued recall debrief, and a semi-structured interview were conducted. We provided participants with screenshots of each room in the game and let them browse freely, aiding their recollection of challenges and experiences during gameplay. Participants described their gaming experiences, discussing both positive and negative aspects, and elaborated on their progression in the game. We also posed clarifying and supplementary questions based on participants' responses and in-game performance. Finally, we thank them for their participation. This sequence: playtesting, survey, and then interviews aimed to progressively gather more detailed insights into players' interactions and responses to the gaming environment.

4 Results and Discussion

The purpose of this study is to understand how visual cues enhance player navigation. To achieve this goal, we created a non-linear game level in the style of Metroidvania as a control group and introduced subtle cues, emphasized cues, and integrated cues to produce three new versions, totaling four versions. Then, a between-subjects Design method game testing was conducted, during which participants were asked to provide verbal reports during gameplay. Following the game testing, participants completed a survey aimed at investigating their gaming habits and preferences, and underwent cued recall debriefs and semi-structured interviews.

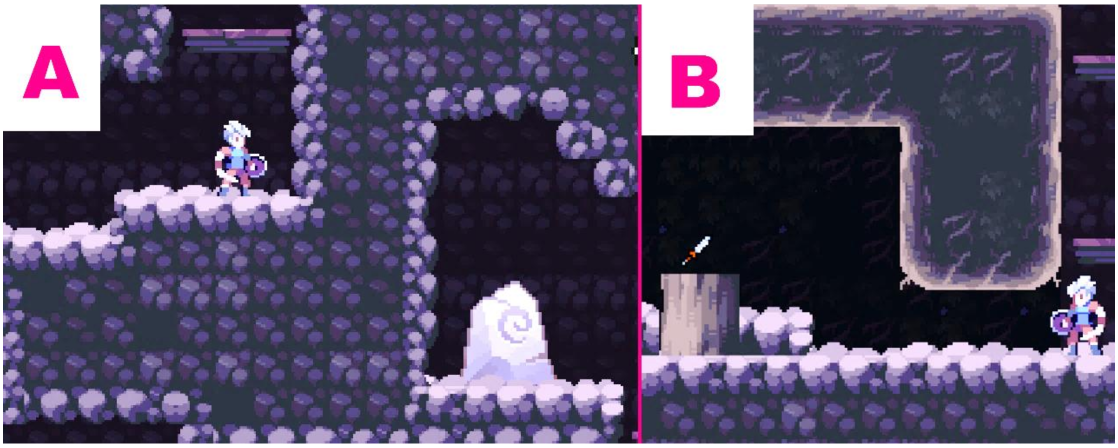
To better address our research question, we decomposed it into two sub-questions: Sub-question 1: How do different visual cues affect the amount of time players take to finish the game? This question was quantitatively analyzed and answered by replaying and calculating participants' completion time from gameplay videos. Sub-question 2: How do different visual cues influence players' decisions on when and where to go? We answered this question through cue recall debriefs and semi-structured interviews for qualitative analysis.

4.1 Result of the Control Group

While testing the game version without any visual cues, we invited a total of 10 participants. Compared to testing with the other three versions, where completion rates were similar, participants took significantly longer to complete the game, with an average time of 23 minutes and 26 seconds. Through video replays, we found that due to the absence of a map system and guidance in the game, when participants verbally expressed not knowing what to do next, 90% of them resorted to a wide range search, repeatedly exploring rooms they had previously experienced. Among these, 60% of participants utilized special items within rooms, checkpoints, or unique terrain features to remember certain rooms, thereby reducing some of the backtracking time. In the two rooms depicted in Figure 4.1.1, room 4.1.1-B left a deep impression on the participants because it involved terrain features requiring sliding upgrades and special items. 60% of participants returned to this room after obtaining the sliding upgrade to acquire the item. Participant A reported that the checkpoint in room 4.1.1-A assured her that she had explored this room before, thus avoiding backtracking.

Figure 4.1.1.

Three factors that help participants memorize the room



In the cued recall debrief and interviews, we asked participants to select the rooms they found easiest and most challenging to navigate and provide reasons for their choices. Five participants identified room 2 as the easiest, as shown in Figure 4.1.2, citing the staircase inside the room as a memorable landmark and the clear objective. All participants prioritized climbing the stairs upon entering room 2 to reach the upper room rather than moving to the room on the right. Three participants chose room 8. The level design of this room, as depicted in Figure 4.1.3, also featured special terrain and a relatively linear exploration process. Participants entered the room from the upper left corner and could only exit from the lower left corner after acquiring the sliding upgrade from room 9 on the right. Therefore, when analyzing the results of the tests for the other three groups, we need to consider whether it was the special terrain that aided participants' navigation rather than visual cues improving their navigation.

Figure 4.1.2

The layout of room 2, participants tend to go upstairs.

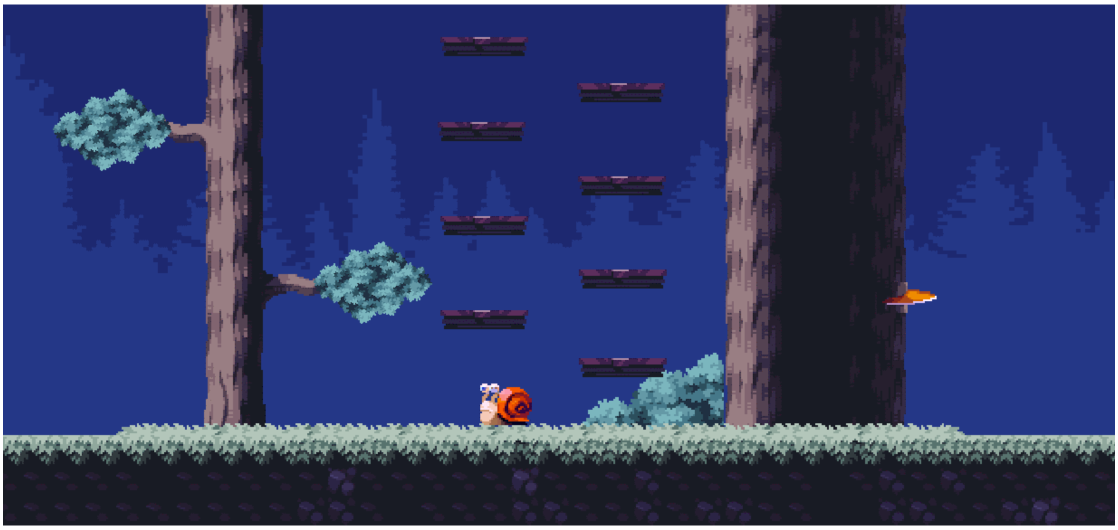
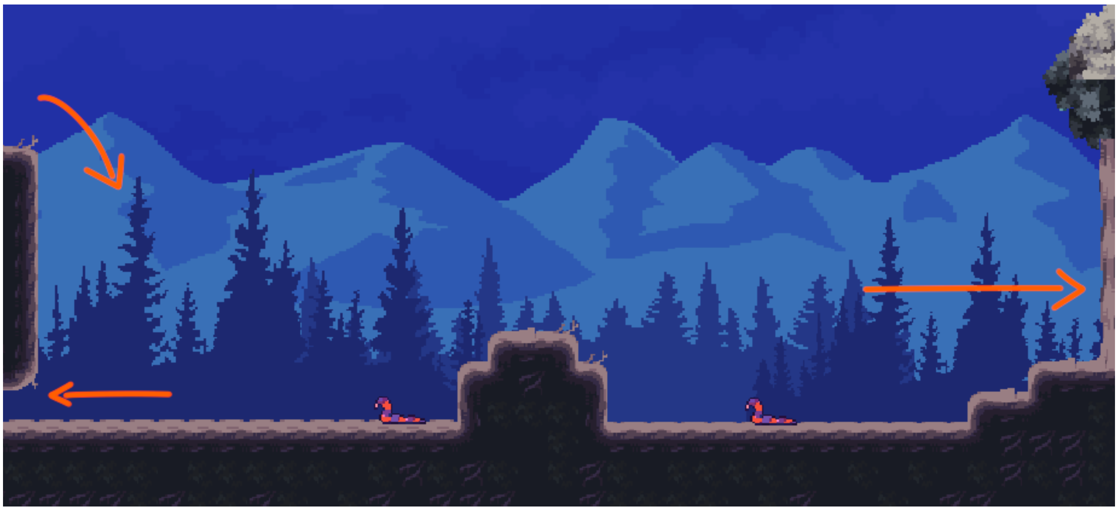


Figure 4.1.3

The layout of room 8, the explore process is relatively linear.



As for the most challenging room, four participants selected room 19, citing the fact that they could not find the room at all. In this case, we believe the issue lies with the adjacent room 18, as shown in Figure 4.1.4, which has a symmetrical design. Similarly, room 15 also utilizes a symmetrical design. Three participants identified room 15 as the most challenging in terms of navigation. Participants cited the room's multiple exits and symmetrical layout as reasons for difficulty, as they were unsure which exit to take. Once they randomly chose an exit, they easily forgot about the other exits.

Figure 4.1.4

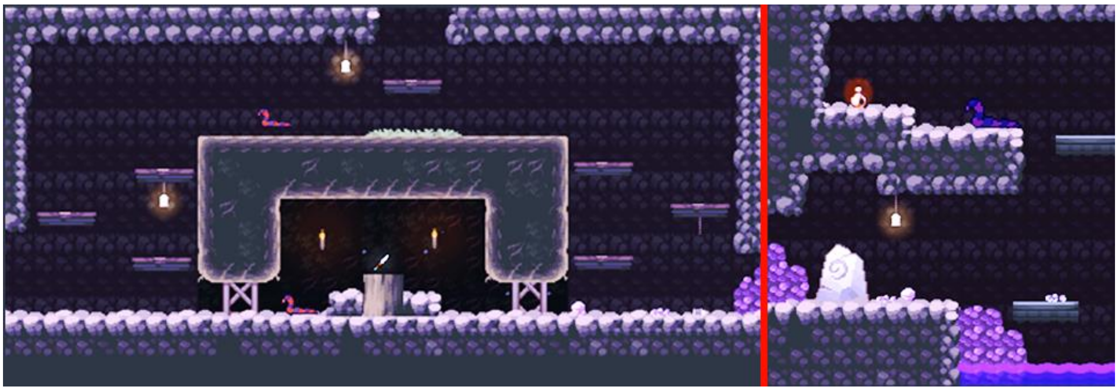
The layout of room 18, features multiple exits and symmetrical design.

4.2 Result of the Subtle Cue Group

This group of tests involved a total of 10 participants. Compared to the control group without visual cues, participants in the subtle cue group completed the game in an average time of 17 minutes and 14 seconds, which is approximately 26.45% faster than the control group. Through replaying participants' recordings, we found that the effect of subtle cues primarily manifested in increasing the recognition of rooms and better connecting adjacent rooms, thereby assisting players in memorizing the relationships between rooms and reducing the frequency and duration of participants backtracking. For example, in Figure 4.2.1, a purple block extending from room 16 on the right was added to the originally symmetrical room 15, prompting participants to prioritize exploring the exit on the right side of room 15 and leaving a deeper impression.

Figure 4.2.1

The purple block extending from room 16 (right image) prompts participants to exit from the right exit of room 15 (left image) first.



From the cued recall debrief and interviews, we noticed that a drawback of subtle cues is that some visual cues are too subtle. In some rooms, certain decorations blend in with the visual cues, causing participants to sometimes struggle to distinguish between the two. As a result, they are unsure whether to follow these cues. For example, participant B1 expressed uncertainty during the interview:

> Although I initially saw it [the fence] on the left side in the first area [room 1], I thought it was just a decoration. (...) When I couldn't find the (upgrade for) double jump, I tried going left and realized I could actually access its [room 1] left side.

And three participants interpreted the save points as a form of visual cue. Among them, two participants prioritized choosing the exit closest to the save point, while the third experienced participant B2 in the game expressed:

> Check points feel like cues, I feel like I was in a right direction or game was telling I'm on a right direction. (...) In room 7, the check points want me to go to left, so I go to right instead as I want to find the secret.

Two participants resorted to extensive searching in the rooms due to their inability to find the double jump upgrade item. During interviews, they both mentioned only noticing the room's lighting, but they perceived it merely as part of the room’s decoration. One of them only realized the attempt of the lighting to guide players towards a particular exit when they saw the overall level design of the room during the cued recall debrief.

In rooms 9 and 19, subtle cues did not assist players in understanding their current tasks. In room 9, the door needed to be unlocked by defeating all the monsters, as depicted in Figure 4.2.2-A. Although the locked room’s lighting did attract participants' attention, it led them to make incorrect inferences on how to open the door, such as attempting to break it or standing in front of it and pressing the confirmation key. In room 19, players needed to pick up a key to unlock the door, as shown in Figure 4.2.2-B. Despite adding a glowing effect to the key, participants found it challenging to notice the faint light in the bottom left corner of the screen due to the key’s small size and the limited size of viewport. Consequently, they attempted to open the door through attacking methods. During interviews, participants suggested that adding a keyhole to the door in room 19 might help them make better inferences and navigation decisions.

Figure 4.2.2

Room 9 (A) requires players to defeat all monsters to unlock the door, while the door in Room 19 (B) needs players to pick up a key to open it.

4.3 Result of the Emphasized Cue Group

Emphasized cues effectively draw players' attention to specific objects and locations, clarifying which objects they can interact with or where they can go. For example, participant C1, upon exiting Room 20 and entering Room 1, initially intended to leave from the right side. However, she instantly noticed the light on the left side, as shown in Figure 4.3.1, and proceeded towards the left, consequently acquiring the double jump upgrade.

> I wasn't sure if I was supposed to go that way [the right exit], but then I thought, wait, there's a light over there [on the left side]. Maybe I can go that way. (...) It feels like the natural inclination is to go right. Maybe it's just me, or maybe it's the way the game is designed, but I tend to go in that direction [towards the right side]. (...)But you know, it's fun to explore the other way [the left side]. [And then] I got the double jump.

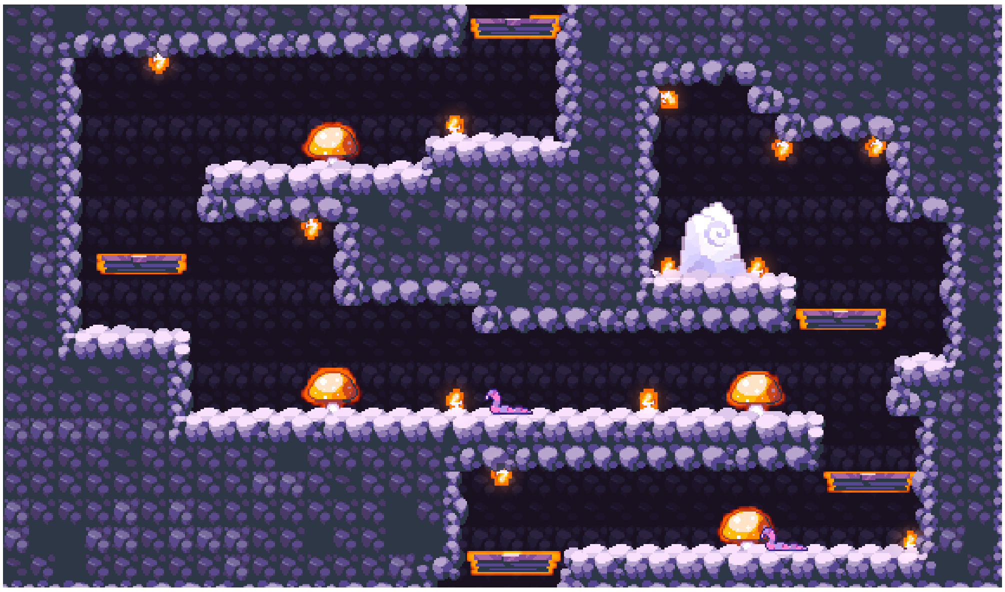
Figure 4.3.1

Participants noticed the light on the left side and proceeded towards the left.

However, in some rooms, emphasized cues also lead participants to mistakenly believe that they are interactable or collectible. For instance, in room 14, as shown in Figure 4.3.2, almost every participant believed that the mushrooms could be interacted with. Consequently, they attempted to pick up or attack the mushrooms, trying to obtain something.

Figure 4.3.2

Mushrooms make participants believe they are interactable. And overuse of emphasized cues make the scene cluttered.



Similarly, in this room, we made a mistake in the use of visual cues: an excessive emphasis on visual cues made the scene cluttered, diminishing the prominence of key elements. Moreover, since this room follows a linear progression, visual cues become redundant. This issue was also highlighted by participant C2:

> In room 14, I feel like visual cues [mushrooms] are not helpful at all. I'm just following the boundaries of the map entirely, and at this point, I think visual cues are no longer necessary.

In contrast, emphasized cues in Room 5 perform better. As shown in Figure 4.3.3, the lights in the overall dark environment stand out prominently, quickly drawing participants' attention to the slide passage. Participant C3 also noted that these lights serve as a cue indicating potential danger ahead.

> I've been keeping an eye on this skull [the signboard on the left], along with these two lights, because I feel they're hinting at something ahead. (...) These two [the lights] are good clues, even though I'm not sure what these lights specifically indicate, but I sense there's something up ahead, not just a feeling of danger.

Figure 4.3.3

The signboard with a skull emblem and the lights beneath the slide passage effectively guide the participants.

4.4 Result of the Integrated Cue Group

Integrated cues can directly convey the designer's intentions, allowing participants to quickly understand their current tasks (Dillman et al., 2018). For example, in Room 19 shown in Figure 4.4.1-A, participants quickly noticed the arrow pointing to the key and obtained the potion, without trying to break the door or interact with it as participants in other versions did. In contrast, Room 9 shown in Figure 4.4.1-B is a room where all monsters must be killed to open the door. Participants also understood that they needed to fight in this room. However, due to the large and strongly illuminated cue, two participants misinterpreted the task in the room. Participant D1 noted:

> At least when I see two swords or like a really big red, (...) I thought it was more of a boss fight than the room clear kind of thing.

They initially mistook it for an upcoming boss fight and reported verbally that they were not prepared. However, once they saw the monsters in the room, they understood that they needed to kill these monsters.

Figure 4.4.1

In room 19 (A), participants noticed the arrows above the key quickly. In Room 9 (B), participants had to defeat all monsters to unlock the door.

In addition, arrows at the edges of the rooms clearly indicated the exits to the participants. We also placed arrows in the corresponding colors of the required items where special abilities were needed, as shown in Figure 4.4.2. Consequently, participants adopted a navigation strategy of following the arrows. This group had the shortest average completion time among the four groups. However, two Metroidvania enthusiasts in this group did not appreciate the simplicity and directness of these cues. Participant D2 noted:

> I actually don’t think it’s necessary to give me hints in these places [Shown in Figure 4.4.2]. If I jump up there myself, I’ll know I can’t reach it yet. Although I understand that the arrow tells me I need an item and it saves me time, so I just left immediately after seeing it, I would rather discover these things on my own.

Figure 4.4.2

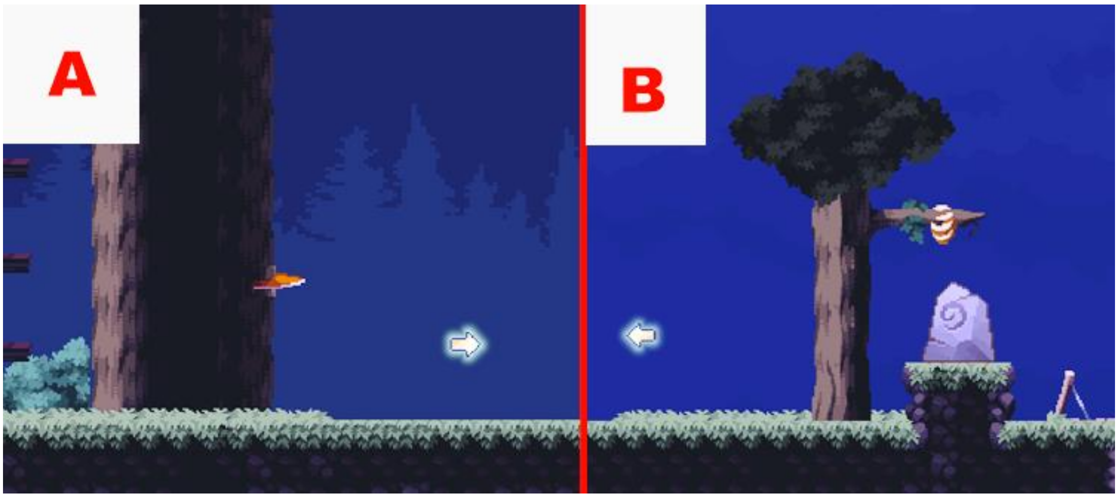
Yellow arrows point out the exit of the room, green arrow tells participants to use double jump here.

Participant D3 had a similar commented:

These arrows are definitely very obvious and do their job. But I would prefer some hints integrated into the environment, (...) like mushrooms [shown in Figure 4.4.3-A] guiding me to the right, or a branch or hive [shown in Figure 4.4.3-B] pointing to the left. For now, I feel like I’m being treated like a baby who needs care.

Figure 4.4.3

Participant D3 prefers to set subtle cues in the scene.



4.5 Discussion

According to the definition, Metroidvania is characterized by extensive map layouts, guided non-linear level and utility-gated exploration and progression (Cook et al., 2012). Due to the vast and non-linear exploration of levels, players often encounter backtracking (Oliveira et al., 2020). As backtracking constitutes a navigation task, which relies on visual cues (Barbosa, 2017), it becomes crucial to understand how visual cues address challenges in games resembling Metroidvania.

However, there is a scarcity of research concerning how visual cues improve navigation in Metroidvania. This study aims to address this gap. In this section, we will compare the test results of the four groups and discuss the primary findings.

4.5.1 SQ1: Effect of Visual Cues on Completion Time

As shown in Figure 4.5.1, the average completion rates of the four groups differ by no more than 5%. This indicates that the margin of error due to participants' preferences for exploration versus speed running is minimal. This means we can more reliably compare the completion times between different groups because the similar map completion rates suggest that the participants in each group explored the game to a similar extent.

To address Sub-question 1: How do different visual cues affect the amount of time required for a player to finish the game? We can compare the completion times of the four groups, as shown in Figure 4.5.2.

Figure 4.5.1

Comparison of average completion rates among four groups.

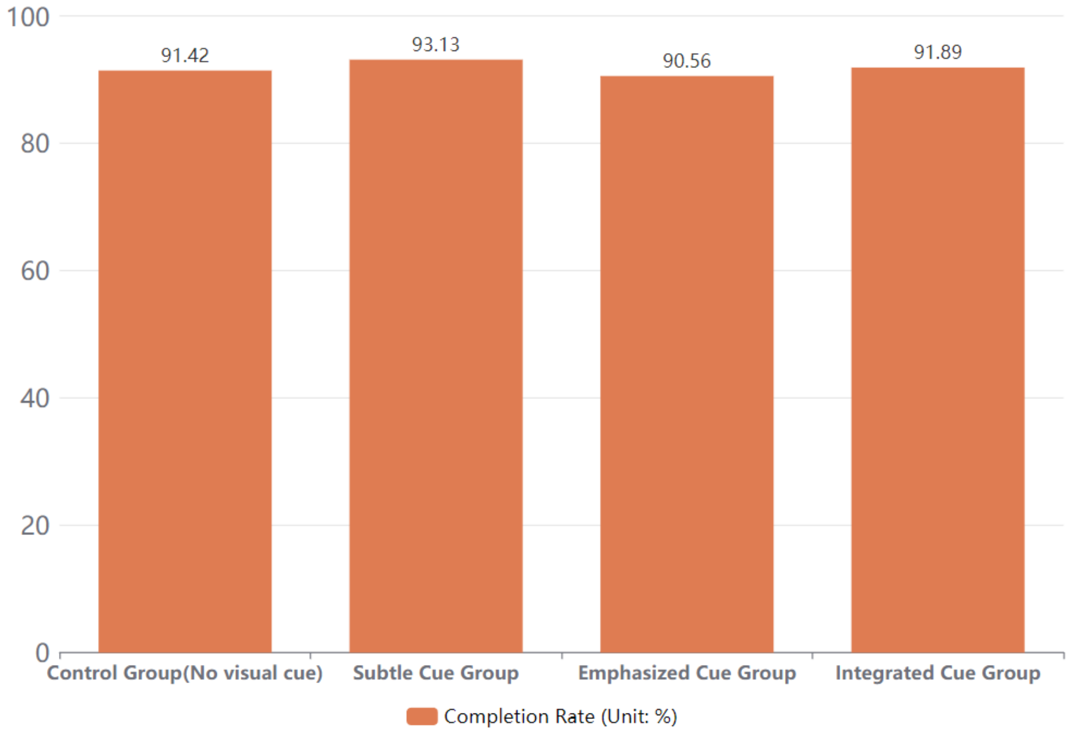
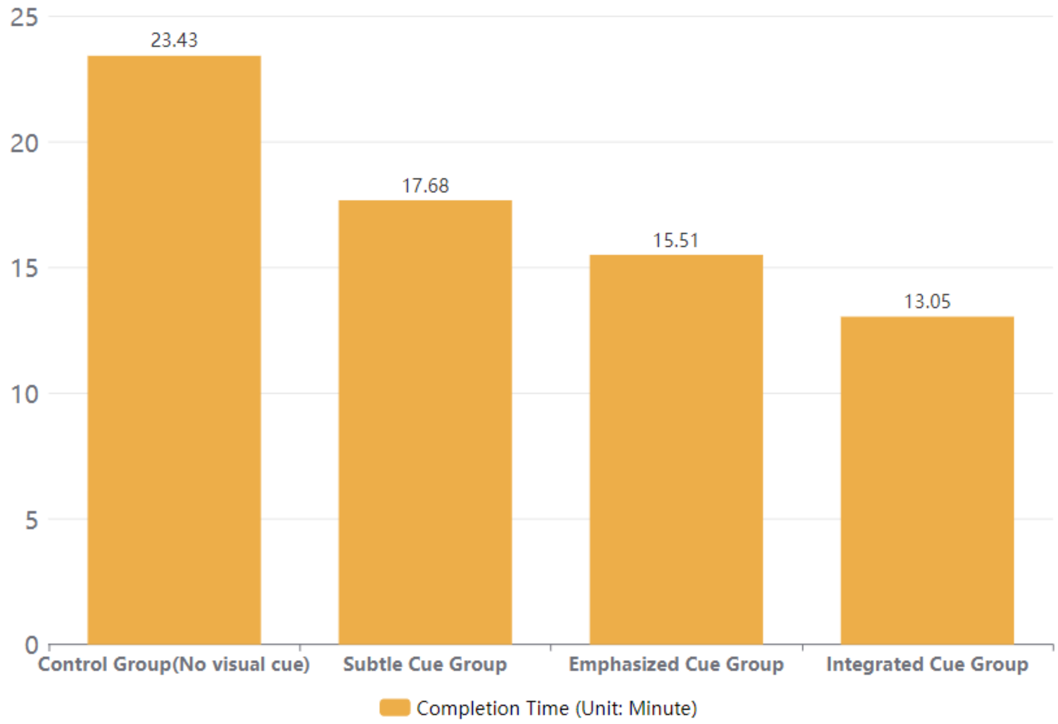


Figure 4.5.2

Comparison of average completion time among four groups.



First, the control group had an average completion time of 23.43 minutes. This group serves as the baseline for comparison since it did not use any visual cues. Participants took significantly longer to complete the game, because they often got lost or had to backtrack due to the lack of navigation. They frequently relied on extensive searching and used checkpoints and unique terrain features to help remember rooms.

The subtle cue group had an average completion time of 17.68 minutes. Introducing subtle visual cues reduced the average completion time by approximately 26.45% compared to the Control Group. These cues helped participants better recognize and connect rooms, thereby reducing backtracking. However, some visual cues were too subtle, leading to occasional confusion and uncertainty among participants.

In the emphasized cue group, participants had an average completion time of 15.51 minutes. Completion time was further reduced, approximately 12.27% faster than the subtle cue group and 33.82% faster than the control group. Emphasized cues were more noticeable and effective in guiding participants to specific objects and locations. Although there were instances where participants mistook non-interactable objects for interactable ones and excessive cues made some scenes cluttered, these cues were prominent enough to be quickly recognized, making navigation more efficient than in the subtle cue group.

The integrated cue group had the shortest average completion time of 13.05 minutes, which is 44.30% faster than the control group. This is because integrated cues provided clear guidance, allowing participants to quickly understand their tasks and navigate efficiently.

There is a clear trend indicating that more explicit visual cues lead to faster completion times. From no cues (control group) to subtle cues, to emphasized cues, to integrated cues, each increase in the level of markedness resulted in progressively shorter average completion times.

4.5.2 SQ2: Impact of Visual Cues on Navigation Decisions

In the control group, without any visual cues, participants often expressed confusion about what to do next. This uncertainty led 90% of them to engage in extensive searching, repeatedly exploring rooms they had already visited. Participants used special items, checkpoints, or unique terrain features to remember certain rooms, thereby reducing some backtracking time. However, they still relied heavily on trial and error, leading to inefficiencies in navigation.

Subtle cues primarily help in enhancing room recognition and forming better connections between adjacent rooms. This assistance reduces the frequency and duration of backtracking. Players experienced in Metroidvania or similar games tend to prefer subtle cues. As participants D2 and D3 mentioned, they do not like being treated like babies who need care; instead, they enjoy the fun of exploration and trial and error. These players are also more likely to pick up on subtle cues but might tend to go against the visual cues because they want to prioritize exploring treasures hidden off the main path.

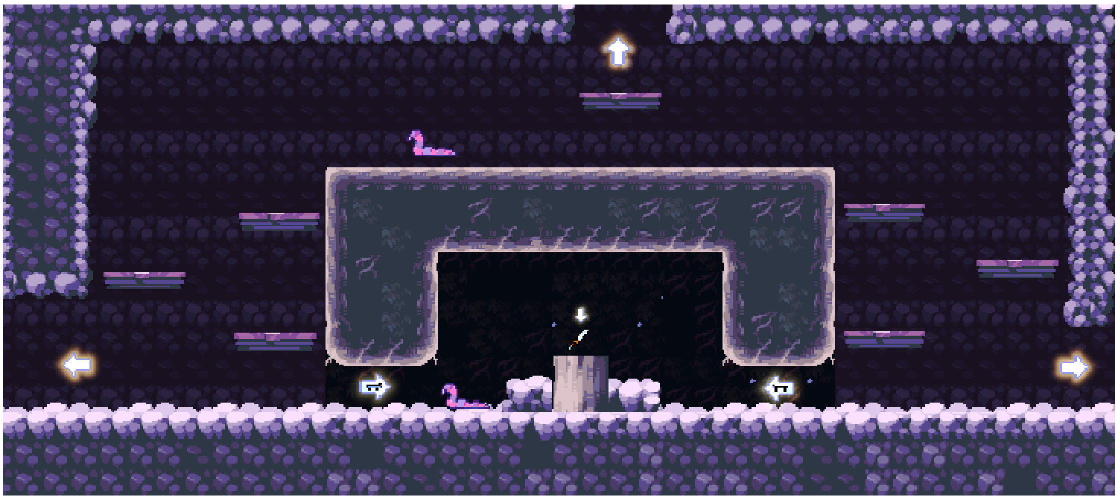
When participants find subtle cues too vague or are uncertain if they are cues, it can lead to confusion and hesitation about whether to follow them. In such cases, participants' strategies are influenced by their preferences or habits. For instance, participant B1 would try to verify their guesses, while some participants would choose to ignore the cues and go towards other more obvious exits. For example, participant B3 never entered room 12 through the left exit of room 1 throughout the game. Instead, he obtained the double jump upgrade by falling from the broken bridge in room 11 into room 12.

Emphasized cues are more noticeable and effectively draw participants' attention to specific objects and locations. This clear guidance helps participants make quicker decisions about where to go and what to interact with. However, the unreasonable use or overuse of emphasized cues in some rooms can sometimes lead participants to mistakenly believe that non-interactable objects are interactable, even causing them to lose focus. This conclusion is consistent with Barbosa's (2017) study, which indicated that too many cues resulted in players avoiding the cues or losing interest in the game. Despite this, overall navigation efficiency is higher compared to the subtle cue group, as participants can more quickly and confidently identify their objectives.

Integrated cues provide clear and direct guidance, allowing participants to quickly understand their current tasks and navigate the game world effectively. Arrows at key points and color-coded indicators minimize confusion and misdirection. Participants in this group tended to follow the cues closely, which significantly simplified their navigation process. However, this also led to participants overly relying on arrows for guidance rather than exploring on their own. For example, participant D4 stayed in room 15 for only 4 seconds (shown in Figure 4.6.1), just following the yellow arrow, entering the room, and then leaving it. Despite the item's position and corresponding cues being obvious, he still missed the item and never returned to the area. Additionally, some experienced participants felt that these cues were too direct, diminishing their sense of exploration and discovery.

Figure 4.6.1

Although the sword and blue arrows are obvious, participant D4 missed the item.



5 Conclusion

In conclusion, the aim of this paper was to investigate "How visual cues can enhance player navigation in level design resembling Metroidvania-style games?" With between-group design, we created a prototype of a nonlinear level game that highlights the characteristics of games resembling Metroidvania, and based on this, we created three variant versions incorporating three different levels of markedness of visual cues. We gradually collected participants' reactions to visual cues and navigation strategies through think-aloud protocols, observations, questionnaires, cued recall debriefs, and semi-structured interviews.

By comparing the average completion times of participants in the four groups, we found that Integrated cues provided the clearest guidance for players, enabling them to quickly understand their tasks and navigate effectively. Regarding how visual cues improve player navigation in games resembling Metroidvania, according to our findings, subtle cues are more conducive to maintaining a sense of discovery, emphasized cues can be used to highlight certain items or secrets, and integrated cues can be used for key points to avoid excessive backtracking.

In terms of player experience, although integrated cues were most effective in reducing completion time, some participants found them too direct, especially those who enjoy exploration and discovery in games resembling Metroidvania. This indicates a need to balance efficiency and player experience. The study by Boer Rookhuiszen and Theune (2009) suggests that sometimes “overly effective” cues can disrupt gameplay because users might avoid exploration, thereby missing important items or information in space. This finding calls for more research on how to “properly guide” players based on more realistic game tasks rather than focusing solely on “effective cues” in more mundane environments. Therefore, when improving navigation in games resembling Metroidvania, we should not only focus on navigation efficiency but also consider player experience. Thus, a combination of different types of cues may be a better solution. Game designers should balance the use of visual cues in level design to find a balance between excellent navigation efficiency and good player experience. However, we did not have additional time to create and test a game version mixing the three levels of markedness of visual cues for a more rigorous validation.

Additionally, visual cues could be used for purposes other than go cues or not be shown all the time, which we did not attempt to explore. During the game development process, there were many visual cue patterns we wanted to practice that could not be consistent with other visual cues in these two dimensions, and we needed to control variables, so we could not attempt them. Future research on this topic could continue to rely on this theoretical framework and testing process to test other dimensions of visual cues, to better contribute to Metroidvania genre.

6 References

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Appendix A: Questionaries

A.1 Player Demographic Survey

1.What's your name/preferred name?

2. I consider myself:

○ A novice video game player

○ An occasional video game player

○ A frequent video game player

○ An experienced video game player

3. What platform do you use to play video games? (please select all that apply)

○ PC

○ Console (PS2/PS3, Xbox, Wii)

○ Portable (Cell phone, DS, PSP)

4. In which platform do you play more frequently?

○ PC

○ Console (PS2/PS3, Xbox, Wii)

○ Portable (Cell phone, DS, PSP)

5. What are your favorite game genres? Please rank them, or specify if you don't have any preference.

○ Action-adventure

○ Fighting

○ Maze

○ Puzzle

○ Racing

○ Role-playing

○ Shooter

○ Simulation

- ○ Sports
- ○ Strategy

6. Could you cite two or three of your favorite games?

7. How do you typically play? (please select all that apply)

- ○ Single player
- ○ Multiplayer

8. When you start playing a new game, do you appreciate hints and tutorials?

- ○ Yes
- ○ No

9. Do you normally feel overwhelmed by the challenges during the first couple of hours of playtime with a new game?

- ○ Yes
- ○ No

10. During an average week, how many hours do you spend playing video games? (days/week * hours/session = hours/week)

A.2 Interview Questions

1. Which three rooms do you think are the easiest in terms of pathfinding?

2. Could you explain why you think they are easier in terms of pathfinding?

3. Which three rooms do you think are the most difficult in terms of pathfinding?

4. Could you explain why you think they are harder in terms of pathfinding?

5. What specific challenges did you encounter in the game? Please share your experience overcoming these challenges.

6. How did you navigate and understand the game world?

7. Did you notice any form of visual cues or guidance in the game? If so, how did you utilize these cues to navigate and understand the game world?

8. Compared to other Metroidvania titled games, how do you rate the navigation and comprehensibility of this game?

9. If you had the opportunity to add or change something in the level you think is hard to navigate, what would it be?

Appendix B: Example of Images used in Cued Recall Debrief

B.1 Non-visual cues version (control group)

Figure B.1.1

A screenshot of the layout of room 4 in non-visual cues version.

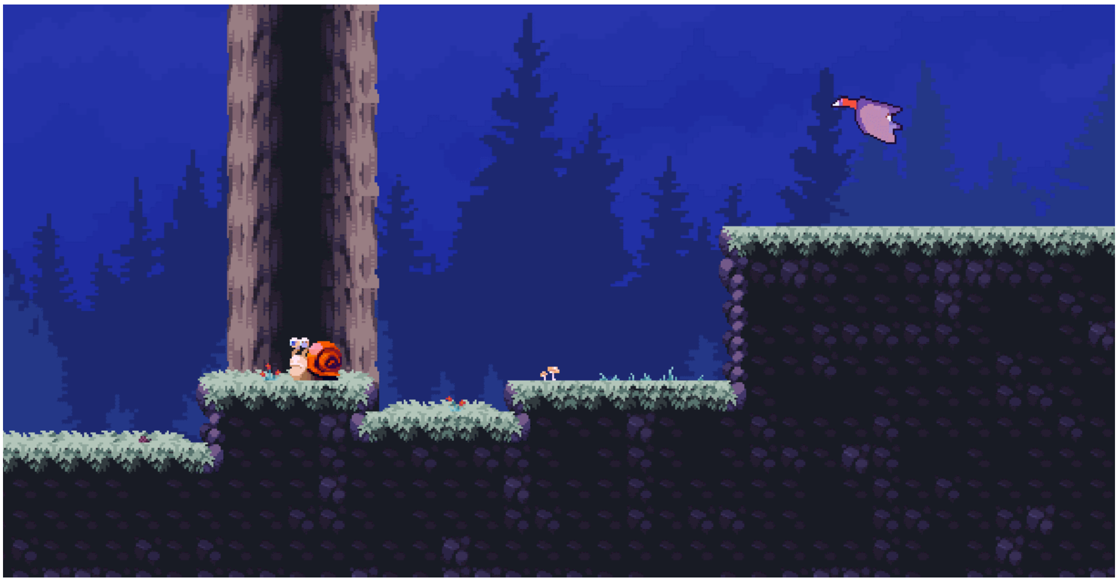


Figure B.1.2

A screenshot of the layout of room 7 in non-visual cues version.

Figure B.1.3

A screenshot of the layout of room 9 in non-visual cues version.

B.2 Subtle cue version

Figure B.2.1

A screenshot of the layout of room 20 in subtle cues version.

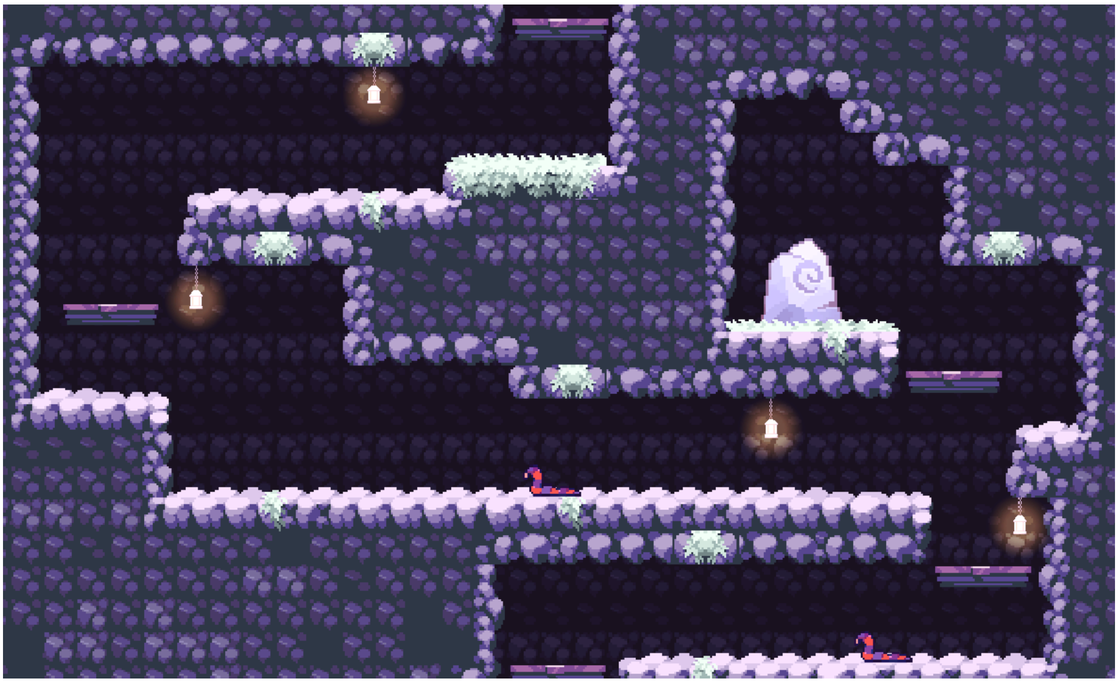


Figure B.2.2

A screenshot of the layout of room 16 in subtle cues version.

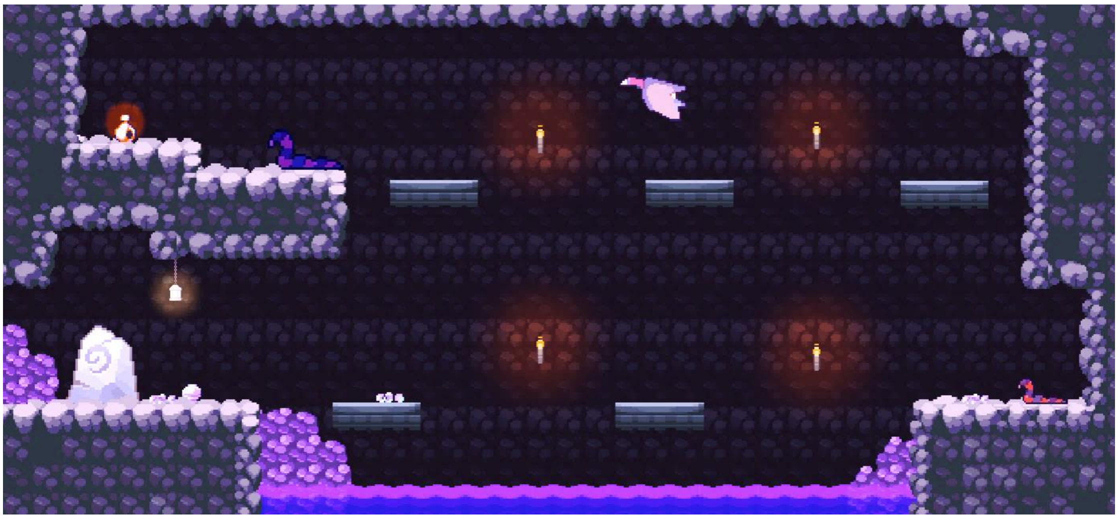
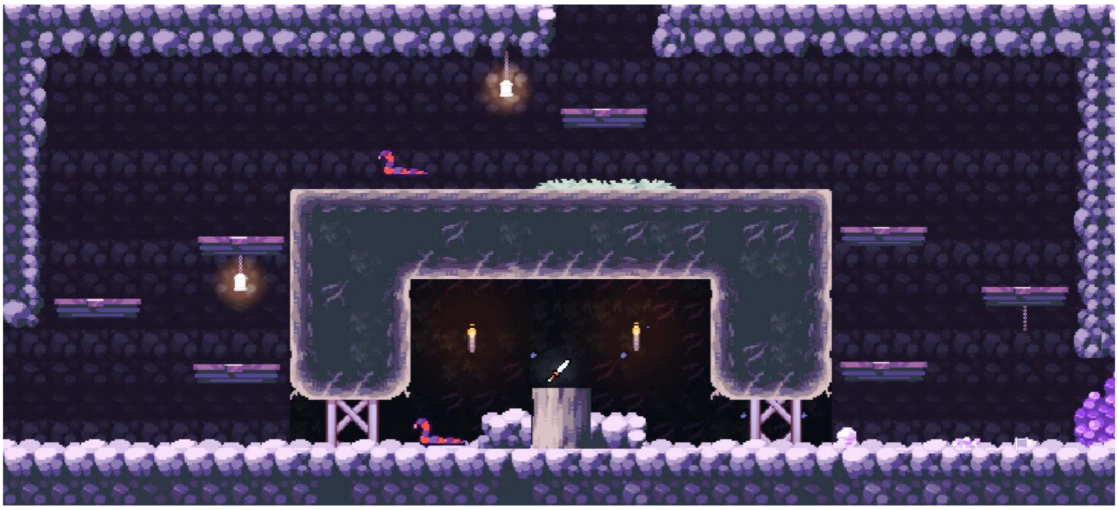


Figure B.2.3

A screenshot of the layout of room 15 in subtle cues version.



B.3 Emphasized cue version

Figure B.3.1

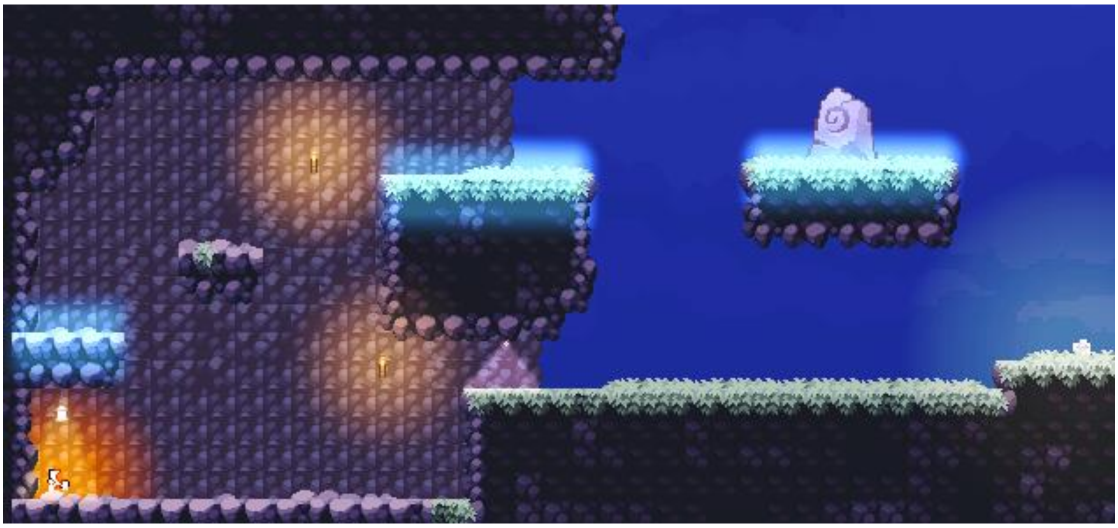
A screenshot of the layout of room 3 in emphasized cues version.

Figure B.3.2

A screenshot of the layout of room 5 in emphasized cues version.

Figure B.3.3

A screenshot of the layout of room 13 in emphasized cues version.



B.4 Integrated cue version

Figure B.4.1

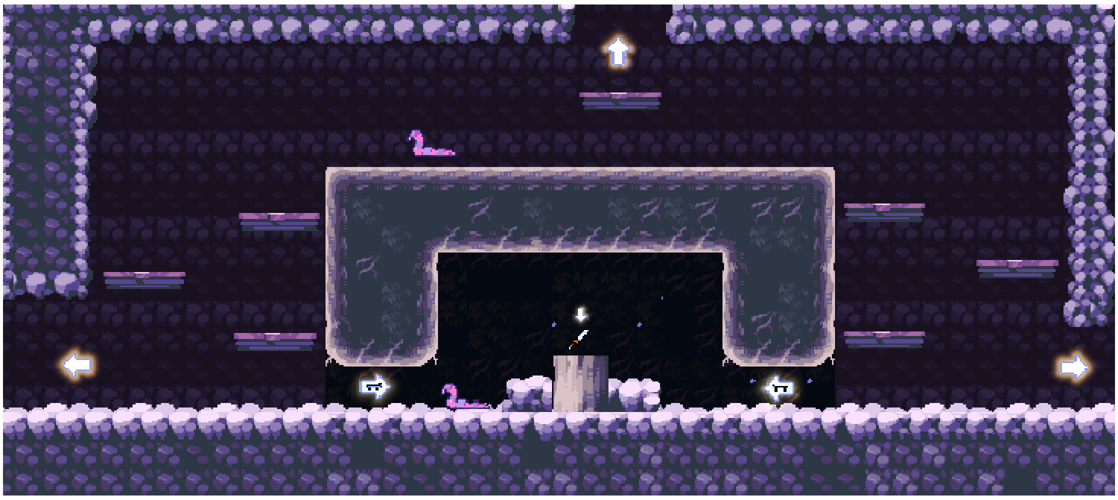
A screenshot of the layout of room 4 in integrated cues version.

Figure B.4.2

A screenshot of the layout of room 12 in integrated cues version.

Figure B.4.3

A screenshot of the layout of room 15 in integrated cues version.



Appendix C: Control Scheme

Figure C.1

The keyboard control scheme.

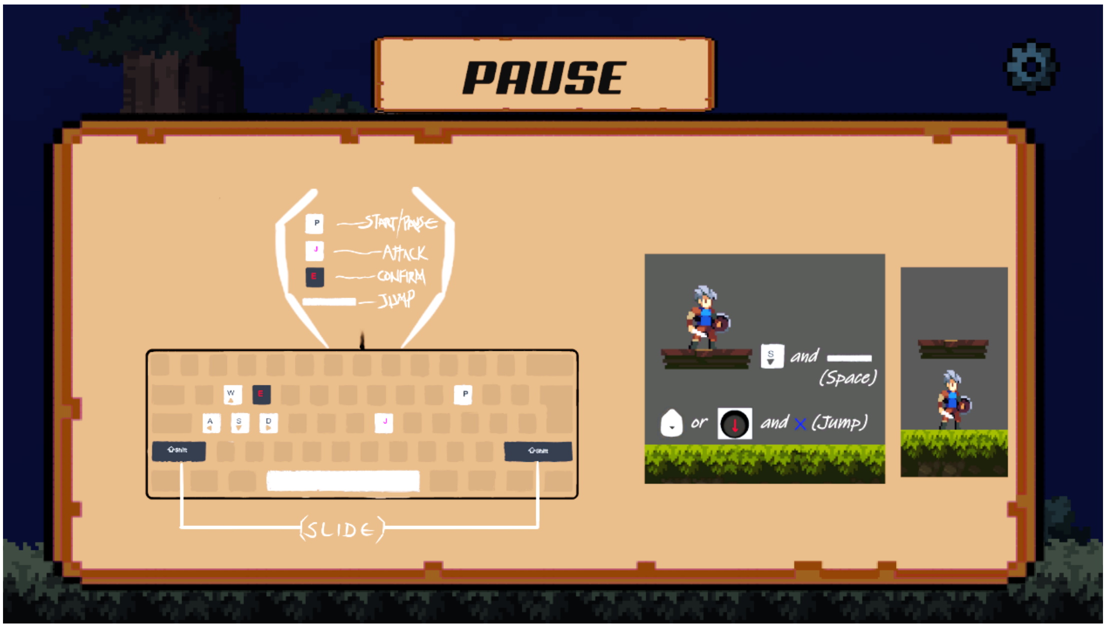


Figure C.2

The controller control scheme.